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ERRATA

Page 12	line 9	for	'*europea*'	read	'*europaea*'
54	31	,,	'*gramineum*'	,,	'*graminum*'
54	45	,,	'*Cyclogonium*'	,,	'*Cycloconium*'
61	49	,,	'*muranium*'	,,	'*murinum*'
75	16	,,	'*Ersiphe*'	,,	'*Erysiphe*'
95	lines 1 and 4	,,	'*sempervivens*'	,,	'*sempervirens*'
96	line 42	,,	'*Cytosporina*'	,,	'*Cytospora*'
109	30	,,	'*kopkii*'	,,	'*kopkei*'
122	48	,,	'*chromatosporum*'	,,	'*chomatosporum*'
156	15	,,	'*Hemeleia*'	,,	'*Hemileia*'
159	13	,,	'*gramineum*'	,,	'*graminum*'
208	39	,,	'*catharticus*'	,,	'*cathartica*'
212	29	,,	'*gramineum*'	,,	'*graminum*'
220	22	,,	'*fructigena*'	,,	'*cinerea*'
243	34	,,	'*Leontodontis*'	,,	'*Leontodon*'
322	41	,,	'*Tillettia*'	,,	'*Tilletia*'
334	24	,,	'Tisdale (W. T.)'	,,	'Tisdale (W. H.)'
356	27	delete 'of'			
357	44	for	'*atropurpurem*'	,,	'*atropurpureum*'
361	2	,,	'rot'	,,	'rust'
416	14	,,	'*Cercosporella*'	,,	'*Cercospora*'
471	20	,,	'*Reichanst*'	,,	'*Reichsanst*'
497	45	,,	'*gramineum*'	,,	'*graminum*'
532	4	,,	'*fimbriata*'	,,	'*fimbriatum*'
571	12	,,	'Obliteration'	,,	'Lignification'
578	40	,,	'288'	,,	'88'
586	29	,,	'*Hyalospora*'	,,	'*Hyalopsora*'

IMPERIAL BUREAU OF MYCOLOGY

REVIEW

OF

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Spierenburg (Dina). **Een onbekende ziekte in de Iepen. II.** [An unknown disease of Elms. II.]—*Versl. en Meded. Plantenziektenkundigen Dienst te Wageninen*, 24, 31 pp., 1 fig., 4 pl., 1922.

The unknown disease of elms, which caused so much damage in Holland in 1920 [see this *Review*, i, 8, p. 277], continued its ravages in 1921. The districts mainly affected were Brabant, the Betuwe and various localities in the south, Rotterdam and its environs (where the disease was extremely prevalent and severe), Alkmaar, and Amsterdam. Sporadic cases were reported from the north-eastern provinces, where the infection appears to be in an incipient stage. Attacks are also reported from France [see this *Review*, i, 10, p. 334] and Belgium. According to official German statements, elms in Germany are not affected, but Dutch visitors to the Rhine districts believe that the disease is also present in that area. It has not, however, actually been seen in any foreign country by the officials attached to the Dutch Phytopathological Service.

The following are the principal varieties attacked: *Ulmus campestris latifolia*, *U. monumentalis*, *U. hollandica*, *U. rupelli*, *U. campestris suberosa*, *U. americana*, and *U. campestris aurea*. *U. vegeta* appears to be immune, but this variety is not adapted to street planting.

Affected trees may be divided into three groups according to the symptoms manifested: (*a*) Comparatively young trees in which the withering of the top leaves quickly spreads downwards, forming a sharp contrast to the green leaves of the lowest branches. This form of the disease appears to be fatal. (*b*) Large, old trees in which one of the branches suddenly withers, to be followed within a few weeks by others and then by the top. (*c*) Chiefly old trees which appear to be more or less permanently affected. The leaves emerge slowly in the spring and remain small. They turn colour prematurely, dry up about the middle of July, and fall early. Throughout the summer the foliage is scanty.

Trees, especially old ones, may show wilting of the shoots early in the year, and later burst into new foliage which, however, rapidly withers. Such trees rarely recover. So-called water-shoots may often be seen on the trunk.

Severely affected trees as a rule develop buds for the following year on their shoots, but the buds are small, and appear dried up. In milder cases, flower buds are formed as though to continue the species by seed.

Very old trees appear to be more resistant than the younger ones, but this seeming immunity may be due to their larger food reserves and available water-conducting tissue. In 1921 the disease was much more prevalent in nurseries than in the previous year. Usually the youngest trees attacked are not less than four years old, but cases have again been observed in trees one year old.

In addition to the discoloration of the wood already noted [see earlier abstract], a discoloration of the bast in the shoots of young trees has been observed, but not frequently enough to associate this symptom with the disease. Sometimes a brown ring appears between the bast and the wood of the branches which, in such cases, die rapidly. A very thin layer of healthy wood is usually present beyond the last discoloured tissue. The latter does not always extend the whole length of the branch, but it is always present in the top branches of young diseased trees and in the thin branches and roots of old ones.

Microscopical examination showed that the discoloured tissues are plainly recognizable and always occur in the previous year's wood. The medullary rays usually contain large starch grains which, in the affected parts, become brown. Spots are seen in the walls of all the ligneous elements. Tyloses are common in the vessels. The discoloration of the wood is irregular, very dark stripes occurring next to lighter areas.

In the winter of 1921–22 many further cases of attack by *Eccoptogaster scolytus* were noticed. The larvae of flies of undetermined species were also found under the bast. *Typhlocyba* and *Oribata* were of frequent occurrence, whilst *Anthocoptes* sp. were found on 1921 shoots.

The following fungi have been isolated from diseased tissues:— a form with *Cephalosporium* and *Graphium* stages, *Fusarium* sp., *Monilia* sp., *Botrytis* sp. (in 1920 but not 1921), *Dematium* sp., *Ramularia* sp., *Phoma* sp., and also bacteria.

From non-discoloured wood were isolated: *Fusarium* sp., *Cytosporina* sp., and *Dematium pullulans* (?). In spite of the rapid development of the *Cephalosporium* form in culture, the mycelium of this fungus is never visible in the tissues of the discoloured wood.

Inoculations with *Cephalosporium* (with or without the *Graphium* stage) on two and three year old elms produced the discoloration in the wood, and cultures of such wood always yielded the same fungus again. Other fungi also produced discoloration of the wood, but could not be re-isolated. It has not been found possible to decide which organism is responsible for the disease or whether the disease is an infectious one. The writer states that some extreme influence of a more or less general character appears to be predisposing the elms to the attacks of fungi and bacteria which are the immediate cause of the disease.

No control measures can be definitely recommended. Drastic pruning appears to render the trees susceptible to the disease.

HEDGCOCK (G. G.), HAHN (G. G.), & HUNT (N. R.). **Two important Pine cone rusts and their new Cronartial stages.**—*Phytopath.*, xii, 3, pp. 199–122, 2 pl., 1922.

The paper is divided into two parts. The first by Hedgcock and Hahn, is entitled '*Cronartium strobilinum* (Arthur) Hedgc. and Hahn, comb. nov.' This rust has been known in Florida and Mississippi as *Caeoma strobilina* Arth. on *Pinus palustris* and *P. heterophylla*, and frequently exerts a very damaging effect on the reproduction of these pines. Immature, first year cones are infected and swell up, produce pycnidia and aecidia, then usually fall. Artificial inoculations were successful in producing uredosori, sometimes also with teleutosori, on three species of *Castanea* and twenty-five species of *Quercus*. The fungus is fully described.

The second part by Hedgcock and Hunt is entitled '*Cronartium conigenum* (Pat.) Hedgc. and Hunt, comb. nov.' Patouillard described *Caeoma conigenum* from Mexico on cones of an undetermined pine. An examination of portions of the type shows that the fungus is morphologically a *Peridermium*, and the host was probably *Pinus chihuahuana*. The fungus has been found in Arizona on this host, and causes damage to the cones. Inoculation tests were successful on three species of *Castanea* and seventeen species of *Quercus*.

SPAULDING (P.). **Investigations of the White-Pine blister rust.**—*U.S. Dept. of Agric. Bull.* 957, 90 pp., 6 pl. (1 col.), 13 figs., 1922.

In this comprehensive monograph the author endeavours to present all the information at present available on the white pine blister rust. The work is divided into the following sections: The origin and distribution of *Cronartium ribicola*, in which the theory of the Asiatic origin of the disease is discussed and supported; an account of its hosts, giving a complete list of all the species of *Pinus* and *Ribes* naturally attacked or capable of artificial infection, with details of their relative susceptibility as far as known; the life-history of the parasite, comprising the *Peridermium* stage on pines and the *Cronartium* stage on *Ribes*, with a very full account of the different types of infection, methods of dissemination, germination and viability of the spores, &c.; the overwintering of the fungus on pines and on *Ribes*; important dates in its life-history; and the control of the disease.

The author points out that there are certain significant features in the life-history of *C. ribicola* and in its relation to the environment which have an influence on its control. The pycnospores (spermatia) are apparently functionless; the aecidiospores and uredospores are not known to infect pines but do infect *Ribes*; while the sporidia produced by the teleutospores are not known to infect *Ribes* but do infect pine. The wind is the chief agent of distribution, the aecidiospores being capable of infecting *Ribes* leaves several miles away from their source. The viability of the uredospores appears to be soon lost, so that infection by them is more limited in distance. The sporidia are still more frail and, as a rule, can only carry infection to a distance of 100 to 600 yards. The aecidiospores produced by the overwintered mycelium in the pine bark are the principal source of infection of *Ribes* leaves in the spring, the resulting uredospores still further disseminating the disease. High atmospheric humidity is an essential for the germination of any of the spore forms.

The present status of the control of the white pine blister rust in North America may be summed up as follows:—Eradication of *C. ribicola* is impossible except in small, isolated, advance infections. As a national problem control is the only feasible measure. Protection of uninfected or sparsely infected areas by the enforcement of the present Federal quarantines is necessary, since this disease is distributed to great distances only by means of infected nursery stock. The western forests of white pines can be protected from the blister rust for an indefinite period by the rigid enforcement of the Mississippi Valley quarantine. A single diseased shipment may undo all attempts to restrict it to the eastern forests.

A very full bibliography of 180 titles is appended.

White-Pine blister rust in the Western United States.—*U.S. Dept. Agric. Circ.* 226, 7 pp., 9 figs., (5 col.), 1922.

White pine blister rust (*Cronartium ribicola*), which has for some years past been ineradicably established in New England, New York, and the Lake States, was discovered in the autumn of 1921 to have invaded western British Columbia [see this *Review*, i, p. 455] and the Puget Sound region of Washington State. The valuable forests of western white pine (*P. monticola*) and sugar pine (*P. lambertiana*) are now directly threatened by this destructive disease, and can only be saved by the rigid enforcement of the Federal quarantines which restrict the movements of five-needle pines, currants, and gooseberries. The co-operation of all is invoked to assist in finding and destroying any outbreaks of the disease in *Ribes* or pines. The planting of black currants is deprecated.

Approximately three-quarters of the commercial five-needle pine stand of the United States is stated to be in the western forests.

Spaulding (P.). **Viability of telia of Cronartium ribicola in early winter.**—*Phytopath.*, xii, 5, pp. 221–224, 1922.

Experiments have been carried out at Bethel, Vermont, to determine how late in the season the teleutospores of *Cronartium ribicola* may remain viable under natural conditions.

Vigorous leaves of five species of *Ribes*—*nigrum*, *odoratum*, *americanum*, *rotundifolium*, and *cynosbati*, bearing abundant teleutosori, were enclosed in mosquito bags and hung out of doors on 26th September, 1921. Germination tests were made at intervals until 8th December, when the experiment ended. The results obtained showed that while teleutospores on *R. cynosbati*, *rotundifolium*, and *odoratum* had almost reached their limit of viability by 8th December, those of *R. americanum* retained considerable vigour and those of *R. nigrum* were almost as vigorous as when first collected. It has long been recognized that *R. nigrum* is far the most dangerous species of *Ribes* known in relation to the blister rust of white pine.

Further tests showed that leaves killed suddenly by frosts bore teleutospores of maximum germinating power, and attention is called to the fact that the danger of infection is increased by the ability of teleutospores to germinate in winter, when the temperature rises a few degrees above freezing, although it is not known whether the pines are susceptible at this season.

RATHBUN (ANNIE E.). **Root rot of Pine seedlings.**—*Phytopath.*, xii, 5, pp. 213–220, 1 fig., 1922.

For several years coniferous seedlings, too old to succumb to ordinary damping-off, have been known to suffer from late damping off and root rot. Inoculation experiments were carried out on *Pinus resinosa* and *P. banksiana* to confirm the conclusion arrived at by field observations, namely that damping-off fungi may be responsible for these root injuries. The fungi tested were: *Pythium de Baryanum*, *Corticium vagum*, *Fusarium* spp., *Botrytis* spp., *Phomopsis juniperovora*, and *Rheosporangium aphanidermatus*. The inoculum on rice mush was applied directly to the roots, which in most cases were again covered with sterilized sand. Root rot developed to a slight extent in the controls. The inoculations were too few to permit more than a comparison of the virulence of different genera.

P. de Baryanum and the *cinerea* type of *Botrytis* caused decay to most of the roots. A small sclerotial form of *Botrytis*, however, produced no injury. *C. vagum* caused a decided increase in the amount of root rot compared with the controls. The results with *Fusarium* spp. were variable but on the whole root rot was somewhat increased. *R. aphanidermatus* caused no appreciable decay, but *P. juniperovora* produced considerable decay in one trial with twenty seedlings. The latter result suggests the possibility that under favourable conditions other fungi as well as damping-off parasites may cause root rot.

The results of these very artificial tests, though in no sense representative, may be taken as an indication that the root decay of pine seedlings is at least partly due to damping-off fungi.

MEIER (F. C.), DRECHSLER (C.), & EDDY (E. D.). **Black rot of Carrots caused by Alternaria radicina n. sp.**—*Phytopath.*, xii, 4, pp. 157–166, 2 figs., 1 pl., 1922.

During 1918–19 complaints were made from Long Island of the heavy losses by decay of carrots in transit and storage. Later investigations have shown that other localities in the States of New York, Massachusetts, and possibly Pennsylvania are also affected.

The trouble is characterized by a progressive softening and blackening of the tissues of the root, infection frequently starting at the crown and extending down the core, but sometimes also originating at other points.

A fungus was easily isolated from diseased carrots and proved to be pathogenic both on the root and on the foliage. Search for affected foliage in the field was not successful. The fungus, a new species of *Alternaria*, is named *A. radicina* and is fully described.

A close comparison is made with a disease of the foliage of carrots caused by *Macrosporium carotae* Ell. and Lang. The latter, however, is an obligate parasite which attacks vigorous plants, while *A. radicina* is a facultative parasite affecting mature tissues, especially those of more or less bruised or wounded roots during harvesting or storage.

VOGLINO (R.). **Servizio di segnalazione degli attacchi di Plasmopara viticola nel 1921 nelle Province di Torino, Cuneo, Novara.** [The system of forecasting attacks of *Plasmopara viticola* in 1921 in the Provinces of Turin, Cuneo, and Novara.] —*Nuovi Ann. Min. Agric.*, ii, 1, pp. 72–80, 1922.

Meteorological conditions likely to influence epidemics of fungous diseases of the vine were recorded at various localities and at altitudes ranging from 230 to 550 m. in the provinces of Turin, Cuneo, and Novara, and the observations forwarded to the central Phytopathological Station at Turin. From the data furnished by the local observatories, fortnightly bulletins were compiled containing particulars of the maximum and minimum temperatures, atmospheric pressure, atmospheric and soil humidity, rainfall, winds, fogs and dews, cloud, &c. All the members of the observatory staffs were instructed to pay special attention to the rainfall, dense fogs, and continuous dews, and to inform the central authorities immediately of the appearance of a white efflorescence on the vines.

The central Phytopathological Station issued preliminary instructions for preventive treatment as soon as the information received indicated that the conditions were favourable for the germination of the winter spores and the first infection of the vines. Thereafter instructions were issued to vine-growers from time to time, in accordance with the reports of rainfall and other meteorological conditions supplied by the local observatories, regarding the appropriate treatment for every phase of the attack. These announcements were published in the provincial newspapers, at the Agricultural Colleges of the different centres, and by various agrarian committees, co-operative associations, and syndicates.

The relatively dry and mild winter of 1920–21 was followed by snowstorms in April which appreciably lowered the temperature and caused considerable physiological disturbances in growing plants, predisposing them to the attacks of parasites. The formation of zoospores from the winter spores began on 12th to 15th April, but not until 28th or 29th April did conditions admit of infection of the tissues of the vine. The first symptoms of attack became apparent on 16th to 17th May in the entire region under discussion, conidia being formed from 23rd to 25th May. During the last fortnight of May and almost the whole of June, conditions were favourable for the development of the disease, heavy dew and rain being followed by abnormally hot days. The virulence of the attack was most pronounced during the second half of June and the first ten days of July, especially on neglected vines. The persistent morning dews and the high humidity caused by evaporation at soil-level facilitated the continuous propagation of the parasite. The high temperature prevailing during the second part of July and the whole of August prevented any further spread of the attack.

PETCH (T.). **Report on the work of the Division of Botany and Mycology.**—*Ann. Rept. Ceylon Dept. Agric.*, 1921, pp. 21–23, 1922.

Some of the diseases recorded in this Report have already been mentioned in the Quarterly Reports of the Botanist and Mycologist [see this *Review*, i, 5, p. 160; 10, p. 331]. The following are additional details:

RUBBER. The irregular rainfall during the south-west monsoon was unfavourable to leaf-fall and pod disease [*Phytophthora*], and there was no general outbreak. Root diseases were common, 43 per cent. of the specimens examined being due to *Fomes lignosus*, 41 per cent. to *F. lamaoensis*, 11 per cent. to *Ustulina zonata*, and 3 per cent. to *Poria hypobrunnea*.

TEA. Branch canker on young stems caused by *Macrophoma theicola* has been fairly prevalent. Like red rust [see this *Review*, i, 3, p. 92] it may be attributed to the cessation of manuring which was a consequence of the war.

COCO-NUTS. The Assistant Mycologist, Mr. C. H. Gadd, carried out experiments to determine the efficacy of Bordeaux mixture as a preventive of the parasitic form of nut-fall, but owing to the non-appearance of the causal organism (*Phytophthora* sp.) no apparent benefit was derived from the spraying. Of the total number of nuts removed from the palms during the year, 53·3 per cent. fell before reaching the age of two months, probably from natural causes; 44 per cent. were picked; and the remaining 2·7 per cent. fell before attaining maturity. A few cases of bud rot, one of great virulence, occurred during the year.

COFFEE. Die-back attributed to *Colletotrichum incarnatum* occurred on *C. robusta*. The teleutospores of *Hemileia vastatrix* were found throughout the year.

The diseases caused by species of *Phytophthora* in Ceylon are being investigated by Mr. Gadd, who found that a species isolated from papaw fruits [*Carica papaya*] was apparently identical with that attacking cacao and rubber 'pods', namely *P. faberi*. Cross inoculations showed that the strains from cacao and rubber would infect papaw fruits, though not so virulently as the papaw strain itself. The species of *Phytophthora* isolated from Nam Nam fruits (*Cynometra cauliflora*), which was at first believed to be identical with *P. meadii*, is now regarded as a distinct species. The fungus differs from *P. meadii* in its ready production of oospores in culture, and inoculation experiments on rubber pods gave negative results with it.

The species of *Pestalozzia* on tea, coco-nut, &c., are being investigated by Mr. Bertus, the results so far obtained indicating that the species on tea is not the same as that on coco-nut. *Mycosphaerella citrullina* was recorded on *Luffa acutangula*, *Cephaleuros minimus* on cacao twigs suffering from die-back; a species of *Cladosporium* caused a disease of *Setaria italica*, and a bacterial disease of cannas was observed.

Van Hall (C. J. J.). **Ziekten en plagen der cultuurgewassen in Nederlandsch-Indie in 1921.** [Diseases and pests of cultivated plants in the Dutch East Indies during 1921.]—*Meded. Inst. voor Plantenziekten*, 53, 46 pp., 1921.

The meteorological conditions during 1921 were approximately normal, except for the excessive rainfall during the west monsoon in February and March, and during the east monsoon in October and December. The damage caused by fungi to the more important crops may be summarized under the following headings:

Rice. An extremely severe outbreak of root rot of rice was probably the aftermath of the abnormally rainy east monsoon of 1920. In Java and Madoera the loss of 'sawah' paddy in 1921 amounted to 12 per cent. of the entire area under rice. This estimate does not include partially damaged crops, so that the total figure would be at least half as much again. *Helminthosporium oryzae* occurred sporadically on the west coast of Sumatra.

Rubber. No new diseases were reported during the year. On the east coast of Sumatra brown bast, stripe canker (*Phytophthora*), and root diseases (*Poria* and *Fomes*) were the commonest diseases and were everywhere under treatment by recognized methods. *Hypochnus* was also very widespread. The general experience seems to point to a considerable decrease of brown bast throughout the E. Indies as the result of the alternate day tapping system. Pink disease (*Corticium salmonicolor*) and canker occurred sporadically in certain localities, and were principally due to the neglect of proper precautions. In Central Java there was one severe outbreak of mouldy rot [*Sphaeronema* sp.], while another estate suffered considerable losses from a die-back of the tops of young trees. Mildew [*Oidium* sp.] was fairly prevalent in many districts, and on the east coast of Sumatra some of the defoliated trees failed to form new leaves in the rainy season. The Director of the Besoeki Experiment Station reported a severe case of infection by *Fomes pseudoferreus* (*Poria hypolateritia*). A few instances of 'kringrot', a peeling off of the outermost bast layer, occurred on the east coast of Sumatra.

Potatoes were severely attacked by leaf roll in the Tengger district of Pasoeroean, where the disease seems to be on the increase. Sprain also occurred in the Tengger district, and in the Residency of Tapanoeli. Scab was recorded from the Poedjonsche district of Pasoeroean. Slime disease (*Bact. solanacearum*) was of frequent occurrence on the 'kentang betawi' variety on the west coast of Sumatra, while the more or less sweet 'sawah' potato was immune. Dry rot was reported from the province of Preanger.

Sugar-cane in Java was severely attacked during the early part of the year by pineapple disease (*Thielaviopsis ethaceticus*). Red rot [*Colletotrichum falcatum*] occurred on one estate, and root rot was reported from all parts, especially in the variety EK 28. The yellow stripe [mosaic] and sereh diseases were not of much importance. Gummosis occurred sporadically all over Java, but in most cases the attacks were very mild.

Tobacco. At the Deli Experiment Station extremely virulent outbreaks occurred of *Phytophthora nicotianae* and slime disease (*Bact. solanacearum*), especially the latter which was prevalent both in the seed-beds and in the field. Both these diseases were recorded from other localities, but not to the same extent. Considerable damage was done by *Phytophthora* to the stalks of tobacco plants in the field at the Besoeki Experiment Station. Black rust (*Bacillus pseudozoogloeae*) occurred at Deli. Mildew [*Oidium* sp.] was again very prevalent at the Vorstenland Experiment Station, its extremely rapid spread being particularly noticeable. Mosaic disease was reported from the Besoeki Experiment Station, the shoots of topped plants being particularly liable. Two abnormal conditions, 'krepoh' [leaf curl] and 'kroepoek', which are not described, also caused considerable losses.

TEA. Mild attacks of *Pestalozzia*, *Laestadia*, *Hypochnus theae*, *Corticium javanicum*, *Capnodium*, *Thyridaria tarda*, &c., were recorded from the tea plantations of Java and Sumatra. The damage caused by red rust (*Cephaleuros virescens*), the most formidable vegetable parasite of tea in Java, was in some districts considerable. Root diseases caused by various fungi (*Rosellinia*, *Armillaria*, *Ustulina zonata*) are found in gardens at high elevations, and the root disease problem is a serious one on the east coast of Sumatra.

COCO-NUT. *Pestalozzia* was prevalent in one or two districts, and a leaf disease, the cause of which is not specified, was recorded from the province of Menado.

COFFEE. The incidence of the cobweb disease (*Hypochnus*) was higher than in previous years. Mottling of the leaves of young Robusta coffee trees occurred on a large scale in one estate. Pink disease (*Corticium salmonicolor*) and brown root disease [*Fomes lamaoensis*] were also reported, the latter being common on freshly cleared land.

MAIZE. Downy mildew (*Sclerospora javanica*) was prevalent in most districts, but only in a few instances were the losses heavy. In the province of Pasoeroean the late planted 'sawah' maize was severely attacked by this disease.

OIL PALM. The crown or 'juvenile' disease [see this *Review*, i, 1, p. 20] was again very prevalent. The disease never ends fatally, but the development of the trees is arrested, and they remain in a backward condition. It has now been ascertained that trees above five years old are also liable to attack, so that the term 'juvenile' is scarcely applicable. The cause of the disease is not known, but a physiological origin is indicated. A case of bud rot was reported from Besoeki.

GROUND-NUT (*Arachis hypogaea*) was severely attacked by slime disease (*Bact. solanacearum*) in all districts. In one case the loss amounted to 15 per cent. Leaf curl occurred in the Kediri province, and is attributed by the natives to a sudden rainy period following a prolonged drought.

CINNAMON (*Cinnamomum burmanni*) was attacked by bark or stripe canker (*Phytophthora cinnamomi* Rands) at an experiment station on the west coast of Sumatra.

CINCHONA. Pink disease (*Corticium salmonicolor*) occurred on young 'Ledger' seedlings after an attack of *Helopeltis*, as well as on older plants. Cinchona roots are liable to attack both by *Armillaria* and by a species of *Rosellinia*, and the mycelia of these fungi are frequently visible on the diseased parts. There are many cases of root disease, however, in which the most striking symptom is the decay of the cortex. Pressure on the damaged tissue causes moisture to exude, and the diseased parts emit a foul smell. The cause appears to be unknown. Stem rust and canker continue to occur, while 'mopog' (*Moniliopsis aderholdi*) is reported from various estates.

Amongst the diseases recorded on various minor crops were leaf curl on *Phaseolus mungo* and *Vigna sinensis*, and *Bact. solanacearum* on soy-beans.

Departmental Activities: Botany.—*Journ. Dept. Agric. S. Africa*, iv, 4, p. 306, 1922.

Downy mildew, due to *Sclerospora graminicola*, has occurred for the last two seasons on Sudan grass (*Sorghum sudanense*). The crop in a field which became affected with the disease after the second cutting had a scorched appearance, and the leaves were marked with long, narrow, at first yellow or reddish, and finally dark brown, streaks or patches, covered with a fine, white down consisting of the conidia of the fungus. The affected areas appear to spread from the lower to the upper leaves and from the apex to the base of individual leaves. In other countries, especially in India, *S. graminicola* occurs on several important cereals, and while at present the disease is not a serious one in South Africa, it may, under suitable conditions, become very troublesome, and it should therefore be kept under close observation.

Regulations to prevent the introduction of potato wart disease (*Synchytrium endobioticum*) with imported seed have been in force in South Africa for the last ten years, but it now appears that the disease had been introduced in certain areas before they were applied. Its occurrence in the Impendhle Division, Natal, has recently been reported, while a similar report from the Queenstown-Cathcart area awaits confirmation.

Smith (E. F.). **Fasciation and prolepsis due to crown gall.**—*Phytopath.*, xii, 6, pp. 265–269, 5 pl., 1922.

The author has succeeded in demonstrating that fasciation can be produced experimentally by inoculating the crown gall organism (*Bacterium tumefaciens*) into the leaf axils of *Nicotiana*, *Pelargonium*, *Ricinus*, *Brassica*, and *Tropaeolum*, and suggests that many other fasciations may be due to the penetration of foreign organisms into the growing point.

In the striking case which is fully illustrated by photographs, a young nasturtium plant was inoculated through needle pricks in a leaf axil. The fasciated shoot (shown as it appeared a month later) was the only axillary shoot that developed. It arose from a dormant bud along with the growth of the tumour resulting from the inoculation. This was the only successful case out of fifteen nasturtiums inoculated; apparently the needle must enter the actual dormant bud, which is not always easy to attain. In the rest, the shoot which usually developed from the inoculated axil (none of the other axils gave shoots) was not fasciated. It was, however, abnormally vigorous in growth in several cases, and rapidly gave rise to secondary, tertiary, and even quaternary shoots within a period of two months, from buds that under normal circumstances would have remained dormant. This forced growth is compared with that which occurs in peach yellows, and is explained on the supposition that the growth of the tumour at the base of the shoot stimulates the movement of water and nutrients in this direction. Continual growth of the tumour, however, effects an invasion and compression of the vascular tissues at the base of the shoot, with the result that the latter wilts. At an early stage of this compression, the downward movement of elaborated foodstuffs from the axillary shoot would very likely be interfered with sufficiently to act as a further stimulus to its growth. Tests for starch showed a marked accumulation in the cortex, pith, and medullary rays of these shoots, as would be expected if the downward flow of elaborated nutrients were checked. It is suggested that the proximate cause of the forced growth in peach yellows must be the same, namely the stimulus of excessive amounts of water and foodstuffs acting locally as the result of phloem injury.

BENOIST (J.) & BAILLY (P.). **Moyens de combattre le piétin des céréales.** [Control measures against foot rot of cereals.]—*La Vie agricole*, xi, 40, pp. 266–268, 1 fig., 1922.

The authors report that their previous investigations indicated that one crop of wheat immediately succeeding another is seldom attacked by foot rot (*Ophiobolus graminis* [*O. cariceti*] and *Leptosphaeria herpotrichoides*), whereas infection almost always occurs on soil which carried wheat two years previously. The longer period between crops appears in some way to favour the disease.

Experiments in the control of the disease were carried out on autumn wheat of the Geffroy variety, the trial crop, sown on 8th November, 1921, having been preceded by wheat. An application of stable manure, which is stated to promote the development of foot rot, was given, together with 400 kg. per hectare of superphosphate. The field was divided into six plots, which were treated as follows: (1) control; (2) sprinkling of the stubble, before ploughing, with a 4 per cent. solution of iron sulphate; (3) 400 kg. per hectare of iron sulphate mixed with the soil by ploughing; (4) sprinkling on 9th March, 1922, with a 4 per cent. solution of iron sulphate; (5) sprinkling on the same date with a solution of sulphuric acid; (6) 600 kg. per hectare of chloride of potassium spread in January.

The control plot was slightly attacked by foot rot, but owing to the drought, and to the fact that wheat immediately succeeded wheat, the damage was not severe. The percentage of infection was considerably reduced both by sprinkling the stubble with iron sulphate, and by mixing this in at ploughing time. Very slightly less favourable results followed sprinkling with iron sulphate in the spring. Excellent effects were produced by spreading chloride of potassium and by sprinkling with sulphuric acid. It is uncertain whether the marked reduction of infection in the two latter cases was due to the caustic action of the minerals or to their fertilizing powers.

Smith (C. O.). **Pathogenicity of the Olive knot organism on hosts related to the Olive.** *Phytopath.*, xii, 6, pp. 271–278, 2 pl., 1922.

The pathogenicity of *Pseudomonas savastanoi* E. F. Smith on the olive has been fully determined, but hitherto negative results were obtained in the various attempts to inoculate plants more or less closely allied to the olive.

The present paper deals with inoculation experiments extending from 1919 to 1921, and carried out on the olive (*Olea europea*), *Fraxinus velutina*, *F. floribunda*, *Adelia acuminata*, *Ligustrum ovalifolium*, *Chionanthus virginica*, *Osmanthus fragrans*, *Osmanthus aquifolium*, *Vinca*, *Thevetia nereifolia*, *Nerium oleander*, *Coprosma baueri*, *Carissa grandiflora*, *Chrysanthemum frutescens*, *Elaeagnus angustifolia*, lilac, jasmine, and several species of *Prunus*. Typical artificial knots were produced only on *Adelia*, both species of *Fraxinus*, and jasmine. Definite lesions were produced on *Osmanthus aquifolium* and *Chionanthus*, and small knob-like growths developed on *Ligustrum* in one series of tests. The galls produced on *Adelia*, *Fraxinus*, and jasmine were smaller than those on the olive, with the possible exception of some on *F. floribunda*. They appear to reach their maximum size in three or four months, after which the tissue gradually dies. In the olive this process is of longer duration.

Infection seems to be restricted to plants allied botanically to the olive, especially those of the family Oleaceae. The olive knot organism is characterized by the production of masses of bacteria in definite cavities within the hypertrophied tissue of the olive. It differs herein from the galls of *Bacterium tumefaciens* on various hosts, where very few organisms are present in the hypertrophied cells. *Ps. savastanoi* is further differentiated from *Bact. tumefaciens* by its limited pathogenicity.

MacInnes (Jean). **The growth of the Wheat scab organism in relation to hydrogen-ion concentration.**—*Phytopath.*, xii, 6, pp. 290–294, 1 fig., 1922.

A strain of *Fusarium* isolated from scabby wheat in Minnesota was found to be capable of growing in nutrient media ranging from P_H 3·0 to P_H 11·7. This exceptionally wide range of tolerance is compared with the published figures for a number of other pathogenic organisms, the authority in each case being given. The *Fusarium* strain in question has been found to be capable of attacking a very large number of hosts, and further work with it will be published elsewhere.

Kulkarni (G. S.). **Conditions influencing the distribution of grain smut (Sphacelotheca sorghi) of Jowar (Sorghum) in India.**—*Agric. Journ. India*, xxvii, 2, pp. 159–162, 1922.

In a previous publication (*Pusa Bull.* 78, p. 13) the author suggested, on the evidence obtained from germination studies of the spores of *Sphacelotheca sorghi*, that temperature had an important bearing on the distribution of the disease. Sorghum is usually sown in India in June–July, with an average temperature of 21° to 30° C., which is favourable for the germination of the smut spores, but below the optimum for the germination of the grain. In certain areas, however, e.g. the Indo-Gangetic plain, the temperature at sowing time is 30° to 40° C., which is too high for the spores to germinate, but favourable for the germination and rapid growth of sorghum; the disease in these regions is scarce. In pot experiments carried out at the Mycological Laboratory at Poona, pots sown with infected sorghum and incubated at 40° C. for three days showed no infection of the seedlings, while in other pots incubated at 25° C. the amount of infection varied from 50 to 60 per cent. This clearly shows that temperature is a limiting factor to infection by this smut. A confirmation of this conclusion was also supplied by field experiments carried out by sowing seed mixed with spores in 1918 and 1920 at Pusa, and at the Government farms at Larkhana and Jacobabad in Sind, similar sowings at Poona serving as a control. The results, full details of which are given, were particularly definite at Jacobabad in 1920, where, with a temperature of 36° to 40° C. at sowing time, there was no smut, against 65 per cent. at Poona where the temperature was only 25° C.

HURSH (C. R.). **The relation of temperature and hydrogen-ion concentration to urediniospore germination of biologic forms of stem rust of Wheat.**—*Phytopath.*, xii, 8, pp. 353–361, 7 figs., 1922.

Two biologic forms of *Puccinia graminis* of wheat, collected in California and France respectively, and differing in their parasitic behaviour, showed considerable differences in germination response to temperature and hydrogen-ion concentration when uredospores of the same age, grown under similar greenhouse conditions on Little Club Wheat (which is susceptible to both forms), were used. Temperatures of 10°, 20°, and 30° C. were used, and a P_H range of from 2·5 to 8·0. The form more limited in its host range (that sent from France) was also more restricted in tolerance of extremes of hydrogen-ion concentration and temperature. The differentiation of biologic forms is not entirely dependent on their parasitic behaviour on certain plants. At least some biologic forms apparently possess individual physiological characteristics demonstrable by physical and chemical means. The possession of such characteristics alone may be sufficient to establish them as definite taxonomic entities.

HUNGERFORD (C. W.). **The relation of soil moisture and soil temperature to bunt infection in Wheat.**—*Phytopath.*, xii, 7, pp. 337–352, 5 figs., 1922.

The infection of the soil with wind-blown spores of *Tilletia tritici* has been known for a number of years to result in smutted crops in the Pacific North-West region of the United States. This infestation does serious damage, and renders control very difficult.

Soil temperature and soil moisture have been proved in recent years to be important factors in infection by fungi. Observations made at Idaho have shown that, on contaminated soils, the amount of soil moisture at planting time may have a very marked effect on the amount of bunt in the resulting wheat crop. Experiments were carried out to determine this relationship more exactly.

Wheat was grown at Moscow, Idaho, in six containers filled with bunt-contaminated soil, varying in moisture content from 8 to 32 per cent. at the time of planting, and with a 'moisture equivalent' of 27·2 [cf. Briggs and McLane, *Proc. Amer. Soc. Agron.*, ii, p. 138, 1911]. The percentage of bunt increased progressively to 100 per cent. infection as the percentage of soil moisture increased. A repeat experiment at Nez Perce, Idaho, gave similar results.

Greenhouse experiments in which both moisture and temperature were controlled showed that low soil temperature (9° to 12° C.) and a fairly high percentage of moisture in the soil (about 22 per cent. with a moisture equivalent of 20·7) are both favourable to infection. An exceedingly high percentage of moisture, however, seemed to inhibit infection. A small amount of infection took place even when the temperature was as high as 25° to 28° C.

Preliminary experiments appear to indicate that bunt spores lose their power to infect rather rapidly, since not more than 4½ per cent. infection resulted from artificially infected soil sown after the lapse of a month.

Peltier (G. L.). **A study of the environmental conditions influencing the development of stem rust in the absence of an alternate host. I. The viability of the urediniospores of Puccinia graminis tritici Form III.**—*Agric. Exper. Stat. Nebraska, Res. Bull.* 22, 15 pp., 3 figs., 1922.

In order to determine with accuracy the viability of the uredospores of stem rust of wheat under controlled conditions, the author subjected uredosori of approximately the same age on detached wheat seedling leaves to various combinations of constant temperatures and relative humidities. Ordinary bacteriological incubators were employed for temperatures of 25° and 30° C., while for lower temperatures a special apparatus [which is described in detail] was devised. Constant relative humidity was maintained in each chamber by means of sulphuric acid solutions. The experiments extended over a period of sixteen weeks.

The method of procedure was as follows: Some 2,000 Little Club Wheat seedlings were inoculated with two weeks old material of *Puccinia graminis tritici* Form III from a stock culture supplied by Stakman, in a greenhouse free from other rusts, a composite inoculum being obtained by shaking the spores from the sori on to a glass plate. The inoculated plants were incubated at a constant temperature of 25° C. for forty-eight hours, after which they were placed in a controlled-temperature greenhouse for twelve days at a mean temperature of 24° C. The infected leaves were then cut off and some thirty leaves were placed in each moist chamber. The moist chambers were in sets of 11, each set forming a series of from 0 to 100 per cent. relative humidity at approximately 10 per cent. intervals. One such set was placed in each temperature chamber, the temperatures used being 5°, 10°, 15°, 20°, 25°, and 30° C. No germination of the uredospores occurred at 30° C., while at 25° C. germination took place only at the medium relative humidities. The maximum duration of viability (five weeks) at this temperature occurred at the relative humidity of 49·0 per cent. At 20° C. the spores were viable for one week at 100 per cent.

relative humidity, and for eleven weeks at 49·0 per cent.; with each succeeding drop in the relative humidity below 49.0 there was a decrease in the percentage of germination and the duration of viability. At 15° C. the uredospores were viable for longer periods at all humidities than at 20° C., but the duration of viability was again longest at relative humidities of 49·0 to 60·7 per cent. (ten weeks). At 10° C. the spores gave a higher percentage of germination, and were viable for longer periods at nearly all humidities than at 15° C.; fairly high percentages of germination occurred at the end of the sixteenth week at the relative humidities of 38·0, 49·0, and 70·4 per cent. At 5° C. the viability of the spores at the medium humidities was still fairly high at the conclusion of the experiment, but at relative humidities below 38·0 per cent. the spores were not viable for such long periods as at 10° C. Somewhat peculiar results were obtained at the relative humidity of 10·5 per cent. at all temperatures below 25° C., a lower percentage of germination occurring at this point than at the relative humidities of 0 and 21·5 per cent.

The results of infection tests corresponded as a rule with those of the germination trials. Few or no infections were obtained with any inoculum showing less than 10 per cent. of germination. As the percentage of germination decreased from week to week, the germ-tubes became shorter and narrower, and their protoplasm less dense. The use of such a comparatively weak inoculum resulted in the production of hypersensitive flecks on the leaves, indicating that, while the spores were capable of germination and of penetrating the tissues, the resistance offered by the host cells was greater than the fungus could overcome.

The writer's field experiments at Lincoln support the general consensus of opinion on the viability of the uredospores of stem rust, namely that the latter do not overwinter in the North. Rust epidemics were started in the autumn and the uredospores germinated readily until January, but not later. The results of the experiments reported above show that down to certain temperatures the uredospores are viable for long periods at the prevailing relative humidities encountered in the field during the autumn in the winter wheat belt. It is further clearly demonstrated that at constant temperatures somewhat below the average prevailing during the summer in the South, the uredospores are not viable for any length of time at any relative humidity. The mortality of the free uredospores, extremely high at all times, is greatly increased by the absence of suitable conditions for infection. It therefore seems safe to assume, in view of the brief duration of such conditions, that only a small proportion of the countless number of spores produced actually infect the host.

STONE (R. E.). **Leaf scorch or mollisiose of the Strawberry.**—*Phytopath.*, xii, 8, p. 375–380, 3 figs., 1922.

Leaf scorch or mollisiose is very prevalent in parts of Ontario and the United States. The first symptoms in new attacks appear on the leaves in May in the form of irregular purple blotches, $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter. Purple stripes may be present on the petioles and flower peduncles. The blotches gradually turn grey and coalesce, and in time the whole leaf may be involved. By July or August the beds frequently present a scorched appearance. The following spring the disease appears early. The diseased plants do not winter well, and the crop may be very short the second year.

Varietal susceptibility is very marked. The most susceptible varieties appear to be Clyde, Glen Mary, Doctor Burrill, and Pokomoke, the remaining common varieties being moderately or slightly susceptible.

An examination of the older portions of leaf blotches and diseased petioles reveals the presence of dark acervuli filled with hyaline bicellular spores belonging to the fungus *Marssonia potentillae* (Desm.) Fischer. The fungus overwinters in the leaves and produces conidia in the spring. An ascigerous stage, agreeing with descriptions and specimens of *Mollisia earliana* (E. & E.) Sacc., may be found on the more exposed leaves from late April to June. The conidia of *M. potentillae* are often present on the leaves, simultaneously with the ascocarps of *M. earliana*, and cultures from single ascospores have given the *Marssonia* stage.

Full descriptions of both the stages are given and also their synonymy. Inoculations with pure cultures bearing conidia were successful.

The disease can probably be controlled by the measures applicable to leaf spot (*Mycosphaerella fragariae*).

HEMMI (T.). **On the occurrence of Mycosphaerella wilt of Musk-melons in Japan.**—*Phytopath.*, xii, 8, pp. 394–397, 1922.

The presence of *Mycosphaerella citrullina* in both the perithecial and pycnidial stages is recorded on diseased musk-melons in Japan. The symptoms of the disease and characters of the fungus agree with those previously described in America. The pycnospores are hyaline and mostly bicellular, but may be continuous or with two or three septa. The writer was recently informed that the fungus had also been found on the leaves and vines of a species of gourd (*Lagenaria vulgaris* var. *gourda*) in the Shizuoka Prefecture.

SKUBEZ (V.). **Plötzliches Absterben der Obstbäume.** [Sudden death of fruit trees.]—*Allg. Weinzeit.*, xxxix, 34, pp. 133–134, 1922.

During the spring of 1922 great numbers of young fruit trees, chiefly apples, in all the fruit-growing districts of Carinthia [Tyrol] were suddenly killed off just when beginning to bloom. To the naked eye there were no signs of disease or mechanical injury on the trees. The phenomenon was assumed to be connected with the abrupt alternations of temperature between the abnormally hot summer of 1921 and the severe winter of 1921–22. Specimens of the affected material have been examined, and although the final results of the investigation will not be announced until later, a preliminary report is already available.

The typical symptoms of frost injury could not be detected either in the wood or cortex. Occasional brownish discolorations were observed in the phellogen and in that part of the conducting cells of the phloem bordering on the cambium, where the cell-walls were also swollen at intervals. These symptoms, however, were not present in all the branches. The cambium was usually dead, the formation of wood having ceased from the previous autumn with the exception of a few, isolated, spring wood cells. The pith was discoloured only in places.

These investigations, together with the meteorological conditions referred to above, suggest the following conclusions. The trees were suffering in the first instance from the abnormal drought of the summer of 1921, which principally affected the tissues of the cambium. This water-shortage was intensified by the excessively low temperatures of the following winter, which extended into the soil to a depth of one metre. As the result of the protracted plasmolysis of the living cells thus brought about, the latter were unable to meet the demands of the newly-circulating sap in the spring and the development of shoots and blossoms stopped abruptly. Hence the sudden death of the trees was only indirectly due to the cold, the proximate cause being the exhaustion of the water-supply.

Rankin (W. H.) & Hockey (J. F.). **Mosaic and leaf curl (yellows) of the cultivated red Raspberry.**—*Phytopath.*, xii, 6, pp. 253–264, 1922.

This is a more detailed account of the author's investigations referred to in a previous abstract [see this *Review*, i, 7, p. 218]. One or other of the two diseases is stated to be probably present in all the larger small-fruit districts of the northern United States and Canada. The 'running-out' of varieties, especially the Marlboro and Cuthbert, and the marked decline in acreage in many districts have been attributed to them.

The leaf curl has many points of similarity to potato leaf roll, and raspberry plants affected with this disease show a necrosis of certain elements of the phloem and pericycle resembling potato phloem-necrosis.

A list of thirty red and purple varieties of raspberry which have been observed affected with mosaic is given. An outwardly similar disease is also common on some cultivated varieties of black raspberries. Leaf curl has been seen on the wild *Rubus strigosus*, the ornamental *R. phoenicolasius*, and an unknown variety of black raspberry.

Girola (C. D.). **Ganoderma sessile Murrill.**—*Bol. Minis. Agric. Nación (Buenos Aires)*, pp. 236–239, 2 pl., 1922.

Considerable damage is caused to various fruit and forest trees in the Argentine by *Ganoderma sessile* Murrill, which has been found in one plantation on *Prunus armeniaca*, *P. domestica*, *Pyrus communis*, *Ficus carica*, *Punica granatum*, *Robinia pseud-acacia*, *Gourliea decorticans*, *Casuarina stricta*, *Eucalyptus globulus*, *Tipuana tipa*, &c. Infection is caused either by the mycelium, which spreads from diseased to healthy roots, or by spores falling on to wounds or lesions on the exposed roots or base of the trunk.

Severely attacked trees, and all sporophores, should be removed and burnt. In limited attacks the affected parts should be excised and the wound disinfected. In new plantations the application of manure should be avoided, and care must be taken not to wound the young plants. In suspicious cases the roots may be treated before planting with formalin or with 1 in 1,000 corrosive sublimate. Stakes for young trees should be disinfected with copper sulphate, formalin, or hot tar. A period of three years should be allowed to elapse before replanting in infected soil. Humidity promotes the development of the fungus, and care should therefore be taken to drain the water from the collars of the trees.

CSETE (A.). **Die Wirkungen von Uspulun, Formalin, Kupfervitriol, Schwefelkalkbrühe und Klorol auf die Keimfähigkeit des Zuckerrübensamens.** [The action of uspulun, formalin, copper sulphate, lime-sulphur, and klorol on the germination of the seed of Sugar Beet.]—*Kisérletügyi Közlemények*, xxiv, 1921. [Abs. in *Zentralbl. für Agrikulturchemie*, li, 8, p. 207, 1922.]

The vitality and germinative power of the seed of sugar beet are increased by the use of uspulun, copper sulphate, klorol, formalin, and lime-sulphur, in the order given. These preparations are recorded as being of practical and scientific value, not only on account of their fungicidal properties, but also because of the stimulus which they afford to germination.

BUTLER (O.) & SMITH (T. O.). **On the use of acetates of copper as fungicides.**—*Phytopath.*, xii, 6, pp. 280–289, 1 fig., 1922.

Two acetates of copper are used as fungicides, the normal or neutral acetate of copper $Cu(C_2H_3O_2)_2.H_2O$, and the basic acetate of copper $Cu(C_2H_3O_2)CuO.6H_2O$, the former containing 31·8 per cent. of metallic copper and the latter 34·4 per cent. There is ample evidence that the acetates of copper compare favourably with Bordeaux mixture in fungicidal properties. Both the acetates ('verdets') have been used by vine-growers for the last thirty years in the south of France and Italy, with excellent results, but in America they are very little known. The acetates of copper are non-toxic to the plants on which they are used, and form less conspicuous spots than the cuprammoniums (ammoniacal copper compounds).

The adhesiveness of the acetates of copper depends on the degree of decomposition which takes place during drying, and on the length of time elapsing between application and the first washing rain. Basic acetate is more adhesive than neutral acetate, and decomposes more rapidly on exposure to air. Neutral acetate, however, is more easily obtainable than basic acetate, and its adhesiveness can be greatly increased at a small cost by the addition of 0·05 per cent. of gelatine. At the end of forty-eight hours the adhesiveness of neutral acetate plus gelatine is virtually equal to that of basic acetate alone, and at subsequent periods it is only slightly lower. The same proportion of gelatine added to basic acetate also produces an increase of adhesiveness chiefly during the first day of drying, i.e. the time when the maximum of adhesiveness is required.

The writers propose the following formulae, using a stock solution of the acetate made by dissolving the substance in cold water at the rate of 1 lb. per gall. Formula 1: water 49 galls., basic acetate of copper (stock solution) 1 gall. (or for a stronger solution 46 : 4). Formula 2: water 48 galls., basic acetate or neutral acetate (stock solution) 1 gall., gelatine (stock solution) 1 gall. (or for a stronger solution 45 : 4 : 1). The stock solution of gelatine is made by dissolving 4 oz. of gelatine in 5 quarts of hot water, and should not be above 40° C. when added to the acetate. The weaker strengths given above are intended for use in place of a cuprammonium spray, the stronger where a colourless fungicide is required in place of Bordeaux mixture and of the same fungicidal value.

Henning (E.). **Om betning mot Stinkbrand (Tilletia tritici), Stråbrand (Urocystis occulta), och Hårdbrand (Ustilago hordei). II. Bidrag till formalinbetningens teknik.** [Disinfection against bunt (*Tilletia tritici*), flag smut (*Urocystis occulta*), and covered smut (*Ustilago hordei*). II. Contribution to the technique of disinfection with formalin.]—*Meddel. Centralanst. för försöksväsendet på jordbruksområdet*, 231, 36 pp., 3 figs., 1922.

The preparations in general use in Sweden for the control of bunt and other smuts are copper sulphate, uspulun, and formalin. The two first named have various drawbacks. Both are poisonous, and the residue of the treated seed therefore cannot be used for feeding. The application of copper sulphate is tedious and complicated, and its danger to seed damaged by threshing is not entirely removed by the addition of milk of lime. The poisonous constituents of the mercury chlorophenol contained in uspulun still adhere to the seed even if the latter is washed after treatment. A further disadvantage of uspulun is that the effective principle is absorbed by the seed at a quicker rate than the water, so that a certain quantity of the fungicide has to be added to maintain the proper concentration during repeated use.

The author has conducted numerous experiments with a view to modifying the technique of formalin disinfection, the one objection to which is the reduction of germinative power during storage. The results showed that washing the seed in water after treatment with formaldehyde at various concentrations lessened this injury. Ordinary rinsing is usually sufficient, but if a very high concentration of formaldehyde is used, or if the varieties are particularly susceptible to injury, then the seed should be immersed in water. Further tests showed that seed rinsed after treatment and dried in a cellar germinated to the extent of 87·7 per cent. even when kept for eleven months before sowing. The results of comparative tests with germisan, formaldehyde, and hot water showed no appreciable difference between the two former methods. Germisan has the disadvantage of being extremely poisonous. The percentage of seed which germinated after treatment with hot water was slightly below the other two methods and the control.

Formalin is comparatively inexpensive, the quantity of diluted solution required (80 litres) for the disinfection of 100 kg. of grain costing only Kr. 1.20 [about 1*s.* 5*d.*]. When the treatment is carried out with 100 kg. lots, each further 100 kg. of grain requires only 10 litres of the solution to replace what has been used. Formalin does not lose its strength after repeated use. Immersion is a far more reliable method of disinfection than sprinkling.

The concentrations recommended are 0·15 per cent. formaldehyde for rye and wheat, and 0·2 per cent. for barley and oats. The temperature of the solution should not be less than 12° to 15° C. The grain should be poured slowly into the solution (which should stand 10 cm. above the grain) and stirred with a blunt wooden shovel. The subsequent washing in water is carried out as follows: Three barrels are used, one raised above the others. The steeping takes place in the raised barrel (*a*) which is furnished with a tap. After twenty minutes the solution is drawn off into the left-hand lower barrel (*b*), (*a*) being filled with water for rinsing. After five to ten minutes the rinsing water is drawn off into the right-hand lower barrel (*c*). The solution in (*b*) can then be poured back into (*a*) and used again. If the process is carried out in the open the third barrel is superfluous, the water simply being run off on to the ground. Treated in this way the grain may be kept for a week or more before sowing.

A comprehensive bibliography, containing seventy references, is appended.

KREUZPOINTER (J.). **Einiges über das Beizen der Samen.** [Notes on seed steeping.]—*Wegweiser im Obst- und Gartenbau*, v, 1922. [Abs. in *Zentralbl. für Agrikulturchemie*, li, 8, p. 208, 1922.]

Uspulun used as a seed steep on old seed of celery and mangolds stimulated germination while a steep of corrosive sublimate retarded it. Anthracnose of kidney beans [*Colletotrichum lindemuthianum*] was controlled, and the yield increased fivefold. Celery rust was also suppressed. In both cases, however, the treated crop later became infected from neighbouring diseased plants. The beds should therefore be isolated as far as possible.

WIELER (A.). **Die Beteiligung des Bodens an den durch Rauchsäuren hervorgerufenen Vegetationsschäden.** [The rôle of the soil in the injuries to vegetation produced by smoke acids.]—*Zeitschr. für Forst- und Jagdwesen*, liv, 9, pp. 534–543, 1922.

The prevailing opinion that the injuries caused to vegetation by the fumes of acid gases develop almost entirely in the leaves cannot be unreservedly accepted. The author's observations and investigations in the forests of Stolberg on the Rhine and Clausthal in the Harz Mountains, both of which have suffered severely from smoke injury, have convinced him that the removal of lime from the soil by acid gases is primarily responsible for the protracted enfeeblement and final death of the trees. Experiments showed that the withdrawal of lime from the soil caused the formation of bare patches, on which even the common weeds of the district would not grow. After the application of lime to the affected patches, however, it was possible to grow broad-leaved trees and conifers. It has also been shown by comparative investigations that the withdrawal of lime takes place on a more extensive scale immediately under trees suffering from smoke injury. The absence of grass under trees in the parks and suburbs of manufacturing towns is due, not to the shade cast by the branches, but to a deficiency of lime in the soil under them. In the coal-mining districts of Westphalia the author noticed large bare patches in fields, the site of which was formerly occupied by woods. The application of lime removed all trace of these bare patches.

The root system is the first part of the plant to suffer from the deficiency of lime, but the effects are rapidly communicated to the aerial organs. Removal of lime also produces important modifications in the physical and biological composition of the soil, which react on the development of the trees.

These and other investigations show that, in forests especially, the influence of the acid gases on the soil, quite apart from any direct action on the leaves, must be taken into consideration. In cases of general debility, with no definite external symptoms, soil disturbances may reasonably be suspected, while they are frequently, as stated above, correlated with damage to the leaves.

Smoke injury may be combated to some extent by liming, but in severe cases it may be necessary to convert the forests into pasture and arable land, which are very much less susceptible than trees to the action of the fumes.

LANGERON (M.). **Un nouveau Sporotrichum malgache : Sporotrichum carougeaui Langeron, 1913, et remarques sur les Sporotrichés.** [A new Madagascar *Sporotrichum*: *Sporotrichum carougeaui* Langeron, 1913, and observations on the *Sporotricha*.]—*Bull. Soc. Path. exot.*, xv, 6, pp. 453–459, 2 figs., 1922.

After a brief discussion of the characters and systematic position of the genus *Sporotrichum*, the author describes in detail a new pathogenic *Sporotrichum* discovered in 1910 in Madagascar by Fontoynont and Carougeau. The fungus, which was isolated from ulcers on the neck and armpit of a native child, differs macroscopically from other species of *Sporotrichum* by its dazzling white colour which persists in the oldest cultures. The hyphae are septate, creeping, and 2·5 to 4 μ in diameter. The conidia are at first elliptical, and measure 2 by 4 μ, afterwards becoming circular, and attaining a diameter of 4 to 5 μ. They are produced at irregular intervals, along the whole length of the hyphae, either singly or in clusters, and may elongate and give rise, by a budding process, to secondary conidia.

The cultures of *S. carougeaui* exhibited a remarkable morphological uniformity, with no tendency to the production of *Botrytis*, *Graphium*, or other forms such as Boulanger and Vuillemin observed in cultures of *Sporotrichum* and *Rhinocladium*. Yeast forms were produced in abundance in cultures under certain conditions not yet determined. Probably this is the form in which the fungus exists in the tissues.

ELMER (O. H.). **Mosaic cross-inoculation and insect transmission studies.**—*Science*, N. S., lvi, pp. 370–372, 1922.

It is generally believed that the mosaic diseases of the Cucurbitaceae, Solanaceae, and Leguminosae are transmissible, with few exceptions, only to species within the same family. Cross-inoculation experiments by the writer have shown, however, that these three diseases are inter-transmissible.

Four petunia plants inoculated by inserting pieces of tissue with mosaic from crookneck squash into wounds in the stem became infected, while an equal number of controls remained healthy. Hypodermic inoculation of four crookneck squash plants with juice from tomato mosaic and four with juice from tobacco mosaic resulted in infection in all cases. One tobacco and two tomato plants inoculated with juice from mosaic crookneck squash leaves also became infected. In another experiment the insertion of mosaic crookneck squash leaf tissue into the midribs of five tobacco plants resulted in complete infection. Only one of five tobacco plants similarly inoculated with mosaic cucumber tissue became infected. Three out of five tomato plants inoculated with mosaic from catnip (*Nepeta cataria*) became infected.

Experiments with the cow-pea (*Vigna catjang*), which is susceptible to mosaic under greenhouse conditions, showed that the disease is transmissible by aphids, full infection occurring on seedlings in insect proof cages into which aphids from mosaic plants were introduced, while all the controls remained healthy. Numerous experiments have also demonstrated that the mealy bug (*Dactylopus* sp.) transmits the disease, especially in the case of cow-peas and soy-beans. When mealy bugs from a mosaic crookneck squash plant were transferred to 33 cow-pea seedlings they gave 100 per cent. of infection. Identical results were obtained in the case of 38 cow-pea seedlings inoculated by means of mealy bugs from mosaic infected eggplant. The transference of aphids from mosaic potato to 36 cow-pea seedlings resulted in the infection of 28. Mealy bugs were transferred from mosaic infected cow-pea to soy-bean seedlings, a large percentage of which developed the disease. In all the above experiments the controls remained healthy. The tobacco plants and one tomato were also infected with mosaic from crookneck squash through the agency of *Dactylopus* sp.

The writer is of opinion that mosaic infection is largely determined by the growth condition of the plant, unchecked, vigorous development promoting infection. Successful cross-infections between members of different families are more readily obtained with plants growing under favourable conditions than with those less well situated.

Narasimhan (M. J.). **The Areca koleroga work during 1921.**—*Mysore Agric. Calendar*, pp. 4–8, 1922.

The year under consideration was marked in Mysore by a recrudescence of the koleroga disease of areca palms [*Phytophthora arecae*] due to the heavy rainfall during the later part of the season. In five districts the number of trees sprayed against the disease amounted to about 372,000, covering a total area of over 900 acres as against 300 acres treated during the previous year. A fairly successful attempt was made to induce all the owners of block gardens to take up spraying, as it was believed that the disease appeared virulently every year if only isolated lots in a block were sprayed; in certain places where the disease had been virulent for some years, the Pest Act was enforced.

Experiments carried out over several consecutive years with a view to ascertaining the possibility of stamping out the disease in particular areas gave satisfactory results. The Kerodi garden showed no traces of the infection for three years after the cessation of the treatment, in spite of being in close proximity to badly infected areas; in the fourth year, however, the disease reappeared on a few trees, and has been increasing since then, but not with its former virulence. After a few years of spraying the disease has been completely stamped out in the Agumbe garden; during the last eight years, following the cessation of the control work, not a single tree has been attacked, notwithstanding the fact that the garden is situated in an area of high rainfall, and in a locality where koleroga is at its worst.

No change has been found necessary in the formula of the spraying mixture as originally recommended by the Department [Coleman. Diseases of the areca palm. 1. Koleroga, *Mysore Dept. Agric. Mycol. Ser. Bull.*, ii, 1910], except in the amount of soda with which the resin is boiled; this quantity may vary from $\frac{1}{2}$ to 1 lb. according to the nature of the soda. 'Blighty' Burgundy mixture did not give satisfactory results. The present cost of spraying 100 trees is from Rs. 2–12–0 to Rs. 3 [R. 1 = about 1*s.* 4*d*].

FULTON (H. R.). **Occurrence of Thielaviopsis paradoxa on the cocoa-nut palm in Florida.**—*Phytopath.*, xii, 8, pp. 398–399, 1922.

Sections of a diseased trunk of a coco-nut palm from Florida, examined in January 1922, showed extensive rotting of the ground tissue of mature parts, resulting in large internal cavities. The disintegrated part was dry and brittle, surrounded by a zone of recently invaded tissue which was brown and water-soaked. Cultures from the advancing margins of the decaying areas yielded almost pure growths of an organism agreeing closely with the description of *Thielaviopsis paradoxa*. The identity of the fungus was confirmed by inoculating healthy pineapples with pure cultures, which caused typical *Thielaviopsis* rot. *T. paradoxa* was readily recovered in pure culture from the artificially infected pineapple fruits and leaves.

The results of a series of tests indicated that 25° C. is the optimum temperature for mycelial growth in this fungus. At 15° C. there is distinct retardation, and at 10° C. visible development does not occur in twelve days.

FUNKE (G. L.). **The influence of hydrogen-ion concentration upon the action of the amylase of Aspergillus niger.** Reprinted from *Proc. Kon. Akad. Wetenschap. Amsterdam*, xxv, 1–2, 3 pp., 2 figs., 1922.

The action of the amylase produced in large quantities by *Aspergillus niger* does not appear to be unfavourably influenced by a high hydrogen-ion concentration of the nutrient medium. It was therefore assumed that the optimum concentration for the action of this amylase would not be found to be the same as the optimum for ptyalin, namely, an almost neutral or faintly acid reaction.

Preliminary investigations were made, equal amounts of enzyme solution from the nutritive liquid being mixed with buffer solution and 0·16 per cent. amylum solution. The hydrogen-ion concentration of this mixture was determined by the aid of colorimetric indicators, and the rate of hydrolysis of the amylum by the iodine reaction. It was found that there was no point of optimum action, but a broad optimal zone extending from P_H 3.5 to 5·5. No apparent influence was exercised either by the concentration of the amylase or the composition of the nutritive liquid. Amylase extracted from the mycelium gave the same results. The theory of Michaëlis, that the enzymes are ampholytes, is largely confirmed by these results.

The dissociation constant of the acid of the amylase of malt appears to be the same as for the amylase of *Aspergillus*, that of the base being larger, namely, $5{\cdot}76 \times 10^{-11}$. Thus as acids the two amylases are equally strong, as bases that of the malt is the weaker.

Hopkins (E. J.). **The effect of lactic acid on spore production of Colletotrichum lindemuthianum.**—*Phytopath.*, xii, 8, pp. 390–393, 2 figs., 1922.

The author found that the addition of three drops of lactic acid to 20 c.c. of potato agar greatly increased spore-production in cultures of the β strain of *Colletotrichum lindemuthianum*. In cultures containing two drops of acid a few pustules were observed, while the addition of only one drop caused no appreciable degree of sporulation. Spore-production in this species appears to increase with increase in hydrogen-ion concentration, while there is an accompanying decrease in the amount of vegetative growth.

Brown (W.). **On the germination and growth of fungi at various temperatures and in various concentrations of oxygen and of carbon dioxide.**—*Ann. of Botany*, xxxvi, 142, pp. 257–283, 1922.

The object of the author's investgations was to examine the behaviour of fungi under similar conditions to those of fruit storage. Of the two methods of fruit storage known—cold storage and gas storage—the former is widely employed, while the latter is still in the experimental stage. The temperature employed in practice for cold storing fruits usually does not go below 2° to 3° C.; and for his experiments the author has taken 5° C. as his lowest temperature except in a few cases. The gas storage method is based on the retarding action of carbon dioxide on metabolic processes. In practice, the maximum feasible concentration of this gas is somewhat below 20 per cent., for the concentration of oxygen in the atmosphere of the store has to be kept at a certain level so as to avoid anaërobic respiration. In the experiments special attention has therefore been given to the concentrations admissible in practice.

The work of other investigators in similar fields is touched upon in the historical section of the present paper, and an account given of the methods followed in the course of the experiments. The results obtained indicate that the conclusion can be drawn that, within very wide limits, variation of oxygen pressure has little effect on the germination and growth of the ordinary fruit-rotting organisms such as *Botrytis*, *Fusarium*, *Alternaria*, &c., no appreciable decrease in germination being shown until very low concentrations of oxygen—about 1 per cent.—have been reached. Even with a CO_2 concentration of 30 per cent., the oxygen content of air would still be 14 per cent. Hence, in practice, variations in the latter must be regarded as of negligible importance.

Carbon dioxide, on the other hand, retards the germination and growth of fruit-rotting fungi. This action is most marked at the lowest temperatures and in the weakest nutrient solutions, and is, to a lesser degree, dependent on the density at which spores are sown, greater density favouring retardation. Parallel series of germination tests—one in water and the other in a turnip extract made by extracting the juice of turnips boiled without any added water, and then diluted with water to one-fifth strength—showed that *Penicillium glaucum* is the most insensible of the fungi tested to CO_2, the concentration required to stop germination in the nutrient medium being 80 to 95 per cent., and in water over 30 per cent. This compares with 50 per cent. and 20 to 30 per cent. respectively for *Botrytis cinerea*, while *Aspergillus repens* required 40 per cent. CO_2 in the nutrient medium to prevent it from germinating. The time allowed for germination was seven days (the author considering this period sufficient for assuming complete inhibition if no germination had taken place by then), and the temperature was 15° to 18° C. In the case of *Rhizopus nigricans*, the spores of which, in 50 per cent. CO_2, showed universal germination, the germ-tubes, instead of being long, straight, cylindrical, and of uniform diameter, appeared as short, stunted structures, irregularly swollen. This is attributed to the formation of 'giant cells' ('*Riesenzellen*') due to acidity brought about by the high pressure of carbon dioxide. On being brought back to normal atmospheric conditions, these distorted germ-tubes resumed normal growth. This absence of permanent injury was observed in all the fungi treated with CO_2, as they germinated with their usual vigour and produced ordinary germ-tubes as soon as they were placed in normal atmospheric conditions.

The combined action of carbon dioxide and low temperature was tested upon (*a*) germination of the spores, (*b*) rate of growth of colonies on artificial media, (*c*) rate of growth of specific fungi on certain fruits. It was found that the inhibitory action of carbon dioxide is greatly increased by lowering the temperature. Even with the very resistant *Penicillium glaucum* a 10° C. drop from ordinary temperature, combined with 10 to 20 per cent. carbon dioxide, slows down the rate of growth of the germ-tube 6 to 9 times. Most of the measurements, however, were done not on germ-tube length, but on the diameter of plate colonies. It was found that the amount of retardation of growth is greatest in the earliest phases of growth and decreases with time usually up to a certain limit, but in some cases, at the higher temperatures, the carbon dioxide cultures overtake and may even pass those in air. This is due to partial neutralization by the carbon dioxide of the 'staling' which in these cases is associated with a development of alkalinity by the fungus.

As in the case of CO_2 action on germination, the retarding effect of CO_2 combined with low temperature varies with different fungi, in roughly the same order in both cases.

When inoculated into fruit the same general results were obtained, but the additional factor due to the different degrees of parasitism of the fungi tried had an effect on the results. For instance, *Botrytis* is a weaker parasite on apple than *Monilia*, and one may suppose that living apple tissue is a poorer nutrient for the former than for the latter. All the results obtained are believed to be covered by the statement that the carbon dioxide retarding factor has greatest effect when the energy of growth is small. Hence one would expect that *Botrytis* is more readily retarded than *Monilia* on living fruit, and this is the case.

The general conclusion is reached that the gas storage method is most effectively used in combination with the ordinary cold storage method, and that it will give the best results when no attack of the fruit has begun previous to storage, and when conditions are such that a minimum of nutrient is available for spores on the surface of the fruit.

Graphs and tables are given of the rates of growth of a number of fungi at various temperatures and in various concentrations of carbon dioxide.

DICKSON (B. T.). **Diseases of the Potato.**—*Fourteenth Ann. Rept. Quebec Soc. Prot. Plants*, pp. 67–105, 12 figs., 1922.

This is a somewhat popular account of the diseases of the potato in Canada, reprinted from *Scientific Agriculture.* The diseases described are hopperburn, mosaic and mosaic dwarf, leaf roll, powdery scab (*Spongospora subterranea*), blackleg (*Bacillus atrosepticus*), wart (*Synchytrium endobioticum*), leak (*Pythium de Baryanum*), late blight (*Phytophthora infestans*), wilt and stem rot (*Sclerotinia libertiana*), scurf (*Corticium vagum*), early blight (*Alternaria solani*), wilt and net necrosis (*Fusarium oxysporum*), scab (*Actinomyces scabies*), skin spot (*Oospora pustulans*), silver scurf (*Spondylocladium atrovirens*), dry rot (*Fusarium* spp.), and black dot (*Vermicularia varians*).

The last-named is new to America. It was first discovered in France by Ducomet in 1908, and named 'dartrose', and was afterwards found in Australia and South Africa. The symptoms of the disease are a slight yellowing of the foliage, sometimes accompanied by dwarfing, followed by the withering of the leaves, and the development of minute, black sclerotia on the surface, especially of the lower part of the stem. Sclerotia are also found lining the inside walls of the vascular cylinder and covering the tubers. The roots and rhizomes are also attacked. The mycelium is found throughout the tissues, including the leaves when the latter bear sclerotia. In the tubers it is confined to the outer layers and does not cause serious damage. In the author's cultures the spores were slightly smaller than those described by Ducomet and the setae longer, while the sclerotia were not closed pycnidia as he states. Ducomet's spore-measurements were 18 to 22 by 2·5 to 3 μ and the setae 100 to 130 μ.

The fungus is stated to be also parasitic on tomato and *Physalis peruviana* in France. The author has artificially infected the former. The disease is only serious in so far as it weakens the plants and thereby reduces the crop.

Crépin (C.). **Une maladie grave de la Pomme de terre dans le nord de la Loire.** [A serious Potato disease in the north of the Loire Department.]—*Comptes rendus Acad. Agric. France*, viii, 30, pp. 803–806, 1922.

A serious disease of potatoes has recently been observed in various localities in the north of the Loire Department. The symptoms appear towards flowering time, when the topmost leaves begin to curl, followed by those of the middle and base of the stem. In hot, dry weather the plants are killed in a few days, desiccation beginning with the lower leaves, which droop down along the stem. In dull or damp weather the plants may live for some time, their curled leaves frequently leading to confusion with leaf roll or leptonecrosis, from which, however, the present disease may be distinguished by two main characteristics. The topmost leaves are the first to be affected, and they become soft, flaccid, and drooping; whereas in leaf roll the leaves at the base show the first symptoms, and they usually remain firm and upright. In cases where the plants live for some time after attack, the stems and leaves gradually lose their chlorophyll and assume a greenish-yellow tinge, while the axillary buds develop into more or less swollen axes.

On pulling up a diseased plant it will be found that the stolons, roots, and underground portions of the stem are attacked by a dry rot. The cortex is easily detachable, leaving the central cylinder exposed. Under the periderm may be seen a number of minute, black sclerotia, situated around the medulla of the base of the stems and even in the wood. They are also present on the stem up to several centimetres above soil level.

On the tubers are grey or discoloured patches which also bear sclerotia, smaller than those on the stem. This disease of the tuber was investigated by Ducomet in 1908, found to be due to the previously undescribed fungus *Vermicularia varians*, and named 'dartrose' [see preceding abstract]. Since that time the disease has not been reported in France, which suggests that the fungus may be only a facultative parasite. In any case the damage caused by it is extremely serious in the vicinity of Saint-Germain-Laval, where all the fields are attacked, and not a single plant is immune. The yield is considerably reduced and many of the tubers are soft.

It will be necessary to institute a series of experiments during 1923 to test the resistance of the better-known commercial varieties, great care being taken to distinguish between what may be termed 'flaccid' leaf roll, and the true disease of that name.

Lachaine (O. W.). **Sclerotial disease of the Potato.**—*Fourteenth Ann. Rept. Quebec Soc. Prot. Plants*, pp. 105–109, 6 figs., 1922.

During 1921 the writer found 10 per cent. of sclerotial disease in a four-acre field of potatoes in New Brunswick, and 1 to 2 per cent. in four other fields. A blackish zone was found extending upwards from the soil for about five inches, giving the plants the appearance of blackleg. The cortical tissues were easily removed by rubbing. Three weeks later the outer necrotic tissues were dried out and the leaves yellowed. Abundant sclerotia were found in the place of the pith. After a month's freezing, followed by sterilization in mercuric chloride 1 : 1,000 and washing in sterile water, cultures were obtained from the sclerotia. No apothecia were observed.

Greenhouse experiments showed that the earliest signs of the disease are patches of whitish mycelium on the outside of the potato or tomato stem, at the point of infection level with the surface of the soil. In damp weather profuse mycelial growth occurs, with a subsequent development of external sclerotia, which are whitish at first, afterwards turning black and falling to the ground. The mycelium gradually penetrates to the pith, where rapid growth takes place with the formation of the internal sclerotia.

Inoculations on potato and tomato plants caused the destruction of the cortical tissue of the latter two inches above soil level, and wilting of the plant. The tissues of one potato plant were destroyed to a height of three-quarters of an inch, and half the circumference of the stem; on another the mycelium spread no farther than the tissues at the place of inoculation.

The fungus cannot be certainly identified in the absence of apothecia, but appears to be identical with *Sclerotinia libertiana*, Fcl. The only effectual control measures are the destruction of diseased material and crop rotation.

Lutman (B. F.). **The relation of the water pores and stomata of the Potato leaf to the early stages and advance of tip burn.**—*Phytopath.*, xii, 7, pp. 305–333, 9 figs., 1922.

The type of tip burn here studied is that associated with hot, dry weather and clear, brilliant sunshine, and is entirely distinct from that due to leaf-hopper injury. The work was carried out in Vermont, where leaf-hoppers are very rare.

Hydathodes have long been known to occur in the potato leaf, but no accurate study of them has been made. They occur on all margins, but are most frequently found toward the tip of the leaf. In structure they are not unlike stomata; the guard cells are larger, but otherwise identical, and they open and close in the same manner. The water cavity is larger, and opens directly on the vessels of the marginal vein, which is very highly developed and very characteristic.

Tip burn begins beneath the hydathodes, especially at the tips of the leaflets, the palisade parenchyma under the openings turning brown. The death of the tissues is probably brought about by excessive transpiration leading to extreme plasmolysis, and it proceeds backwards along the edges of the leaflet.

Poisonous substances (e.g. borax) are capable of being absorbed by the roots and producing a somewhat similar type of injury to that just described. In most cases of tip burn, however, the effect of poisons is likely to be secondary, but at times it is undoubtedly a primary factor.

The advance of tip burn into the leaf is explained as follows: The marginal vein, which probably plays an important rôle in equalizing the water-supply to all parts of the leaf, is liable to be killed under the influence of heat and intense sunlight. The result would be that the vein would not be able to supply water to prevent the wilting and plasmolysis of the tissues towards the midrib. Cells plasmolysed beyond a certain limit die, whilst those less severely affected become yellowed owing to the destruction of chlorophyll. Experiments showed that severing the marginal vein in a number of places in hot, sunny weather led to tip burn.

The stomata are important in relation to the transpiration of water, and were therefore studied. The number of stomata on the upper side is much greater than usually supposed, the proportion to the total number on the leaf varying from one-third on the young leaves to less than one-fourth on the older ones. Tip burn seems to have little effect on the stomata or tissues under them.

The author is inclined to distinguish another type of tip burn with rather clearly defined edges, which is more of the nature of a scorch, and appears to be the result of excessive sunlight, as it may be reproduced in the laboratory with mirrors.

SHAPOVALOV (M.). **Rhizoctonia solani as a Potato-tuber rot fungus.**—*Phytopath.*, xii, 7, pp. 334–336, 1 pl., 1922.

Rhizoctonia solani has been found producing a tuber rot on abnormal tubers of the varieties Netted Gem and Burbank in the western United States. Only the abnormally elongated stem ends of these tubers, and occasionally knobs and eye ends, appear to be susceptible, a very peculiar jelly type of decay being produced.

The flesh of the elongated stem ends is deficient in starch and differs from the remaining tissues of the tuber by its watery and somewhat translucent appearance. If uninfected these stem ends shrivel up.

Tubers showing the jelly-like decay, carefully selected from healthy plants, yielded only *R. solani* in culture. Affected tissues in the first stage of the infection were nearly white, but as the decay developed they turned yellow and brown. This *Rhizoctonia* jelly rot does not usually advance beyond the elongated part of the stem end, the decayed portion being ultimately sloughed off or drying up and hardening.

Inoculations with *R. solani* on five abnormally elongated tubers all gave successful infections. Although this fungus appears to be responsible for jelly end rot in the present case, the possibility that other organisms, especially species of *Fusarium*, cause a similar form of decay (as maintained by previous workers) is not excluded.

RICHTER. **Der Einfluss von Rhizoctonia solani auf den Keimungsverlauf der Kartoffeln.** [The influence of *Rhizoctonia solani* on the germination of Potatoes.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 3, pp. 19–20, 1922.

Investigations on the germination of potato tubers of the varieties Wohltmann and Kaiserkrone, carried out at Landsberg in 1922, showed a high degree of infection by *Rhizoctonia solani*—35 per cent. in the case of Wohltmann and 40 per cent. in that of Kaiserkrone. The small, dark brown or black nodules on the skin, after swelling and becoming soft, sent out vegetative hyphae which generally extended over the surface of the tubers, where they formed a brownish network. In many cases this surface growth, on reaching the newly-formed shoots, penetrated the latter, usually near the growing-point. Shoots thus infected turned brown and died. In a few cases the hyphae penetrated the older portions of the shoots first, generally from a lateral bud. The decay then appeared as a brown, scutiform spot, which gradually encircled the shoot and separated the upper, healthy part from the lower. The decay spread from infected to healthy shoots.

This disease was generally fatal, but occasionally particularly vigorous individuals managed to throw out new lateral shoots from buds situated below the decayed portion. The attacked tissues were completely rotted, and secondary infections by various bacteria frequently occurred. The fungus was isolated from the diseased tissues and formed sclerotia on various media. Out of the 68 Kaiserkrone tubers bearing *Rhizoctonia* scabs, the hyphae reached the shoots in the manner described above in 39, and of the 196 shoots borne by these 39 tubers, nearly 50 per cent. suffered from more or less severe rot. The resulting plants were poorly developed and their yield was reduced. The degree of infection was not lessened by germinating the tubers in dry, damp, or sterilized sand.

Kartoffelkrebs. [Wart disease of Potatoes.]—*Nachrichtenbl. für deutsch. Pflanzenschutzdienst*, ii, 10, p. 84, 1922.

The introduction of wart disease [*Synchytrium endobioticum*] into the small holdings of Berlin and its suburbs has led to the disease rapidly assuming the character of an epidemic, especially in the case of the Wohltmann variety. The infection dates back at least three years. At Dahlem a garden of about one acre in extent is completely infested, while neighbouring properties, separated by streets, appear to be still clean. The locality from which the infection was introduced has not yet been ascertained.

Poole (R. F.). **Recent investigations on the control of three important field diseases of Sweet Potatoes.**—*New Jersey Agric. Exper. Stat. Bull.* 365, 39 pp., 10 figs., 1922.

The loss from stem-end rot or yellows, a disease which can be caused either by *Fusarium batatatis* or *F. hyperoxysporum*, may amount to 65 per cent. or more in some parts of New Jersey, and is increasing in virgin soils. The Yellow Jersey is the most susceptible variety grown in the State, the Big Stem strains, the Red Jersey, and the Gold Skin varieties being more resistant. The so-called Southern Yams, such as the Porto Rico and Dooley varieties, are highly resistant under New Jersey conditions.

The vegetative mycelia of the fungi penetrate the fibro-vascular bundles of roots and stems, causing the wilting and death of the foliage. Dissemination is effected largely by the use of diseased seed-tubers and planting out infected cuttings, but soil, wind, water, animals, and manures are also involved. The selection of disease-free seed reduces the losses to some extent, even on severely infected soils. Some infected plants are very productive, yielding a large number of uniformly small tubers. Crop rotation over several years has failed to control the disease. Comparative trials with different fertilizers gave variable and inconclusive results in regard to the incidence of infection. Careful management of the seed-beds is very important. After a large leaf surface has developed, sufficient water should be given to prevent the hardening of the stems. Sprouts should be set in the field before the hardening of the stems and general stunting takes place.

Ground rot, 'pit', or 'pox' (*Cystospora batata*) is severe in one isolated area in New Jersey, infection ranging up to 85 per cent. In other States this disease is also generally restricted to particular areas. In the locality referred to the disease has spread only a few miles in over thirty years. Soils that pack and harden after rains are favourable to the development of the organism. Large and small roots are attacked with equal severity. The growth of the stems may be shortened as a result of the attack on the feeding roots, the leaves lose their normal colour, and the yield is reduced. The disease does not spread in storage or on sprouts. Sulphur added to the soil at the rate of 200 to 400 lb. per acre is recommended for the control of the disease, and also has the effect of increasing the yield. The experiments in its use showed that sulphur applied directly round the plants caused injury to the roots, but that 300 to 400 lb. per acre of 'inoculated' sulphur [see this *Review*, i, 3, p. 82] can be broadcasted with advantage on infected soil about a month before planting. A higher proportion of nitrogen is recommended for infected soils than is usually applied to sweet potatoes.

Scurf or soil stain (*Monilochaetes infuscans*) causes an average infection of 50 per cent. in New Jersey, and occurs even in virgin soils. Severely infected potatoes may lose more than half their weight in storage. The growth of the fungus is stimulated by organic manures, especially when applied in the row. Spores are formed best on a soil-extract medium. In storage the fungus spreads from healthy to diseased potatoes. The disease was slightly reduced by a combined application of lime and sulphur, while sulphur, 'inoculated' sulphur, and 'Bac-sul' were extremely effective. Inoculated sulphur applied at the same rate and time as in the last disease is recommended. The destruction of the fungus on the tubers may be effected by soaking the seed for eight to ten minutes in 1 in 1,000 corrosive sublimate. The use of infected tubers for seed should be avoided. Allowing a period of five years between successive sweet potato crops gave a slight decrease in infection in some cases, but in others no benefit was apparent.

SHAW (F. J. F.). **A diseased condition of Rice.**—*Agric. Journ. of India*, xvii, 2, pp. 152–154, 1922.

The author states that a diseased condition of rice, similar to that described in the United States under the name of 'straighthead' by Tisdale and Jenkins [see this *Review*, i, 3, p. 83], is not uncommon in India. He believes, however, that if the disease is due to lack of soil aeration, as held by these authors, it is not improbable that the deficit of oxygen is due to more complex causes than are suggested by them. The presence of decaying organic matter in the soil would at least suggest that bacterial activity may result in the production of toxins, and that the benefits of aeration are due rather to the oxidation of these toxins than to the direct supply of oxygen to the plant. Besides, the fact that in some parts of

India large quantities of green leaf are puddled into the soil is in contradiction to the view that decaying organic matter produces a soil condition injurious to rice. Straighthead resembles 'brusone' in its two chief symptoms, namely the feeble development of the fine root system and the lack of grain. Attention is called to the work of Brizi, who showed that a diseased condition of rice with root symptoms similar to those of 'brusone' is dependent on a deficiency in the supply of oxygen to the roots. While this is not considered to be sufficient to explain the occurrence of 'brusone', the author considers that a more extensive knowledge of the biochemical processes involved in the activity of the micro-organisms of the soil would be of value in postulating a general cause for this group of diseases.

Scientific Research Notes.—*Bull. Rubber Growers' Assoc.*, iv, 3, pp. 107–110, 1922.

The mycologists of the Malaya Research Branch of the Rubber Growers' Association report that *Kretzschmaria micropus*, which is commonly found associated with *Ustulina zonata*, may prove to be a dangerous parasite.

Young rubber trees in South India are reported by Ashplant to be affected by a die-back, caused not by *Diplodia*, but apparently by *Phytophthora meadii*. The symptoms are confined to the greener portions of the shoot, and the disease is arrested at the nodes. It was noticeable that the attacks were chiefly on the side of the plantation nearest to old rubber. It is suspected that the fungus may live over the dry season in the tissues, as McRae has shown to be the case with *P. meadii*, and the removal of all affected shoots at a point three-quarters of an inch below the diseased zone is recommended. Spraying may help to avert fresh outbreaks during the next monsoon. The effects of the disease being most serious on unbranched trees, leaf-pruning is advised as a means of inducing the trees to branch.

Contrary to the general belief in the efficacy of the scraping and tarring method in curing brown bast, a recent examination by Ashplant of an estate so treated showed 98 per cent. of disease, in spite of the unusual care with which the operation was conducted. In 75 per cent. of the cases, however, the affection was so superficial that a repetition of the treatment might eliminate it. The new tissues were highly laticiferous, the quantity of latex derived subsequent to scraping apparently equalling, if not exceeding, that obtained prior to the outbreak of disease, although trial tappings were not made.

Patch canker (*Phytophthora*) is far more prevalent in South India than in Malaya or the Dutch East Indies, probably on account of climatic conditions. Invasion of the cells by the patch canker fungus leads to the formation of a protective corky tissue. Under conditions favourable to the fungus (the excessive damp of the early monsoon) all the tissues outside the corky layer are destroyed, and in many cases the organism penetrates to the cambium, causing an open wound. Later in the season the course of the attack is modified by climatic changes, the dry, hot weather inhibiting the development of the fungus in the tissues. The chief danger of patch canker is said to lie in the possibility of subsequent physiological disturbances which may end in brown bast.

Dash (J. S.). **Insectes et maladies.** [Insects and diseases.]—*Troisième Rapport Stat. Agron. Guadeloupe, 1920–1921,* pp. 14–16, 1922.

The previous season's drought was responsible for a large extension in Guadeloupe of the root disease of sugar-cane due to *Marasmius sacchari*, especially in the coastal regions; in some cases the crop of whole fields was almost destroyed. Sugar-cane mosaic does not seem to occur in this island. Diseased cacao pods examined at the station were found to be attacked by *Phytophthora faberi*; practical measures for the control of the disease are recommended. The only diseases of coco-nut palm observed during the year were a few cases of bud rot and one of stem bleeding disease (*Thielaviopsis paradoxa*).

Overbrenging van Gelestrepenziekte door insecten. [Transmission of yellow stripe disease by insects.]—Abs. of a paper by L. O. Kunkel in *Hawaiian Planters' Record*, xxvi, p. 58, 1922. *Arch. Suikerind. Nederl.-Indie,* xxx, 21, pp. 357–358, 1922.

The results of very careful experimental work in Hawaii showed that *Aphis sacchari*, transferred from mosaic to healthy sugar-canes, flourished and multiplied, but no infection was observed. Experiments were also carried out with *Aphis maydis* (*A. adusta*), specimens of which were transferred from diseased (mosaic) maize plants to healthy Lahaina sugar-canes. In twelve days the first symptoms began to appear, and by degrees most of the plants thus treated became infected with mosaic, the controls remaining healthy. This confirmed Brandes's observations that *A. maydis* was an agent in the transmission of yellow stripe or mosaic disease from maize to sugar-cane.

Negative results have hitherto been obtained from similar experiments with *Peregrinus maydis* (which is able, however, to transmit the disease from one maize plant to another), and *Perkinsiella saccharicida*. These investigations are still in progress.

The danger of direct transmission of the disease from cane to cane by *A. maydis* appears to be slight. The insect only lives for a few days on the sugar-cane, which cannot therefore take the place of a permanent host like maize. Indirect infection by means of other regular hosts of the insect, such as *Eleusine indica*, *Panicum crus-galli*, *P. sanguinale*, *Polytrias diverisflora*, &c., is more probable.

Ledeboer (F.). **Gelestrepenziekte.** [Yellow stripe disease.]—*Arch. Suikerind. Nederl.-Indie,* xxx, 21, pp. 359–362, 1922.

The author states that a full report of the experiments on the transmission of yellow stripe (mosaic) disease of sugar-cane, carried out at the Cheribon Sugar Experiment Station, is in preparation. Meanwhile it is considered advisable to announce that *Aphis adusta* has been proved to be an active agent in this transmission. There is no actual evidence that *A. sacchari* is implicated, though at one stage of the investigations this seemed probable. In the course of the experiments it was ascertained that *A. adusta* occurs much more generally in sugar-cane plantations than is usually supposed, especially on *Panicum colonum* and *Paspalum (Panicum) sanguinale*. These grasses, in which the virus of the disease persists for long periods, are capable not only of infecting the canes in their vicinity, but also serve as new sources of infection when the diseased canes have been removed. All such grasses should therefore be burnt or buried. The cultivation of susceptible varieties of cane, e.g. the Cheribon-Chunnee crosses, should be restricted to outlying districts, where they will not contaminate healthy plantations.

Van Harreveld (P.). **Gelestrepenziekte en bladluizen.** [Yellow stripe disease and green-flies.]—*Arch. Suikerind. Nederl.-Indie*, xxx, 16, pp. 261–262, and 17, pp. 262–264, 1922.

It was recently announced in the Java Press by the Cheribon Sugar Experiment Station that the yellow stripe (mosaic) disease of sugar-cane was an infectious disease transmitted by the agency of a green-fly, *Aphis adusta (A. maydis)*. The exact cause of yellow stripe disease, which in Java assumes the form of partial chlorosis or mosaic, is still obscure, but this information will be of great service to investigators. It has been proved by American workers that the corresponding disease in Cuba, Porto Rico, and Louisiana can be transmitted by green-flies, but it is not certain whether the yellow stripe in Java is identical with the American form of the disease.

Two species of *Aphis* occur on sugar-cane in Java, viz. *Aphis sacchari* Zehntner and *A. adusta* Zehntner. The latter is much less common than *A. sacchari*, and is frequently concealed between the expanding leaves of the young shoots. It has not yet been observed on sugar-cane in the gardens of the Java Sugar Industry Experiment Station at Pasoeroean, although yellow stripe disease is prevalent there. The suppression of *A. adusta*, which is common on maize, sorghum, and other grasses, would be no easy task, especially as it is so readily concealed. Other insects may also be involved. In any case the method of selecting healthy canes from the young setts is not likely to be superseded by this new discovery. Canes of the Chunnee variety have been known to suffer from yellow stripe to the extent of 100 per cent. in the absence of any contact with grass or green-flies. This susceptible variety does not improve on being transferred to the mountains, but seems, on the contrary, to deteriorate. Other varieties liable to the disease are D I 52, 36, 213, 826, 979, 1499, 1507, 1547, and 2379 P O J.

Siggers (P. V.). **Torula ligniperda (Willk.) Sacc., a Hyphomycete occurring in wood tissue.**—*Phytopath.*, xii, 6, pp. 369–373, 1 pl., 1922.

The examination of logs of white ash (*Fraxinus americana*) from Tennessee and yellow poplar (*Liriodendron tulipifera*) from Kentucky revealed the dark, catenulate spores of *Torula ligniperda* scattered deeply in the wood. The fungus has been previously recorded in spruce, fir, oak, *Rhamnus cathartica*, and *Erica arborea* in Europe, and in maple, basswood, *Tsuga canadensis*, and red gum in the United States. In the laboratory the author grew it in cypress, white ash, yellow poplar, and cucumber tree.

The results of mechanical tests made on the yellow poplar and white ash logs, and a careful comparison of the values obtained with sound and infected test pieces, showed that in the former case the differences in these results could scarcely be correlated with the presence or absence of the fungus. In the white ash, on the other hand, all the infected logs except one had a lower specific gravity than the average for sound logs, while the logs, in which infection was readily apparent showed a marked decrease in strength values.

VRIEND (J.). **Stachytarpheta vatbaar door slijmziekte.** [*Stachytarpheta* susceptible to slime disease.]—*Vlugsch. Deli-Proefstat. te Medan* [Sumatra], 16, 4 pp., 1 fig., 1922.

The occurrence of slime disease (caused by *Bacillus solanacearum*) on *Stachytarpheta indica* in four different localities in Sumatra is reported. The plant is found at times in tobacco fields, and seeds freely in cultivated soils. The microscopic characters of the disease corresponded to those of slime disease in tobacco; a bacillus agreeing with *B. solanacearum* was found in the vessels, and an extract of the diseased tissues caused the death of inoculated tomato seedlings. An extract from these produced typical slime disease in young tobacco plants.

Stachytarpheta appears to be less susceptible than tobacco, possibly because of its more woody nature. There may be many other similar hosts of *B. solanacearum* amongst the weeds of tobacco fields, and if so they may have an important bearing on the perpetuation of the disease.

PALM (B. T.). **Verslag van het Deli Proefstation over 1 Juli 1920–30 Juni 1921.** [Report of the Deli Experiment Station from 1st July 1920 to 30th June 1921.]—*Meded. Deli Proefstat. te Medan-Sumatra*, Series II, 21, 72 pp., 4 figs., 1921 [1922].

The Botanical Department has been engaged in researches connected with the selection of tobacco in which disease resistance is taken into account. The question whether seed from plants affected by mosaic or slime disease (*Bacillus solanacearum*) inherits susceptibility to these diseases or not is also being studied. The available evidence does not yet admit of a conclusive statement on this subject, but it appears certain that the seed from mosaic plants does not produce a greater number of diseased seedlings than that derived from healthy plants. It has further been ascertained that a number of common Solanaceous weeds on tobacco plantations are also attacked by mosaic disease. *Physalis* and *Solanum* spp. are frequently affected and undoubtedly constitute a source of infection of tobacco. Mosaic also occurs on other plants, such as *Passiflora foetida*, *Jussieua* spp., *Cucurbita* spp., and various plants grown for green manuring, but it is not yet certain whether it can be transmitted to tobacco from plants belonging to other families.

Owing to the great difficulty of culturing the bacillus of slime disease it was necessary to find some other method of establishing its presence in the soil. Tomato seedlings, which are even more susceptible to the disease than tobacco, and grow more rapidly, were sown on tiles in about 1 cm. of sterilized soil. When the seedlings attained a height of about 5 cm. and developed four leaves they were used for soil tests. An aqueous extract of the soil to be examined was made (1 kg. of soil to 1 litre of water), and the extract distributed as evenly as possible over the tomato seedlings. The roots were then cut with a sterilized knife, the controls being treated in exactly the same way, except that sterilized water was substituted for soil-extract. If the soil was sufficiently rich in *B. solanacearum* the symptoms of slime disease began to appear in the infected plants after three or four days. After six days in one test there was a total of twenty-seven infections from diseased soil, as against an entire absence of contamination in the case of 'healthy' soil and the controls. It was found that weaker concentrations of the soil-extract (the extract as prepared above diluted with one and with nine volumes of water respectively) resulted in a reduction of infection. Thus, out of 108 plants, twenty-five were infected after six days by the undiluted extract, while the lower concentrations gave seventeen and eleven infections respectively. This method has been very accurately worked out and should prove extremely useful in determining the intensity of the soil contamination.

Recent investigations, which are still incomplete, indicate that infection commonly takes place at the moment of lifting the seedling for transplanting. This explains the necessity of using only seedlings from healthy beds. Other tests have shown that from ten to fifty per cent. of the cases of slime disease in the field are attributable to the use of infected seedlings. Researches are also in progress concerning the period of incubation of *B. solanacearum*, and the breeding of a partially or totally immune strain of tobacco.

D'Angremond (A.). **Die Bekämpfung von Phytophthora nicotianae in den Vorstenlanden.** [The control of *Phytophthora nicotianae* in the Vorstenland.]—*Meded. Proefstat. voor Vorstenlandsche Tabak*, xliii. [Abs. in *Zentralbl. für Agrikulturchemie*, li, 8, pp. 203–205, 1922.]

A number of samples of soil and manure have been analysed for the presence of *Phytophthora nicotianae* by the following method. The samples were stirred with water into a paste and spread on living tobacco leaves, which were covered with a layer of banana leaves. Twenty-four hours later the paste was washed off and the leaves preserved in tins for some days, when the spots were counted. The results showed that a large proportion of the stable manure used in the Vorstenland province was infected by *Phytophthora*. Comparative tests showed that the use of manure giving a positive *Phytophthora* reaction, however slight, endangered the tobacco crop. Even with a negative test the danger was by no means absent. Control plots, on which stable manure was not used, showed a much lower proportion of infection. Disinfection of the manure with carbon disulphide was effectual, but too expensive. The results of treatment with copper sulphate were not satisfactory. The use of stable manure for seed-beds is therefore very undesirable.

There are other secondary channels of infection, such as the water flowing from old tobacco fields to new ones, the floors of storehouses, &c. The practice of planting out seedlings between the existing rows of tobacco plants should also be avoided.

VALLEAU (W. D.) & KINNEY (E. J.). **Strains of Standup White Burley Tobacco resistant to root rot.**—*Kentucky Agric. Exper. Stat. Circ.* 28, 16 pp., 6 figs., 1922.

Root rot (*Thielavia basicola*) causes very serious losses to Kentucky tobacco growers, and pure line selection work has therefore been undertaken with a view to developing resistant strains. Twenty-five resistant strains of Judy's Pride and Vimont Kelley White Burley Tobacco have now been tested, and about fifty other selections have been made from a Standup variety called Station Kelley. The results so far secured indicate that it is possible to obtain strains of White Burley which combine high quality with immunity from root rot.

CLINTON (G. P.) & MCCORMICK (FLORENCE A.). **Wildfire of Tobacco in Connecticut.**—*Connecticut Agric. Exper. Stat. Bull.* 239, pp. 365–423, 4 pl., 1922.

Tobacco wildfire (*Bacterium tabacum*) differs from all other leaf spot diseases in certain definite characters. Both in the seed-bed and the field, infected plants develop yellow discolorations in the green tissues, the spots usually being rounded and about the size of a finger tip. In the centre of the spots is a small point of white to brownish, dead tissue, which gradually encroaches on the yellow discoloration. The latter then becomes limited to a narrow, encircling band, or halo. In severe cases a large part of the leaf surface may be killed, and damage up to 60 or 70 per cent. has been estimated to occur in a number of fields. The symptoms of the disease in advanced stages resemble sun scorch or the so-called rust following calico. The yellow halo rings, however, generally persist to the end.

An examination of specimens of tobacco from Rustenburg, South Africa, convinced the writers, in spite of the recently published statement to the contrary [see this *Review*, i, 11, p. 376], that the disease in that country was identical with wildfire in the United States. Inoculation experiments with a water extract of crushed infected tissues sent from South Africa in January 1922 proved unusually successful. It is suggested that a more careful comparison of angular spot and wildfire is required. In the United States wildfire has been reported from North Carolina, Virginia, Maryland, Massachusetts, Kentucky, Tennessee, Wisconsin, Georgia, Pennsylvania, Vermont, Florida, and possibly South Carolina. It was first recognized in Connecticut in 1919, and was probably introduced with seed, though possibly in matting, fertilizers, or other imports from some infected area.

Previous workers have held that the disease is seed-borne, but the writers' own experience does not suggest that the seed is the chief source of annual infection in Connecticut. There seems to be no doubt that the seed-pods are liable to infection under favourable conditions, while healthy seed may also be contaminated by dust laden with germs. One of the most frequent methods of spreading the disease is the planting of seedlings from infected fields. Other probable agents of dissemination are implements, the old tent-cloth used for seed-bed coverings, insects (especially flea-beetles), wind and rain, and the workers passing from one field to another.

It is not known how long the germs of the disease can remain attached to the dry seed and retain their viability, but it is assumed that the organism may overwinter on one-year-old seed so as to reinfect the next year's seedlings. It is very unlikely that the germs retain their viability as long as the tobacco seed, which germinates fairly well when eight to ten years old. Possibly the germs may overwinter in old canvas, in the soil, or in tobacco refuse.

In May 1921 the senior writer examined some seedlings which showed symptoms of rotting and shrivelling at the tips or upper edges of the leaves. Under favourable moisture conditions the plants ultimately shrivelled up altogether, leaving vacant patches in the beds. In less severe cases the rotten tissues fell away, leaving the rest of the leaf apparently healthy. Masses of bacteria were found in certain intercellular spaces in the rotten tissues. The general appearance of the seedlings resembled that of plants attacked by the damping-off fungi. About a week later these and other plants at a somewhat more advanced phase of growth showed the typical halo spots described above. The wet rot was evidently the first stage of the wildfire disease, not hitherto described. Probably the first leaves of very young plants come into contact with the soil, whence the wildfire germs may penetrate into the intercellular spaces through the large stomata at the tip or margin of the leaf. The second stage of the disease is the halo or yellow spot referred to above, and the third stage, which does not usually occur until the seedlings have been transplanted into the field, is the death of the healthy tissues between the spots. Plants left in the infected seed-beds are apparently not subject to a progressive form of the disease, partly on account of the reduction in moisture accompanying the removal of the covers, and partly because of the slow growth of the thickly set plants, which checks the spread of infection.

Cold, wet weather favours the development of the disease, which is always particularly serious when rain-water stands on the leaves. For this reason glass is a better protection to the seed-beds than cloth, and it also facilitates airing the beds. The latter should be lightly watered, preferably in the early morning or late afternoon. The Broadleaf, Havana, Cuban, and Round Tip varieties are all susceptible, especially the two former. As all Connecticut tobacco is grown for wrappers, the leaf injury results in much greater loss than in localities where the leaves are used for other purposes.

Southern investigators lay great stress on seed treatment for the control of the disease, but the writers question the importance of this measure in the north. Experiments in Connecticut with formalin (1 oz. to 1 pint of water for 15 minutes), and corrosive sublimate (1 part to 1,000 of water for 15 minutes), recommended by Fromme [see this *Review*, i, 3, p. 94], have resulted in the death of some of the seed, especially with formalin. Where the seed is suspected to have come from a diseased crop, disinfection with corrosive sublimate should be carried out. Steam sterilization of infected soil at a pressure of 100 lb. for 30 minutes before the next year's planting is recommended. Spraying the seedlings with Bordeaux mixture, 4–4–50, and lead arsenate, has given excellent results and was not found to injure the plants appreciably. The first application should be given when the seedlings have just taken root, the largest leaves then being about the size of a thumb-nail, and the spraying should be continued every week thereafter until the end of the transplanting season. The writers believe this to be the only remedy which prevents the spread of wildfire in a bed, no matter what the source of its introduction. For the field crop the removal of infected leaves once or twice shortly after the plants have started to grow may somewhat reduce infection, and in some cases, if the infected plants are still small, ploughing up and resetting with new seedlings may be recommended. Such cases must be left to the discretion of individual growers. The greatest care should be taken to transplant out only plants absolutely free from the disease; if this is done, the grower has usually little to fear in regard to the field crop. After pulling the plants for transplanting, infection may spread from diseased to sound plants, especially if left wet in baskets overnight before planting out. Aerial spread from a distance into isolated fields planted with healthy seedlings does not appear to be common. Spraying the field crop is not believed to be practicable on account of the cost and the unknown effect of the spray on the quality of the mature leaf. Nitrogenous fertilizers promote rapid, watery growth and thus indirectly favour the development of the disease. Potash has been recommended as tending to increase resistance by promoting a hardier growth.

Cultures of *Bacterium tabacum* are fairly easily obtained from the wildfire spots on tobacco leaves, the organism being isolated with equal facility either from the dead centre or the yellow halo. There are certain discrepancies between the characters attributed to the organism by Wolf and Foster (*Journ. Agric. Res.*, xii, pp. 449–458, 1918) and those observed by the present writers. The former give the dimensions as 2·4 to 5 by 0·9 to 1·5 μ, the latter as 1·3 to 2·5 by 0·6 to 0·8 μ. The writers also found one to four or even five flagella, Wolf and Foster only one. The dimensions of *Bacterium angulatum*, the cause of angular leaf spot, are stated to be 2 to 2·5 by 0·5 μ, the number of flagella ranging from three to six. These particulars do not differ widely from those of *B. tabacum* as observed by the present writers, and may account for the prevalent confusion between the two diseases.

By puncturing the tissues infections were easily secured in the leaf parenchyma, ribs, or stems of growing greenhouse plants, especially young plants. In general, young, recently isolated cultures were more virulent than those several months old that had been frequently subcultured. In nature, however, infection undoubtedly takes place as a rule through the open stomata. The writers have not observed the occurrence of wildfire on any weeds or plants in or near tobacco fields, and their inoculations on tomato and other related plants were also unsuccessful. It is stated, however, that Chapman and Anderson (*Mass. Agric. Exper. Stat. Bull.* 203, p. 74, 1921) inoculated petunia, eggplant, and pokeweed

(*Phytolacca decandra*) by spraying with suspensions of the bacteria in water, and also isolated the wildfire organism from spots on tomatoes growing in an infected tobacco seed-bed. The organism can remain alive in dried leaves for about a year, but not much longer. It can live in the soil for short periods, and there are indications that it overwinters in soil at times.

A full bibliography of thirty-four titles is appended.

GARDNER (M. W.) & KENDRICK (J. B.). **Overwintering of Tomato mosaic.**—*Botan. Gaz.*, lxxiii, 6, pp. 469–485, 1 pl., 1922.

Tomato mosaic might conceivably be carried over winter in Indiana by means of hot-house tomato crops, in tomato seed, in related perennial weed hosts, or by insects. Hot-house tomatoes do bear mosaic during the winter, but are not widely grown, and will not account for the widespread appearance of mosaic in the tomato crop in the fields. In a total of 22,944 tomato plants grown from seed from mosaic plants, no evidence of seed transmission of the disease was obtained. Previous workers have not found that aphids carry it through the winter.

Perennial weeds were found to be important agents in the overwintering of the disease. It has been found in the weeds *Physalis subglabrata*, *P. virginiana*, *P. heterophylla*, and *Solanum carolinense*, and has been transmitted from each of these to the tomato. *P. subglabrata* carries mosaic over winter in its rootstocks, and the symptoms appear on the young shoots in the spring. This weed is very prevalent in Indiana. Mosaic does not commonly occur spontaneously in *Physalis* weeds, but infection was common when these weeds grew in fields which had grown tomatoes, and was found to have spread to them over a distance of 200 to 400 ft. from the tomatoes. Aphids, and apparently also flea-beetles (*Epitrix cucumeris*), may serve to distribute the mosaic.

Mosaic has been transmitted from tomato to the annual plants *Solanum nigrum*, *S. integrifolium*, and *Lycopersicum pimpinnellifolium*, but not to *Datura stramonium*. It has also been transferred from tobacco to tomato, and has been noted on cultivated *Physalis pubescens*. Susceptible annual weeds may aid in the spread of the disease during the growing season.

Solanaceous weeds, especially the perennial ones and those in and near tomato-plant beds early in the season, should be eradicated as a control measure against mosaic.

PRITCHARD (F. J.). **Development of wilt-resistant Tomatoes.**—*U.S. Dept. of Agric. Bull.* 1015, 18 pp., 10 pl., 1922.

Tomato wilt (*Fusarium lycopersici*) causes an estimated annual loss of over 115,000 tons of tomatoes in the Middle Atlantic, Gulf, and lower Mississippi Valley States, and is also prevalent in the Ohio River Valley, California, and parts of Colorado and Utah. The only reliable means of controlling wilt (the symptoms and effects of which are briefly described) is the development of resistant varieties.

From 1915 to 1919 the writer was engaged in an attempt to breed resistant strains. The original selections were made from the worst wilt-infested fields that could be found, and pure line selections from these were tested by repeated plantings on infected soil. The resistance of the strains was graded by a combination of characters correlated with the degree of infection, namely, the percentage of infected plants, the percentage of dead plants, and the yield of fruit.

The only commercial varieties combining natural resistance with size and quality of fruit were found to be Duke of York and Buckeye State, which the author regards as virtually identical. Livingston's Globe was somewhat resistant, but besides being very susceptible to nail-head rust (*Macrosporium* sp.), it is unsuitable for canning. Absolute immunity was not exhibited by any of the forty varieties tested during the period under review. In the 1915 test the Louisiana Wilt-Resistant showed the smallest percentage of plants killed by wilt and Willis the highest, but in subsequent years Duke of York and Buckeye State gave almost as good results as Louisiana. In 1918 The Marvel, Columbia, Norton, Arlington (these four being strains developed by the writer from the Greater Baltimore, Stone, and Merveille des Marchés varieties), Louisiana Red, Louisiana Pink, and Tennessee A 16–2 were almost free from wilt, while John Baer, Greater Baltimore, Stone, Royal Red, Delaware Beauty, Red Head, Early Jewel, and Bonny Best were almost destroyed by the disease. The Mansfield tree tomato was fairly resistant, but produced little fruit; the results of tests with the Success and Mississippi Girl varieties were conflicting.

Most varieties differ little in the wilt resistance of the individual plants within the variety. A few, however, showed great variability in this respect, and selections can be made from them that transmit a high degree of resistance. Most selected plants transmit to their offspring approximately the same degree of resistance possessed by the parent plant, though occasionally the character may be strengthened in the second selection. The process of selection is somewhat complicated by environmental factors, which cause a certain amount of fluctuation in the character of resistance. On an average, however, wilt resistance is less variable than tomato fruit characters, its stability being maintained under both continued and discontinued selection, and in a number of different localities.

Several very resistant strains have now been developed by the writer, and are of high yield and superior quality of fruit. Field tests have been carried out with them in various parts of the United States, and have given excellent results. These strains are described in detail.

Champion (H. G.). **Notes on the death of Chir (Pinus longifolia) poles in the Almora plantations of Kumaon.**—*Indian Forester*, xlviii, 4, pp. 168–174, and 5, pp. 232–246, 1922.

Since 1916 the author has carried on investigations and collected all the available information regarding the extensive mortality in young *Pinus longifolia* grown from seed sown since 1875 in the Almora plantations, in the Himalaya. The disease was observed by Stebbing in 1908, and ascribed to the attacks of a weevil. This view is critically examined by the writer, who is satisfied that the insect is secondary to the real cause of the trouble. The same applies to the other insect pests found by the writer, full notes on which are given. The deaths occur principally among trees of $1\frac{1}{2}$ to 4 ft. in height, especially on dry and shallow soils, but in certain districts well-established poles of thirteen years old and 1 to 2 ft. in girth, growing in good soil, have succumbed on a large scale. Schistose rock is the foundation of most of these soils, and there is an abundance of grass, much of which is *Andropogon repens*. In one district the loss of plants under 1 ft. in girth amounted in 1918–19 to 2,055 and in 1920–21 to 930. In the course of three years a sample plot of trees, $1\frac{1}{2}$ to 2 ft. in girth, has lost 25 per cent. of its dominant trees.

Three years is the normal period elapsing between the first symptoms and death. During this time the appearance of the crown remains quite normal, though removal of the bark may show that the cambium has been completely girdled for at least twelve months. The growth in height, the length and density of the needles, and the date of expansion of the buds are not affected by the disease. At length an abrupt change takes place. The twigs lose their normal brittleness and the foliage its bright colouring, and in a week or two the entire crown turns yellow and dry. There is usually a more or less copious exudation of resin from the basal parts of the stem, generally extending over a zone from $\frac{1}{2}$ to $3\frac{1}{2}$ ft. in height. In all cases death seems to be the final result of the resin flow, though one tree has survived since 1918. The cases are frequently, but by no means always, concentrated in patches. The advanced stage of the disease may be observed at almost any time of year, but the periods of maximum incidence are March to April, coinciding with the renewal of growth after the winter rest, and August, corresponding to the height of insect activity.

The primary cause of the disease is believed to be the fungus described by Barclay as *Peridermium complanatum* var. *corticola*. The writer, however, thinks that the fructifications on the needles are not due to the same fungus as those on the bark, their identity never having been demonstrated. They are here referred to, for convenience, as f. *acicola* and f. *corticola*. The former is extremely common, but appears to do little damage to its host. The bark form is less common in natural regenerations, but in the plantations may become severe. It sends its orange aecidia through crevices of the bark towards the end of the hot weather in May. External bleeding is not always caused, but a trickle of resin may be the first indication of an infection. An examination of the cortical tissues below the origin of such a flow revealed on one occasion a mycelium probably belonging to the *Peridermium*. Reduced resistance and the resin flux attract various injurious insects, which complete the destruction of the tree.

The general indications show that the fungus is prevalent enough to account for the damage. In a plot 100 ft. square, in one plantation, 77 out of 127 plants, 2 to 6 ft. in height, showed the fructifications of the *corticola* form, while f. *acicola* was present on all the trees. The fructifications of the former generally occur on the main trunk, 6 in. to 3 ft. from the ground, and are often confined to one side. Two cases were noted in which one or two branches became badly infested, swollen, and cankered; they finally dried off without infecting the rest of the tree. In no case so far seen could the swellings and cankers sometimes found be attributed exclusively to the action of the fungus. Possible alternative hosts mentioned are *Crataegus* and *Rosa moschata*.

Drastic measures are necessary for the control of the disease. All trees showing signs of going off colour should be immediately removed and burnt, taking care to cut a few inches below ground-level. It is of the utmost importance to eradicate infected plants before the spores are shed. Any new sowings on a large scale should be made in uninfected areas. The plantations near Almora are isolated from other pine forests, so that the danger of external infection is small. Frequent inspections are essential, especially in April and May, the only months when the fungus is sure to be visible.

FAES (H.) & TONDUZ (P.). **Rapport annuel 1921. Station fédérale d'essais viticoles à Lausanne et Domaine de Pully.** [Annual Report for 1921 of the Federal Station of Viticultural Experiments at Lausanne and the Domain of Pully.]—Reprinted from the *Annuaire agricole de la Suisse 1922*, 20 pp., 7 figs., 1922.

The Cantonal Viticultural Station at Lausanne (Vaud) was in 1920 transformed into a Federal Station serving the cantons of Fribourg, Geneva, Neuchâtel, Ticino, Valais, and Vaud. The Station has as its objects the perfecting of the various methods of control used against the insect and fungous parasites of the vine; the prevention or cure of 'diseases' of wines, and the development of viticulture in the canton of Ticino, where a series of researches has been undertaken in collaboration with the Agricultural College of Mezzana. In addition to this work the Station is also carrying out a series of investigations in fruit growing. It is proposed to undertake the selection of the most suitable varieties of apple for dessert and cider-making respectively, in order to increase the desirable types and eliminate the inferior ones already in cultivation. Special attention will be given to different blends of varieties suitable for cider-making, and also to problems of cultivation, manuring, and the control of parasites.

The section of physiology and pathology deals, among other subjects, with diseases of the vine, fruit trees, and other plants, and the comparative efficiency of the various fungicides, &c., utilized in phytopathology, while that of viticultural chemistry and fermentation is concerned with the study of 'diseases' of wine and cider, the control of proprietary insecticides and fungicides, the selection of pure races of yeasts, and the general microbiology of viticulture and agriculture, in addition to more purely chemical problems.

A short account is given of the activities of the Station during the year. The results of the two chief inquiries of interest here have been separately published, and are noticed below.

FAES (H.), TONDUZ (P.), & STAEHELIN (M.). **La lutte contre le mildiou en 1921.** [The campaign against mildew in 1921.]—*Stat. féd. d'essais vitic. de Lausanne*, Pamphlet, 14 pp. [1922].

It would appear, generally speaking, that meteorological conditions during the last few years have been more favourable for the control of [downy] mildew [*Plasmopara viticola*] than was the case during the period 1901–1917. In 1921 the writers carried out a series of observations in the vineyard of Pully, which is connected with the Federal Station of Viticultural Experiments at Lausanne. The incubation period of the fungus during the summer varied from seven to eleven days. The principal phases in the development of the disease are described, and a chart is given showing the variations in temperature and other meteorological conditions from May to the beginning of October. The season was very favourable to the development of the vine, and the damage caused by the fungus was therefore inconsiderable, except in the case of a few plots treated with inferior fungicides.

Attention is drawn to the difficulties encountered by the meteorological experts attached to the viticultural stations in warning growers of the necessity for treating vines. The system of forecasting attacks is based on the incubation period of the fungus, and, as the season advances, the successive invasions overlap and it becomes necessary to provide not only for the treatment of each fresh wave, but also for that of previous infections. Attempts to do this every time that the meteorological conditions are favourable for sporulation and infection usually lead to too many applications of fungicides being recommended.

Experiments were carried out with eleven preparations for the control of mildew, two of which, the Bouillie Villedieu and 'Burdigal', contained no copper. These two proved complete failures and need not be further considered. The results with the others are summarized below:—

Bouillie mixte (a commercial preparation containing sulphates of copper, nickel, zinc, and iron), 3 kg. of the mixed sulphates, neutralized with the corresponding quantity of milk of lime, per hectol. of water. The preparation was very effective, scarcely a trace of the disease being observed. The leaves fell in October. Kurtakol (a commercial preparation of colloidal copper), 500 gm. to 100 l. of water. Slight attacks of the fungus occurred, but the foliage remained in good condition till November. This preparation is worthy of extended trials. Neutral verdet [copper acetate], 1,000 gm., gelatine 500 gm., water 100 l. The attacks were very slight and the foliage well preserved. The adhesiveness of the mixture was very marked. Caffaro paste (a commercial preparation of oxychloride of copper), 1 kg. to 100 l. of water. The treatment was not begun till June, and the results were not altogether successful, several slight attacks occurring and the foliage turning yellow in the middle of September. Bordeaux mixture (3 per cent. copper sulphate) and casein (50 gm. per hectol.). This treatment was most effective, infection being reduced to a minimum. The copper adhered to the leaves unusually well, forming a coating which completely resisted the action of rain; it is not necessary to add more casein than the quantity given above. Bouillie Sanavigne (a commercial cupric mixture with casein), 1,000 gm. to 100 l. of water. Excellent results were obtained, mildew being almost absent. Sulfadhérent (a commercial preparation of lime and casein to be added to copper sulphate solution made by dissolving 3 kg. $CuSO_4$ in 100 l. water). The vines were well protected against mildew, but in spite of the great quantity of caseined lime employed the adhesiveness of the preparation was no greater than in the ordinary caseined Bordeaux mixture. The consistency of the mixture is too thick and the spraying machines become clogged. Kukaka (a commercial caseined cupric mixture prepared in Zürich). Moderate protection against mildew. Insufficient resistance to the action of rain. Ordinary Bordeaux mixture (3 per cent. copper sulphate). Results satisfactory on the whole.

It is pointed out that the critical period in the development of the disease in the area referred to is from the end of May to the end of July. If during this period the oily patches of infection appear seven to ten days after a warm rain, vigorous measures should be taken to protect the sound foliage from infection.

FAES (H.) & STAEHELIN (M.). **Le coître de la vigne (Coniothyrium diplodiella) ou maladie de la grêle.** [The coitre (*Coniothyrium diplodiella*) or hail disease of the Vine.]—*Stat. féd. d'essais vitic. de Lausanne*, Pamphlet, 14 pp., 7 figs. [1922].

Coitre, livid rot, or hail disease of the vine is caused by *Coniothyrium diplodiella* Sacc., a fungus that has certain analogies with the black rot organism (*Guignardia bidwellii*) with which it is often confused. A brief account is given of the history and distribution of the parasite, which has been recorded from Italy, France, Austria, Hungary, America, Algeria, and Switzerland. The most comprehensive work on the disease is that of de Istvanffi (Études sur le rot livide de la vigne (*Coniothyrium diplodiella*), *Ann. de l'Inst. central ampélologique royal hongrois*, ii, 1902). The present article is intended only as a preliminary outline of the problems still demanding investigation, the most important of which are stated to be the following:—

In the vineyards of Latin Switzerland epidemics of livid rot generally occur only after a hailstorm, whereas in other countries they often take place independently of the latter. The reason for this is not yet clearly known, and requires investigation based on exact knowledge of the local conditions of climate and cultivation in the different areas affected. Even in Latin Switzerland every hailstorm is not necessarily followed by an outbreak of livid rot. It sometimes happens that hailstorms in July and August, months ordinarily favourable to the disease, do not bring on an attack, and the reason for this is, again, unknown. Furthermore, little is known as regards the treatment of livid rot. The practice of cutting the grape-stalk above the point of attack in order to prevent the spread of the fungus is lengthy and tedious, and can only be carried out over a limited area. Treatment with copper sulphate mixtures immediately after hailstorms does not appear to have much effect on the disease, but is usually recommended in the absence of anything better. The application of sulphur immediately before or after a hailstorm has also been advised, but without any scientific justification. All that is known is that the spores of *Coniothyrium diplodiella* are highly resistant to the action of copper salts.

The authors' own observations indicate that infection of the grapes occurs through wounds inflicted by hail. The spores actually penetrate through these wounds and germinate in the interior of the grape. The mycelium ramifies quickly through the tissues of the fruit, extends down to the rachis, and from the latter reaches other grapes of the bunch. The damage is most severe on mature grapes, especially at the end of July and during August, owing to the high sugar-content of the fruit at that time. The fungus may begin its attack at any point on the bunch, never attacking all the grapes simultaneously. The first symptom of infection is the appearance of zones of different colours on the grape. The outermost zone is of a greenish-golden colour, and this is followed by a reddish-yellow and a brownish zone, the centre of the spot being livid in colour. Gradually the entire grape assumes the livid hue and becomes dotted with pycnidia varying in colour from greyish-white to rose-brown. At this stage the rot is a 'wet' one, and the grapes adhere loosely to the pedicels and are easily detached by the wind or any slight shock. Those that remain gradually become mummified, adhering very firmly to the stalk in this state and giving rise in the following year to new spores which perpetuate the disease. De Istvanffi estimates the average number of pycnidia on an ordinary-sized grape at 200, each containing about 80,000 spores, which retain their viability for nine or ten months under dry conditions. When the pycnidia are placed in a drop of water, the whole mass of spores exudes through the ostiole. Those given out by young pycnidia are mostly hyaline, those from the older pycnidia coloured; both kinds germinate readily in nutrient solutions, giving rise to a hyaline, septate mycelium with granular contents and numerous vacuoles.

Inoculations were carried out at Pully on the 5th August 1921 with spores from mummies of the previous year, kept dry in the laboratory until forty-eight hours before use, when they were placed in a warm, damp situation. Drops of water containing these spores were placed on Chasselas grapes which had been wounded with a scalpel. On 8th August the infected grapes showed the typical livid discoloration and the pedicels were turning brown and shrivelling. The next day the infection spread from the pedicels to the unwounded grapes. The pycnidia appeared on the surface two days later, and by the end of the month the infected bunches were almost entirely mummified. On the control bunches, which were wounded but not inoculated, there were slight evidences of *Botrytis cinerea*, but no livid rot. These results prove that livid rot is not caused by wounding alone, as, for instance, by hailstones, but the spores of the fungus must also be present, which was evidently not the case on the non-inoculated grapes in this vineyard. Further inoculation experiments were undertaken to ascertain whether infection could be produced through wounds on the leaves, peduncles, and shoots. The results were all negative so long as water was used to germinate the spores, thus agreeing with the practical experience of the local vine-growers, who have never observed livid rot elsewhere than on the grapes. It was noticed that the spores germinated much more readily in grape juice than in water, this fact being, no doubt, one of the reasons why wounds favour infection. Further attempts to inoculate leaves with spores sown in drops of grape juice were successful, entry into the leaves probably occurring through the stomata. The minimum amount of sugar required for spore-germination was found to be about 0·01 per cent. With a nutrient solution containing 2 per cent. of sugar, germination was rapid and complete, but there was none when the sugar-content was only 0·001 per cent.

Experiments on the treatment of the disease are still in the preliminary stage. Applications, two hours after infection, of Bordeaux mixture (3 and 4 per cent. copper sulphate) and of potassium bisulphite (2·5 per cent.) gave promising results. A lapse of four days between artificial infection and treatment rendered the latter completely useless.

Der Referentenentwurf des neuen Pflanzenschutzgesetzes. [Extract from the new Plant Protection Order.]—*Deutsche Obstbauzeit.*, lxviii, 32, pp. 299–300, 1922.

The following is a summary of the new order regulating measures for the suppression of diseases and pests injurious to cultivated plants in Germany.

The Plant Protection Service is carried on by (*a*) the Biological Institute for Agriculture and Forestry at Dahlem, Berlin; and (*b*) local head-quarters of the Plant Protection Service in the various districts of the country. The establishment and maintenance of these local head-quarters and the organization and development of the Plant Protection Service in the different provinces is in the hands of the provincial authorities, but is carried out in accordance with regulations issued by the Minister of Agriculture and Food Supply. The authorities of the different provinces may unite for the execution of the order.

The diseases and pests to be dealt with, together with the means of control, will be announced by the Minister of Agriculture. The directions for treatment will be issued by the authorities in consultation with the experts of the Plant Protection Service.

On the occurrence or suspected occurrence of any such disease or pest, the occupier ['Besitzer'] of the infected land is to notify the proper authority within three days. The local head-quarters of the Plant Protection Service, on discovering the existence of a notifiable disease or pest, must provide for the immediate execution of the prescribed directions. In urgent cases they may issue special directions for control, immediately informing the Biological Institute that they have done so. In cases where the occupier does not agree with the findings of the local Plant Protection authorities, the verdict of the Biological Institute must be obtained and is final.

The occupier of the ground on which the disease or pest occurs is obliged to carry out, at his own expense, the directions issued by the local head-quarters, and to give every facility for supervision of the work by the proper authorities. He has the right to appeal against the directions, but the work is not to be suspended pending the hearing of the appeal.

In the event of the occupier refusing to carry out, or carrying out inadequately, the prescribed measures, the local head-quarters may carry them out at his expense. He is not entitled to compensation for loss or damage resulting from the prescribed measures.

Duly authorized members of the inspection staff are entitled to enter private land, buildings, &c., and to remove samples.

The import of plants and parts of plants into Germany is already partly regulated by Orders issued on 16th January 1917 and 22nd March 1920. These Orders are not affected by the new Order, which further extends them.

The import into German territory of plants and parts of plants regarded as carrying dangerous plant diseases or pests, and the import of injurious pests and germs of disease is prohibited. The Minister of Agriculture shall determine what plant diseases, pests, and germs are to be regarded as dangerous, and also what plants and parts thereof are to be regarded as bearers of them. Importation of living plants and parts of plants is restricted to certain points of entry and requires an import-permit. The latter will be issued, subject to inspection of the consignment on arrival, in the following cases:—(*a*) consignments from countries with adequate plant protection legislation when the consignment is accompanied by a certificate of examination, signed by an official expert, and stating (1) that the contents of the consignment are free from diseases and pests which would exclude it from admission; and (2) that the consignment originated in a locality free from infection. (*b*) Consignments from countries with inadequate plant protection legislation in accordance with directions to be issued by the Minister of Agriculture and Food Supply. [The remainder of the Order deals mainly with the penalties attaching to infringements of the various sections.]

Décret du 21 décembre 1921, No. 15198, approuvant le règlement de la défense sanitaire végétale au Brésil. [Decree of 21st December, 1921, No. 15198, authorizing the regulation of sanitary measures for plant protection in Brazil.]—*Diario official*, No. 14, 18th Jan., 1922. [Abs. in *Bull. mens. des Renseignements agricoles et des Maladies des Plantes*, xiii, 5–6, p. 809, 1922.]

The decree prohibits the importation, commerce, and transit in Brazil of live plants or parts of plants attacked by diseases or parasites recognized as dangerous; of harmful live insects at all stages of their development; of cultures of bacteria and fungi injurious to plants; of soils and organic débris liable to contain, at whatever stage of development, cryptogamic, or insect, or other pests of plants, even if such material forms an integral part of living plants; and of boxes, sacks, or other packing-material having served for the transport of the above-mentioned products.

The Minister of Agriculture, Industry, and Commerce is further authorized to prohibit the importation of any vegetable product originating in countries where diseases and pests, the introduction of which would constitute a menace to home-grown crops, are prevalent.

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IMPERIAL BUREAU OF MYCOLOGY

REVIEW

OF

APPLIED MYCOLOGY

VOL. II FEBRUARY 1923

BROWN (J. G.). **An undescribed fungus on the Pepper tree.**—Abs. in *Science*, N.S. lv, p. 547, 1922.

The pepper tree (*Schinus molle*), which is grown as an ornamental tree in warmer areas in the south-western United States, was found attacked by a fungus causing rotting of the wood. The branches may die gradually, or the entire tree may wilt and die suddenly on account of mycelial growth in the tracheae. Infection takes place through wounds.

Sporophores were found on the trunk and branches during the rainy season, and are bracket-like, brown to blackish, azonate, annual, usually from 12 to 15 cm. in diameter. The fungus is named *Inonotus schini* n. sp.

DUFRÉNOY (J.). **The occurrence of Cronartium ribicola in Europe.** —*Phytopath.*, xii, 6, pp. 302–304, 1922.

In Europe the aecidial stage of *Cronartium ribicola* chiefly occurs on the Weymouth pine (*Pinus strobus*), though *P. lambertiana* and *P. flexilis* may also be infected. The disease has not been observed in southern or central France. The teleuto stage is uncommon, and has never been seen by the author on wild *Ribes*. References are given to the published records of the distribution of this fungus in some other European countries.

MACCALLUM (BELLA D.). **Some wood-staining fungi.**—*Trans. Brit. Mycol. Soc.*, vii, 4, pp. 231–236, 2 pl., 1922.

After a short reference to the literature on wood-staining fungi, the author states that 'blue-rot' has been known for many years in Great Britain, and it has been assumed to be caused by one or more species of *Ceratostomella*, without, so far as she knows, any description of the species concerned. Her present investigation showed that *C. pini* Münch and *C. piceae* Münch occur very commonly in and around Edinburgh, and in all the woods visited between that town and Inverness. In all the cases affecting standing trees which have come under observation the bark of the tree was riddled with holes made by the pine beetle *Hylesinus piniperda.*

The author gives a detailed account, based on the study of artificial cultures, of the life-history of *C. piceae.* This species occurs as a nearly pure growth on *Picea excelsa.* It is not certain how far it stains the wood. In Scotland spruce timber is quite unstained by it even when perithecia occur thickly all over the surface. It occurs very frequently on badly stained *Pinus sylvestris,* but has never been found unaccompanied by other fungi, with which it is inextricably mingled. Pure cultures on sterilized blocks caused only a very slight discoloration.

Cultures started from ascopores rapidly give rise to conidia of the *Cladosporium* type. Later on a *Graphium* form appears, probably *G. penicillioides* Corda. Perithecia were formed in culture in about two weeks. Attempts to isolate single ascopores failed owing to their slimy covering. Cultures from single *Graphium* conidia only gave conidial forms. Cultures from single *Cladosporium* conidia have, however, given the perithecial stage as well as the *Graphium* form, and though the author does not consider the evidence complete owing to the few successful cases, she thinks that Münch was correct in including a *Graphium* stage in the life-history of *C. piceae.*

WILSON (M.). **The blueing of coniferous timber.**—*Trans. Roy. Scot. Arbor. Soc.*, xxxvi, 1, pp. 82–92, 1922.

This paper is a concise account of the present state of knowledge of the blueing of coniferous timber, which the author states is widely distributed in Great Britain with the result that a considerable quantity of affected timber is being put on the market. Blued wood is graded and priced considerably lower than sound timber, and is frequently rejected for such purposes as pit props, sleepers, shipbuilding, &c. Its value for furniture construction is also usually reduced by 25 to 50 per cent.

The fungi most frequently found in blued wood are mentioned, and details are given of the investigations in other countries as well as in Great Britain regarding their life-history, the conditions favouring their attacks, and their effect on the wood.

It is concluded that blued wood is slightly weaker than healthy timber and should not be used for structural purposes where failure would result in serious consequences.

BONAR (L.). **The life-history of Rosellinia caryae sp. nov. causing a Hickory canker and disease.**—*Phytopath.*, xii, 8, pp. 381–385, 3 figs., 1922.

A disease of hickory (*Carya ovata*) was found in Michigan in the spring of 1921. Affected branches showed dead, sunken areas on otherwise vigorously growing, young shoots. There was a high percentage of canker among the younger growth. The cankers varied in size from mere spots to patches 6 in. by 3 in. in diameter, and nearly always occurred round the leaf scars or on the tips. Examination of the diseased areas on the younger twigs showed abundant fruiting bodies of a fungus in the bark, which broke through the periderm in isolated, small pustules. These proved to be pycnidial structures, somewhat variable in form, growing immediately beneath the periderm, which ruptures and exposes a black dome. In section a black, differentiated wall over the top only is seen. Subsequently, however, the black wall develops downward all the way round except a narrow portion at the base.

There is no definite ostiole, but the hymenial layer extends over the entire inner surface of the pycnidium. Hyaline spores, broadly fusoid, usually containing oil globules, 5 to 7 by 2·5 to 3 μ are borne in great profusion on Indian club-shaped conidiophores. At maturity the pycnidium ruptures irregularly, the upper carbonaceous part frequently breaking away and leaving a cup-like cavity.

The fungus grew readily from single spore isolations on sterilized green bean pods or green bean agar. Pycnidia formed in artificial culture had a pycnidial wall all the way round, a slight papilla-like growth similar to an ostiole being observed in some cases. Clean hickory twigs inoculated with a pure culture of the fungus became covered with mycelium in which pycnidia formed.

The ascigerous stage of the fungus was developed on naturally infected twigs, sterilized on the outside with corrosive sublimate and kept in sterile tubes for six months. Single ascospore cultures gave rise to the pycnidial stage. The fungus falls into the genus *Rosellinia*, and the species being hitherto undescribed the name of *R. caryae* is given, together with a technical description. The imperfect stage agrees with the characteristics of the genus *Dothichiza* as understood by Diedicke, but, like the other members of this genus, comes very near *Phomopsis*.

SCHMITZ (H.). **Studies in wood decay. III. The toxicity of Western Yellow Pine crude oil to Lenzites saepiaria Fries.**—*Journ. Indus. and Engin. Chem.*, xiv, 7, pp. 617–618, 1922.

Crude western yellow pine oil is a heavy, syrupy liquid, acid in reaction, and with a sharp, pungent odour. In order to test its value as a wood preservative, it was added, in concentrations ranging from 0·5 to 15 per cent., to cultures of *Lenzites saepiaria* grown on sawdust from lowland white fir (*Abies grandis*), Douglas fir (*Pseudotsuga taxifolia*), and sugar maple (*Acer saccharum*). The culture flasks were kept under observation for three weeks and examined at frequent intervals. It was found that the toxic concentration, calculated on the dry weight of the sawdust, was 9 to 10 per cent. in white fir, 10 to 11 per cent. in Douglas fir, and 11 to 12 per cent. in sugar maple. Nine per cent. of the oil was lost by evaporation when the impregnated sawdust was exposed to the air for twenty-four hours.

The ideal way of examining the toxicity of wood preservatives to wood-destroying fungi would be to set up a culture series as described above, and ascertain the extent of the actual decomposition of the wood as indicated by the loss in weight in each flask. There are, however, several drawbacks to such a method, the most serious of which are the lengthy incubation period (at least three months) before reliable results would be obtained, and, with volatile substances (coal-tar creosote, wood tar, &c.), the loss in weight due to evaporation. The latter objection does not apply to non-volatile substances, such as zinc chloride, sodium fluoride, &c., and the method is now in use in connexion with an investigation of the effects of soil alkali on the rate of decay of wood.

A further experiment on the toxicity of yellow pine oil was carried out on a medium of hard potato agar, to which the oil was added in concentrations varying from 0·05 to 1·4 per cent. The plates were then inoculated from plate cultures of *L. saepiaria* and incubated for four weeks at 24° C. The toxic concentration was found to be between 0·5 and 0·6 per cent. It is apparent from these results that the toxic properties of western yellow pine oil are very limited.

Matsumoto (T.). **Some experiments with Azuki-Bean mosaic.**—*Phytopath.*, xii, 6, pp. 295–297, 2 figs., 1922.

In July 1921 a considerable amount of mosaic disease was found among Azuki beans (*Phaseolus radiatus* var. *aurea*) at the Morioka College of Agriculture and Dendrology, Japan. The anatomical characters of the light and dark green areas in the mottled leaves are illustrated and briefly described. They are similar to those of mosaic cucumber leaves as described by Doolittle. It was shown by tests that the accumulation of starch, and probably also of sugar, was greater in the dark than in the light areas. Some varieties were found to escape the disease, but it was not determined whether they were entirely immune.

The disease is a typical mosaic, resembling that of the soy-bean.

Van Poeteren (N.). **Verslag over de Werkzaamheden van den Plantenziektenkundigen Dienst in de Jaren 1920 en 1921** [Report of the work of the Phytopathological Service during the years 1920 and 1921.]—*Versl. en Meded. Plantenziektenkundigen Dienst te Wageningen*, 27, 90 pp., 2 pl., 1922.

In this publication is presented a general survey of the incidence and severity of plant diseases in Holland during the years 1920 and 1921. With the reorganization of the Dutch Phytopathological Service in 1919 provision has been made for closer contact with the actual cultivators throughout the country, and a more complete report of the situation as regards plant diseases in Holland is now possible than was formerly the case. The staff consists of a director. four pathologists, an ornithologist, two agricultural and horticultural consultants, and twenty-four technical officers and inspectors stationed in different parts of the country, besides administrative and laboratory assistants. The Institute for Phytopathology at Wageningen is concentrating on the study of certain diseases of major importance, the causes of which are insufficiently known, while the Phytopathological Service, distinct from, but working in close contact with the Institute, handles all other phytopathological matters, including the administration of the various legislative measures dealing with plant diseases and pests. Research work is not undertaken by the Service unless other duties permit; experimental work, especially in the causation and treatment of disease, is, however, carried on.

The present report contains a mass of information, and it is impossible to give more than a brief mention of certain points of special interest.

CEREALS. The scab and foot rot caused by *Gibberella saubinetii* was common on oats. It is noted that, though the *Fusarium* stage of this fungus was found attacking wheat, barley, rye, clover, &c., perithecia were only observed on oats in Holland previous to 1920, when they were found on wheat. Seed disinfection with 1 per cent. uspulun or 0·5 per cent. corrosive sublimate is recommended for this disease. The perithecia of *Pleospora trichostoma* were found on the glumes of germinated grain of barley, the seedlings from which were affected by stripe disease (*Helminthosporium gramineum*) and even on those from which the seedlings, though weakly, were not marked by definite stripes. It was further found that perithecia could be induced to form on glumes of unthreshed barley when incubated for three days in a warm, moist atmosphere, and this suggests a method of determining whether a sample of grain is infected by the disease.

POTATOES were extensively attacked with streak ('stippelstreepziekte') in the northern part of the country in 1921. Rotting of the tops of the shoots before they were up was caused by *Rhizoctonia solani*. Tuber disinfection with corrosive sublimate against the latter disease has now become a practice in some places.

BEET. Severe damage was caused by *Peronospora schachtii* in 1920 and by *Rhizoctonia violacea* in 1921.

FLAX. In 1921 the crops in various parts of Zuid-Beveland were so severely diseased that they had to be ploughed up. The damage was apparently caused by an unusually virulent strain of *Botrytis cinerea*, which attacked the stalks and even the underground parts, and was perhaps favoured by the drought.

FRUIT. In 1921 *Fusarium gemmiperda* was found associated with a disease which destroyed many pear buds, but whether the disease was due to this fungus or to some physiological cause was not determined. A purple-coloured decay of the interior of cooking pears was associated with a fungus which formed pycnidia somewhat resembling *Fusicoccum* in pure culture. The fungus is believed to be a new genus. Other rotting pears were found to bear pycnidia of a *Phomopsis* (probably *Ph. ambigua*). *Roesleria hypogaea* was found on pear roots (which were extensively rotted by it) in 1921. This is the first Dutch record of damage caused by this fungus. Raspberries were attacked by *Coniothyrium fuckelii* and a red *Fusarium*; good results were got by spraying with Bordeaux mixture and lime-sulphur. A bacterial disease of cherries, which appeared to correspond to that described in Flugblatt 39 (1910) of the Biologische Anstalt at Dahlem, was observed in 1920. Red currants were attacked by *Collybia velutipes*, a fungus that may grow for years within the tissues of the branches before fructifying on the surface. A species of *Coniothyrium* is thought to cause the so-called 'marginal blight' of German sour red currants, previously reported. A disease of gooseberries, resulting in the discoloration and death of the twigs, was observed in 1920; a species of *Phytophthora* was isolated from the diseased wood and successful inoculations were obtained. Experiments in the control of American gooseberry mildew [*Sphaerotheca mors-uvae*] gave excellent results with alkaline Burgundy mixture (1·5 kg. copper sulphate and 1·5 kg. soda ['sodex'] to 100 litres of water). It should be applied before the first appearance of the mildew. Good results were also obtained with 3 per cent. carbolineum solution, but the growth of the plants was arrested for a time.

Amongst the numerous records of diseases in garden vegetables and ornamental plants may be mentioned a minor disease of bean pods caused by *Isariopsis griseola*; an attack of *Phoma oleracea* on Brussels sprouts, the fungus being disseminated with the seed; a 'spot' disease of cabbage, very prevalent in 1921 and believed to be caused by a bacterium; the spinach disease described by Schoevers in 1918 [*Meded. Landbouwhoogeschool, Wageningen*, xv, p. 75] in which the same so-called 'X organisms' were again found and thought by Stahel to have an interest in connexion with the *Euphorbia* latex flagellates; an attack of a *Urocystis*, apparently *U. colchici*, on the bulbs of *Bulbocodium vernum*, of *Pythium de Baryanum* on *Pelargonium* cuttings, *Entyloma* (?) *calendula* on Dahlia leaves, and *Diplodia lycopersici* on *Capsicum annum*.

A section of the report is devoted to the effects of the drought of 1921. The dry, hot, summer was favourable to the development of potato leaf roll and *Rhizoctonia solani* but unfavourable to the wart disease parasite, *Synchytrium endobioticum*. Tests of a number of fungicides, chiefly proprietary preparations, are reported. A few of the more interesting diseases are illustrated.

MIÈGE (E.). **Observations sur quelques maladies des plantes cultivées au Maroc en 1921.**—[Notes on some diseases of cultivated plants in Morocco in 1921.]—*Bull. Soc. Path. Vég. de France*, ix, 2, pp. 102–108, 1922.

Notes are given on the principal diseases of crops observed by the author in Morocco in 1921. Mildew (*Erysiphe graminis*) and the various cereal rusts were severe. No resistance to rust was noticed in *Triticum durum*, *T. turgidum*, or *T. monococcum*. *Septoria gramineum* injured some varieties of wheat and oats, and *Fusarium hordearum* Duc. was found on barley. The same common cereal smuts as previously recorded [see this *Review* 1, p. 34], were again present.

Potato blight (*Phytophthora infestans*) caused a good deal of damage. It appeared first in April on the crop sown in January and in early December on that sown in October. *Alternaria solani* frequently accompanied the *Phytophthora*. *Fusarium solani* and *Verticillium albo-atrum* did little damage. Mosaic and leaf roll were also observed, as well as another disease, believed to be new, which is more fully described elsewhere [see below p. 86]. Tomatoes were attacked by a *Fusarium* which caused a collar rot, and by a *Macrosporium*. Leaf roll was also seen on this crop.

Other parasitic fungi observed on cultivated plants included *Cyclogonium oleaginum* on olives, *Septoria apii* on celery, *Uromyces fabae* on beans (occasionally causing much damage), *Plasmopara viticola* and *Oidium* [*Uncinula necator*] on vines (vine mildew severe in certain districts in spite of repeated treatments, and increasing with the extension of European vine-growing; *Oidium* common in coastal regions), *Melampsora lini* on flax (slight), *Cercospora beticola* and *Uromyces betae* wherever beet was grown, *Cercospora violae* on violet, and *Peronospora trifoliorum* on clover.

SMITH (E. F.). **Appositional growth in crown-gall tumors and in cancers.**—Reprinted from *Journ. of Cancer Research*, vii, 1, 49 pp., 4 figs., 28 pl., 1922.

The author has found in various crown gall tumours produced by *Bacterium tumefaciens* in tobacco, *Chrysanthemum frutescens,* and other plants, that normal tissue cells around the tumour become converted by division into tumour cells. The phenomenon is figured in one of his earlier papers but not mentioned in the text. It is stated to be distinct from the ordinary irritational hyperplasia which also occurs in the vicinity of many crown galls, in that whereas the cells in the latter case have a normal arrangement, normal staining properties, and normal functions, those here described are smaller, more or less disoriented, and stain and behave like tumour cells.

The particular cases described and very fully illustrated by photomicrographs in the present paper are the result of fifteen single, shallow, needle-prick inoculations in the cortex of the stem of two young, growing tobacco plants, the galls being removed for examination after three weeks. In all cases there is the plainest evidence of growth of the tumour 'by apposition', that is by the conversion of adjacent normal cortex cells into tumour cells, of which a hundred or more may arise from the division of a single cortex cell. Beyond the tissue in process of active conversion is an area in which the cortex cells are enlarging (often to twice their normal diameter) and have large nuclei.

The bearing of these observations on the controversy regarding the growth of animal cancer tumours by apposition is very fully discussed, the author ranging himself on the side of those who believe that such growth takes place. In crown gall he is inclined to think that growth by apposition is the common form of growth and that, at least very often, the apparent invasion of surrounding tissues by the tumour cells and the formation of the 'tumour strands' previously described by him, is the result of appositional growth in one direction only, a narrow strand of normal tissue becoming converted by the division of its cells into an extension of the tumour. Possibly all the tumour strands originate in this way.

The first stage in the conversion of a normal cortex cell into tumour cells is the enlargement of the former; then it divides (apparently always by mitosis) very rapidly, and one can see 4, 8, or 16 smaller cells enclosed by the stretched and thickened wall of the original cortex cell. Division goes on until a mass of small tumour cells, with no intercellular spaces, is formed. Later on these cells may enlarge so as to equal or even exceed in size those from which they originated. The stimulus causing these changes may be a chemico-physical one derived from the bacteria and acting at a distance from them, or it may be due to a direct transfer of the bacteria from cell to cell through the pits in the cell walls. The author believes that the appositional hyperplasia is due to the latter cause, whereas the hypertrophy prior to division may be due to the former.

In nearly all the tumours examined in this series, the vascular cylinder had been split open by the appositional growth of the tumour along the medullary rays, and the pith was in process of invasion. In certain cases downward extension (in the direction of the axis of the stem) occurred in a narrow strand along the medullary ray, thus originating a longitudinal tumour strand. In the outer pith, in some cases, various scattered, small tumours were found which were not connected in any evident way, such as by the presence of tumour strands, with the main tumour. The author supposes that these secondary tumours originated by the liberation of mobile bacteria from tumour cells, crushed during the splitting of the vascular cylinder, into the intercellular spaces or fissures in the neighbourhood, along which they passed to reach torn pith cells further in, converting the latter into new centres of tumour formation. The author distinguishes these cases from the formation of secondary tumours by metastasis, i.e. by the tumour strands previously described, under the term 'pseudometastases'.

TROST (J. F.). **Relation of the character of the endosperm to the susceptibility of dent Corn to root rotting.**—*U.S. Dept. of Agric. Bull.*, 1062, 7 pp., 2 pl., 1922.

In the course of investigations in Indiana on the various rots of maize, the ears were classified on the basis of the endosperm with a view to determining the possibility of the recognition and elimination of infected ears. Six degrees of starchiness were recognized and designated as types A to F. Most of the ears studied were included in the range of types C, D, and E, in which one half, one quarter, or less of the endosperm was starchy. There was a tendency to greater starchiness in the larger, late-maturing strains grown in the south of the State than in the northern varieties.

Experiments with a number of varieties showed that the starchy ears, especially types C and D, were in every case characterized by a higher percentage of infection from *Fusarium* spp., *Diplodia zeae*, or *Penicillium* spp. than the horny ears (types E and F). The average degree of infection in the starchy group was 50·9 per cent. and in the horny group 33·5 per cent.

It was apparent from an experiment with nine separate strains of the Reid Yellow Dent variety that the variations in the character of the endosperm in different ears may be as great within a strain as among distinct varieties.

In starchy ears a number of factors contribute to the increase of infection. Starchiness is indicative of immature ears, and in the late-ripening varieties the less advanced ears are exposed to attack while maturing under weather conditions more favourable to infection by the root-rotting organisms. The high moisture content of immature ears is also more suitable for the development of external fungi. An unbalanced food supply or a root-rotted condition of the parent stalk also leads to the ears being starchy, and the latter is perhaps the most important factor contributing to infection.

Further experiments showed that, in almost every case, the horny ears produced a higher initial stand in the field, and were healthier and more vigorous than those with starchy grains, and this superiority was maintained throughout the growing season. The yield from the horny grains was also superior to that from starchy ears, the average decrease in yield incurred through the use of starchy seed-ears being estimated at 4·2 per cent.

The data from the experiments are believed to furnish direct evidence of the correlation of resistance to root rots, in dent varieties of maize, with a horny endosperm, and of susceptibility with a starchy endosperm.

ARMSTRONG (S. F.). **The Mendelian inheritance of susceptibility and resistance to yellow rust (Puccinia glumarum Erikss. et Henn.) in Wheat.**—*Journ. Agric. Science*, xii, 1, pp. 57–96, 1922.

During 1917–20 a series of experiments on the susceptibility and resistance to rust of different varieties of wheat was carried out at Cambridge. Biffen's investigations (*Journ. Agric. Sci.*, i, p. 1; ii, p. 109; and iv, p. 421) showed that resistance to yellow rust was inherited as a simple Mendelian recessive character, but owing to the high rate of mortality among his F_3 plants the validity of his conclusions was to some extent impaired. The present researches were intended to clear up the uncertain points.

The varieties chosen for crossing in the main experiment were Wilhelmina and American Club, which differ in several important respects—colour of chaff, length of straw, &c.—as well as in their degree of resistance to yellow rust, American Club being normally immune while Wilhelmina is moderately susceptible. The F_1 plants (1917) derived from this cross were moderately attacked by rust. With regard to the F_2 generation (1918), of 829 plants in the autumn-sown portion, 202 remained rust-free throughout the season, while the remaining 627 proved more or less susceptible. These results closely approximate to the 3 : 1 Mendelian ratio. In the spring-sown portion the proportion of immune individuals was less than one quarter of the total number, but, on the other hand, the number of plants bearing only traces of rust was much higher than in the autumn-sown crop. The F_3 plants (1919) were, almost without exception, more severely attacked than their parents in the previous year. The year 1919 was particularly favourable to the spread of rust, which during the cool and moist weather of July attained the dimensions of an epidemic. It was incidentally observed in the course of that summer that the more susceptible varieties are liable to an earlier successful attack than the more resistant kinds, and also that, at any rate, on susceptible varieties, yellow rust can make rapid progress in the tissues of the host during the hottest weather likely to be experienced in England. The general results obtained from the F_3 cultures may be briefly summarized as follows. Up to 10th July the cultures were sharply divided into three groups. (1) Every plant attacked. (2) No trace of attack. (3) Extent of attack very variable. The homozygous susceptible cultures (1) were all characterized by comparatively early infection, rapid spread of the disease, and exceptional severity of attack. The homozygous 'immune' cultures (2) were characterized by remarkable resistance to attack under most adverse conditions and by the extreme lateness and mild nature of the infection when it did occur. The cultures in which segregation was occurring (3) occupied an intermediate position as regards the period of infection and rust spread, though finally a proportion of the plants was as severely rusted as the homozygous susceptible cultures, while

660 out of 3,045 plants had only a slight attack or none. There is sufficient evidence to show that under very adverse conditions genetically immune plants may be subject to a mild attack. It therefore appears safe to conclude that in the segregating cultures one quarter of the plants were genetically immune, and that these cultures were the product of F_2 heterozygotes for rust resistance. The results of the F_4 cultures (1920) bore out the conclusions drawn from the previous work, the cultures from obviously segregating F_3 plants [group (3)] showing definitely that pure resistant, pure susceptible, and impure susceptible types were present in the F_3 cultures, while the groups (1) and (2) above gave respectively badly rusted and quite or almost quite rust-free plants.

The final conclusion is reached that susceptibility and immunity behave as unit-characters, and depend primarily on definite characters which are inherited according to the simple Mendelian law. This inherited predisposition or resistance to attack is liable to modification by external environmental factors, such as abnormal climatic conditions and the application of certain fertilizers. The greater severity of the attack in 1919 was undoubtedly due in part to the character of the season. But experiments showed that a heavy application of nitrate of soda increased the number of infected plants and the degree of the infection even in the 'immune' lines. Wide spacing also acts in the same direction. In these cases, however, the success of the parasite was of a very limited nature, and did not justify the conclusion that resistance could be destroyed or seriously broken down by the action of such conditions.

The author believes that a re-combination of other inherited characters in a line homozygous for resistance to rust may modify the degree of this resistance. Some of these other characters may obviously modify the metabolism of the plant, and in different combinations it would appear that they may increase or reduce susceptibility or stabilize the inherited resistance. Cases are detailed where factors of this sort appear to have come into play. and are regarded as affording definite promise of the feasibility of breeding stable, highly immune strains.

In an attempt to estimate the reduction in yield due to yellow rust the conclusion is reached that a moderately susceptible variety may give a yield at least 25 per cent. below that obtainable from almost precisely the same form when rendered immune.

Zimmermann (H.). **Typhulapilzbefall der Wintergerste 1921.** [The attack of the *Typhula* fungus on Winter Barley in 1921.] —*Nachrichtenbl. deutsch. Pflanzenschutzdienst,* ii, 6, pp. 41–42, 1922.

In Brandenburg, Mecklenburg-Schwerin, and Mecklenburg-Strelitz the winter barley was found in the early spring of 1921 bearing large numbers of sclerotia of *Typhula graminis.* The leaf sheaths and decaying leaf tissues of the young plants were particularly liable to infection. The plants turned yellow and withered. Eelworms were sometimes also present in the affected plants. Top-dressings with nitrate of soda and sulphate of ammonia, together with thorough hoeing and harrowing, greatly improved the condition of the crop.

STEVENS (F. L.). **The Helminthosporium foot-rot of Wheat, with observations on the morphology of Helminthosporium and on the occurrence of saltation in the genus.**—*Illinois Dept. Registr. and Educ., Div. of Nat. Hist. Survey, Bull.* xiv, Art v, pp. 76–185, 23 figs., 25 diagrams, 34 pl., 1922.

In all cases of the Illinois foot-rot of wheat, which has become known as the 'so-called take-all' disease, examined by the author, the rotten basal portion of the shoot was found largely occupied by a hyaline, septate, vacuolar mycelium of irregular thickness, which grew luxuriantly within the wheat tissue though sparsely on its surface. The mycelium belongs to a species of *Helminthosporium* which is for the present termed *Helminthosporium* No. 1. No other organism has been found constantly associated with the disease.

The cultural characters of this fungus were studied in great detail under various environmental conditions and on numerous media, the best of which were found to be autoclaved cereal shoots (especially maize) and corn-meal agar. A marked effect on growth characters was produced by slight differences in the formulae used or by variations in the temperature at which the medium was prepared. The morphological characters of the fungus were also greatly influenced by environment. The humidity of the medium and of the atmosphere exerted an important influence on the production of conidia and their length, on the amount of aerial mycelium, and on sclerotium formation, the last-named being favoured by relative dryness. This is important in view of the fact that sclerotium formation has been suggested as a character for the separation of certain species. The number and average length of the conidia were much reduced by comparatively dry conditions, while their relative variability was considerably increased. Free conidium formation was only obtained at relative humidities above 90 per cent., and was therefore rare on diseased plants in the field. Gradual drying out may increase the number of conidia per conidiophore from the usual 1 to 3 up to as many as 13. Excessive humidity promoted a profuse development of aerial mycelium. The optimum temperature for the development of the fungus was about 25° C. Diurnal zonation was marked in many cultures, but was much influenced by temperature (being absent at 10° C.), nature of the medium, &c. The presence of carbohydrates in the medium induced a dark coloration of the colonies owing to profuse sporulation, while striking modifications were observed in the conidial length, septation, and shape, as a result of variations in the nutritive or osmotic conditions. Comparisons of colony characters on artificial media should therefore be made only under standard conditions and on substrata as nearly as possible identical in composition. A method for securing this is appended to the *Bulletin.*

The mycelium in wheat tissue was often much thicker than that grown in agar, and occasionally branched in a close, fan-like fashion on the surface. Some races produced mycelial clumps in culture, due to a distortion and crowded growth of the aerial mycelial tips. Anastomoses were frequent. The old aerial mycelium dissolved, probably by auto-digestion. The conidiophores are single, erect, and darker than the mycelium, and the conidia are borne terminally, growth being renewed from below each of the successively produced conidia, which usually fall and leave lateral scars. The length from base to first scar was 78 to 88 μ.

The colour of the conidia ranges from pale straw to light brown, sometimes with a faint bluish-green tinge. An extremely short, black stipe (2 by 4 μ) remains attached to the basal end after falling. They germinate readily, usually from the basal ends, the endospore and septa being apparently consumed during germination. The exact duration of viability is not known, but the conidia germinated normally on wheat straw that had remained air-dry for fourteen months. The conidia are thickest at a point between the base and the middle. They are described at considerable length, the concepts 'coefficient of longitudinal eccentricity' and 'coefficient of cylindricity' being introduced for purposes of greater accuracy. Conidial length, breadth, and septation are studied biometrically and compared with the corresponding characters of *H. ravenelii*. The average dimensions and septation observed by the author in the case of *Helminthosporium* No. 1 on wheat were as follows: length, 76·8 μ; breadth, 20·4 μ; septa, 7·9.

Inoculation experiments were carried out on maize, wheat, oats, barley, and rye, sixteen other species and strains of *Helminthosporium* being used for comparison with *H.* No. 1. The results of these preliminary tests indicate a wide difference in the susceptibility of cereals to rot by the various forms of *Helminthosporium*, oats being the least liable to infection, and maize and wheat the most. *H.* No. 1 completely rotted a wheat shoot 11 mm. long in five days, maize was rotted less rapidly, and oats, barley, and rye still less; while *H. ravenelii* produced no decay on any cereal. Several other strains showed high rotting power on wheat shoots, especially *H. teres* and *H. sativum* both isolated from barley, and *H.* No. 9 isolated from wheat. *H. interseminatum* from the Centraal Bureau voor Schimmelcultures also caused a rot of wheat. Numerous inoculations of seedlings in Petri dishes, in 'rag doll' germinators, and in soil all gave positive results with *H.* No. 1, the cells of leaf-sheath, stem, and root being rapidly invaded.

Appressoria are formed by the germ-tube prior to penetration, and the cell wall of the epidermis is pierced by a fine infection hypha from the appressorium, a callus-like swelling being formed on the inside of the cell wall. The mycelium grows rapidly within the host cells, often forming a dense mass resembling a pseudoparenchyma. Other hosts susceptible to the rot caused by *H.* No. 1, besides those mentioned above, were sorghum, Sudan grass, and millet (*Setaria italica*).

Saltation, a term used by the author because of the existing differences in the definition and usage of the term mutation, is much in evidence in certain races of *Helminthosporium*, and is exhibited by the appearance of a sector differing from the rest of the colony in various characters; rate of growth, degree of conidial production, length, breadth, septation, and shape of the conidia, density, colour, and zonation of the mycelium, and sclerotium formation. Certain saltants far exceeded the accepted specific limits in divergence from their parent. The correlation of certain characters in saltation was observed; thus, colonies of slow linear growth were usually high in conidial production and vice versa. In other cases rapid growth or slow conidial production, verging on sterility, was coupled with paleness of colour; and the development of much aerial mycelium was accompanied by low conidial production. In the main the saltants were permanent in character in subculture. Occasional reversions to the originals occurred, but in no case where the true saltant character was established by constancy through several transfers did the whole stock revert. All attempts to secure artificial saltation by various means failed. Single-conidium cultures gave rise to numerous saltations. As compared with bud-variation on potatoes and tobacco, saltation in *Helminthosporium* is of very frequent occurrence. One hundred and twenty-six variant sectors were studied, and this number might easily have been doubled or trebled. Even supposing some of the forms to have been mere modifications, there was a large proportion of permanent saltants. The author believes that several of the strains received from correspondents were saltants from the original form isolated. A general discussion on saltation and mutation in fungi is given, with references to the work of various investigators.

The author places in the general type *H. sativum* the following elementary species: *H.* No. 1. 1 a. 1 b, 1 c, and 1 d (isolations from foot-rot in Illinois); also his numbers 3 to 9, 11 to 19, 22 to 27, 34, 37, 38, 42, and 43. These include forms sent by correspondents as *H. sativum*, *H. teres*, *H. gramineum*, and *H. avenae*. *H.* No. 20 is an instance of saltation sufficiently pronounced to remove the organism entirely from the group under discussion, though it was descended from Bakke's isolations of *H. sativum*. *H. ravenelii* is a distinct type. Other apparently distinct types are briefly described, including one causing a disease of wheat in the Sudan which is allied to a form isolated by the author from *Setaria italica*. In the author's opinion tenable distinctive diagnoses could be drawn up, through the methods of biometry and a study of biological relations and cultural characters, for many races of *Helminthosporium* on the principal cereals, but whether they should be given distinctive specific names is a question of utility.

A bibliography of 129 entries is appended, and the work is illustrated chiefly by photographs and photomicrographs.

Paxton (G. E.). **Studies on Helminthosporium species found on cultivated Barley in California.**—Abs. in *Phytopath.*, xii, 9, pp. 446–447, 1922.

The perithecial stage of *Helminthosporium gramineum* was found in California on barley straw two years old. Cultures obtained from the ascospores yielded typical *H. gramineum* conidia and inoculations with the same gave typical lesions of this species. A culture bearing conidia was also obtained from herbarium specimens of *H. gramineum* sixteen years old.

Helminthosporium sativum from barley was grown in pure culture and successfully inoculated on *Hordeum muranium* and vice versa. The optimum temperature for this fungus is about 30° C.

Fawcett (G. L.). **La 'gomosis' de los Naranjos.** ['Gummosis' of Orange trees.]—*Rev. Indust. y Agric. de Tucumán*, xii, 11–12, pp. 149–155, 5 figs., 1922.

This is a semi-popular account of gummosis of citrus trees, as it occurs in the province of Tucuman, in Argentina. The author distinguishes two forms of the disease: one, which affects the stem at soil level and the root system just below the collar, producing the well-known foot-rot. and another, less common, which is confined to the trunk and branches. The first is due to the attack of various fungi, the most common in Tucuman being *Phytophthora terrestria* [*P. parasitica*]. *Diplodia* is also frequently responsible for the disease, while a *Fusarium* (a form of *Nectria hematochroma*) is sometimes found but is less often parasitic. The disease chiefly attacks trees that have not been budded and has destroyed large numbers of these. Several factors which predispose to it are known, the chief being excessive soil moisture, too deep planting, and faulty methods of irrigation. Gumming of bitter orange trees is believed to be unknown, hence the frequency with which they are used as stocks. Where foot-rot has not made excessive progress, exposing the roots around the collar and excising diseased parts is recommended. The author states that the healing of the wounds thus produced is often more satisfactory when they are exposed to the action of air and light without employing disinfectants. If the latter are used, he recommends Bordeaux paste. The roots may be left exposed for a week or two.

The second form of gummosis is found sometimes on orange trees. Where these are grafted on bitter oranges the affection extends downwards until it is arrested at the union of the two varieties, and this would seem to indicate that grafting at high levels is of advantage. The cause of this form of the disease may be different from that of foot rot, but it has not been fully studied as yet.

McLean (F. T.) & Lee (H. A.). **Pressures required to cause stomatal infection with the Citrus-canker organism.**—*Philipp. Journ. of Science*, xx, 3, pp. 309–320, 2 figs., 1922.

The authors have shown in previous papers that the resistance to canker (*Pseudomonas citri*) of the mandarin orange is due to some character in the epidermis of that species [see this *Review*, i, p. 12], and that the stomata of the resistant mandarin orange differ considerably in structure from those of such a very susceptible species as the grapefruit. These and other investigations suggested that resistance is largely determined by differences in the structure of the stomata and in the degree of their permeability to water. It was decided to test this theory by introducing the canker bacteria into the leaf tissue of the resistant mandarin orange without mechanical injury, and a method was devised of drawing water, containing a suspension of the bacteria, into intact leaves on the tree in the orchard by known and easily measurable pressure. The contrivance employed was an adaptation of the porometer, the construction and mechanism of which are described.

During the dry season (April and May) of 1921, tests were made of the pressure required to inject water alone into citrus leaves by means of the above apparatus. It was ascertained that the degree of permeability, as judged by visible injection resulting in the appearance of translucent spots, varied greatly in leaves of the same age and on the same tree. Of the citrus varieties tested, the Szinkom mandarin orange, believed to be a native of China, is one of the most canker-resistant horticultural varieties of any species. The grapefruit trees on which the tests were carried out belonged both to the Pernambuco and seedling varieties, and were supplemented by a susceptible type of East Indian pomelo. The susceptible Pernambuco grapefruit and the pomelo were the easiest to inject (average pressures required 19·5 cm. and 19·6 cm. respectively), the highly resistant Szinkom mandarin orange the most difficult (average pressure 33·6 cm.), and the moderately resistant Washington navel intermediate (average pressure 20·8 cm.). These comparative figures indicate that visible injection pressure is an approximate index of resistance to citrus canker.

A suspension of *Pseudomonas citri* was then substituted for the water-bath immersion, young, and therefore susceptible, leaves being used. The temperature of the suspension varied between 28° and 31° C. In the Szinkom mandarin orange infection of the leaves did not usually result until the pressure recorded by 10 cm. of mercury was reached during injection and was not general below 19 or 20 cm., whereas in the grapefruit and pomelo it took place either without pressure or at a very low pressure. The water containing canker organisms was drawn into the leaf tissues at lower pressures than those causing visible injection. The pressure causing visible injection thus appears to be roughly proportionate to, but not identical with, that necessary for infection.

It is evident from the results of the experiments that canker will develop in the leaves of the mandarin orange once the bacteria have gained admission to the leaf, even in the absence of injury to the tissues. It has already been shown in the earlier paper, referred to above, that the stomata of the mandarin orange were so constructed as to preclude the ready ingress of water. The experiments described in the present paper indicate that pressure is necessary for the absorption of water by the stomata of the mandarin orange. On the other hand, the stomata of the grapefruit are constructed in such a way that simple immersion in water containing the bacteria is sufficient to cause infection.

Lee (H. A.). **Relation of the age of Citrus tissues to the susceptibility to Citrus canker.**—*Philipp. Journ. of Science*, xx, 3, pp. 331–339, 4 pl., 1922.

In an earlier paper (*Phytopath.*, xi, p. 70, 1921) the author demonstrated the correlation between advancing maturity and an increasing degree of resistance to citrus canker (*Pseudomonas citri*). The present article describes inoculation experiments undertaken in 1918–19 to gauge the amounts of canker occurring at different stages of maturity. Preliminary tests were conducted in the Philippines on fruits of the pineapple orange (*Citrus sinensis*) and the Valencia orange. The fruits were inoculated from the same suspension of cultures of the bacillus, and maintained under identical environmental conditions favourable for canker formation. The resulting data showed very considerable susceptibility for fruits of a small diameter, while large fruits approaching maturity were but slightly, if at all, affected.

The experiments were continued in the Nagasaki Prefecture, Japan, on fruits of the Washington navel orange. The fruits were inoculated when the petals dropped in late May and early June, and again at different periods as they approached maturity. The tissues became virtually immune as the fruit ripened. Tests were also carried out on several strains of the Unshiu (Satsuma) orange (*Citrus nobilis* var. *unshiu*). It was ascertained that the total period of possible infection for the Unshiu oranges did not exceed 98 days, as compared with 115 to 120 days for the Washington navel. Further data point to a longer period of susceptibility for the fruit tissues of the grapefruit [*Citrus maxima* (*decumana*)] than for either the Washington navel or the Unshiu oranges.

Exact information on the increase in resistance with advancing maturity of the foliage tissues is very difficult to obtain and of less practical importance. The results of experiments conducted on young, intermediate, and fully matured leaves show that the latter are entirely resistant, the amounts of infection decreasing as the final stages of development are reached. In all the experiments inoculations were made both by means of needle punctures and without puncturing (stomatal infections). The fruits were susceptible to the former for a longer period than to the latter.

The results from this work materially affect field practice for the prevention of canker. In western Japan the fruits of the Washington navel orange are virtually immune from stomatal infection after 85 days and wound infection after 110 to 120 days. Preventive methods may therefore be largely confined to the period from June to August. Canker on Unshiu oranges is uncommon in Japan, being almost negligible from the growers' point of view, and the results with this variety are of less practical interest.

SPINOSA (J. P.). **Apuntes sobre el cultivo del Naranjo referidos especialmente al Territorio Nacional de Misiones.** [Notes on the cultivation of Orange trees, with special reference to the National Territory of Misiones.]—*Bol. Minis. Agric. Nacion. (Argentina)*, xxvii, 1, pp. 3–185, 31 illus., 1922.

This article has been written with the object of attracting citrus growers to the province of Misiones, in Argentina, where climatic and other conditions are highly favourable to the development of this industry. A chapter is devoted to pests and diseases, with full descriptions of symptoms and advice as to the most effective remedial measures.

Amongst fungous diseases, sooty mould is commonly found in the wake of scale and similar insects, though the author states that there are cases where its presence is traceable to purely physiological causes. Spraying with Bordeaux mixture, to which 1 per cent. tobacco extract has been added, has given uniformly good results when the trouble has been due to insect attack. When, however, it originates in excess of humidity and lack of aeration and light, cultural measures to remedy these defects will check it.

Gummosis is a very common disease and a formidable problem in many plantations. The worst outbreaks occur in localities where conditions generally tend to encourage vigorous growth. The province of Corrientes is at present the greatest sufferer, whole regions having been devastated by this terrible scourge, but its occurrence in other provinces in a more or less virulent form has been observed, and it is feared that the present rapid rate of progress of the disease may eventually kill the industry altogether, unless energetic measures for combating it are taken. Unfortunately the cause of the disease has not been traced with absolute certainty so far, some ascribing it to parasitic action and others to purely physiological causes. The characters of the disease are described and methods for its control discussed. These should include planting in high, well-drained, loamy soil, with a deep and permeable subsoil, to permit vigorous root development; choice of stocks such as the bitter or Seville orange [*C. bigaradia*], the rough brown lemon [*C.* sp.], *C. trifoliata*, and *C. myrtifolia*, which are known to be resistant; and good cultivation. The treatment of affected plants by opening up the collar and main roots and cutting away the diseased tissues, followed by antiseptic treatment of the exposed parts, is recommended.

The author states that in northern Argentina shade is required in the citrus plantations, free exposure to the sun favouring the development of gummosis. Cases are quoted of severe attacks of gummosis following the removal of shade in forest clearings in which wild and semi-wild citrus plants had been retained. Under normal forest conditions these trees are not attacked. He considers that the primary cause of gummosis is unbalanced water relations in the plant, though invasion by parasitic organisms may accentuate the effects.

Other diseases appear to be of minor importance.

Horne (T.). **A Phomopsis in Grape Fruit from the Isle of Pines, W. I., with notes on Diplodia natalensis.**—*Phytopath.*, xii, 9, pp. 414–418, 2 pl., 1 fig., 1922.

In a cargo of grapefruits shipped from the Isle of Pines, W. I., two fruits with a tan-coloured rot were obtained on arrival at San Francisco. From the first *Diplodia natalensis* was isolated, and produced stem-end rot in grapefruits and oranges on inoculation. The other yielded the more delicate, white mycelium of a *Phomopsis*. In the later stages of rotting caused by this fungus the colour was uniformly smoky-brown below the surface, in contrast with the black colour shown by the *Diplodia* at the same level.

The *Phomopsis*, which is considered to be a new species and named *P. caribaea*, gives a white mycelium, sometimes becoming slightly tinted brown, in culture. Dark brown sclerotial bodies, less than 0·5 mm. in diameter, are formed in some media, small, conical pycnidia in others. The lower (newer and moister) pycnidia in the tube cultures mostly bear the scolecospores or B-spores, 20 to 32 by 1 μ, while the upper pycnidia bear chiefly the pycnospores or A-spores, 5·6 to 8 by 2·2 to 3 μ.

Inoculations on grapefruit caused the development of a typical stem-end rot in several cases, though the rot was not fully developed until after about three months. On oranges the parasitism of the fungus was doubtful.

FACWETT (H. S.). **A new Phomopsis of Citrus in California.**—*Phytopath.*, xii, 9, pp. 419–424, 2 figs., 1922.

From citrus fruits affected with stem-end rot in packing houses in Santa Barbara County a *Phomopsis* was isolated. The trouble appeared to be of minor importance, only fruits picked when quite mature or stored for a long time being very occasionally attacked. No fruit with stem-end rot was found in the orchards, but *Phomopsis* pycnidia were discovered on a few dead twigs, and some leaves gave indication of melanose, a condition which, in Florida, is characteristic of attack by *Phomopsis citri*. Some mature fruits picked from branches containing dead twigs, and kept in the laboratory, developed stem-end rot in about five weeks. The fungus was commonly found in the bark of lemon trees affected with 'shell bark', and from inoculation tests it would appear not improbable that it is a factor in the development of the shell bark disease.

Inoculation experiments are described which indicate that the fungus differs from *P. citri*, the species responsible for stem-end rot in Florida. The weaker virulence of the Californian fungus, its lower optimum temperature for growth (20·5° C. as against 24° C.), differences in mycelial growth (fan-like, irregular, surface growth, turning brown on potato and cornmeal agar), and spore production (B-spores predominating on a variety of culture media), have led the author to form a new species *P. californica*. This cannot be distinguished from *P. citri* by spore measurements alone.

RAST (L. E.). **Control of Cotton wilt by the use of potash fertilizers.**—*Journ. Amer. Soc. Agron.*, xiv, 6, pp. 222–224, 3 figs., 1922.

During the spring of 1920 several five-acre fertilizer experiments were conducted on different cotton plantations on alluvial river land. Different combinations of fertilizers were used at each place, at the rate of 500 lb. per acre. One grower used a mixture containing 10 per cent. phosphoric acid, 3 per cent. nitrogen, and no potash. In his fields the cotton plants on both the fertilized and unfertilized areas died to such an extent that no record was kept of the yield. In the spring of 1921 equal parts of the same fertilizer and of kainit containing 12·5 per cent. potash were mixed and applied to a portion of this area, at the rate of 1,000 lb. per acre, before planting. The plants on the unfertilized area began to die long before reaching maturity, and by harvest time 95 per cent. were dead, evidently as the result of an attack of wilt [*Fusarium vasinfectum*]. There was not a single death on the corresponding area to which the complete fertilizer was applied. The fertilized area produced 1,127 lb. of seed cotton per acre as against 225 lb. on the infected, unfertilized part of the field. Plants on an adjoining area, to which the same combination as in 1920 was applied before planting, but which was given an additional 500 lb. per acre of kainit after the plants were up, were equally resistant and prolific.

The writer believes that this control of cotton wilt was due to the potash in the fertilizer. The identification of the disease was confirmed by Dr. J. A. Elliott, Plant Pathologist at the Arkansas Experiment Station. The experiments will be continued with various kinds and quantities of potash, both alone and in combination with other plant foods.

JONES (L. R.) & TISDALE (W. B.). **The influence of soil temperature upon the development of Flax wilt.**—*Phytopath.*, xii, 9, pp. 409–413, 1 fig., 1922.

This paper records further studies in continuation of the earlier work of W. H. Tisdale (*Journ. Agric. Res.*, xi, pp. 573–607, 1917), carried out with the improved Wisconsin soil temperature tanks, on the effect of soil temperature on the rate of infection by the flax wilt organism, *Fusarium lini*. Soil was inoculated with a pure culture of this organism, and placed in tanks held at temperatures of 12°, 14°, 16°, 20°, 24°, 28°, 31°, 34°, and 38° C., one hundred flax seeds being planted in each case. The controls were sterilized. The optimum temperature for infection was 24° C., no infection occurring at 12° or at 38°. The critical temperature—determined by W. H. Tisdale as 14° to 16°—was tested in a third series of experiments with soil readings of 14° to 15° and of 16°. In the former tank only one plant showed slight symptoms, whilst in the latter 22 per cent. of the plants were affected. The delicacy of the temperature balance was further shown when the tanks held at 14° to 15° were raised to 16°; within a week 15 per cent. of the plants showed wilt symptoms. The upper temperature limit is almost as strongly defined as the lower, 67 per cent. of the plants wilting at 34° and none at 38° C. The temperature curve for the disease corresponds closely with that for the growth of the parasite.

Comparing the temperature relations of the very similar *Fusarium* diseases of flax, cabbage, and tomato, it is noted that the lower, or critical, temperatures for infection stand in some relation to the optimum temperatures for the hosts, the tomato being a warmer climate plant than cabbage, and still more so than flax, while the critical temperatures for their *Fusarium* wilts are 19°, 16° to 17°, and 14° C. respectively. The geographical distribution of these diseases in the Mississippi valley agrees broadly with these results, tomato wilt being confined to the southern States with its northern range in the latitude of central Illinois, while the maximum virulence of cabbage yellow lies between Ohio to Iowa and Southern Wisconsin, and flax wilt extends to the northern boundary of the United States, and probably into Canada.

HALL (T. R.). **Disease factor in commercial pomology.**—*Better Fruit*, xvii, 2, pp. 5, 6, & 18, 1922.

Instructions are given as to the best methods to employ in the harvesting, storage, and transportation of fruits. It is estimated that careless handling in picking, grading, &c., may reduce the market value of fruit by 50 to 75 per cent. In the case of the more perishable fruits (apple, pear, quince, cherry, lemon, citron, lime, plum, persimmon, grape, strawberry, and fig) the stem should not be pulled out, as the skins are apt to break and admit fungi and bacteria. The stems may safely be removed from the orange, pomelo, peach, apricot, prune, olive, raspberry, dewberry, almond, and walnut. It is extremely important to ascertain the exact stage of maturity for successful picking, and brief directions are given by which the state of the different fruits may be tested. The construction of packing-cases and the wrapping of the fruits are also described. Oiled apple wraps have been found to retard the life processes considerably, thereby increasing the length of time during which the fruit may safely be kept, besides preventing the dissemination of spores. Low and even temperatures (31° to 32° F.) are also essential during storage and transit. Such blemishes as scald, soft scald, and Jonathan spot may be prevented by these means. Ice scald appears to be due to insufficient oxygen and an accumulation of carbon dioxide within the paper wrappers of peaches, and may be prevented by good ventilation with refrigeration. The water content of most fruits ranges from 80 to 84 per cent., and the atmospheric humidity should not exceed this figure, otherwise moisture will collect on the surface of the fruit and facilitate the action of decay organisms.

Unsuitable conditions of transit frequently impair the resistance of the fruit considerably. The car should be loaded to secure the maximum ventilation, refrigeration, and stability. The packages should be spaced widely enough apart to allow a free circulation of air, but not to permit shifting. False flooring should be installed to promote the maximum circulation around and through the load. The top tier of packages should be below the line of safe refrigeration and well within the cooler portion of the car.

CUNNINGHAM (G. H.). **Silver-blight, Stereum purpureum Pers., its appearance, cause, and preventive treatment.**—*New Zealand Journ. of Agric.*, xxiv, 5, pp. 276–283, 8 figs., 1922.

The symptoms of silver leaf, which is common in New Zealand orchards, are described, and also the life-history of the causal organism (*Stereum purpureum*). In apple orchards it is said to cause a loss of about 1 per cent., on pears even less, but on apricots, peaches and plums, the loss may be well over 10 per cent. It is pointed out that fructifications may be produced in New Zealand at any time of the year, but are found especially during wet weather or in damp localities. The life of the fructification, which produces spores at intervals, may last for several seasons. The spores are the sole means of dissemination of the fungus, and they can only enter the tissues of a tree through some kind of wound or bark injury. The disease can therefore be combated by the removal and destruction of all dead stumps bearing *Stereum* fructifications, and by the dressing of wounds with coal-tar. Spraying is quite useless, as the internal mycelium cannot be reached by such means, and the injection into the tree of substances toxic to the fungus has also failed.

MCKAY (M. B.). **Thielavia basicola on watermelon in Oregon.**—Abs. in *Phytopath.*, xii, 9, p. 445, 1922.

During 1916 diseased watermelon plants were received from Oregon which showed the older leaves turning brown and drying up from the centre of the hill outward, the leaves on the young portions of the runners (then about 18 in. long) being apparently unaffected. The outer tissues of the main stalk, from 1 to 4 in. below the ground, were sometimes severely disintegrated, and had a scurfy appearance. This diseased tissue contained chlamydospores, and on culturing yielded *Thielavia basicola*. Inoculations of watermelon seedlings gave a vigorous rot in two weeks. This disease was reported on watermelons from Utah by O'Gara in 1915.

LAIDLAW (W.) & BRITTLEBANK (C. C.). **Brown rot of stone fruits.**—*Journ. Dept. Agric. Victoria*, xx, 7, pp. 442–443, 1922.

A series of experiments in the control of brown rot (*Sclerotinia cinerea*), a short description of which is given, was carried out at Bairnsdale, Victoria, in 1921. The disease was extremely severe in the season 1920–21, over 75 per cent. of the peaches in the locality mentioned being destroyed. The following sprays were used on July 28, when the trees were dormant: commercial lime-sulphur, 1 in 9; copper-soda [Burgundy mixture] 6 : 9 : 40, Bordeaux mixture, 6 : 9 : 40; neutral copper acetate, 3 lb. to 40 galls.; copper sulphate, 1 in 10. A second spraying was given when the buds were showing pink, the following being used in place of the above in the same order: commercial lime-sulphur, 1 in 20; copper-soda, 3 : $4\frac{1}{2}$: 40; Bordeaux mixture, 3 : 2 : 40; neutral copper acetate, 3 lb. to 60 galls.; atomic sulphur, 1 in 10 (used in place of copper sulphate). Three or four weeks before the fruit was ready for picking it was sprayed again, lime-sulphur 1 in 30 and 1 in 40 and atomic sulphur 6 lb. to 60 galls. being used. In the case of the copper-soda, Bordeaux, and copper acetate plots, an extra application of self-boiled lime-sulphur 8 : 8 : 50 was given five weeks after the second spray.

The peach varieties treated were Pullar's Cling, Tuscans, and Goodman's Choice. The best results were obtained with commercial lime-sulphur, the trees being free from brown rot, peach aphis, and leaf injury. Bordeaux and copper-soda also gave very satisfactory results. Copper sulphate and copper acetate were the least effective.

GARBOWSKI (L.). **La lutte contre le blanc du groseillier (Sphaerotheca mors-uvae Berk. et Curt.).** [The struggle against Gooseberry mildew (*Sphaerotheca mors-uvae* Berk. & Curt.).]—*Bull. Soc. Myc. de France*, xxxviii, 2, pp. 98–99, 1922.

This is an account of spraying tests carried out at the Experiment Station for Pomology at Sympheropol (Crimea) in 1917 and 1918. The experiments are stated to have demonstrated the superiority of weak solutions of arsenite of soda (0·01 to 0·02 per cent.) over various concentrations of polysulphides (lime-sulphur solutions)—long held to be the best remedy—and over powdered sulphur in the treatment of American gooseberry mildew. In practice powdered sulphur acts exclusively on the foliage, and almost entirely fails to protect the fruit from infection.

The percentage of bushes bearing contaminated fruits was 51 in those sprayed with arsenite of soda, 83 in those receiving lime-sulphur, and 100 in the controls, which were very heavily attacked. The advantages of the first over the second treatment stand out even more clearly when the comparison is applied to the berries picked from the treated plants. Four degrees of infection were recorded: (1) perfectly healthy berries with no trace of mildew; (2) slightly affected, with small spots; (3) more severely attacked;

(4) very severely attacked, more than half the surface being covered with mildew spots. Marking these degrees as 0, 1, 2, and 3, and taking the infection on the controls to be equal to 100, plants treated with lime-sulphur had an infection figure of 65, while those treated with arsenite of soda had only 28. In comparing the weight of the berries, the difference is still further accentuated, the average weight of healthy berries on each bush being 80·4 per cent. of the total weight with arsenite, 36·6 per cent. with lime-sulphur, and only 3·1 per cent. in the controls.

It is unfortunately the case that arsenite of soda (like lime-sulphur), even in very dilute concentrations, causes burning of the foliage, but the amount of this varies in different varieties. Amongst 25 [unnamed] varieties examined, some retained their foliage uninjured, while others suffered severe burns, or even lost a portion of their leaves.

Putterill (V. A.). **Plant diseases in the Western Provinces. IV. Two diseases of the Loquat.**—*Journ. Dept. Agric. S. Africa*, iv, 4, pp. 332–337, 7 figs., 1922.

The loquat (*Eriobotrya japonica*) is very common in gardens round Cape Town, and a leaf scab, due to a species of *Fusicladium*, was first reported on it from Kenilworth, Capetown, in 1920. In the following year affected fruit was examined, and it was found that loquat scab is very similar to those of the apple and pear [*Venturia inaequalis* and *V. pirina*]. The author thinks that the disease cannot have existed in South Africa for more than nine or ten years. It causes dark olive-green, velvety spots on the under side of the leaves, frequently distorting them, and also produces markings on the fruit which are very similar to those found on scabbed apples. It is not known whether the fungus overwinters on old leaves, as is the case with the allied scabs of other pomaceous fruits, but the loquat being an evergreen this means of bridging the seasons appears hardly necessary. In controlling loquat scab on the lines already known to be effective against pear scab in the Western Province, the method of leaf renewal demands a more frequent application of either Bordeaux (4–4–50) or lime-sulphur (1 in 45), than is the case with the pear, where the complete shedding of the foliage in the autumn facilitates treatment. From April onwards the frequency of the sprayings will depend on the intensity of the disease and on weather conditions, but up to maturity both the fruit and foliage should always have a protective coating of fungicide. From November to April, which is the dry season, sprayings can be reduced to once every two months. Clean cultivation is recommended, and badly diseased twigs should be cut out and burned.

A blight of loquats caused by *Entomosporium* sp., which has so far only been reported from one locality in Cape Province, was found associated with scab. It is also known in other parts of the Union outside the Cape Province. The first symptoms are the appearance of small, circular, shiny, black spots, somewhat convex in shape, which appear on the fruit, while small, circular, reddish-brown spots, surrounded by a yellow zone, stud the leaves, being much less noticeable than the scab markings due to *Fusicladium*.

It is only when the spots on the fruits are numerous and aggregated into patches that the two diseases can be confused. A similar, if not the same species of *Entomosporium* (*E. maculatum* with its perfect stage *Fabraea maculata*) causes leaf blight of the quince and pear, considerable damage from it having been recorded in South Africa, particularly in Natal and in the Orange Free State.

The control measures advocated for scab should apply equally well to this blight, owing to the similarity of the two fungi. It is thought that blight will be more readily controlled than scab, judging by the relative prevalence and severity of the two allied pear diseases, under the prevailing climatic conditions of the Province.

Dutton (W. C.) & Johnston (S.). **Dusting and spraying experiments of 1920 and 1921.**—*Michigan Agric. Exper. Stat. Special Bull.* 115. 54 pp., 23 figs., 1922.

In this bulletin a long series of dusting and spraying experiments carried out in 1920 and 1921 is described. The first experiment arose from the general practice of growers in Michigan of waiting until the blossom buds have separated (pinking or cluster stage) before spraying for apple scab. Observations indicated that scab infection occurred previous to this, and more information was desired as to the value of spraying at the pre-pinking stage (when the buds first show colour, but before they separate). Three plots were selected for experiment; the first was sprayed according to the normal practice, the second was similarly treated, but an extra spray given at the pre-pinking stage, and a third plot was left as control. Lime-sulphur was used ($1\frac{1}{4}$ in 50), and the results gave 46 per cent. scabbed for plot 1, 16 per cent. for plot 2, and 100 per cent. for the control.

The second series of trials was carried out to obtain information as to the comparative value of dusting and spraying in controlling apple scab and codlin moth. The 1920 experiment was made on 100 twelve year old Grimes Golden trees which were divided into four plots, the first being used as a control, the second sprayed with dilute lime-sulphur with lead arsenate, the third with sulphur-arsenate dust (90 per cent. sulphur, 10 per cent. dry lead arsenate), and the fourth with lime-copper-arsenate dust (80 per cent. hydrated lime, 10 per cent. anhydrous copper sulphate, and 10 per cent. lead arsenate). Four sprayings were applied, and the plots gave 89, 20, 22, and 68 per cent. scab and 10·0, 1·9, 0·5 and 5·0 per cent. codling moth respectively. Lime-sulphur-arsenate solution and sulphur-arsenate dust gave therefore much better results than lime-copper-arsenate dust, but the control of scab was not entirely satisfactory in any case. The fruit was tested on a very high standard; many of the apples would not have been classed as scabby commercially.

The 1921 experiment was similar, but the lime-copper-arsenate dust was omitted. The control gave 75 per cent. scab and 34 per cent. codling moth, the sprayed plot [four times with lime-sulphur ($1\frac{1}{4}$–50) with lead arsenate, and once with Bordeaux with lead arsenate] 8 and 5 per cent. respectively, and the dusted plot [six times with sulphur-arsenate dust (90–10)] gave 8 and 12 per cent. The figures showed that dusting and spraying gave equally satisfactory control of scab, but that the control of codlin moth by dusting was not so good as by spraying. A further dusting test was made in 1921: sulphur-lime-arsenate of lead dust (80–10–10) being used and seven dustings given. The controls gave 24 to 84 per cent. scabby, and 4 to 41 per cent. wormy fruits, while the dusted area gave 4 to 14 per cent. scabby (except on the late blooming variety Delicious which gave 51) and 7 to 14 per cent. wormy.

To sum up the results of the above dusting trials, sulphur dust, used according to the regular summer schedule, has given satisfactory control of apple scab. Lime-copper-arsenate dust, in the proportions used, has not so far proved successful.

Experiments on pear scab [*Venturia pirina*] were undertaken in 1920 to ascertain whether more than three sprayings are necessary to control this disease, and to compare the respective efficiency of lime-sulphur, sulphur dust, and copper sulphate dust (containing 10 per cent. dehydrated copper sulphate), lead arsenate being added to these materials when necessary. Four applications were given—at pre-pinking, pinking, calyx stage (just after the petals had dropped), and about a fortnight later.

In the first experiment, lime-sulphur (1–50) gave 10 per cent. scabbed; sulphur dust (omitting the last dusting) 15 per cent., and (omitting the pre-pinking dusting) 22 per cent.; copper sulphate dust 23 per cent.; and the control 58 per cent.

In the second experiment, lime-sulphur (1–40) gave 16 per cent.; sulphur dust (4 dustings) 10 per cent.; copper sulphate dust 20 per cent.; and the control 60 per cent.

In the third experiment three dustings [sulphur alone; sulphur-lead arsenate-nicotine sulphate; sulphur-lead arsenate (90–10)] gave 1·9 per cent. scabby and 0·5 per cent. wormy, while three sprayings (Bordeaux; lime-sulphur (1–40)–lead arsenate–Blackleaf 40; Bordeaux-lead arsenate) gave 3·1 per cent. scabby and 1·3 per cent. wormy.

Considering the results of the pear scab control as a whole, dusting and spraying were almost equally effective, but further tests are necessary. Foliage sprayed with lime-sulphur was considerably damaged, especially after the 'calyx' application, while that dusted was uninjured. The value of the pre-pinking spraying was definitely proved.

Brown rot [*Sclerotinia cinerea*] has been the cause of excessive loss of peaches and plums in recent years, apparently healthy fruit decaying before shipment or in transit. This has led to fruit being put on the market in an immature state, resulting in reduced sales and injury to commercial interests. Experiments were therefore undertaken in 1920 and 1921 to develop a satisfactory method of improving the keeping qualities of the fruit by control of brown rot.

In the first experiment, the sprayed trees were treated three times with lime-sulphur ($1\frac{1}{4}$–50) combined with lead-arsenate ($1\frac{1}{4}$ lb. in 50 galls.) and once with lime-sulphur alone, while the dusted trees were treated four times with sulphur-arsenate dust (90–10) and twice with sulphur alone. The results both from spraying and dusting up to the time the fruit was picked were very satisfactory, while a late application of sulphur dust reduced the development of rot after picking.

In the second experiment, sulphur-hydrated lime-arsenate dust (first dusting 75–15–10, second dusting 85–15–0) gave at the time of picking 0·7 per cent. of peach scab and 3 per cent. of brown rot, while the control gave 18 and 13 per cent. respectively.

A series of experiments was carried out on plums and peaches with the single purpose of finding whether sulphur-hydrated lime dust (85–15 or 90–10) would retard the development of brown rot after picking. The dusted trees invariably gave a lower percentage of brown rot (5 to 35) than the controls (30 to 100). The dusting was done three days to one month before the picking, and the results were taken four to twelve days after picking.

The late application of sulphur dust therefore greatly improves the keeping qualities of the fruit, but such treatment should only be considered as supplementary to the regular summer schedule and not as a substitute for it.

Experiments were also carried out in 1920 and 1921 to test the efficiency of lime-sulphur, Bordeaux, sulphur dust, and dehydrated copper sulphate dust in controlling leaf spot of cherry [*Coccomyces hiemalis*] on the varieties English Morello and Montmorency. On the latter the results were inconclusive owing to the slightness of attack. On the former, however, in 1920, Bordeaux mixture (4–6 hydrated lime–50) gave good control, but caused serious injury to the foliage; lime-sulphur ($1\frac{1}{4}$–50) ranked second, and the two dusts, sulphur-arsenate (90–10) and lime-copper-arsenate (75–15–10) a little lower still. In 1921 the control by all materials [lime-sulphur ($1\frac{1}{2}$–50), Bordeaux (4–7 hydrated lime-50), sulphur-arsenate-lime dust (80–10–10), and lime-copper-arsenate dust (70–20–10) with 10 per cent. talc] was almost perfect, but Bordeaux resulted in the fruit being undersized, a similar trouble having recently been reported from the North-West.

Comparative tests of dry and liquid lime-sulphur for the control of apple scab showed, as in previous years, that the latter gave the better results.

Following an experiment made in 1919, another trial was made to control peach leaf curl [*Exoascus deformans*] by dry spraying, but satisfactory control was not obtained with soluble sulphur or Bordeaux dusts.

COONS (G. H.). **Copper dust treatment for stinking smut.**—*Quarterly Bull. Michigan Agric. Exper. Stat.*, v, 1, pp. 8–11, 1 fig., 1922.

Stinking smut or bunt of wheat [*Tilletia tritici*] reduces the Michigan crop by at least 5 per cent. annually. In the autumn of 1921 experiments were carried out on very heavily smutted wheat to determine the comparative efficiency of various methods of control. The following results were obtained: 'dry' formaldehyde [see this *Review*, i, p. 436], 3 per cent. of infection; sprinkling with 1 pint commercial solution of formaldehyde in 40 galls. of water, 0 per cent.; immersing in the same solution and skimming off the unbroken bunt balls, 0·5 per cent.; copper carbonate dust, 2 oz. per bushel, 1·4 per cent.; dehydrated copper sulphate and lime dust, 2 oz. per bushel, 4 per cent.; untreated, 51 per cent.

The formaldehyde treatments gave satisfactory control, but somewhat reduced the stand. The copper carbonate and copper sulphate-lime dusts would probably effect complete control on ordinary grain fit for seed purposes. The copper dusts had no adverse effects on germination, and their use on a large scale (for wheat only) is recommended.

BOUILLARD (R.). **Emploi du lysol contre la carie.** [Use of lysol against bunt.]—*Journ. Agric. Prat.*, lxxxvi, p. 203, 1922.

The writer states that he has obtained excellent control of bunt by the disinfection of seed wheat with 5 per cent. lysol (200 gm. lysol and 4 litres of water per hectolitre of seed). Not a trace of the disease has been observed during the four years over which the tests have extended. Compared with copper sulphate, lysol appears very slightly to retard germination (one to three days), but no difference is noticeable at maturity. The retail price of lysol is slightly higher than that of copper sulphate, but the former is in several respects more convenient. Seed steeped in lysol in the morning can be sown the same evening, and the preparation of the mixture is very simple. Seed which has been thoroughly treated by lysol assumes a light walnut tint. The treatment is applied by sprinkling the grain, which should be well shovelled over during the process.

KLAPHAAK (P. J.) & BARTLETT (H. H.). **A preliminary notice of genetical studies of resistance to mildew in Oenothera.**—*Amer. Journ. of Bot.*, ix, 8, pp. 446–458, 1922.

Oenotheras grown for experimental purposes showed that nothing is more characteristic of the various elementary species and hybrids than the great difference they exhibit in susceptibility to mildew (*Erysiphe polygoni*). Such material therefore offered an excellent opportunity for an investigation of the inheritance of disease resistance, part of the results of which are given in this paper.

General observation indicated that susceptible species when crossed reciprocally with immune ones gave only one immune cross. It was not possible to get immune hybrids by crossing susceptible parents, while in the case of crosses between immune strains, both reciprocals might be immune, or one of them immune and the other susceptible.

In earlier papers the hypothesis of heterogametism has been formulated (Bartlett, *Amer. Nat.*, 50, pp. 513–529, 1916, and Cobb and Bartlett, *Journ. Wash. Acad. Sc.*, 9, pp. 462–483, 1919) according to which each species of *Oenothera* is supposed to produce two types of gametes called α and β gametes. The former are generally the female ones and the latter the male, but in a few exceptions the pistil may transmit the β gametes and the pollen the α, in which case instead of a normal hybrid of $\alpha\,\beta$ combination, usually similar in character to one of its parents, a metaclinic hybrid $\beta\,\alpha$ is produced, which plant resembles the reciprocal cross.

The hypothesis which is suggested to account for immunity is as follows. The immune strains carry a factor **I** for immunity, the susceptible strains a factor **i** which denotes absence of immunity or presence of a factor for susceptibility. If in an immune strain only one type of gamete bears the **I** factor, and if only $\alpha\beta$ combinations are viable, then such a strain will breed true for immunity but will give a susceptible hybrid, one way or the other, when reciprocally crossed with a susceptible strain. **I** is considered to be the dominant factor and may be an attribute of the α gamete or the β gamete.

On the basis of the above hypothesis the authors have worked out the zygotic composition of the five strains of *Oenothera* selected for the experiments as follows:—

Oenothera pratincola ('Lexington C')	α **i** β **i**, susceptible.
'*Oe. biennis Chicago*'	α **i** β **i**, susceptible.
Oe. mississippiensis	α **i** β **i**, susceptible.
Oe. pratincola hyb. *immunis*	α **i** β **I**, immune.
Oe. cinerescens	α **I** β **i**, immune.

Ersiphe polygoni appeared to show indications of the existence of 'biologic strains', as conidia from the pea did not produce infection on *Oenothera* whilst conidia from *Oenothera* did so. No morphological differences could be correlated with this behaviour.

In planning the experiments the immune strains were freely tested as regards immunity, by growing them among highly susceptible ones. The objection that strains of *E. polygoni* might exist elsewhere which would infect the so-called immune strains of *Oenothera* is hardly revelant, since the authors are concerned not with the production of disease-free plants, but rather with the fact that immunity to certain strains of *E. polygoni* exists, and that such immunity acts as a dominant unit factor in heredity.

Details are given of numerous crosses made with the five strains of *Oenothera* mentioned above, each strain being selfed and also crossed with the four remaining ones. Three examples may be cited as illustrative of the crosses made, the pistillate parent being named first in each case.

(1) *Oe. mississippiensis* (susceptible) × *Oe. cinerescens* (immune) gave all susceptible progeny of the constitution α **i** β **i** with the exception of one metaclinic plant which was immune. In the reciprocal cross, the progeny, α **I** β **i**, were all immune except in the case of one metaclinic plant of the type *Oe. mississippiensis*, which was susceptible.

(2) *Oe. mississippiensis* (susceptible) × *Oe. pratincola* hyb. *immunis* (immune) gave all immune progeny (α **i** β **I**) of the *mississippiensis* type. From the reciprocal cross, all the progeny (α **i** β **i**) except one, a mutation, were matroclinic and resembled *Oe. pratincola* except in susceptibility to mildew.

(3) *Oe. cinerescens* (immune) × *Oe. pratincola* hyb. *immunis* (immune) gave all immune progeny (α **I** β **I**), and the reciprocal cross gave all susceptible plants (α **i** β **i**).

In every one of the cases analyzed in this way the reaction of the hybrid to mildew conformed exactly to expectations, according to the formulation above.

On account of the peculiar type of heterogametism in *Oenothera*, immunity due to a single factor must breed as true as that due to a factor pair.

The F_2 generation obtained by self pollination of the hybrids showed the same characteristics as regards susceptibility or immunity as the F_1 generation, a result which should have been expected on the basis of the authors' hypotheses of heterogametism and immunity.

In the case of metaclinic hybrids from immune and susceptible parents, the immunity factor combination which would insure susceptibility or immunity in one particular type seems not to insure the same effect in another type. Further investigations have been started on this matter, but so far as the normal hybrids are concerned the results are all consistent.

BONAR (L.). **An albino mutation of the Dematiaceous fungus Brachysporium trifolii.**—*Science*, N.S. lvi, pp. 226–227, 1922.

Cultures of *B. trifolii* were started from a single spore in October 1919, and have been continued as a pure strain ever since. The fungus is normally of the *Dematiaceous* type, with dark brown hyphae forming a dense, black mat in and on the culture medium. In one of a series of cultures made in November 1921, a sector of growth appeared which completely lacked the usual dark brown colour, although the mycelium and conidia were identical in all other respects with the normal growth.

Pure cultures of the albino material were carried on through sixteen consecutive non-sexual generations without any variation in the appearance or nature of the strain. The mycelium in mass is a true albino or may at times assume a pale flesh colour. Every modification in conditions thought of was used in these cultures for the two and a half years they have been maintained, and there has been an entire absence of any sexual process either in the normal or albino strains. The phenomenon of albino mutation must therefore be referred to some sudden change, hitherto inexplicable, in the mycelium or conidia of the normal strain.

LAGERBERG (T.). **Cordiceps militaris (L.) Link i Sverige.** [*Cordiceps militaris* (L.) Link in Sweden.]—*Svensk Botan. Tidskr.*, xvi, 2, pp. 285–290, 2 figs., 1922.

The author found *Cordiceps militaris* in 1920 and 1921 on larvae of *Smerinthus populi*, *Cymatophora flavicornis*, and *C. duplaris*. The locality was a ravine in South Dalarne, the trees in which were mainly *Populus tremula* and *Salix*. The soil humus was markedly alkaline and the ground was covered with a layer of damp, rotting foliage. Further ecological particulars of the locality are given, together with a list of the mosses, ferns, grasses, &c., represented there.

According to Bülow (*Svampar*, 3rd Ed., p. 253, 1919), *C. militaris* is extremely rare in Sweden, but may be found year after year in the same place. The fungus is represented by only a very few specimens in Swedish collections. A brief description of its macroscopic characters and life-history is given.

JOHNSON (J.). **The relation of air temperature to the mosaic disease of Potatoes and other plants.**—*Phytopath.*, xii, 9, pp. 438–440, 1 fig., 1922.

Following his previous work on the temperature relations of the mosaic disease of tobacco [see this *Review*, i, p. 243], the author gives the results of similar experiments which he has conducted with mosaic diseases of potatoes, tomatoes, soy-beans, pea-beans, and clover.

Young potato plants showing symptoms of mosaic were placed in air-control chambers held at temperatures ranging between 6° and 36° C. for one to three weeks, parts of the individual tubers in each series being represented in each chamber. The effect of temperature was gauged by the intensity of the symptoms of the mosaic or the rate of 'recovery' from the disease.

The results have shown that temperatures as low as 6° C. seemingly do not inhibit the disease, which persists at temperatures where the potato makes little or no growth. Taking the growth of the host into consideration, the optimum temperature for the disease lies between 14° and 18° C. Above 20° C. symptoms disappear, but a temperature of 24° to 25° C. is necessary to cause them to disappear in one to two weeks (old leaves taking longer to 'recover' than young ones), so that this temperature may be regarded as the maximum temperature for mosaic manifestation in the potato.

The expectation that exposure to high temperatures would destroy the mosaic virus has not been realized so far, although the effect of exposure for 10 days at 36° C., while not entirely destroying the virus, indicated that longer treatment may be effective without destroying the germination of the tuber.

Certain other mosaic diseases, worked with in less detail, have responded to temperature, some, like tomato mosaic (inoculated with tobacco virus), falling in the high temperature class with tobacco, others, like clover mosaic, in the low temperature class, and others being intermediate. Soy-bean mosaic is inhibited at temperatures of from 26° to 28° C., but the pea-bean mosaic can apparently persist at a considerably higher temperature.

NELSON (R.). **Transference of the Bean mosaic virus by Macrosiphum solanifolii.**—*Science*, N.S. lvi, pp. 342–344, 1922.

The author describes a series of observations and experiments which are regarded as definitely proving that *Macrosiphum solanifolii* is concerned in the transmission of mosaic disease of beans (*Phaseolus vulgaris*). This is stated to be the first experimental proof of the transmission of this mosaic by insects. The varieties affected were Long White, Golden Wax, Brittle Wax, and Green Pod Stringless.

MELIN (E.). **Untersuchungen über die Larix-Mykorrhiza. I. Synthese der Mykorrhiza in Reinkultur.** [Investigations of the *Larix* mycorrhiza. I. Synthesis of the mycorrhiza in pure culture.]—*Svensk Bot. Tidskr.*, xvi, 2, pp. 161–195, 13 figs., 1922.

This is a full account of the author's successful syntheses of certain coniferous mycorrhiza, especially that of *Larix europaea*, of which a preliminary statement has already been noticed [see this *Review*, i, p. 442].

A description is given of the characters of larch mycorrhiza and the constant association of *Boletus elegans* with the larch is noted. The methods of growing both symbionts in pure culture are described at length and a full account is given of the effects of bringing together the fungus and larch roots in pure cultures. The mycorrhiza thus formed by synthesis resembled the natural mycorrhiza, and enabled the author to study the different stages of mycorrhiza formation in some detail.

In similar attempts to synthesize larch mycorrhiza, using as the fungus symbiont *Mycelium radicis sylvestris* α, β, and γ [see this *Review*, i, p. 122], only those with the β form gave typical mycorrhiza, which, however, differed from those formed with *B. elegans* in certain morphological characters. The α and γ forms appeared to act in a more parasitic manner than *B. elegans*, the γ form producing no true mycorrhiza. *M. r. abietis* formed no mycorrhiza on the larch, which it attacked parasitically.

Boletus elegans was next tried on *Pinus sylvestris* and *Picea abies* without effect, and the author concludes that the association of this fungus with the larch is of an obligate nature. The relationship is believed to be one of mutual symbiosis, each giving support of some sort to the other.

Direct attempts to isolate the fungus from naturally formed larch mycorrhiza failed, and even those produced synthetically gave no fungous growth when the usual methods of isolation were tried.

McLuckie (J.). **Studies in symbiosis. I. The mycorrhiza of Dipodium punctatum R. Br.**—*Proc. Linn. Soc. New South Wales*, xlvii, 3, pp. 293–310, 26 figs., 1922.

The cortex of the root of *Dipodium punctatum*, a holosaprophytic orchid growing in the humus under Eucalypts in New South Wales, contains an endophytic fungus which forms close coils in the cells, especially in the vicinity of the nucleus. The fungus occurs in the soil surrounding the root in the form of numerous, branching, fine hyphae, many of which form a close tangle on the surface of the root. From this tangle, hyphae penetrate the cortex through the passage cells of the exodermis, branching freely and infecting numerous cells within the exodermis, but not entering the raphide cells or the meristematic zone of the root. In newly-infected cells the hyphae are very slender, but they increase in thickness after they have been within the cell for some time, and become filled with dense, deeply staining, granular protoplasm with few vacuoles. No vesicles are formed. The starch grains gradually disappear from the cells after infection. In certain cells occupied by the fungus for some time, the highly nourished hyphae begin to disorganize, losing their individuality and forming a deeply staining mass in the centre of the hyphal tangle. The nucleus of the infected cell at the same time increases to twice or three times its normal size, the nucleolus also enlarging. The chromatin stains more deeply and appears more abundant, the whole condition being suggestive of a high state of nutrition. The final appearance of the fungus is an irregular mass of indefinite structure, but apparently composed largely of proteids. Small droplets of a yellowish, highly refractive substance were in some cases present in the host cells at this stage. The gradual destruction of the fungus appears to be the result of its digestion by the cytoplasm of the host cells. The latter process is particularly marked immediately before and during the development of the flowering shoot, when an extra supply of proteid is evidently necessary. After digestion the cytoplasm of the host cells appears quite normal, and starch reappears during the process, though in smaller quantities than before.

The penetration of the hyphae from cell to cell, and from the soil into the root, is probably the result of a chemotropic stimulus due to the presence in the host cells of a nutritive substance, probably sugar. The greater concentration of this substance round the nucleus would explain the growth of the hyphae in that direction. The protoplasm or proteid of the fungal hyphae increases at the expense of the starch which disappears from the infected host-cells; hence the carbohydrates of the latter appear to be used in the synthesis of nitrogenous food in the mycelium, which at this stage must be regarded as parasitic. The nitrogen for this process is probably derived from the soil through the hyphae connecting the endophytic mycelium with that on the surface of the root. In the next stage the substance of the fungus is taken up by the host plant by a process of digestion.

In *Dipodium* the higher plant appears to derive most benefit from the association. The fungal hyphae forming the mycorrhiza are indispensable to the host, which is devoid of chlorophyll, and therefore incapable of photosynthesis. Such starch as it contains is probably the result of the presence of the endophyte, which appears to be never exterminated, but to be always active in some part or other of the root. The higher plant is further without root-hairs and, therefore, dependent on the fungus for its supplies of water, ash constituents, carbonaceous substances, and nitrogen; in fact, it appears that all its requirements are supplied directly or indirectly by the fungus. Thus the higher plant may be regarded as being, on balance, parasitic upon the endophyte.

Sundararaman (S.). **The Coconut-bleeding disease.**—*Agric. Res. Inst. Pusa, Bull.* 127, 8 pp., 6 pl. (1 col.), 1922.

The first symptom of the coco-nut bleeding disease, which is widely distributed in the Madras Presidency, is the exudation of a reddish-brown fluid from cracks on the surface of the stem. This fluid turns black as it dries. The tissue below the bleeding portion is decayed and yellow, at first in localized patches, then extending and involving much of the interior of the stem. At an advanced stage of the disease, the crown dwindles and the palm ceases to bear nuts and finally dies. Young palms are the most severely affected, especially when the base is attacked. The inner, soft tissue rots, and a cavity is formed in the centre of the stem. Here a thin, yellowish fluid accumulates and gushes out when the cavity is incised. If the decay extends downwards the tree becomes hollowed out, no external symptoms of disease being visible. When this occurs the whole palm should be cut out and burnt as treatment is impossible. The disease is caused by a fungus, *Thielaviopsis paradoxa*, a brief historical and descriptive account of which is given. Inoculations with mycelium from glucose agar cultures were carried out on seedling plants grown in pots. The results indicated that the fungus infects the stem through a wound or crack, and also that it cannot attack uninjured leaves or petioles.

The most effective remedy in cases of localized infection is to excise the diseased parts, together with about an inch of the surrounding healthy tissue. This operation should be followed by the drying of the cut surface with fire, and the application of hot tar to the wound. This treatment has proved very successful in a case under the writer's observation, in which one hundred trees were completely cured. It is important to remember that the external symptoms do not always indicate the extent of the internal decay, the latter often being found at a considerable distance from the parts visibly affected on the exterior of the stem.

GARNER (W. W.), McMURTREY (J. E.), & MOSS (E. G.). **Sand drown, a chlorosis of Tobacco and other plants resulting from magnesium deficiency.**—*Science*, N.S., lvi, pp. 341–342, 1922.

Investigations have been carried out by the Bureau of Plant Industry, in co-operation with the North Carolina Department of Agriculture, on a chlorosis of tobacco popularly known as 'sand drown'. The disease, which occurs in an aggravated form on sandy fields after heavy rainfall, has been found to be due to an insufficient supply of magnesium in the soil or fertilizer. The ratio between the quantities of sulphur (sulphate) and magnesium contained in the fertilizer is also important, the symptoms of magnesium deficiency being intensified by an increase in the quantity of sulphur applied to the soil.

The chlorosis usually begins at the tip and along the outer margins of the older leaves, advancing towards the leaf base and extending progressively to the upper leaves of the plant. Sometimes, however, large areas of the leaf surface may already be involved when the symptoms first become noticeable. The veins and midrib of the leaf tend to retain their normal colour, but there is more or less complete blanching of the lamina, both yellow and green chlorophyll pigments being affected. In this respect, and in the more gradual death of the affected tissues, 'sand drown' differs from the chlorosis due to potassium deficiency. Sandy and sandy loam soils appear to be chiefly affected, especially where the rainfall is abundant.

The addition of sulphate or chloride of magnesium to the fertilizer has always resulted in the control of the disease. Comparative tests indicated that low grade sulphates and chlorides of potassium containing large quantities of magnesium, such as kainit and 'double manure salt', prevent this chlorosis, while high grade sulphates and chlorides of potassium intensify it. Dolomitic limestone also prevents it, while comparatively pure calcite is ineffective. Cotton seed meal, tobacco stalks and stems, and organic manures also tend to reduce 'sand drown', as they all contain appreciable quantities of magnesium, while other common sources of nitrogen which are deficient in magnesium, e.g. nitrate of soda, dried blood, and ammonium sulphate, favour its development. In pot cultures this type of chlorosis is readily induced by omitting magnesium from the nutrient solution, and may be cured by adding magnesium, at any rate in the early stages. The constant addition of sulphur to the soil from rain water during rainy seasons, and the corresponding loss of magnesium by leaching, explain the greater prevalence of the disease under such conditions.

Experiments have shown that maize is also liable to 'sand drown', which probably affects a wide range of crops in light, sandy soils. Probably less than 50 lb. of magnesium per acre would suffice to remedy the deficiency. These investigations indicate the necessity for taking magnesium into account both in the general problem of liming and in the composition of so-called complete fertilizers.

Nobécourt (P.). **Sur le mécanisme de l'action parasitaire du Penicillium glaucum Link et du Mucor stolonifer Ehrb.** [On the mechanism of the parasitic action of *Penicillium glaucum* Link and *Mucor stolonifer* Ehrb.]—*Comptes Rendus Acad. des Sciences*, clxxiv, 26, pp. 1720–1722, 1922.

The author's experiments, a short description of which is given, indicate that the destructive action of *Penicillium glaucum* and *Mucor stolonifer* on fruits is due to enzymes secreted by these fungi. The juice expressed from fruits rotted by them was found to have a pronounced cytolytic and plasmolytic action on thick slabs of different fruits, pieces of carrot, Jerusalem artichoke, onion bulbs, broad bean stalks, &c., immersed in it. By heating at about 60° C. for 15 minutes the juice loses this destructive power, which is furthermore temporarily inhibited at temperatures near the freezing point. The active substances can be extracted from the juice by strong alcohol, and water solutions of the precipitate thus obtained act in the same way as the juice itself. These enzymes, which the author calls 'fungal toxins', only act in an acid medium; after adding bicarbonate of soda to the active juice, the latter can no longer destroy plant tissues immersed in it. An attempt to obtain the toxins from carrot broth in which both fungi were cultivated was unsuccessful, even though there was an abundant growth of mycelium in the medium, but the liquid obtained by macerating the mycelium of *M. stolonifer* for a few days in distilled water possessed the power of disorganizing plant tissue. The toxins secreted both by *P. glaucum* and *M. stolonifer* disorganize tissues of plants which the fungi themselves cannot attack; the author concludes therefore that the immunity of such plants is not due to the resistance of their tissues to the substances secreted by the fungi, but to some other causes which he is trying to determine.

Willaman (J. J.) & Davison (F. R.). **Biochemistry of plant diseases. IV. Proximate analysis of Plums rotted by Sclerotinia cinerea.**—*Botan. Gaz.*, lxxiv, 1, pp. 104–109, 2 figs., 1922.

Proximate analyses of several resistant and non-resistant varieties of plums rotted by *Sclerotinia cinerea* showed that the rotted tissue consistently contained a higher percentage of ash, calcium oxide, nitrogen, and ether extract than the tissue of sound plums; the authors believe this to be probably due to a loss of dry matter through respiration, which previous work has shown to be higher in infected than in sound plums. Crude fibre contents were found to be markedly higher in the resistant than in the susceptible varieties, while the percentage of all other constituents was lower in the former, but not sufficiently so to limit the nutrition of the invading organism. It appears quite probable that the quality and quantity of cellulose material are important factors in resistance. It was noted that as the ripening of the plums proceeded, there was a decrease in the ash, nitrogen, and calcium content, due probably to storage of carbohydrates and acids.

YOUNG (H. C.) & BENNETT (C. W.). **Growth of some parasitic fungi in synthetic culture media.**—*Amer. Journ. of Bot.*, ix, 8, pp. 459–469, 4 text figs., 1922.

The authors have carried out an investigation of the importance of the various elements in synthetic culture media for fungi, and the best concentrations in which to use them.

A review of previous work on the food requirements of fungi is given, together with formulae by Raulin, Mayer, Pfeffer, Richards, Currie, Uschinsky, Czapek, and Coons. In general all the solutions yet devised depend upon whether the investigator considered the presence or absence of the inorganic constituents important for the growth of the fungus, and do not appear to have been founded on accurate study. The rôles of calcium, iron, and zinc seem to have especially caused discussion. Molisch considered calcium unnecessary for normal growth, and although this fact is based on little experimental data it has been generally accepted. Currie concluded that iron has no effect on *Aspergillus niger*. Others, however, have found both iron and calcium beneficial although not essential. Steinburg has more recently shown that zinc has a very decided stimulative effect.

In determining the rôle of the so-called essential inorganic elements along with that of calcium and zinc, Richards' solution (potassium nitrate 1 gm., potassium acid phosphate (monobasic) 0·5 gm., magnesium sulphate 0·25 gm., ferric chloride a trace, saccharose 3·43 gm., and water 100 c.c. Reaction P_H 4·2) was used as a standard and as a basis for the deviations, the inorganic constituents being replaced by non-essentials and the sucrose by different sugars. The possible importance of impurities was recognized and only selected glass and specially prepared chemicals were used. Cultures of *Fusarium oxysporum*, *Aspergillus niger*, and *Rhizopus nigricans* were made in flasks containing the various solutions and the dry weight of mycelium taken after sixteen days. The results indicate that calcium exerts a stimulative action on growth, and although the exact manner in which this is effected is problematical the rôle of calcium in counteracting acidity probably plays an important part in the process. To make sure that the increased weight was due to fungous growth and not to calcium oxalate, the mycelium was treated with alcohol and 30 per cent. hydrochloric acid. Zinc sulphate stimulated the growth of *A. niger* but not of *F. oxysporum* or *R. nigricans*. The quantity of acid produced by *A. niger* and *R. nigricans* is proportional to the amount of fungous material produced; with available carbon, growth continues until stopped by hydrogen-ion concentration. The acidity of the culture solution in which *F. oxysporum* was grown increased to a maximum of P_H 3·6 and then diminished, alkalinity developing until all the organic compounds were broken up and a P_H value of 8·4 was reached.

A further experiment on the effect of calcium and zinc on the growth of eighteen parasitic organisms showed that calcium is generally beneficial, though in the case of four organisms it retarded growth. *Rhizoctonia solani* grew only when calcium was present. *Fusarium radicicola* was pink in solutions containing calcium and colourless in potassium solutions. Zinc sulphate gave slightly beneficial effects with only two organisms.

It would seem that the salt requirements for an optimum synthetic solution should contain nitrogen, phosphorus, sulphur, potassium, calcium, and magnesium. There is no evidence of the correct proportions in which these inorganic elements should be used, but since the salt requirements for fungi are probably the same as for higher plants, two triplicate series of twenty-one cultures were made on the method used by the National Research Council [United States] for work in the study of the nutrition of higher plants. Potassium acid phosphate (monobasic), calcium nitrate, and magnesium sulphate were used in one series. The salts varied in the different solutions by increments of one-eighth and had an osmotic concentration of 3·5 atmospheres. Sucrose was added in equal amounts of 3·43 gm. per 100 c.c. of the solution, thereby giving the culture solutions a total osmotic pressure of 4·5 atmospheres. Potassium nitrate, calcium acid phosphate, and magnesium sulphate were similarly used in the other series. *Fusarium oxysporum*, *Macrosporium sarcinaeforme*, and *Phoma apiicola* were the fungi used, and dry weights were determined after sixteen days incubation. The results of this experiment show clearly that a proper balance of the inorganic constituents in the solution is essential for maximum growth, and that this balance can be readily obtained by the use of the triangular system of the National Research Council. By this system the mineral requirements of any particular fungus can be quickly and accurately ascertained, and by selecting the sugar most readily used, a favourable culture solution can be made.

POLE EVANS (I. B. & MARY). **Rise in temperature of living plant tissue when infected by a parasitic fungus.**—*Nature*, cx, 2762, pp. 480–481, 1922.

In investigating the effects of inoculating oranges and grapefruit with *Penicillium digitatum* the authors found that a very definite rise of temperature took place in the infected living tissues, while the temperature was not observed to rise when the host tissue was killed prior to inoculation. To what extent direct reaction of the host is responsible for this rise of temperature is still to be determined, and also whether the phenomenon is a general one, occurring in all cases of attack by parasitic fungi on living plant tissue.

Testing of new varieties of the Potato for immunity from wart disease.—*Scottish Journ. of Agric.*, v, 3, pp. 306–311, 1922.

New potato varieties sent in for trial are tested for immunity from wart disease during at least two years at the Philipstoun station of the Scottish Board of Agriculture, as a susceptible variety might conceivably escape detection in a dry season unfavourable for the development of the disease. A certificate of immunity is given to the varieties which satisfactorily stand the test. In the second year of trial the varieties are grouped together in the field according to certain standard characteristics of the tubers and haulms, of which the colour of the sprouts grown in diffuse light and the date of maturity of the tubers form the two main bases of classification; both features are fairly constant and the latter is of the greatest importance to the growers.

The tests completed in 1921 comprised 130 varieties, including some eighty from the United States and twenty-two from Germany; in addition, a large number of single tubers and seedlings were submitted for a preliminary test. Among the American varieties, only four of the Up-to-Date type were of outstanding merit and these were non-immune from wart disease: eighteen named sorts and three seedlings proved to be immune. These eighteen named varieties comprise only ten types as follows:—Irish Cobbler (4), Early Harvest, Ehnola. Perfect Peachblow, Early Manistee, Green Mountain (6). Netted Gem, Keeper. Northern King, and McCormick. It is noted that Irish Cobbler and Keeper are indistinguishable from the British varieties America and Sutton's Flourball respectively; these sorts were first put on the market in the United States and the stocks have been subsequently sent over to England. The non-immune varieties included representatives of the Rural New York, Early Rose, and Beauty of Hebron types, and also of the British Up-to-Date type. Of the German varieties tested only four proved to be immune, while none appeared to be as good as the British standard types.

A very large and representative collection of British varieties, immune and non-immune, was sent to the United States in 1920. According to the report of 1921 the following sorts proved to be free from leaf-roll, mosaic, streak, and diseases of unknown origin: Ally, May Queen, Great Scot, Rector, Climax, Provost, and Duchess, while the varieties Epicure, Dargill Early, Majestic, and Rhoderick Dhu had only 5 per cent. of their numbers affected. The amount of disease in Tinwald Perfection, Golden Wonder, Resistant Snowdrop, Eclipse, Langworthy, Arran Victory, Irish Queen, Templar, King Edward, Lochar, Witchhill, Mauve Queen, Bishop, and Immune Ashleaf was over 50 per cent. Of a similar consignment sent to Germany, many were destroyed by frost and only Great Scot was regarded with favour.

Wart disease of Potatoes: immunity trials.—*Gard. Chron.*, lxxii, p. 229, 1922.

The results of the tests for immunity from wart disease demonstrated on 28th September 1922, by the Scottish Board of Agriculture at Philipstoun, West Lothian, showed that selfed immune varieties of potatoes produced a large number of immune seedlings. In many respects the latter reproduced their parents' characteristics; some, such as those from Ally, Abundance, and Templar, were indistinguishable from the parents and showed a high percentage of immune individuals. The result of crossing an immune and a susceptible variety (Flourball × President), showed about 40 per cent. of immune individuals after two years, whereas the crossing of two immunes (Majestic × Flourball) gave 70 to 80 per cent. of immunity. Seedlings of Up-to-Date × Majestic also showed a fair proportion of immune types.

WAKSMAN (S. A.). **The influence of soil reaction upon the growth of Actinomycetes causing Potato scab.**—*Soil Science*, xiv, 1, pp. 61–79, 1922.

The results of a series of experiments showed that the limiting acid reaction for the growth of *Actinomyces scabies* in culture solutions, properly buffered, and in sterile soil, varies with the strain. The determinations of the growth in liquid cultures were made by filtering off and weighing the fungus, and in soil cultures by measuring the production of ammonia. In some of the soil series the amount of *Actinomyces* was determined by plating and counting the colonies.

In the majority of cases, the limiting acid reaction is about P_H 5·0 to 5·2; some strains even grow at P_H 4·8, while others begin to develop only at P_H 5·3 to 5·6. These results, in the main, bear out those of Gillespie (*Phytopath.*, viii, 6, p. 257; *Soil Science*, iv, 4, p. 313; and v, 3, p. 219). The optimum hydrogen-ion concentration in the soil cultures was found to be from P_H 5·8 to 7·7, while the limit on the alkaline side was P_H 8·8. The alkaline limit is therefore too high for arable cultivation, but the acid limit will allow good crops of potatoes to be grown. The saprophytic soil *Actinomyces* appear to be more acid resistant than the strains of *A. scabies*. By the use of the proper amount of sulphur inoculated with *Thiobacillus thiooxidans*, an acid reaction can be obtained which will control common potato scab. This is equivalent to making the soil acid by means of sulphuric acid, since the sulphur is oxidized to H_2SO_4 by the action of the bacillus. In soils that are already of an acid nature, the use of green manures may suffice to control scab owing to the formation of organic acids during their decomposition.

It is admitted that the term *Actinomyces scabies* includes a group of pathogenic forms, but the various strains examined by the writer appear to be covered by the limitations given above.

JENNISON (H. M.). **Potato blackleg, with special reference to the etiological agent.**—Abs. in *Phytopath.*, xii, 9, p. 444, 1922.

Continuing his investigations of *Bacillus atrosepticus* van Hall [see this *Review*, 1, p. 82], the author presents the index-number 5312–32120–2110 in lieu of a fuller (revised) description of this organism. The bacillus develops acid and gas in the presence of a number of saccharides. Gas production is weak initially, but is capable of intensification by cultivation in sugars which the organism can utilize. It secretes invertase, lactase, and maltase, and quantitative determinations showed that it cannot hydrolyse potato starch or dextrin.

RICHARDS (B. L.). **Corticium vagum as a factor in Potato production.**—Abs. in *Phytopath.*, xii, 9, p. 444, 1922.

In a series of pure culture experiments, several strains of *C.*

vagum were found to produce severe and characteristic cankers on all underground parts of the potato, young plants being attacked most vigorously, and growing points being especially susceptible.

In extensive field experiments the fungus, under favourable conditions, seriously reduced the number and size of the tubers, decreased the number of stems per hill, and greatly weakened the surviving ones which were usually undersized and died early. Yields from 500 diseased hills and 500 disease-free hills, grown under comparable conditions, showed that inoculation of the soil with the *Rhizoctonia* stage of *C. vagum* reduced the crop to 50 per cent. of that obtained from treated seed. Under natural conditions, soil temperature proved to be the most important factor in determining the loss.

Raeder (J. M.) & Hungerford (C. W.). **The effect of presprinkling with water upon the efficiency of certain Potato seed treatments for the control of Rhizoctonia.**—Abs. in *Phytopath.*, xii, 9, p. 447, 1922.

Preliminary laboratory tests have shown that disinfective treatments for seed potatoes are rendered more efficient by presprinkling with water. Potatoes sprinkled and covered for 24 hours, then treated with formaldehyde (1 in 120) at 50° C. for 3 minutes or 55° C. for 1 minute, or covered for 48 hours and treated with formaldehyde (1 in 120) at 50° C. for 2 minutes, gave clean seed, but cultures from seed similarly treated, except that they were not presprinkled, showed that the control was not absolute.

Sprinkling with water and covering 24 to 48 hours before treatment with mercuric chloride was advantageous, but in no case was the control absolute.

Miège (E.). **Sur une maladie de la Pomme de terre observée au Maroc.** [On a Potato disease observed in Morocco.]—*Bull. Soc. Path. Vég. de France*, ix, 2, pp. 109–112, 1922.

The author believes that a disease of potatoes observed by him at Rabat (Morocco) in 1921 has not previously been described. Although a bacterial origin is suspected, his inoculation experiments so far have given inconclusive results.

The symptoms visible on the aerial portion of the plant are very characteristic. The progress of the disease is plainly basipetal. It begins at the extremity of the branches, usually those at the top or middle of the plant. The terminal leaflet after being covered with brown patches resembling burns, blackens and dries up rapidly and completely; the petiole is immediately afterwards attacked at its upper extremity and soon dries up, the diseased portion being at first sharply defined from the lower part, which remains green and healthy. The disease spreads progressively and pretty rapidly over the whole of the branch, working toward the main stem and destroying all the leaflets on the way. In a few days the whole of the branch first attacked is completely withered and blackened and other branches become involved. The main stems are invaded and covered with elongated, blackish spots which originate from contact with a diseased branch. The tubers are sometimes infected before maturity, but they may show no symptoms whatever at harvest time, and only become outwardly diseased some days or even weeks after lifting. The disease is easily recognized on the surface of the tuber by the presence of blackish-purple dots, at first rare, later more and more numerous. Subsequently the zone underlying these dots takes on a blackish-brown hue, which spreads progressively. Finally, the affected parts undergo a soft rot from which, under pressure, a fairly clear liquid exudes; the whole tuber rots rapidly, and is rendered useless. Even where the symptoms are not visible on tubers just dug up, the number and size of the latter are frequently reduced, even more so than is the case with *Phytophthora*.

The trouble occurred again in the autumn crop, planted on the 4th October. At the beginning of December the varieties Italie Blanche, Early Rose, and especially Saucisse and Mayette Hâtive, were suffering from a rather mild attack, while Italie Rouge, Ricce, La Quarantaine, and Express remained more or less immune.

The damage done by this disease is considerable, most of the varieties cultivated in Morocco being affected in varying degree throughout the growing season.

BENNETT (J. P.) & BARTHOLOMEW (E. T.). **Respiration of Potatoes in relation to the occurrence of blackheart in storage.**—Abs. in *Phytopath.*, xii, 9, p. 443, 1922.

The work of earlier investigators indicated that blackheart was due to a disturbance of respirational processes dependent on a temperature-time-oxygen relationship. This relationship appears to be fairly definite. From 40° down to 5° C. the period of exposure required to induce blackheart increased from 8 to 77 days. Below 35° C. blackheart did not occur until the oxygen was practically exhausted; with increase of temperature above 30° C. an increasing amount of oxygen remained when blackheart appeared. Injury leading to the development of blackheart appears to be due to anaerobic processes. At temperatures where oxygen exhaustion precedes blackheart, the injury may appear in any part of the tuber; at higher temperatures it usually occurs centrally.

GÄUMANN (E.). **Enkele opmerkingen omtrent de Lampongsche Peperziekte.** [Some observations on the Lampong Pepper disease.]—*Teysmannia*, xxxiii, 7–8, pp. 289–293, 1 pl., 1922.

Although the premature death of pepper vines [*Piper nigrum*], which has long been known as a serious disease in Sumatra and West Java, is, according to Rutgers' observations (*Meded. Inst. voor Plantenziekten* 18, 19, and 27), closely connected with defective or unsuitable cultivation, cases have also occurred of the sudden decline of apparently healthy vines in well cared for plantations. The present paper deals with the writer's preliminary investigations of the latter form of the disease. The material studied was from an experimental plantation of the Phytopathological Institute at Buitenzorg, started in 1915. It had received the most careful attention, but by 1920 a number of vines had begun to die off, and the disease has now attained serious dimensions.

The death of the vines was preceded by certain well-defined symptoms. Transverse sections of branches which were already losing their leaves revealed a brownish discoloration of a part or the whole of the vascular bundles. Microscopic examination showed that most of the discoloured vascular bundles were dead and filled with a brown, gummy exudation. Hyphae or bacteria were not present, but the dead vessels or adjacent cells sometimes contained a granular deposit along the cell walls. This discoloration was found almost from the top to the bottom of the branches, and extended to the veins of the leaves. The nearer the top of the branch or the tip of the leaf, the weaker was the discoloration until a point was reached when it disappeared. Sections through the zone just beyond the point of visible discoloration revealed masses of bacteria in many of the vascular bundles and adjacent cells, more than one-third of the xylem being invaded. The author's observations indicated that the premature death of the vines was always accompanied by discoloration, vines from which the discoloration was absent not tending to succumb before their time.

Experiments were conducted to ascertain whether the bacteria were concerned in the causation of the disease. Young plants raised from seed, and also young healthy vines, were inoculated with cultures of the bacteria obtained from the vascular bundles, while others were inoculated for control purposes with a common saprophytic bacterium. After a week the vascular bundles of the former group of plants exhibited the typical discoloration to a height of 10 cm., those of the latter showing only a general discoloration of the inoculation canal. At the end of about ten weeks, two of the young plants and three of the vines, inoculated with the material from the diseased vascular bundles, shed their leaves and died. The results of these tests prove that the premature death of pepper vines, preceded by discoloration of the vascular bundles, is due to bacteria, the systematic position, life-history, distribution, and control of which require further elucidation.

The following tentative explanation is advanced for the diseased condition of pepper vines found in the affected areas of the Dutch East Indies. In addition to the continuous decay of the plants in neglected plantations, which is directly due to malnutrition, there is a bacterial disease which probably attacks only the vascular bundles. This disease, like the corresponding one of bananas [see this *Review*, i, p. 223], may long remain latent, the decisive factor in its activity being neglect of cultivation. The specific agent of the disease, however, is a bacterium, or group of bacteria, parasitic in the vascular bundles, the conditions of cultivation, &c., being only contributory factors. Care must be taken not to use the discoloured vines as cuttings for planting out as they will presumably transmit the disease, and the possibility of growing the plants from seed should be considered.

Lee (H. A.) & Medalla (M. G.). **The season's experiments on Fiji disease, mosaic disease, and smut of Sugar-cane.**—*Philipp. Agric. Rev.*, xiv, 4, pp. 402–412, 8 pl., 1922.

Field experiments carried out at Canlubang in 1921 on Fiji disease, mosaic disease, and smut gave the following results. The germination of setts from canes affected with Fiji disease was much lower than that of setts from healthy stools, and those that did germinate gave diseased plants in any type of soil. None of these diseased plants yielded any cane whatever, while many died at a very early age. The spread of infection from diseased to healthy plants was very low (3·46 per cent.). Thus the losses from Fiji disease may be largely attributed to the use of tops and setts from infected stools.

The germination of setts from stools affected with mosaic disease was slightly lower than that of setts from healthy canes, and, as already found in Java, Hawaii, and Porto Rico, they usually transmitted the disease, often to 100 per cent. of the resulting plants, irrespective of the type of soil. Under Canlubang conditions the spread of the disease from affected to healthy plants appears to be very restricted, but further experiments will be necessary to determine the exact importance of insect and other methods of aerial transmission. A small proportion of the plants may outgrow the disease to such an extent that the leaf symptoms are no longer visible.

The germination of setts from stools of the susceptible Uba cane affected with smut [*Ustilago sacchari*] was distinctly poorer than that of cuttings from healthy canes, and the disease was transmitted in a large proportion of cases. There was no yield of cane from affected cuttings. The spread of the disease to healthy stools was very slight (0·75 per cent.) in the six months during which the experiment lasted. Setts from healthy cane soaked in the same receptacle as smutted cuttings showed 8·38 per cent. of infection in the same time.

The results of all these trials indicate that the use of healthy cuttings for planting is essential if the plantations are to be maintained free from disease.

Lee (H. A.), Welles (C. G.), & Medalla (M. G.). **Fiji disease of Sugar-cane in the Philippines.**—*Philipp. Agric. Rev.*, xiv, 4, pp. 413–417, 3 pl., 1922.

Fiji disease, which is now fairly widely distributed in the Philippines and rapidly spreading from north to south, appears to have been introduced on cane cuttings from Australia or some of the other countries affected. Its presence in the Philippines was first detected in 1919.

The symptoms of the disease [see this *Review*, i, pp. 187 and 269] are described and illustrated by excellent photographs. It is stated that entire loss of the crop has been observed, but that it is usually restricted to 10 to 25 per cent. of the plants. Badilla cane appears to be the least susceptible variety, and it is in other respects a better cane than the Negros Purple variety now generally planted in Negros.

Richards (B. L.). **Relation of rainfall to the late blight or Phoma rot of the Sugar Beet.**—Abs. in *Phytopath.*, xii, 9, p. 443, 1922.

During 1921 a late blight of sugar beet became epidemic in northern Utah and southern Idaho and caused severe damage, the intensity of the attack varying from a fraction of 1 per cent. to the total destruction of the crop.

The available evidence indicates that the trouble is possibly identical with the *Phoma* root rot of Edson and European workers.

The experience of 1917 to 1919 showed that such epidemics are favoured by drought which, especially during June, appears to create a dangerous period in the life of the beet. During certain years, as in 1921, an early drought reduces the vitality of the beets so much that they fail to recover and later succumb to late blight and root rot.

ESSIG (F. M.). **The morphology, development, and economic aspects of Schizophyllum commune Fries.**—*Univ. of California Publ. in Bot.*, vii, 14, pp. 447–498, 11 pl., 1922.

The author is of opinion that most of the damage to living trees attributed to *Schizophyllum commune* is really the work of other, more slowly growing fungi, such as *Polystictus versicolor*; no evidence was found that the first-named species is able to infect healthy trees or that it can grow on living wood except under very favourable conditions. His inoculations were made on wounded branches of young apple, pear, and plum trees. A detailed account of the morphology and development of the sporophore is given.

ZELLER (S. M.). **Morphological differences between Nectria galligena Bres. and N. coccinea (ditissima).**—Abs. in *Phytopath.*, xii, 9, p. 442, 1922.

Nectria galligena, described by Bresadola as the organism causing European apple and pear canker, is distinct from *N. coccinea* Fries (*N. ditissima* Tul.), to which the disease had been attributed previously. These two species differ morphologically and physiologically. Perithecia of *N. coccinea* from Oregon have walls composed entirely of pseudoparenchyma which stretches up to the ostiole, whilst in those of *N. galligena* from the same district the pseudoparenchyma extends only three-fourths the distance from the base, the remainder being composed of long, narrow cells which radiate from the ostiole, forming a cone. In size and colour of perithecia the two species are similar. Ascospores of *N. galligena* are 14 to 22 μ in length, those of *N. coccinea* 8 to 14 μ. Conidia of the former (*Fusarium willkommii*) are borne on creamy-white stromata and average 65·9 by 4 to 5 μ, those of the latter (*Fusarium* sp.) on orange-coloured stromata and measure 54 by 6 μ. Also the conidia of *N. coccinea* have more rounded ends and a curvature of shorter radius than those of *N. galligena*.

HUBERT (E. E.). **A staining method for hyphae of wood-inhabiting fungi.**—*Phytopath.*, xii, 9, pp. 440–441, 1922.

This is a rapid method for staining fungous hyphae in wood. The directions are essentially as follows. Cut sections from $\frac{3}{8}$ inch cubes of infected wood after boiling them in water for half an hour or more and soaking in glycerine alcohol (50 parts glycerine, 50 parts 70 per cent. alcohol) for one to two minutes. Wash with distilled water. Stain from two to five minutes with dilute methyl violet (4 parts of a saturated aqueous solution of methyl violet with 12 parts of distilled water), or in some cases full strength methyl violet for one to two minutes. Wash with distilled water, examine, and if the violet colour is faint repeat the methyl violet staining, or if the counterstain is faint stain again from the beginning. Dry slowly on a warming plate, using a cover glass to keep the sections flat, as dehydration with alcohol apparently removes the violet stain. If sections curl, use egg albumen or gum arabic fixative. Add xylol and mount in balsam.

The method has been employed in the routine examination of woods for the determination of decay, and so far has given satisfactory results.

Poole (R. F.). **A new fruit rot of Tomatoes.**—*Botan. Gaz.*, lxxiv, 2, pp. 210–214, 1 pl., 1922.

During the summer of 1921 a fungous rot due to *Oospora lactis* was observed on fruit of several tomato varieties in New Jersey. Both green and ripe fruits showed cracks in the surface, apparently due to some physiological cause, and the fungous growth appeared in the open cracks of the ripe fruit. The fungus caused a soft rot which affected the whole fruit in from two to five days. *O. lactis*, which occurs commonly in milk products, cheeses, decaying vegetables, &c., forms a dense, greyish-white, prominent, fluffy mycelium on the cracked tomato fruits, without any great production of spores. When the rotted internal tissues are incubated, the formation of abundant spore chains with little mycelium results. Inoculations from pure cultures rotted wounded ripe tomatoes readily, but had little effect on the unripe fruit. The optimum temperature for the development of the fungus is 18° to 20° C. A slight degree of control was secured by spraying with Bordeaux mixture, and also by dusting with a dust composed of 16 lb. anhydrous copper sulphate, 6 lb. lead arsenate, and 78 lb. hydrated lime.

Ciferri (R.). **La 'carie' del Pomodoro.** ['Caries' of Tomato.]—*Le Staz. Sperim. Agrarie Italiane*, lv, 4–6, pp. 145–162, 1922.

Further experiments, carried out since the author's preliminary paper [see this *Review*, i, p. 363], confirm the pathogenicity of *Phoma ferrarisii* Cif., except that, normally, the fungus produces a dry rot, while the wet rot described in the first paper is due to the intervention of *Bacillus mesentericus*, acting, in the author's opinion, in symbiosis with the fungus. The bacterial action is apparently limited to the secretion of cytase, which disintegrates the binding substance between the cells without influencing the cells themselves. The fungus is believed to absorb the cellular contents by osmosis, thus killing the protoplasm, though it is possibly aided by the secretion of toxic enzymes.

A symbiotic relationship of this type is not known to the author to have been described in any other fruit rot. Parasitic action is reserved for the *Phoma*, while the saprophytic *B. mesentericus* works exclusively in favour of the fungus by removing the mechanical obstacles to its growth presented by the cell walls. This condition is termed by the author 'unilateral parasitic symbiosis', and it is thought that a similar phenomenon may explain certain wet and dry rots of potatoes associated with *Bacillus amylobacter*, *Fusarium solani*, and *Phytophthora infestans*.

Although conclusive proof cannot now be given owing to the accidental loss of evidential material, the results obtained with parallel cultures of *P. ferrarisii* and the *Ramularia* referred to in the preliminary paper make it more than probable that the latter is a conidial stage of the former. It is named *Ramularia ferrarisii* n. sp. Extended Latin diagnoses for the two new species are now given.

Infection takes place solely through abrasions in the epidermis. Hailstorms and insect punctures undoubtedly help in the development of the disease, and non-parasitic troubles such as tomato 'split' ('screpolatura') are thought also to have some influence. Caries, though very destructive, has so far no great economic importance owing to its rare occurrence. The only remedial measure advocated is the immediate destruction of affected fruits.

ELLIOTT (J. A.) & CRAWFORD (R. F.). **The spread of Tomato wilt by infected seed.**—*Phytopath.*, xii, 9, pp. 428–434, 1 pl., 2 figs., 1922.

Although several authors have expressed the view that *Fusarium lycopersici* is transmitted through tomato seed, no one has fully established this fact. Seed was accordingly collected from wilted plants in September and October 1921, cleaned by fermentation and washing, then dried and placed in plugged flasks until 20th January 1922, when plating was commenced. Before plating the seeds were treated either with sterile water, or with mercuric chloride (1 in 1,000) for two minutes and then washed in sterile water, or with concentrated sulphuric acid, washed in water, and soaked for two minutes in mercuric chloride solution. Sterilized blotting-paper soaked in rice water was found useful in identifying *F. lycopersici*, as the fungus produced an alizarine pink to old rose coloration on this medium. Every fungus resembling the wilt organism was saved and tested by inoculation on tomatoes later. The number of isolations of *F. lycopersici* from 400 seeds treated with water only was 13, from 400 sublimated seeds 2, from 390 seeds treated with sulphuric acid and sublimate 4.

These results indicate that the organism is carried on the outside of the seed coat as a rule, but the isolation from seed treated with sulphuric acid and sublimate suggests that there is sometimes an internal infection. The strains isolated were tested on tomato seedlings and showed considerable difference in virulence, a result in accord with those previously reported.

SCHWARZ (MARIE B.). **Das Zweigsterben der Ulmen, Trauerweiden und Pfirsichbäume.** [The dying of twigs of Elms, Weeping Willows, and Peach trees.]—Thesis presented to the University of Utrecht, 73 pp., 7 pl., 15 figs., 1922.

DIE-BACK OF ELMS. This disease, which was first recorded in Holland in 1919 and became epidemic in 1920 [see this *Review*, i, p. 277, & ii, p. 1], is characterized by the sudden withering of the twig tips and the simultaneous death of the leaves. No lesions or fungous growth could be observed on the bark or leaves of dead twigs. Occasionally the latter were attacked by red mites, but the injury could not be ascribed to them as they were absent from a large proportion of diseased trees.

Transverse sections of diseased stems show the wood discoloured over a ring-like area of variable thickness. Such discoloration varies in intensity and extends into the limbs, trunk, and in the worst cases even to the extreme ramifications of the root system. From the fact that this discoloration was present in many trees showing no outward signs of disease, the author deduces that the disease existed in a latent stage for a few years before the outbreak of the epidemic. The discoloration is produced by an alteration of the walls of the vascular bundles. First the vessels are seen to be invaded by thin hyphae, against which tyloses are formed which later disappear. The walls of the vessels then become swollen and softened to a gum-like consistency, and fuse together. The other constituents of the wood assume a macerated appearance.

Cultures from dead twigs yielded different fungi, predominantly species of *Fusarium*. Cultures from fragments of the discoloured wood from inside the bigger limbs, however, always produced a fungus, which gave positive results from artificial inoculations, the wood being discoloured up to a distance as much as 30 cm. from the point of inoculation, although the other characteristic symptoms were not produced. The fungus produced a white fibrous *Cephalosporium*-like mycelium ('A' stage) on cherry agar, and under certain conditions yielded yeast-like spores ('B' stage). Later coremia appeared, consisting, when mature, of dark brown to black stalks, with light-coloured heads composed of an agglomeration of spores held together by mucilage. This stage agrees with the genus *Graphium*, and the author considers the fungus a new species which she has named *G. ulmi*, a full description being given of the various stages.

A few cases of primary infection were found on one year old shoots. The discoloration was seen to originate in the petioles and midribs, indicating that the leaves form the principal point of entry. The fungus is not, however, essentially a leaf parasite. Infections carried out on twigs showed that the fungus, after penetrating the leaf tissue, passes into the midrib, the petiole, and finally the stem. Leaf scars and wounds also allow its entrance. Introduced artificially into the wood, the mycelium spreads equally in all directions, whereas naturally it always progresses from above downwards and from the youngest wood to the older.

No difference in susceptibility was observed between *Ulmus campestris* L. and *U. campestris* f. *monumentalis* Rehd.

The disease is undoubtedly affected by weather conditions, but data are too meagre to warrant any exact deductions being made. As to control, the author does not recommend uprooting all infected trees, as a large proportion may recover by the growth of new wood over the discoloured ring. Curative treatment is not practicable, but the spread of infection into the main branches might be prevented by cutting out diseased twigs. Spraying immediately on the bursting of the leaf buds may be effective, but no trials have yet been made.

Die-back of Weeping Willow. The Dutch weeping willow, *Salix alba* var. *vitellina pendula* S., was heavily attacked in 1920 by the 'bark scorch' disease, a detailed description of the symptoms of which are given. The fungus *Fusicladium saliciperdum* was preponderant and is, according to Rostrup and Tubeuf, responsible for the disease. The author, however, was unsuccessful in isolating it and did not carry out infection experiments.

A very considerable number of other fungi were usually present on portions of willow twigs killed by the *Fusicladium*; infection trials with pure cultures showed that some of them could be induced to parasitize living twigs. Especially common were *Aposphaeria pulviscula* Sacc. and numerous species of *Phoma*. One of the latter gave positive results from inoculation, and as it did not correspond with previously described species on *Salix*, the author named it *Phoma intricans*. A full description of this species is given. On a number of old *Fusicladium* bark lesions, *Physalospora salicis* occurred.

Dying of the shoots in autumn after defoliation was caused by *Discella carbonacea*. When the terminal bud is discoloured the tip of the twig soon dies back, always up to a node. The fructifications are at first covered by periderm through which, later, appear greyish-white to pink masses of spores. This fungus is known as one of the most frequent saprophytes of *Salix*, but the author's infection trials and observations showed that, after entering the host through wounds or dead parts, it can continue to develop vigorously as a parasite.

Die-back of Peach. Several fungi are concerned in the die-back of peach shoots which is very common in Holland. Only *Monilia cinerea*, however, is a true parasite. In 1921 this fungus did little damage to the peaches, probably on account of the hot, dry weather.

At the beginning of the winter, peaches which had suffered from mildew were found dying back at their shoots. Such shoots were covered with *Cladosporium herbarum* and, to a small extent, *M. cinerea* was also present. In a neglected glass house, *C. herbarum* alone was found, causing bark lesions on one or two year old shoots. At first the lesions were wet and brown; later they dried. They did not extend and the portion above did not die.

The author believes *Botrytis cinerea* to be responsible for a dying-back of peach shoots, especially in glass houses, as she found a number of dead shoots from which she could isolate no other organism. The twigs died back progressively, no distinct margin separating the dead portion from the healthy one. Such shoots were especially numerous after lice attacks.

On dead shoots, the author frequently found numerous large black pycnidia of *Cytospora prunorum* Sacc. & Syd. which forms brown, soft lesions on the twigs. These lesions at first are not distinguishable from those of *Monilia*, except that they are located at any point of the branches and not round the buds. Later, however, they dry and become grey in colour. A callus is formed round the scar, which may encircle the stem and kill the shoot above it. Three strains of *C. prunorum* were isolated, two of which gave positive results from inoculations while one did not. The latter sometimes infected weeping willows when inoculated into them, and the author considers it a different physiological strain from the other two.

Dufrénoy (J.). **Tumeurs de Sequoia sempervivens.** [Tumours on *Sequoia sempervivens.*]—*Bull. Soc. Path. Vég. de France*, ix, 2, pp. 148–150, 3 figs., 1922.

On trees of *Sequoia sempervivens* at St. Mandé and Vincennes, which had been pruned or otherwise wounded, the formation of tumours some distance from the wounds was observed, these growths being always absent on trees left intact. The tumours developed in the axils of the wounded branches and bore adventitious shoots covered with young leaves. Sections showed that the growths consisted of a parenchyma formed of giant cells in which were several cauline axes possessing each a well-developed pith and an irregular cambium. The wood was formed of reticulate elements, irregularly oriented and mixed with pitted cells. The polystelic structure was evidently the result of the coalescence of several proliferating adventitious buds, stimulated no doubt by bacterial infection through the wounds. Bacteria were observed in the parenchymatous cells of the tumours.

Vincens (F.). **Maladies des jeunes plantes et champignons microscopiques nouveaux observés sur Cinchona en Indochine.** [Diseases of young plants and new microscopic fungi observed on Cinchona in Indo-China.]—*Bull. Soc. Path. Vég. de France*, ix, 2, pp. 125–133, 4 figs., 1922.

The author describes a disease, which he observed in 1920 in a plantation situated on the mountain of Honba, in Annam, on young plants of *Cinchona ledgeriana*, and, in a much lesser degree, of *C. succirubra*, as well as a hybrid between these two species. The affected plants, which varied in height between 15 to 20 cm. and 35 to 40 cm., were almost defoliated and seemed to be dying. The outbreak appeared to have become severe recently, judging by the slight signs on the older as compared with the younger leaves. The former had a few, small, circular, light brown spots, with a purple border, or were pierced with circular holes resulting from the falling out of the tissues within the border of such spots. On the younger leaves these spots were more numerous, and coalesced freely, forming chequered designs which covered the greater part of the leaf surface. The leaves nearer the top had shrivelled edges, eaten away in places, and were borne on deformed, crooked shoots on which were abnormal corky outgrowths often of a cankerous nature. On the hybrids the disease had the same characters, though the shoots seemed in a more healthy condition. On *C. succirubra*, which was decidedly more vigorous than *C. ledgeriana*, badly affected leaves were rare, and the shoots were all healthy. It is noteworthy that not a single plant seemed to be entirely free from the disease.

No parasitic organism was observed on leaves still attached to the stems, but small, black dots were visible on the spots on leaves that had fallen off some days previously. Similar dots were found on the wrinkled twigs of dying plants near the ground.

The following fungi found on the three species of *Cinchona* are described and figured. On the dead spots on the leaves *Phyllosticta honbaensis* n. sp. (rarely on *C. ledgeriana*, chiefly on *C. succirubra*) and *P. cinchonaecola* n. sp. were found, while *P. yersini* n. sp.

occurred on the lower surface of young leaves still enclosing the bud (and on the browned shoot bearing them) of a dying plant. In the suberized bark at the base of the latter plant numerous fruit bodies of a *Phlyctaena*—*P. cinchonae* n. sp.—were found, and the same fungus was obtained from nearly all the plants examined. A *Phoma*—*P. cinchonae* n. sp.—was present, but less frequently, in the same situation, while a *Dendrophoma*—*D. cinchonae* n. sp.—was observed on the leaf scars of a diseased plant left in a damp place after its collection. Partly buried in the wrinkled bark of the stem base of this same plant were found perithecia of a *Physalospora*—*P. cinchonae* n. sp. Finally, a *Guignardia*—*G. yersini* n. sp.—appeared occasionally on the bark harbouring the *Phlyctaena*.

No inoculation experiments were possible, hence the author is unable to say what share, if any, each fungus has in the production of the disease. He states, however, that the parasitism of the species of *Phyllosticta* does not appear to be in doubt, while the frequency of the *Phlyctaena* in the abnormal corky bark of diseased young plants stamps it also as a parasite. Spraying with copper solutions had a disastrous effect on the plants, and the practice had to be abandoned. Subsequent sowings of *C. ledgeriana* on a different plateau gave healthy plants.

Moss (E. H.). **Observations on two Poplar cankers in Ontario.**—*Phytopath.*, xii, 9, pp. 425–427, 1922.

The first part of this paper deals with the poplar canker caused by *Dothichiza populea* Sacc. and Briard. This disease, which was first reported in America in 1916, was very prevalent at Toronto in 1921 on 500 young Lombardy poplars planted the previous year, 90 per cent. of the trees being girdled by the fungus. The girdled area was usually located about two feet from the tip of the stem and extended for a considerable distance; numerous pycnidia occurred on the diseased parts and spore horns appeared as early as 4th May.

Later the disease was seen very frequently in southern Ontario, young shoots from the roots of old trees being killed back and pustules appearing on the stems. Usually several branches were affected, the older ones being disfigured by elongated, open wounds. In Ontario the disease has undoubtedly been present many years, but the writer's observations support the view that it was brought to America from Europe.

The second part of the paper refers to the canker disease of poplar caused by *Cytosporina chrysosperma* (Pers.) Fr., which occurs at various places in the United States, and is now reported for Ontario, attacking usually *Populus deltoides*, but also *P. italica*, *P. balsamifera*, *P. alba*, and *Acer saccharinum*. Affected trees of *P. alba* and *P. italica* died branch by branch from the top downwards. Near Toronto, *P. deltoides* was found bearing pycnidia close to wounds in the younger branches and lower parts of the trunks; in the latter case the trees were rapidly killed. The poplars had apparently been injured by fire and then attacked by the fungus, a course of events noted by two workers previously.

IMPERIAL BUREAU OF MYCOLOGY

REVIEW

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Meinecke (E. P.). **Pathology of quaking Aspen in Utah in relation to regulation.**—Abs. in *Phytopath.*, xii, 9, p. 446, 1922.

The possibility of utilizing quaking aspen [*Populus tremula*] for pulp in Utah, where it is common, depends largely on the control of wood decay, chiefly caused by *Fomes igniarius.* About 50 per cent. of all wounds become infected, fire being an important predisposing cause.

Mangin (L.) & Patouillard (N.). **Sur la destruction de charpentes au château de Versailles par le Phellinus cryptarum Karst.** [On the rotting of the timberwork in the palace of Versailles by *Phellinus cryptarum* Karst.]—*Comptes Rendus Acad. des Sciences*, clxxv, 9, pp. 389–394, 4 figs.. 1922.

The chief part in the decay of the oak beams in the roof of the old Louis XIII wing of the palace of Versailles, of which so much has been heard recently, is played by the fungus *Phellinus cryptarum* Karst. (syn. *Polyporus* [*Fomes*] *cryptarum* Fr.; *P. undatus* Pers.; *Boletus cryptarum* Bull.). Exceptionally favourable conditions for its development are supplied by the fact that the oak beams have been covered with plaster having an outer air-tight coating which prevents air and light from reaching the wood. The attacked timbers, especially the ends embedded in the masonry, are reduced almost to the consistency of lint, leaving long, fibrous strands extending lengthwise in the beams. The decayed wood is easily crushed together by slight pressure, but does not crumble to powder as in the case of wood destroyed by *Merulius lacrymans.* All the elements of the wood, with the exception of the long, fibrous strands (which consist of still lignified membranes occupying the angles of the cells) and a few transverse bands of tissue (also with intact membranes), which loosely join them together, are reduced to shreds from which the lignin bodies and pecto-celluloses have disappeared. In the portions of the beams bordering on the still sound parts, the initial stages of the rotting could be observed.

One of the most remarkable features of the decay, noted also, but not so constantly, in timber attacked by *Ungulina annosa* [*Fomes annosus*], consisted in the complete dissolution of the membrane limiting the bordered pits of the invaded cells; the walls of the cells thus appeared riddled with holes long before the rest of the cell wall was dissolved. In many cases the bordered pits thus set free were so abundant in the mounting medium of the sections that they were at first mistaken for accumulations of spores. Medullary rays resist the dissolving action of the fungus longer, and appear as broad laminae in the midst of the decayed tissues.

The attacked cells were invaded by numerous widely and irregularly branching hyphae without clamp-connexions, 0·5 to 2 or 3 μ thick, which formed an abundant and loose mycelial felt in the partly destroyed vessels and in cracks in the wood. Perfect fructifications of the fungus, a full description of which is given, appear in the form of more or less orbicular plates, up to 20 cm. in diameter, attached to the substratum by one central point, or by several points in cases where several fructifications have coalesced. Besides this normal form, specimens are often found reduced to a simple, smooth or undulated membrane, easily detachable from the substratum and bearing none of the characteristics of a fruit-body. The fungus has no cystidia, and the authors did not succeed in finding spores. In very wet conditions the fungus exudes numerous droplets of liquid which, on drying, leave irregularly-dispersed, black spots on its surface.

Phellinus cryptarum is generally found in cellars and mines, and is common in damp, dark, and non-aerated places; the authors are not aware of its having been previously recorded as destroying woodwork in buildings. It has been identified with *Fomes annosus* by some authors, but differs from the latter both in its fructifications and in the nature of the wood decay it causes. Montagne wrongly identified as *Phellinus cryptarum* another fungus *Leptoporus* [*Fomes*] *rufo-flavus* B. & C. which is not uncommon in greenhouses, mines, &c., and which has also been described by Rabenhorst as *Polyporus braunii*. Quite recently another case of the rotting of oak beams supporting the ceiling of a room, kept closed for fifteen years, in a school near Etampes, has been examined by the authors and found to be due to *Phellinus cryptarum*. They consider this fungus therefore as a dangerous wood destroyer, but believe that good ventilation and dryness are sufficient to check its development.

A certain number of the beams examined at Versailles were worm-eaten, the insects concerned being chiefly *Xestobium rufovillosum* Deg. and (less often) *Anobium domesticum* Geoffr.

Levy (E. B.). **Investigation of dry rot of Swedes.**—*New Zealand Journ. of Agric.*, xxiv, 6, pp. 336–343, 6 figs., 1922.

The investigation of the dry rot disease of swedes (*Phoma napobrassicae*) during 1920–21 was mainly directed towards soil sterilization, it having been conclusively demonstrated that the organism overwinters in the soil. The trials were conducted as follows, the quantities being calculated to the acre and the material broadcasted on the ploughed surface in all the treated plots except

15, 16, and 18. Plot 1, control; plot 2, burnt lime, 2 tons; plot 3, burnt lime, 8 tons; plot 4, burnt lime, 4 tons; plot 5, control; plot 6, sulphur, 3 cwt.; plot 7, sulphur, 9 cwt.; plot 8, control; plot 9, copper sulphate, 3 cwt.; plot 10, copper sulphate, 9 cwt.; plot 11, control; plot 12, iron sulphate, 3 cwt.; plot 13, iron sulphate, 9 cwt.; plot 14, control; plot 15, formalin, 1 pint to 30 sq. yds.; plot 16, carbon bisulphide, 1 pint to 30 sq. yds.; plot 17, control; plot 18, Bordeaux mixture 4–6–40, 1 gall. to 2 sq. yds. The best results were got on plots 6 and 18, all the others giving over 50 per cent. dry rot after 5 months except plots 13 and 14, which had over 40 per cent., plot 17 over 30 per cent., and plot 10 where there was a serious reduction of germination and about 25 per cent. rot. Even in plots 6 and 18 control was inadequate, and the method cannot be recommended for farm practice. The tests were carried out on land which had carried two consecutive swede crops, the second being rather severely attacked by the disease. A similar series of tests was repeated on adjoining land not previously in swedes, and here the percentage of infection, taking the series as a whole, was only 12, as against 56 per cent. in the field previously in swedes, the division at the junction of diseased and healthy land being quite sharply marked. This 12 per cent. of infection may have been due to a slight attack of dry rot on a crop of soft turnips grown on the same area two years earlier. The infection on the land not previously in swedes was definitely patchy, the remainder of the crop being fairly sound, while on the corresponding area previously in swedes there was infection throughout. Infection likely to have arisen from seed-borne spores was rare.

It is apparent from these results that the organism overwinters in the soil, and forms more or less numerous centres of infection which may involve the whole crop. The subsequent spread is certainly wind-borne, but the radius of infection is quite short, the patches rarely exceeding 20 ft. in diameter. Attempts were made to reduce the secondary wind-borne infection by growing the roots close together to form a denser leaf-cover, and also by interplanting thousand-headed kale with the swedes. The latter method proved very successful, the kale lasting well and affording considerable protection to the swedes. Such preventive measures, however, are only effective in reducing secondary wind-borne infection, and are of no use against the primary or seedling stage of the disease.

A suitable type of crop rotation appears to be the only reliable means of control, and suggestions for a six years' course are given.

Paine (S. G.) & Lacey (Margaret S.). **Chocolate spot disease or streak disease of Broad Beans.**—*Journ. Min. Agric.*, xxix, 2, pp. 175–177, 1 fig., 1922.

The causal organism of the chocolate spot or streak disease of broad beans is *Bacillus lathyri* Manns and Taub., which causes streak in sweet peas and stripe in tomatoes, and is known to attack many leguminous plants. It is considered probable that field beans are seldom, if ever, entirely free from this disease, but serious outbreaks occur only under exceptional weather conditions, as in the summer of 1920 for instance, when a heavy epidemic throughout a large part of England and Wales was preceded in many places by hot, wet, and thundery weather. In 1921, on the other hand, the exceptionally dry weather soon checked the disease which made its appearance in the early spring; the plants quickly recovered from the attack, and a month later showed no sign of injury.

In a typical case described, the first symptoms of the disease—small, purplish-brown spots on the leaves and long or short streaks of a rich bronze colour on the stems—appeared in the last week of May 1920 on beans planted in October 1919; at the end of the first week in June the plants were largely defoliated, the remaining leaves showing a good deal of blackening. About the middle of July the stems in the central portion of the field were beaten down by rain, all the leaves had been shed except a bunch at the top of the stalks, and the whole plants were being rapidly rotted by a *Botrytis* which, in all cases observed, followed closely after the streak disease. In many instances the plants on the borders of the field were less severely attacked, the conditions in the outer, more exposed, portions being drier than in the centre and less favourable to the spread of the disease. During 1920 the epidemic spread apparently from west to east, and this observation seems to suggest wind dispersal of the causative organism, which may find entry into the host through the stomata of the leaves. There is also evidence that the organism is carried on the seed of winter beans, and especially on those which have been bored by the bean beetle *Bruchus rufimanus*: the plants may be inoculated by this beetle when laying its eggs, and the young larvae which develop in the pod may infect the seed when boring their way in.

The authors suggest as a possible means of control, the application to land on which the disease has occurred to a serious extent of a good dressing of potash, since it is known that this treatment has been successful in checking stripe in tomatoes. The seed should be carefully examined and rejected if showing an excessive amount of boring by beetles; before sowing it should be soaked for ten minutes in weak lysol or formalin, or dressed with one of the tarry preparations supplied for seed sterilization.

HUNGERFORD (C. W.). **A Fusarium blight of Spinach.**—Abs. in *Phytopath.*, xii, 9, p. 447, 1922.

A rather serious disease has recently appeared on spinach in Idaho, attacking the plants when young, stunting their growth, causing curling of the leaves, and finally killing them. A species of *Fusarium*, which appears to be new, was constantly isolated from the interior of the crowns and roots of diseased plants, and plants grown in sterilized soil inoculated with this fungus developed the characteristic symptoms of the disease.

BARSS (H. P.). **Destructive rust (Puccinia subnitens Dietel) on Spinach in the northwest.**—Abs. in *Phytopath.*, xii, 9, p. 446, 1922.

In 1922 the vegetable growers of Oregon sustained heavy losses on their early and late crops of spinach owing to the serious damage caused by *Puccinia subnitens*.

Distichlis spicata, the teleutospore host of *P. subnitens*, was found to be one of the three commonest grasses growing in the vicinity of the spinach beds, and experiments at Corvallis have demonstrated that rust sporidia from *D. spicata* can infect the cultivated spinach.

Leonian (L. H.). **Stem and fruit blight of Peppers caused by Phytophthora capsici sp. nov.**—*Phytopath.*, xii, 9, pp. 401–408, 2 figs., 1922.

A disease which attacks the pods and branches of chilli peppers (*Capsicum annuum*) in New Mexico was found to be caused by a species of *Phytophthora*. It usually appears at the beginning of the warm, rainy season in June or later. Small, water-soaked, dull green spots form on the fruits, and develop into elongated lesions that dry up and become straw-coloured. Lateral spread is limited, but the fruit is penetrated and the seeds attacked. The latter are sometimes killed, but remain viable when only the seed coats are infected.

From the fruits extension to the branches takes place, the young shoots being rapidly blighted and destroyed. Usually progress is arrested at the older branches or the main stem. Secondary infections caused by liberated zoospores may occur, especially at the forks, causing girdling lesions which kill the parts above. Lateral spread is much more marked on the branches than on the fruit. The roots are not attacked, except for local lesions on the fine, lateral roots.

The fungus was isolated and grown in pure culture, from which successful inoculations were invariably obtained. It is regarded as a new species, to which the name *P. capsici* is given. It falls in Rosenbaum's *Phaseoli* section, characterized by basal ('amphigynous') antheridia. From the other members of this group it is distinguished by its gnarled, tuberculate mycelium; the large, though very variable, sporangia (35 to 85 by 21 to 56 μ or occasionally up to 105 μ long); the abundant, slightly wrinkled, brown oospores, 25 to 35 μ in diameter; and the absence of chlamydospores.

Infected seeds are an important agent in dissemination. Diseased pods are often not discarded owing to the slight external symptoms. When their seeds are planted the fungus grows out and fructifies in the soil. Infection takes place by zoospores produced in the soil and spattered by rain on to the lower fruits that hang down near the ground.

It is believed that careful seed selection and spraying should be effective in controlling the disease, though no experiments in control have been tried as yet.

Crépin (C.). **Un Oïdium de la Betterave.** [An *Oidium* of the Beet.]—*Bull. Soc. Path. Vég. de France*, ix, 2, pp. 118–119, 1 fig., 1922.

An *Oidium* was observed at Grignon in the autumn of 1921 on beetroot [*Beta vulgaris*] (both fodder and sugar beet) and on *Beta maritima*. The mycelium is very delicate, and covers the whole of the leaf surface on both sides. The conidia are unusually long, mostly 30 to 40 μ; those below 27 are rare, while many are over

40, and a few reach 50 μ. Their width varies within narrower limits, between 9 and 12 or 13 μ, the average being 10 or 11 μ. The conidiophores are usually very long, and terminate in a single conidium. Mycelium, conidiophores, and conidia, as is common in the Erysiphaceae, are covered with small, hollow protuberances. The appressoria are lobed. The conidia of this fungus agree in length with those described in *Microsphaera betae* Vanha (44 by 15 to 20 μ), but they are very much narrower.

Poole (R. F.). **The Sclerotinia rot of Celery.**—*New Jersey Agric. Exper. Stat. Bull.* 359, 27 pp., 15 figs., 1922.

A disease caused by *Sclerotinia libertiana*, affecting all the varieties of celery grown in the greenhouses in the muck bog areas of Bergen County, N.J., has been very destructive for a number of years. It particularly affects seedling plants, which are grown under glass from seed sown in February to be set out in the fields in April; in such cases losses up to 95 per cent. of the crop may be caused. Severe damage in the field has not been observed. The affected seedlings are attacked at the collar and fall over, a white cottony growth of mycelium developing on the leaves and stem after they fall. Sclerotia may appear very quickly and undoubtedly carry the fungus over in the soil. They may bear apothecia in the houses from March to June. Sometimes a watery soft rot, similar to that in the field outbreaks, is caused by the attack of this fungus on celery in storage.

Lettuce drop is caused by the same fungus, and cases have been observed where infected soil from lettuce fields has served to cause infection in celery houses. It appears to be a common practice to grow lettuce in rotation with celery, and this intensifies the disease.

The control measures recommended are the use of clean soil, or treating the infected soil with a formaldehyde solution (3 pints of formalin to 50 gallons of water, applied at the rate of 1 gallon to the square foot, 7 to 14 days before sowing), or steam sterilization of the beds, which, however, is not always practicable for small growers. The question of ventilation should also receive attention. Greenhouses constructed so as to be exposed to the sun's rays in all their parts, and fitted with proper ventilating devices, have consistently shown the smallest percentage of infection. Removal of diseased plants is effective if done early.

The author states that *S. minor* has so far not been observed in the bog soils of New Jersey, but it has attacked upland lettuce.

Rivier (A.). **Observations sur le Sclerotinia libertiana Fckl.** [Notes on *Sclerotinia libertiana* Fckl.]—*Bull. Soc. Path. Vég. de France,* ix, 2, pp. 134–137, 1922.

'Lettuce drop', caused by *Sclerotinia libertiana* Fckl., is responsible for heavy losses in the south-eastern portion of France, half the crop being frequently destroyed by it in the Hyères (Var) district. The virulence of the disease seems to reach its height in November, just before the crop is gathered. At the Agricultural College of Montpellier, during the spring, the fungus frequently attacks melon plants grown under glass on manure beds. Infection occurs chiefly on the stems, especially at the point of bifurcation, which becomes characteristically livid and leaden in hue, the discoloration spreading somewhat rapidly. In a short while, under favourable conditions of humidity, the affected portion is covered by a dense, white mycelium, and the stem frequently breaks at this point. Proper ventilation and drying of the frame or house, as soon as the attack is noticed, usually prevents further spread. The same fungus was found on *Pyrethrum cinerariaefolium*, growing in an experimental field attached to the Pathological Station at Montpellier. Cross-inoculations on lettuce, melon, and *Pyrethrum*, and a comparison of the apothecia resulting from sclerotia collected from all three plants, established the identity of the three diseases. *Pyrethrum* is believed to be a new host for *S. libertiana*. The mode of attack on this plant follows the usual lines, that is to say the spread occurs by means of the mycelium, which is capable of running over the surface of the ground from plant to plant provided the soil is damp enough. The fungus enters the host at the soil level, the stem is covered with the white mycelium, and the plant dries up. On the surface of the stem in the vicinity of the collar sclerotia are formed, which vary in size from a grain of buck-wheat to one of oats. The disease in *Pyrethrum* does not appear to be of great importance. and is believed to be associated with the heavy, wet soil in which the plants were growing, and the vicinity of lettuce, melon, and other plants susceptible to attack.

Cocoe rot.—*Journ. Jamaica Agric. Soc.*, xxvi, 2–3, pp. 62–64, 1922.

Referring to the prevalence of cocoe [*Xanthosoma sagittifolium*] rot, the writer quotes a report by Ashby in 1912 to the effect that the disease was caused by a hitherto undescribed fungus, to which he gave the name *Hormiscium colocasiae* [given by Ashby as *H. xanthosomae* n. sp., and then changed to *Vasculomyces xanthosomae* n. g., n. sp. in *Bull. Dept. Agric. Jamaica*, N.S. ii, p. 151, 1913]. The fungus gains admission to the water-conducting system either from previous infection of the 'seed' used for planting, by means of infection of the freshly cut surface of the planted tuber, or through any subsequent wound of the root or tuber. The fungus obstructs the water-conducting channels, the bundles turn brown, and the internal tissues shrink and split. When the split extends to the surface, insects, worms, and other fungi enter and increase the rot. The first method of infection named above is very common; the fungus in the vessels extends far beyond the discoloured portions, and may still be present, though causing no obvious signs, in the material used for planting.

The 'Commander' variety appears to be specially liable to the disease, which presents certain analogies with the Panama disease of bananas. Continuous planting on infected soil naturally increases the trouble, and rotation of crops should be carefully practised. Maize and peas make good alternative crops to cocoes. The old cocoe roots should be grubbed out and burnt, the land limed, and trenches put through it. The disease is very severe on water-logged soil. The burning of diseased stumps and other refuse has the additional advantage of providing a supply of wood-ash for the soil.

VIVET (E.). **Le mildiou de la Vigne. Dates des invasions. Les périodes critiques des invasions de mildiou.** [Mildew of the Vine. Dates of invasion. The critical periods of mildew invasion.]—*Revue Agric. Afrique du Nord*, xx, 139, pp. 200–202, 1922.

From 1908 to 1913 the date of the first appearance of mildew [*Plasmopara viticola*] spots on vine leaves at the Maison-Carrée Agricultural Institute in Algeria oscillated between the 2nd and 19th of May. As the period of incubation is seven days, it might be concluded that it would suffice to apply the first preventive treatment during the last week in April. But events in 1921, when mildew spots appeared on the 16th April, upset this calculation, and on searching back through the records the author found that the earliest date of its appearance in the Mitidja district noted since 1888 was the 13th April. It follows that by thorough spraying in the last days of March or at the beginning of April the young shoots can be efficiently protected against attacks derived from the germination of the resting spores.

A comparison of the dates shows that the successive attacks of *Plasmopara* during the two very bad years of mildew, 1908 and 1921, synchronize almost completely, if one ignores the unusually early first invasion in 1921. This confirms the observations made in vineyards round Algiers, that the disease is particularly to be feared during May, notably round about the 15th of that month, coincident with the flowering period. This period the author designates as the first critical period for mildew. Though occurring more rarely, the invasions of 'brown rot' (mildew on the fruit) generally take place during the last half of June, towards the 20th of that month, which may be called the second critical period. This coincides with the rapid development of the fruit. Hence it is necessary to concentrate preventive treatment on the two critical periods, in May and in June. During rainy weather, or when mists occur in these periods, adhesive mixtures must be employed at least once a week, and in addition the bunches should be dusted with a fungicidal powder.

WALKER (J. C.). **Seed treatment and rainfall in relation to the control of Cabbage black-leg.**—*United States Dept. of Agric. Bull.* 1029, 26 pp., 1 fig., 2 pl., 1922.

None of the four methods of cabbage-seed disinfection tested, viz. with hot water, dry heat, formaldehyde, and corrosive sublimate, can be relied upon for the complete eradication of the blackleg fungus, *Phoma lingam*, without severe injury to the seed. Seed treatment, however, reduces the number of primary centres of infection by destroying a considerable proportion of the organisms present on the seed. It is doubtful whether dry heat can be used on a commercial basis, because of the wide range of susceptibility to injury in different lots of seeds and because of the difficulty of application. Hot water treatment was proved not to be superior to the chemical fungicides, and in view of the awkwardness of its application it is not at present considered suitable for general use. With the chemical fungicides treatment stronger than a 1 in 240 solution of formaldehyde or a 1 in 1,000 solution of corrosive sublimate for thirty minutes, followed by rinsing, is often unsafe, though some lots of seed will stand much more, especially with corrosive sublimate. Of these two treatments, the latter seems to be slightly superior in controlling the fungus.

Experiments were also made in 1919 and 1920 to study the effect of rainfall on the development of the disease in the seed-bed. In 1919 untreated seed known to contain about 2 per cent. infection, was sown on 14th May in a bed divided into four plots, of which the first was left exposed to natural weather conditions, the second, exposed as the first, was sprinkled with water several times a week during dry weather, the third was covered with a cold frame during rains, and the fourth was covered every evening and during rainy weather. The protected plots were watered artificially, care being taken to avoid splashing and the consequent distribution of pycnospores. A few infection centres appeared in all plots about the 9th June after a period of heavy rain from the 1st to the 5th June. The subsequent spread of the infection was greatest in the first two plots, while in the two protected ones very little spread took place. The results showed clearly that when the splashing action of rain was eliminated spread was slight, while it was enhanced when the plants were artificially sprinkled. Although plot 3 was exposed to numerous heavy dews, these were apparently insufficient for the dissemination of spores to any appreciable distance. The experiments of 1920 confirmed these results. The author considers therefore that in regions where cabbage plants are grown in open seed-beds, variation in the rainfall during the period between the appearance of primary pycnidia and transplanting has a very great influence upon the development of blackleg. Where the plants are grown in covered cold frames or in greenhouses the disease can be checked by avoiding the splashing of water.

TAYLOR (W. A.). **Report of the Bureau of Plant Industry.** 34 pp., 1922.

This report covers the year ending 30th June, 1922. The Bureau of Plant Industry of the United States Department of Agriculture, at Washington, deals with all problems of plant production and, in addition to the head-quarters organization, maintains field stations and conducts experiments in all parts of the United States. Much of its work is carried on in co-operation with the officials of the different States. The scientific work is organized in thirty-two sections, eight of which are wholly occupied with plant pathology (exclusive of insect troubles which are the concern of the Bureau of Entomology), while in several of the others, as for instance the sections for cereal, tobacco, and sugar-plant investigations, the study of diseases of special crops is an important part of the work. On 1st September, 1922, the numerical strength of the Bureau staff was 1,990, of whom 672 were employed at Washington and 1,318 outside.

Amongst the most important results of the year's work, of interest to us, mention may be made of the following. With wheat the introduction into cultivation of rust-resisting varieties is steadily proceeding. Kota, a bearded, hard, red, spring wheat, discovered in 1918, has been tested at thirty experiment stations and found to be nearly equal to the most resistant durum varieties in withstanding stem rust [*Puccinia graminis*]. The campaign for the eradication of barberry in the stem rust areas is now in its fifth year. Thirteen of the north-central wheat-growing States have enacted legislation requiring the removal of common barberry bushes. Altogether 5,625,289 bushes have been located and 4,457,638 removed during the entire campaign. True take-all (*Ophiobolus graminis* [*cariceti*]) has been found on wheat in six States and it has been shown that the 'rosette' disease, the cause of which is still unknown, is distinct both from take-all and the *Helminthosporium* disease. The latter affects chiefly durum wheat and no effective control measures are known.

The complex group of diseases causing root, stalk, and ear rots of maize are of great importance in many States, losses of over 30 per cent. having been experienced in certain trials during the year. The wheat scab fungus, *Gibberella saubinetii*, is one of the important parasites concerned, as is also the dry rot fungus *Diplodia zeae*, while *Fusarium moniliforme* is commonly associated. One or more species of *Cephalosporium* cause another type of disease, characterized by a purple discoloration of the stalks and leaves, browning of the fibrovascular bundles, and barrenness. Bacteria are also associated with these fungi.

Sugar-cane mosaic disease has been found to occur in all the cane-growing States, and a complete survey of its incidence has been made. The destruction of diseased plants and the use of healthy seed are the only known methods of eliminating it, and parts of Porto Rico and Florida have now been practically cleared of the disease in this way. The immune variety Kavangire [Uba] promises to displace the susceptible varieties in badly diseased areas.

The citrus canker [*Pseudomonas citri*] was thought to have been completely eradicated from areas of commercial citrus fruit production, but a centre of infection on grapefruit was discovered in Florida in May 1922, and about 750 trees were found to be involved. This outbreak is being dealt with. A few other infected spots were found in Alabama and Mississippi, there are scattered diseased trees in Louisiana but not in the commercial producing area, and parts of Texas still require attention. Further experiments with the Bordeaux mixture and oil emulsion spray confirm the previous conclusion that it will effectively and economically control melanose and stem-end rot of citrus fruits [*Phomopsis citri*] if applied to the young fruit.

The group of so-called degeneration diseases of potatoes—mosaic, leaf roll, and related troubles—has become the greatest handicap to potato improvement in the United States and causes heavy loss throughout the country. Investigations during the year under review indicate that both streak and curly dwarf are closely related to this group and can be transmitted by juice inoculations. Roguing the crop, in localities where the percentage of mosaic and aphid infestation is low, has reduced mosaic from 10 per cent. to 1 or 2 per cent. in one season. Varieties differ considerably in their reaction to the disease, but resistance is less common than previously believed.

Cucumber mosaic can be caused by infection from the common milkweed [*Asclepias*], which is probably an important source of the disease as it is frequently found near the cucumber fields.

Amongst forest trees it is stated that 'blueing' or blue stain, caused mainly by species of *Ceratostomella*, is the most important degrading factor in air-seasoned southern yellow pine [*Pinus palustris*] and causes deterioration of many other timbers. In the south the control of this and of mould fungi is perhaps the biggest problem in the industry. The ring-scale fungus, *Trametes pini*, has been found to cause all but a small part of the loss through decay in the Douglas fir forests of Oregon and Washington, which contain nearly one-fourth of the remaining stand of saw timber in the United States. Losses of 20 per cent. are said to be common. Affected living trees can now be recognized by external indications, a circumstance that will be very helpful in the management of the forests.

Chestnut blight [*Endothia parasitica*] continues to spread southward. Certain surviving American trees in the infected area are being propagated from as being evidently resistant. Search is being made for resistant or immune varieties of chestnuts both in the United States and in other countries, in addition to attempts to secure these qualities by breeding.

Since attempts to exterminate the white pine blister rust [*Cronartium ribicola*] in the eastern States were abandoned in 1917, on the discovery that the disease had obtained too firm a footing, efforts have been concentrated on the development of practical methods of control, which would ensure the continued growth of white pines in spite of the presence of the fungus. These consist mainly in the eradication of cultivated and wild forms of currant and gooseberry bushes [the chief alternate hosts of the fungus] within 900 feet of the pines. It is stated that control measures can be applied by pine owners at economically practicable rates and that any stand of white pine, large or small, can be adequately protected. But it is considered that these measures will fail in their object unless they are applied generally within the next few years. The chief event of the year in regard to this disease was its discovery in British Columbia and the Puget Sound region of Washington State [see this *Review*, ii, p. 4]. Prompt action has been taken to determine the extent of the invasion and, if possible, to eradicate or control it. The Canadian blister rust quarantine to prevent western migration of this disease was enforced in 1916, but the age of the infections found in British Columbia in 1921 showed that it had succeeded in reaching that area prior to the quarantine.

Verslag over het jaar 1921. Departement van den Landbouw in Suriname. [Report of the Dept. of Agric., Surinam, for the year 1921.] 92 pp., 1922.

The report contains a few references to subjects of phytopathological interest.

Bud rot of coco-nuts caused so much damage in a plantation of 2·3 hect. in extent that further cultivation had to be abandoned. Oil palms (*Elaeis guineënses*) also continued to die of bud rot, only one palm being left alive out of the 130 African specimens that were planted in 1916. *Hibiscus cannabinus*, grown in small quantities for experimental purposes, was severely attacked by a root disease. *H. sabdariffa* will probably, it is thought, prove much more satisfactory than the former species as a substitute for Bengal jute.

LEE (H. A.). **Observations on previously unreported or noteworthy plant diseases in the Philippines.**—*Philipp. Agric. Rev.*, xiv, 4, pp. 422–434, 8 pl., 1922.

Notes are given on the following diseases of plants in the Philippine Islands:

CITRUS. Psorosis or California scaly bark, a disease of unknown origin, causes heavy losses on the sweet orange (*C. sinensis*) and has apparently been present for many years. Florida scaly bark or nail head rust also occurs in Batangas on this host but does little damage. Foot rot, reported to be due to *Phytophthora terrestria* [*P. parasitica*], severely attacks seedling trees of sweet orange and trees budded on sweet orange stock, being probably, next to psorosis, the most serious disease of citrus in Oriental countries. Bark rot, due to an unknown cause, is responsible for heavy losses to mandarin oranges (*C. nobilis*) in the Philippines. Experiments indicate that the disease may be controlled by spraying. Pink disease (*Corticium salmonicolor*) is serious in highly cultivated groves but is readily controllable. Citrus canker (*Pseudomonas citri*) is widely distributed, but most of the varieties grown are resistant. Withertip of limes (*Gloeosporium limetticolum*), withertip of grapefruit and sweet oranges (*Colletotrichum gloeosporioides*), mottled leaf, greasy spot, and sooty mould (*Meliola* sp.) all occur but are of no great importance.

BANANA (*Musa sapientum*). Wilt (*Fusarium cubense*) was detected for the first time in the Philippines in June 1920 and is probably widely distributed throughout the islands. The occurrence of the disease is sporadic; one plantation may be severely affected while adjacent groves remain immune. Heart rot, causing a decay of the terminal bud accompanied by a black discoloration and unpleasant saline odour, is common but does not cause extensive injury. The author believes that it has not yet been reported from other countries. Freckle (*Phoma musae*), a disease occurring on many varieties of banana including the wild banana and abaca, and in isolated parts of the country, is probably endemic. It is of no great importance at present.

ABACA (*Musa textilis*). Heart rot, similar to that of banana, is due to a fungus not yet described, and causes a continuous slight reduction in the total annual production of Manila hemp. A root rot that usually follows the attacks of the root borer (*Cosmopolites* sp.) is mentioned, while another root rot, associated with a species of *Marasmius* and apparently not previously reported, occurs occasionally. Leaf spot diseases of slight importance also have been observed.

SISAL, ZAPUPE & MAGUEY (*Agave* spp.). Anthracnose (*Colletotrichum agaves*) was first observed in 1921 on sisal (*A. cantula*) and zapupe (*A. zapupe*), having probably been introduced on zapupe plants from Mexico. The disease is extremely serious on the latter, the plants being rendered useless for fibre production. Sisal and maguey are less severely affected.

Pineapple. Pineapple wilt [cause not specified] is now recorded for the first time in the Philippines, where it occurs on Hawaiian varieties only. On one estate the losses were fairly severe, but the disease has not made much headway as yet, and should be easily eradicable. The rot due to *Thielaviopsis paradoxa* is very general and severe on the leaves, suckers, and fruits.

Tobacco. Root rot (believed to be that due to *Thielavia basicola*) is the most serious disease of field tobacco in the Philippines, though it has not been previously reported. Bacterial wilt (*Bacterium solanacearum*), *Sclerotium rolfsii*, and the *Cercospora* [*nicotianae*] leaf spot are all present but do not cause serious losses. Mosaic disease affects a large proportion of mature plants but the damage it causes has apparently not yet been recognized by the growers.

Coco-nut. Bud rot is reported from all the most important coconut producing districts of the Philippines. The Bureau of Agriculture is carrying on a campaign for its eradication. Leaf spot (*Pestalozzia palmarum*) is widespread but not serious, the palms usually outgrowing the disease after a few years. Stem bleeding disease, as described from Ceylon [*Thielaviopsis paradoxa*], occurs in Mindanao and Sulu. In the former district especially it curtails the life of the palms.

Sugar-cane. Besides smut (*Ustilago sacchari*), mosaic, and Fiji disease, the following also occur: pineapple disease (*Thielaviopsis paradoxa*), *Sclerotium rolfsii*, top rot, rust (*Puccinia kuehnii*), wilt (*Cephalosporium sacchari*), root disease (*Marasmius sacchari*), leaf spots caused by *Bakerophoma sacchari*, *Leptosphaeria sacchari*, *Phyllachora sacchari*, *Cercospora kopkii*, and *Pestalozzia fuscescens* var. *sacchari*, sooty mould (*Meliola arundinis*) banded sclerotial disease (*Sclerotium* sp.), and downy mildew (*Sclerospora sacchari*). A disease somewhat resembling sereh, but believed to be distinct, is termed red vascular disease. It is considered to be identical with a sereh-like disease of D 1135 cane in Hawaii. Red rot (*Colletotrichum falcatum*) has not yet been found on cane stems in the Philippines but *C. falcatum* attacks and kills the leaves in damp, warm weather. *Melanconium sacchari* has not been observed to cause any injury. The flowering parasite *Aeginetia indica* often causes disastrous losses in certain localities.

Cook (M. T.). **Report of the Department of Plant Pathology of the New Jersey Agricultural College Experiment Station for the year ending June 30, 1921.** pp. 423–475, 3 pl., 1922.

A list is given of the problems under investigation, and the most important diseases of the year are classified under the plants attacked. Dr. W. H. Martin contributes a report of potato-spraying tests, which indicated that five applications of Bordeaux mixture for the control of early blight [*Alternaria solani*] and tip burn gave good results, the 5–5–50 being better than the 4–4–50 formula. Details of his experiments in the control of potato scab [*Actinomyces scabies*] with sulphur are also given. Mr. R. F. Poole investigated root rots of celery and horse-radish and carried out experiments in the control of field diseases of sweet potatoes. Most of this work has been already noticed. Eggplant wilt (*Verticillium albo-atrum*) was studied by Mr. C. M. Haenseler; the disease is serious in New Jersey and the results of inoculations showed that it may cause severe stunting and reduction in yield even when typical wilting is absent. He also continued his experiments in spraying for the control of pear fruit and leaf spot (*Fabraea maculata*). Satisfactory control was effected by four applications of lime-sulphur (1–40), Bordeaux mixture (3–4–50), 'pyrox', and self-boiled lime-sulphur (8–8–50), but only the last caused no spray injury.

Under the title 'Foliage injuries' Dr. Cook deals with the excessive leaf-fall of various deciduous trees, attributable mainly to the sudden alternations of warm weather and frost in the spring of 1921. In the case of the cherry, the leaf spot fungus *Cylindrosporium padi* was also involved. Leaf scald of urban shade trees was caused by the lack of water and food due to the system of drainage in towns, which is directed to preventing the percolation of water into the soil, combined with excessive transpiration. It can be controlled to some extent by pruning out 25 per cent. of the branches in the autumn, by the application of fertilizers in the spring, and by loosening the soil round the roots of the trees.

Departmental Activities: Botany.—*Journ. Dept. Agric. S. Africa*, iv, 5, p. 405, 1922.

A serious outbreak of anthracnose (*Colletotrichum trifolii*) of lucerne has recently occurred in the Uitenhage district. It generally affects the stems and petioles, on which elliptical, sunken spots develop, the leaves being rarely attacked. The plants are said to suffer the greatest injury when the seedlings are exposed to prolonged dry weather, and again during the ripening of the seeds when the effects are most severe on the stem just above the ground level. No definite control measures are known, the only reliable remedy being apparently the raising of resistant varieties.

One of the most serious troubles in the nursery, and the most destructive disease affecting apple stocks, is the *Sclerotium* disease of Northern Spy stocks, the control of which requires constant vigilance. The stocks frequently die out in patches, the collar being covered with white mycelial strands, and minute, hard, brownish sclerotia, not unlike lucerne seed, being found in the soil. The fungus can spread rapidly through the soil. Rotation would appear to be the most effective preventive measure, the site of the nursery being changed frequently. The roots of all stocks, on transplanting, should be sterilized by dipping in a formalin solution. Dead plants, and those adjacent to them, must be incinerated and the soil in which they were growing disinfected.

Nowell (W.). **Diseases of Cacao in Trinidad.**—*Proc. Agric. Soc. Trinidad and Tobago*, xxii, 5, pp, 483–493, 1922.

This is a semi-popular account of fungous diseases affecting cacao plants in the British West Indies, especially Trinidad. *Diplodia* [*theobromae*], which was long believed to be the cause of die-back, is regarded by the author as a weak parasite, the primary cause of this disease being faulty soil and other cultural conditions. The cacao tree is, by its nature, suited to humid conditions; it requires a considerable depth of soil and a fairly abundant supply of humus, and these requirements are usually met by treating the plantations so as to approximate to forest conditions, as, for instance, by interplanting with shade trees, growing wind screens, close planting, and the addition of pen manure or a heavy vegetable mulch to the soil. When such requirements are neglected, die-back is likely to appear even in the absence of *Diplodia*, and die-back can usually be treated by purely cultural methods, directed to remedying soil, drainage, and other defects of the kind. A condition resembling die-back may also be present in trees suffering from *Rosellinia* root disease.

Another trouble in which *Diplodia* often plays a secondary rôle is black pod rot and canker due to *Phytophthora faberi*, a fungus found in all cacao-growing countries, and of great importance to the industry of Trinidad, where the loss from this cause has been estimated as varying from 30 to 60 per cent. of the ripe pods, while young pods are also heavily affected. As spraying is out of the question at present in Trinidad, owing to local conditions, the author recommends efficient soil drainage and reduction of shade trees to the minimum required, where they cannot be dispensed with altogether or replaced by marginal wind-breaks. The pruning of the cacao trees themselves to ensure adequate aeration is recommended, and also the removal and disposal of all diseased pods. In treating canker the author does not favour deep excision and recommends instead the removal of the outer layer of the bark to enable the patch to dry out. Dressings which prevent the drying should be avoided.

The algal disease [*Cephaleuros virescens*] produces effects somewhat resembling die-back, especially on young trees before they are fully established or when planted in poor soils or exposed positions. The affection disappears with the provision of adequate shelter and the improvement of the soil. A minor disease is thread blight which develops only under conditions of excessive humidity.

The root disease caused by *Rosellinia* [*R. bunodes* and *R. pepo* have been recorded] occurs in several districts in Trinidad. In new clearings it spreads to living trees from certain kinds of forest stumps. In older plantations it usually occurs where forest material is deposited by flooded streams. It is a slow working disease caused by a fungus that grows in damp, sheltered situations on wood or other vegetable matter in or on the soil. The remedial measures recommended are chessboard trenching carried below the level of the lateral roots, in order to check extension of the mycelium which can spread through shaded soil rich in organic matter and also along the roots of the trees; the prompt removal and incineration of affected trees with as many of their roots as possible; and the proper cleansing of the surface of the soil and aeration of the deeper layers before replanting.

Maublanc (A.). **La pourriture brune du Cacaoyer.** [Cacao brown rot.]—*L'Agronomie Coloniale*, vi, 54, pp. 177–183, 2 pl., 1922.

The author gives a summary of the present state of knowledge of cacao brown rot (*Phytophthora faberi*) which, he states, is one of the most serious diseases amongst tropical cultures. Navel has reported a case in San Thomé in which 90 per cent. of a particularly fine crop was rendered worthless by brown rot. The author does not believe that the oospores of the fungus have been seen, the bodies taken for these being really chlamydospores. These germinate in a manner similar to that of the conidia. He states that the chances of infection could be reduced by the removal of mosses and lichens growing on the trees, and by pruning the latter so as to ensure a better access of air and sunlight. Diseased fruits should be picked and destroyed immediately they are noticed, and infected material should not be left lying on the ground. Good results have also been obtained by spraying the trees with copper fungicides (Bordeaux mixture with an addition of sugar and resin as adhesives). According to Navel this treatment now forms part of the routine in many plantations in San Thomé.

Melchers (L. E.) & Parker (J. H.). **Rust resistance in winter Wheat varieties.**—*U.S. Dept. of Agric. Bull.* 1046, 29 pp., 11 pl. (3 col.), 2 figs., 1922.

From 1914 to 1917 field experiments to test the resistance to black stem rust (*Puccinia graminis tritici*) of about 100 varieties and strains of winter wheat were carried out in a nursery at Manhattan, Kansas. The varieties included the hard red winter wheats of the Crimean group, such as Turkey and Kharkov, and the soft red winter wheats grown in eastern Kansas and elsewhere. In 1916–17 greenhouse experiments were conducted with the same varieties. Special methods were devised for the inoculation of the test plants with uredospores from rust cultures, and these are described in some detail. By these means severe epidemics of rust were produced each season, and the percentage of infection probably represents the maximum intensity of attack under Kansas field conditions.

With the exception of Kanred, P 1066, and P 1068, all pedigree strains, the winter wheats proved to be very susceptible to rust. In 1915 these three resistant strains were heavily rusted (40 to 70 per cent.), presumably owing to the presence in the nursery of some biologic strain of the fungus which was capable of infecting them, but in 1916–17 the infection percentages were low (5 to 25 per cent. as against 95 to 98 per cent. on some of the other varieties). Some degree of resistance was also exhibited by Kansas No. 2390. Severe rust attack usually reduces the plumpness of the kernels, but the grain produced by the three resistant varieties was of good quality, in contrast to the shrunken kernels of the susceptible strains grown under the same conditions.

Several varieties of spring wheat gave evidence of resistance, including Beloturka (C.I. No. 1513), Iumillo (C.I. No. 1736), Kubanka (C.I. No. 2094), Monad (D-1), and Pentad (D-5), all of the durum or macaroni group (*Triticum durum*). A hybrid of Iumillo × Preston, resembling the durum parent, was also resistant. The only resistant variety of the common or bread-wheat group (*T. vulgare*) was Black Persian. Ghirka Spring was very susceptible. Some degree of resistance was shown by all the strains of emmer and einkorn.

In the greenhouse tests the plants were investigated at two stages of growth, in the seedling stage and at heading time. The results agreed on the whole with those of the field trials, except that Kansas No. 2390 gave no sign of resistance at either stage. The einkorn strains were also more susceptible in the greenhouse than in the field. Greenhouse tests alone do not, in the authors' opinion, furnish a reliable basis for conclusions as to rust resistance, and the results of such trials should be combined with those of nursery experiments in estimating the practical value of any variety.

The reaction of the three resistant varieties, Kanred, P 1066, and P 1068, to inoculation by the rust parasite differs markedly from that of other varieties described as resistant. In the latter prominent flecks are nearly always apparent in eight to twelve days after inoculation, small uredosori being frequently produced. In the three varieties above named, however, only the most minute and inconspicuous flecks are occasionally observed, while uredosori are entirely absent. Reports from Alabama, California, Illinois, Iowa, Missouri, Nebraska, New York, Wisconsin, and New South Wales confirm the results of the Kansas field trials with regard to the resistance of these three strains, but in Minnesota and South Dakota they were somewhat severely attacked by rust. The existence of distinct biologic forms of stem rust greatly complicates the study of resistance and susceptibility, and renders it probable that the behaviour of the wheats in question will vary according to the season and locality. In Alabama, Arkansas, California, Missouri, North Carolina, North Dakota, Oregon, South Dakota, Tennessee, Texas, Virginia, Wisconsin, and New South Wales the three resistant varieties are also resistant to leaf rust (*Puccinia triticina*). In the light of present knowledge it appears very probable that this resistance to leaf rust will be maintained under a wide range of conditions.

Kanred wheat presents a most unusual number of desirable agronomic characters, foremost among which are its high yield, earliness, and resistance to cold. In Kansas it yields from three to five bushels more per acre than either of the two commonly grown varieties, Turkey and Kharkov. Kanred is also reputed to equal the latter in milling and baking qualities. Its introduction into Oklahoma, Texas, Nebraska, eastern Colorado, and other States where hard winter wheats are cultivated, is now taking place on a large scale. Kanred wheat is likely to prove of great value as a parental variety in crosses on account of its resistant qualities, which are evidently transmitted to wheat hybrids in the same way as other characters. Several of the crosses already made appear very promising.

BRITON-JONES (H. R.). **The smuts of Millet.**—*Min. Agric. Egypt Bull.* 18 (Botanical section), 6 pp., 3 pl., 1922.

In this paper is given a short description of the three types of smut which attack sorghum (*Andropogon sorghum*) in Egypt, viz.: long smut (*Tolyposporium filiferum* Busse), head smut (*Ustilago reiliana* Kuehn), and grain smut [*Sphacelotheca sorghi* (Lk) Clinton]. Of these the first is the most common, and can be found in almost every crop of millet throughout the country, but the damage done by it is inconsiderable owing to the low percentage of heads (rarely up to 2 per cent.) and individual grains (about 15 per head) attacked. The fungus, when young, is eaten by the fellaheen in some provinces, and is said to have a peculiar sweet taste; whether it has any effect on the health of the consumer, if taken in large quantities, is not known. Head smut is of rare occurrence in Egypt, and the loss caused by it is negligible, as is also that due to grain smut, although the latter is somewhat more frequent.

The life-history of *Tolyposporium filiferum* is not known, and the only recommendations that can be given for its prevention are to obtain seed from a healthy crop, to remove and burn the spore-sacs when young, and for a few years not to grow sorghum on land that has had a smutted crop. Disinfection of the seed had no effect on this smut in the author's tests, but prevented grain smut. Special treatment against head smut is said to be unnecessary at present.

HECKE (L.). **Ueber Mutterkornkultur.** [The cultivation of Ergot.]—*Nachrichten deutsch. Landwirtschaftsgesellsch. Oesterreich*, cii, (N. F. 6), pp. 119–122, 1922. [Abs. in *Zentralbl. für Agrikulturchemie*, li, 9, pp. 240–242, 1922.]

The toxic properties of ergot—due to ergotin, histamin, cornutin, sphacelic acid, &c.—are stated to fluctuate according to origin, year, and method of preservation of the sclerotia. The latter are best preserved in lime. The writer describes experiments in the cultivation of ergot for medicinal purposes on its natural hosts.

Marchfeld rye was grown in pots and over some of the flowering ears test-tubes containing ripe ascigerous fructifications, resting on damp soil, were placed. The escaping ascospores infected the opening flowers, and a week after the removal of the tubes honeydew was formed in large quantities. The honeydew containing conidia was removed by means of small, dry strips of paper and collected in flat dishes. The drops should be allowed to dry on blotting-paper, as they will otherwise ferment. Conidia can also be obtained by growing the *Sphacelia* stage in pure culture in the laboratory on suitable media. By means of a sprayer of the type used in vineyards, water containing a suspension of the *Sphacelia* spores is then sprayed on the ears of a suitable variety of rye during the flowering stage. The process should be repeated for six consecutive days on account of the varying time of maturity of the flowers.

Practical experiments only can determine the commercial value of artificial infection on the lines indicated. In one instance Schlanstedt rye produced 284 kg. of ergot per hect., an average of three sclerotia per ear. The price of medicinal ergot has risen enormously, and this may render its cultivation profitable.

DE MONICAULT (P.). **L'Ergot du Blé.** [Ergot of Wheat.]—*Journ. Agric. Prat.*, lxxxvi, 34, p. 169, 1922.

The occurrence of ergot [*Claviceps purpurea*] on wheat, usually regarded as quite exceptional, has been frequent among the French crops during 1922, especially in the province of Ain. The abrupt alternations of early heat, rain, and cold are thought to have induced an unusually open condition of the glumes, so that the enclosed florets were more accessible to the attacks of the fungus. The disease was particularly severe on imported Swiss varieties. In view of the high degree of toxicity of the fungus it is very necessary to cleanse contaminated grain by immersing it in water and skimming off all the infected grains, which rise to the surface.

STÄGER (R.). **Beitrag zur Verbreitungsbiologie der Claviceps-Sklerotien.** [Contribution to the biology of dissemination of *Claviceps* sclerotia.]—*Centralbl. für Bakt.*, Ab. 2, lvi, 14–16, pp. 329–339, 2 figs., 1922.

It is generally assumed that the sclerotia of *Claviceps* on reaching maturity fall to the ground close to their host and lie there till the spring, when they germinate and give rise to stromata bearing perithecia and ascospores. The ascospores are then disseminated by means of the wind or of insects. In certain cases, such as that of ergot of rye, this is undoubtedly what occurs. A study of *Claviceps* sclerotia from wild grasses, however, shows that the fungus is not solely dependent on the wind or insect dissemination of its spores, but is also transported in the resting mycelium or sclerotium stage. There are two methods of securing this end. Either the sclerotium makes use of its host's contrivances for dissemination, or it is itself provided with such adaptations.

The author's observations and experiments deal with both alternatives. Two cases are described in which the sclerotium utilizes the host's contrivances for dissemination. *Brachypodium sylvaticum* has an oval caryopsis enclosed within the paleae. The inferior palea has at its apex a hook-shaped or sinuous awn, 1·5 cm. in length. This awn, with the caryopsis, easily attaches itself to passing persons or animals. The crescent-shaped sclerotium, which is surrounded by the paleae at the base, is taken up and transported in the same manner. In *Calamagrostis epigeios* (a new host) the sclerotia are 2 to 4 mm. long, $\frac{1}{3}$ to $\frac{1}{2}$ mm. thick, rod-shaped, and twisted. They are partially enclosed in and adhere to the lancet-shaped paleae. At the base of these paleae is a circle of fine hairs which often exceed the sclerotia in length. In dry weather this ring of hairs expands like an umbrella, and the paleae and sclerotium are carried away with great ease by the wind. It is probable that the autumn gales could carry them for a distance of several miles. A similar process probably occurs in *Melica ciliata* and *Phragmites communis*.

Only one adaptation of the sclerotium itself which aids dissemination is described. Experiments with *Claviceps wilsoni* Cke on the aquatic grass *Glyceria fluitans* showed that the sclerotia of this species float in water. Further tests, particulars of which are given, showed that the sclerotia occurring on the various grasses may be divided into floaters and non-floaters, and that this is correlated with their requirements. Thus the sclerotia of *Glyceria fluitans*, *Molinia coerulea*, *Phragmites communis*, and *Phalaris arundinacea*, all of which grow in or near water or bogs, can float and are not injured by long immersion, while those occurring on rye, *Lolium*, *Brachypodium sylvaticum*, *Sesleria coerulea*, *Arrhenatherum elatius*, *Agropyrum repens*, *Alopecurus myosuroides*, and other land grasses sink in water. The floating capacity of the former group appears to be due solely to the air enclosed in the tissue of the sclerotium, as when this is removed they sink.

In 1899 the author showed that the ergot of *Phalaris arundinacea* was identical with that of rye, *Claviceps purpurea* Tul. The only modification undergone by the fungus on *Phalaris* is biological, the floating habit having been acquired to suit the new surroundings. This important alteration justifies in the author's opinion the creation of the new form *Claviceps purpurea* f. biologica *natans Phalaris arundinaceae.*

The sclerotia of certain land grasses (*Dactylis glomerata, Holcus mollis, H. lanatus, Poa annua,* and *P. nemoralis*) form an intermediate group between the floaters and non-floaters. Thus, in tests carried out near Berne, 69 per cent. of the sclerotia of *Dactylis glomerata,* 40·4 per cent. of the sclerotia of *Poa nemoralis,* 60 per cent. of the *Holcus* sclerotia, and most of those on *Poa annua,* floated. Possibly the sclerotia on these grasses, like those of *Calamagrostis epigeios,* are primarily disseminated by the wind, but when they are freed from the paleae they can float to a greater or lesser degree. In *Phragmites communis* there is little doubt that both methods are made use of.

PETHYBRIDGE (G. H.), LAFFERTY (H. A.), & RHYNEHART (J. G.). **Investigations on Flax diseases. (Third Report.)**—Reprinted from *Journ. Dept. of Agric. and Techn. Inst. Ireland,* xxii, 2, 20 pp., 11 figs., 1922.

This report continues the investigations on flax diseases from previous years [see this *Review*, i, p. 173].

The dry weather of 1921 tended to suppress the growth and spread of parasitic fungi, especially during the drought of the early part of the summer. Investigations of seedling diseases were therefore necessarily limited in their scope. Thus only three reports were received of seedling blight (*Colletotrichum linicolum* Pethybr. & Laff.). In the absence of rain the conidia were not washed from the cotyledons to the stems, so that lesions on the latter were uncommon. The lateral spread of the disease from one plant to the next was also inhibited by the drought.

'Browning' and 'stem-break', both due to *Polyspora lini* Laff. [see this *Review*, i, p. 176], caused little damage, as they only appeared late in the season when most of the crops had been harvested. As infection starts at the base and proceeds upwards, an experiment was conducted to ascertain whether the flax flea-beetle (*Longitarsus parvulus*) could carry the conidia from a lower to a higher leaf. The result showed that the insects can carry the disease, presumably by mechanical transfer of the conidia, to the leaves near the apex from diseased cotyledons near the soil. Once established on the upper leaves the spread of the disease to adjoining plants is assured by direct contact or other means.

The disinfection of flax seed has hitherto been complicated by the fact that the wetted seeds adhere together owing to the outer wall of the epidermis of the seed coat becoming mucilaginous when moist. It was shown, however, by recent trials that this does not take place to any extent, nor is germination reduced, when the seed is steeped from one to five hours in one to ten per cent. aqueous solutions of copper sulphate. On removal from the steep the seeds should be mixed with dry, freshly slaked lime, which, reacting with the copper sulphate, forms a 'Bordeaux' precipitate on each seed. The addition of a small quantity of 40 per cent. formaldehyde to the copper sulphate was also found to be harmless. As a result of these preliminary tests, a series of experiments on flax seed, naturally infected with *P. lini*, was carried out with varying proportions of copper sulphate and formaldehyde, separately and together. The germination of the seed was somewhat impaired by the use of formaldehyde alone, applied either by steeping for ten minutes in 0·1 or 0·2 per cent. formaldehyde or by spraying with 0·5 per cent. formaldehyde so as just to wet the seeds without causing them to become mucilaginous. No injury resulted when 0·2 per cent. formaldehyde was used in conjunction with copper sulphate (steeped for one hour), the latter apparently rendering the seed coat more or less impermeable. Neither seed treatment nor spraying the plants with a 2 per cent. Bordeaux mixture proved effectual in eliminating the disease and subsequent spread led to the treated plots becoming as severely infected at the end of the season as the controls.

Previous tests had shown that the resting or teleutospores of *Melampsora lini*, which cause the black 'fired' areas on flax stems, could, under certain conditions, remain viable from the autumn of one year to the spring of the next. During the summer of 1921 evidence was obtained that the teleutospores can retain their vitality for an even longer period, 'fired' material harvested in 1919 and subsequently stored indoors having successfully infected pots of healthy flax seedlings on which it was spread in the spring of 1921. It is improbable, however, that even under excessively dry conditions, the teleutospores could survive for seven years, the period allowed in Ireland to elapse between successive crops of flax in any given field. The various attempts of the authors and other workers to transmit the strain of this rust commonly found on *Linum catharticum* to cultivated flax have given negative results, and it is now regarded as certain that the two are distinct biologic species. Uredospores of *M. lini* from cultivated flax inoculated on *L. angustifolium* caused only slight infection.

Root rot (*Thielavia basicola*) occurred sporadically in one crop. The plants were pale green and stunted in appearance, owing to malnutrition resulting from a diseased condition of the roots, the whole root system being involved in some cases, while in others only the youngest portions were affected. Microscopic examination revealed the presence of the chlamydospores and conidia of the fungus and inoculation experiments proved its pathogenicity to flax. It was found that two common weeds, groundsel (*Senecio vulgaris*) and goosefoot (*Chenopodium album*), also acted as hosts of *T. basicola*, the latter being specially susceptible. The eradication of these and other susceptible weeds and the cultivation of two successive root crops previous to flax would probably leave the soil comparatively healthy.

'Flax Droop' is the name proposed for an apparently nonparasitic disease of the taller pure line varieties observed for the first time in 1921. The first symptoms were noticed on 10th July, when the plants presented a prematurely ripe appearance. The upper portions were light green in colour and drooped considerably, though actual wilting was not observed. The upper parts of the stalks were soft and herbaceous, but the base and the excessively numerous lateral branches arising below the affected part were normal. About flowering time, and before the development of the seed-bolls, the tops of the affected plants turned yellow, bent over still more, and eventually died. An examination of the roots and stems for the presence of parasites gave negative results. In plants but recently affected the fibre elements of the vascular bundles on the upper or convex side of the drooping stem appeared partially dissolved, while those on the lower or concave side were still normal. At a later stage this condition became general around the vascular ring, and when the upper part of the stem was dead only a trace of cellulose thickening was visible in the fibres. The middle lamellae remained, though in a discoloured and disorganized condition. The immediate cause of 'droop', therefore, is a weakening of the fibres in the affected regions, but the origin of this degeneration is at present obscure. The excessive dryness of the soil in which the diseased plants were growing was not sufficient to account for it. Copious watering did not effect a cure, and dry conditions tend to promote the thickening, rather than the reverse, of the mechanical elements of plants. The value of the varieties in question, which depends largely on their length of stem, would be seriously diminished if this trouble were to become at all general. Seed has been saved in order to ascertain whether the disturbance is due to an inherited character of the varieties.

The fungus causing the *Sclerotium* disease of flax was definitely identified as *Sclerotinia libertiana*, a parasite which is perhaps best known in Ireland, under the name *Sclerotinia sclerotiorum* Massee, as the cause of the 'stalk disease' of potatoes. A healthy potato plant inoculated with a pure culture of the fungus from flax rapidly developed the typical symptoms of stalk disease. The latter has been observed at times in the North of Ireland, and its ability to spread to flax is of considerable interest.

Schilling (E.). **Beobachtungen über eine durch Gloeosporium lini verursachte Flachskrankheit in Deutschland.** [Observations on a disease of Flax in Germany caused by *Gloeosporium lini*.]—*Faserforschung*, ii, 2, pp. 87–113, 13 figs., 1922.

During 1920 and 1921 the flax disease which has been variously termed seedling blight, anthracnose, and canker by different investigators was observed near Sorau, this being its first recorded appearance in Germany. It is caused by the fungus *Gloeosporium* [*Colletotrichum*] *lini*, with which, in the author's opinion, Pethybridge's and Lafferty's subsequently described *Colletotrichum linicolum* is identical [see this *Review*, i, p. 173].

The symptoms of the disease are described at some length and stated to agree in the main with the accounts of Bolley, Pethybridge, and Miss Westerdijk. The last-named, however, reports a spotting of the leaves, stalks, and capsules of older plants which has so far not been observed in Germany, while the exposure of the woody portion of the base of the stem, due to the dissolution of the tissues in advanced stages of the disease, as described by Pethybridge, was not specially noticeable in the German cases.

The fungus was isolated and grown in pure culture. Setae were not invariably present in the acervuli, their development apparently coinciding with dryness of the surrounding atmosphere. Judged by this criterion, the author thinks that the separation of the genera *Colletotrichum* and *Gloeosporium* cannot be maintained. Conclusive evidence was obtained that the disease is transmitted by the seed, by means of mycelium on the testa. Infection by spores direct from plant to plant or from the soil also occurs. In the author's experiments, all the varieties of flax and linseed tested were susceptible, but the conditions of the experiments were exceptionally favourable to infection, and under natural conditions in the field the disease was limited to Bombay and Sicilian linseed, Finnish fibre flax, Russian crown flax, and a Silesian fibre flax.

The disease causes a serious reduction of germination and sometimes a heavy loss of crop. It may best be prevented by the use of clean seed. The effects of climatic conditions, methods of cultivation, and the like have not yet been sufficiently studied to allow of any recommendations of practical value being made in regard to them. It has been observed that the plants succumb to the disease more readily in dry than in damp weather, but that the parasite is more readily disseminated during the latter. The control measures advocated by previous workers on this disease are discussed, and although the author does not appear to have tested them, he is of opinion that such measures could only be applied on a large scale with great difficulty and expense, and that the use of clean seed is the most essential requirement.

LACEY (MARGARET S.). **Studies in bacteriosis. VI, Bacillus carotovorus as the cause of soft rot in cultivated Violets.**—*Ann. of Appl. Biol.*, ix, 2, pp. 169–170, 1922.

This is an account of the occurrence in England, early in 1921, of a destructive disease of cultivated violets caused by *Bacillus carotovorus*. The plants examined had the whole interior of the stem reduced to a soft white mush, the rot spreading to the petioles and causing the leaves to fall. The organism was isolated and identified by comparison with authentic cultures of *B. carotovorus*. Inoculations reproduced the disease in violets and also caused the characteristic white rot of carrots, turnips, potatoes, and onions.

CADORET (A.). **L'Abricotier dans la Vallée du Rhône.** [The Apricot in the Rhone Valley.]—*Journ. Agric. Prat.*, lxxxvi, 39, p. 271, 1922.

For the last thirty years a gummosis of apricot trees, accompanied by the attacks of a hitherto unidentified parasite, has been known in the alluvial soil of the Rhone Valley [see this *Review*, i, pp. 180 and 385]. The writer had opportunities for studying it, while stationed at Tournon (Ardèche) from 1901 to 1913. The damage is particularly severe between Lyons and Peyraud, and between Lyons and Saint-Rambert. The disease is practically non-existent on the dry soils of the hill-sides on the left bank of the river, and from the vicinity of Avignon as far as Tarascon.

The average duration of the disease is two to three years, though it may be fatal within a year in localities exposed to frequent floods. Older trees are uniformly more susceptible to the disease than young ones. During the first year of the attack the trees often present a curious appearance, some portions being healthy and others withered. The following year the withering is complete. It has been observed that the disease is most prevalent in orchards formerly used for the cultivation of mulberries. Cherry trees in excessively wet or dry soils exhibit somewhat similar symptoms. Isolated cases of the withering of apricots in schistose soils have been reported from St. Jean-de-Maurienne (Savoy), where the symptoms appear to be identical with those in the Rhone Valley.

The writer believes that the withering is due to a fungus or bacterium which invades the roots and wood of the stems, or the latter only, and is accompanied by gummosis. As practical measures to reduce loss he recommends that plum trees should not be used as stocks, unless they are planted level with the soil, the roots being covered with a mound, at least 1 m. in width by 0·50 m. in height. The same planting in mounds is advisable with all apricots grown in localities subject to inundation or where the disease is already present. Apricot orchards should be opened, when possible, only in new soil.

Harrison (T. H.). **Note on the occurrence in New South Wales, Australia, of the perfect stage of a Sclerotinia causing brown rot of fruits.**—*Journ. & Proc. R. Soc. of New South Wales*, lv, pp. 215–219, 1 pl., 1922.

In September, 1921, following a season of heavy brown rot infestation of orchard trees in New South Wales, the author found two apothecia of a *Sclerotinia* arising from mummified apricots in an orchard near Sydney. Tissue cultures from one of these on potato dextrose agar gave rise to a typical *Monilia* growth, and inoculation of loquat [*Eriobotrya japonica*] and apple fruits with conidia from a pure culture caused typical brown rot lesions. Further studies are in progress, but there are already definite indications that the organism is *Sclerotinia fructigena* and a distinct biologic form from both the European and American forms. The ascigerous stage of this fungus has not been previously recorded in Australia.

Nordmann. **Der Apfelmehltau und seine Bekämpfung.** [Apple mildew and its control.]—*Deutsche Obstbauzeit.*, lxviii, 21–22, pp. 202–203, 1922.

Apple mildew [*Podosphaera leucotricha*] is stated to be assuming such serious dimensions all over Germany, and more especially in the south, where the summer months are often very dry, that it can only be checked by an organized campaign. One of the chief preventive measures is the selection of resistant varieties for planting, e.g. Charlamowsky, Queen, Winter Golden Pearmain, Lane's Prince Albert, &c. The cultivation of the two extremely susceptible varieties, Landsberger Renette and Cox's Orange, should be discontinued. The American variety Baldwin is the only one known to be wholly immune against mildew in Germany. Drastic and regular pruning is another very effective means of control, the destruction of affected shoots in the summer being particularly important. Of the various fungicides those containing sulphur are chiefly recommended, excellent results having been obtained with solbar and in some cases with colloidal sulphur [see this *Review*, i, pp, 228 and 390]. Dusts are, however, considered to be preferable to sprays, and the new preparation 'elosal' is stated to be extremely effective.

Cunningham (G. H.). **Apple and Pear black-spot: their appearance, cause and control.**—*New Zealand Journ. of Agric.*, xxv, 1, pp. 20–31, 11 figs., 1922.

The symptoms of black spot [scab] of apple (*Venturia inaequalis*) and pear (*V. pirina*) are described and figured. The former is prevalent and is the most serious apple disease throughout New Zealand except in localities where the humidity is low during the growing season, such as Central Otago and certain districts in Marlborough and North Auckland. In New Zealand the ascigerous stage of the fungus develops in the 'spring' (August and September) from mycelium which has 'overwintered' in dead leaves. This stage is found only in the tissues of dead leaves, not on fruits or shoots.

Pear black spot differs from the foregoing in forming conidia freely on young shoots and laterals, sometimes continuously for as long a period as nine months, and it is almost certain that shoot infection is one of the means of carrying the organism over the winter. Perithecia are also produced abundantly on the fallen leaves, and the ascospores so formed are capable of infecting the new leaves and fruits in the spring.

In an appended note on the control of black spot, written by J. A. Campbell, it is pointed out that control by the destruction of infected leaves alone is impracticable, not only on account of the difficulty of ploughing in all the leaves, but also because of the danger from infected shoots. It is, however, advisable to plough deeply in the autumn, in order to bury as many leaves as possible and thereby minimize infection by reducing the number of ascospores. A series of spray applications is necessary to cover the danger period of ascospore infection and to destroy the conidia on shoots and prevent their subsequent development on leaves and fruits. The following schedule has been found to control the disease effectively in Auckland, Hastings, and Nelson, and is accordingly recommended to fruit growers. (1) Green-tip stage [pre-pinking or spur-bursting stage], 5–4–50 Bordeaux or 1–10 lime-sulphur, (2) between open-cluster and pink stage, 3–4–50 Bordeaux or 1–30 lime-sulphur; (3) calyx-spray (petal-fall), 1–100 to 1–120 lime-sulphur; (4) ten days later, 1–100 to 1–120 lime-sulphur; (5) every month until maturity, 1–100 to 1–120 lime-sulphur; (6) immediately before picking, 1–100 lime sulphur. The object of the last spray is to prevent storage infection, and it may be applied with advantage when the fruit is destined for export. Arsenate of lead may be added to the third and subsequent sprays for the simultaneous control of the codling moth and leaf-roll caterpillar. The period covered by the applications, and the thoroughness with which they are given are stated to be more important factors in the control of the disease than the exact strength of the sprays.

Curtis (K. M.). **Ascospore ejection of the Apple and Pear black-spot fungi.**—*New Zealand Journ. of Sci. and Tech.*, v, 2, pp. 83–90, 1922.

A series of experiments has been carried out to determine the duration of the period of discharge of ascospores from the perithecia of *Venturia inaequalis* and *V. pirina*, the fungi responsible for the black spot [scab] of apple and pear respectively. Five apple and three pear leaves were examined daily from 14th September to 20th December, 1921. It was found that ascospore ejection began on 14th September, reached its maximum on and immediately after 2nd October, ceased to be of practical significance by 31st October, and stopped entirely by 12th December. The season's discharge from both pear and apple leaves fell into several distinct periods. There was one period of maximum discharge, which occurred early in the season, five subsidiary periods of lesser importance, but still of practical significance, and several of negligible dimensions. The maximum output of spores for any one wet period occurred between 2nd and 11th October, in the case of all the leaves, both pear and apple. In the majority of the leaves the maximum average daily output for any wet period and the maximum single day's output for the season also occurred during this period. The output of spores from pear leaves, as compared with those of apple, is marked by a greater total number of spores ejected during the season, and a more uniform daily ejection which lasted over more protracted periods.

In another experiment four apple leaves were kept without water from 14th September to 6th December, during which time the majority of the perithecia passed through a very sensitive phase, that of the delimitation of the ascospores within the asci. This did not, however, prevent an appreciable ejection of ascospores when the drought was broken, although in normal leaves ejections of any magnitude had ceased for a month or six weeks before that time.

The usual system of cultivation followed in the orchards tends to bring to the surface a certain proportion of the leaves which have been ploughed in. If this occurs within six to eight weeks after the maturation of the perithecia, the latter will become a direct source of danger as soon as the rain begins. The leaves should therefore be destroyed by fire after they have fallen from the trees.

Jarvis (H.). **Fruit fly investigations.**—*Queensland Agric. Journ.*, xviii, 4, pp. 269–271, 1922.

In this report is included a section on plant pathology, containing notes by H. Tryon on certain diseases of deciduous fruit trees in the Granite Belt district of Queensland. The apple bark canker or bark blister caused by *Coniothecium chromatosporum* is stated to be prevalent all through the district and to attack also the pear. It causes the formation of dark areas in the outer bark, the cells being replaced by masses of closely packed, short-celled mycelium. The segments of the mycelium ultimately become transformed into spores. A second stage with pycnidia of the *Phoma* type is also stated to occur. The attack results in a die-back disease of the twigs and may even kill fairly large branches. Seriously diseased branches should be cut out and the rest of the tree treated with Bordeaux mixture or lime-sulphur.

A second bark canker of the apple in this district is caused by the fungus *Gloeosporium malicorticis* which is also responsible for the bitter rot on the fruit. A short account of the disease is given and the same treatment is recommended as in the other case, with the addition that all rotting fruit should be removed and destroyed.

WATERS (R.). **Cool storage of Apples. An investigation of flesh-collapse.**—*New Zealand Journ. of Agric.*, xxv, 1, pp. 34–39, 1922.

Fruit kept in cool storage is liable to deterioration from a number of causes, which must be carefully distinguished in order to improve the methods of preservation.

Black spot [scab] of apples (*Venturia inaequalis*) undoubtedly continues to develop to some extent in cool storage, and judging by the very early stages of infection that are found, it is clear that it can also spread to sound fruit in spite of the very low temperature. In this case the remedy must obviously be applied before picking.

The disease known as 'sting' refers, strictly speaking, only to the injury succeeding insect punctures. Popularly, however, sting is a form of rot, caused directly by blue mould (*Penicillium*), bitter rot (*Glomerella*), or *Botrytis*, following some form of mechanical injury to the skin. Thus, the origin of this trouble is also to be sought before the arrival of the fruit at the store.

A third type of disease, known as scald, appears in the form of irregular, dark, sunken patches in the surface of the apple, and is caused by vapours or esters given off by the fruit. Scald is most severe among apples packed in barrels, and may be prevented by satisfactory ventilation or wrapping the fruit in oiled paper.

The cause of flesh-collapse, which is probably identical with the 'brown-heart' recently reported as occurring in shipments of Tasmanian and Australian apples to England [see next abstract] has not yet been definitely ascertained. The skin remains intact until the last stage of the disease, while part, or the whole of the interior may be in a state of collapse. Affected apples are springy to the touch. Fungous rots may set in and cause a discoloration of the skin. This disease has already been responsible for extensive losses, and the success of the apple export trade is largely dependent on its prevention.

Various causes have been suggested to account for flesh-collapse, such as drought followed by excessive rain, lack of cultivation, varying degrees of maturity of the fruit, age of the trees, and lapse of time between packing and delivery. Investigation has shown, however, that none of these reasons can be considered adequate, the disease occurring under the most varied conditions. The writer believes that individual apples, even of the same variety, differ considerably on reaching the store in their degree of resistance to flesh-collapse.

In order to test the effects of varying temperatures, a number of Sturmer apples of different lines were subjected to alternating temperatures ranging between 20° and 60° F. No sign of flesh-collapse developed in any of the fruit. Various other attempts at the artificial production of the disease by fluctuating temperatures and other means were unsuccessful. Both in 1920 and 1921 flesh-collapse appeared in September, after the fruit had been in storage for three or four months. The general standard of temperature adopted in the stores was 32°, but there were considerable differences in the time during which the machinery was kept running.

The writer's hypothesis, upon which he is basing his present investigations, is that the flesh of the apple both cools and warms up more slowly than the atmosphere of the store, thus averaging out the varying temperature of the chamber. Some stores keep the refrigerating machinery running continuously so that the store remains for the whole twenty-four hours at 32°, while in others it is only kept running for eight hours, the insulation being relied on for the remainder of the day, and in these the average temperature of the apples will be above 32°. Prolonged exposure to a temperature of 32°, which is known to produce a peculiar physical action on water, might exert some strain on the flesh and consequently cause injury. On board ship and in stores where the machinery runs for long periods, abundant flesh-collapse occurs.

Two important lines of inquiry present themselves as a result of these observations; first, the investigation of the optimum temperatures for the storage of New Zealand apples, and second, the means of increasing the resistance of the fruit to cool storage conditions.

Brown Heart.—*Fruit, Flower, and Vegetable Trades' Journ.*, xlii, 17, p. 455, 1922.

Correspondence between the Agent-General for Tasmania, the Managing Director of the Fruit and Produce Exchange of Great Britain, and Dr. Charles Brooks of the Bureau of Plant Industry, Washington, on the subject of brown heart of apples, is reproduced in full.

A conference of shippers, growers, and others interested in the Australian business was recently called to consider the best means of dealing with brown heart, a disease of apples somewhat similar to apple scald, which has been prevalent in shipments during the last few years. Dr. Brooks states that brown heart is largely due to the accumulation of carbon dioxide given off by the apples, being also favoured by high storage temperatures and over-ripeness at picking-time. Though similar to internal breakdown [see last abstract] brown heart is a distinct disease, while it is totally different from scald, which is primarily a skin disease and can be controlled by the use of oiled wrappers. The removal of foul air from the boat chambers would largely prevent brown heart, while pre-cooling is also very advisable. The latter process, however, can be dispensed with if adequate refrigeration and ventilation are ensured. The ships should carry self-registering thermometers, and a temperature of 30° to 34° F. should be maintained. Under present shipping conditions it is dangerous to open up the storage chamber once it has been closed, the addition of fresh cargo causing a rise in the temperature of the fruit already cooled. During the period elapsing between the removal of the fruit from the ship and its arrival at the place of destination, it should also be kept at a low temperature.

SWINGLE (D. B.). **Pear and Apple blight in Montana.**—*Better Fruit*, xvi, 12, pp. 12–13, 18–19, 1922.

Fireblight [*Bacillus amylovorus*], which attacks apples, pears, and quinces severely, and stone fruit and pomaceous shrubs mildly, is extremely widespread in Montana. The disease, the characters of which are described in detail, is most virulent on rapidly growing, vigorous trees, the damage done to slow-growing trees being comparatively slight.

Amongst apple varieties, Duchess of Oldenburg, Gano, Ben Davis, Rome Beauty, Wagener, Stayman, Winesap, and Thomkins King are relatively resistant; McIntosh Red, Jonathan, Delaware Red, Grimes Golden, Wealthy, Baldwin, and Northwest Greening are moderately resistant; Yellow Transparent, Fameuse (Snow) Spitzenberg, Delicious, Whitney crab, Martha crab, and Hyslop crab are moderately susceptible; Alexander, Wolf River, Transcendent crab, McMahon, and Winter Banana, are very susceptible.

Of pear varieties, Kieffer, Flemish Beauty, and Beurré d'Anjou are moderately resistant; Bartlett moderately susceptible; and Clapp's Favourite extremely susceptible. It is recommended in grafting to use the Chinese sand pear (often called 'Japanese') as a stock, and Kieffer or some other resistant variety as a scion.

MILBRATH (D. G.). **Résumé of Pear blight history and methods of control.**—*Monthly Bull. Dept. Agric. California*, xi, 10, pp. 760–765, 1922.

Fireblight of pears (*Bacillus amylovorus*) was widespread and serious in California during 1922, especially in the Sacramento Valley and the adjoining foot-hills. Its occurrence in the coastal regions, and in the San Joaquin and Antelope Valleys, was sporadic. In other States also pear blight was very severe in 1922, the damage in New Jersey being probably heavier than ever before. The disease was reported to be prevalent in Michigan, Montana, Arizona. New York, Ohio, Missouri, South Dakota, and Washington. The direct losses from the disease in California may be estimated at 5 to 10 per cent. of the crop, in addition to the indirect loss due to heavy expenditure on control measures, and to a set-back in the growth of the trees as a result of drastic pruning.

An account is given of the symptoms of the disease, plants liable to infection, and methods of dissemination. It is stated that the practice of bee-keeping, recently taken up by orchardists in certain districts of Washington, has greatly increased the severity of the disease.

Pear blight can be largely controlled by the use of resistant root stocks, e.g. *Pyrus ussuriensis*. The possibilities of infection may be reduced to a minimum by high budding, successfully practised in Grass Valley with the susceptible Bartlett variety on *ussuriensis* root stocks. Seckel, Sand, Abraham, and Le Conte are also extremely susceptible, Kieffer, Duchess, and Winter Nelis slightly less so, and Douglas, a Kansas variety, comparatively resistant. Thorough pruning and excision of infected parts is very important. The most virulent and active bacteria are found on the margins and advancing points of the cankers, and the bark should be removed for at least four inches beyond the slightest tinge of discoloration. Suckers at the foot of the tree readily become infected and should be cut off as they appear. A solution of mercuric cyanide and corrosive sublimate (1 oz. of each to 4 galls. of water) is useful for washing wounds and disinfecting implements.

PUTTERILL (V. A.). **Pear scab in the Western Province: experiments and facts relating to its control.**—*Dept. of Agric. S. Africa, Bull.* 2, 31 pp., 12 pls., 1922.

Spraying experiments on experimental orchards at Ida's Valley, Stellenbosch (1920–1921), and at Lourensford Estate, Somerset West (1921–1922), are described. The results indicate that pear scab or *Fusicladium pirinum* (*Venturia pirina*) can be satisfactorily controlled by five sprayings with 4–4–50 Bordeaux mixture, the last three of which are given in combination with arsenate of lead in order to control the codling moth. This does not include a dormant spraying with lime-sulphur which is applied for general hygienic purposes before growth is renewed after the winter.

The schedule recommended is (1) when the buds are breaking and leaves just showing; (2) when the blossom buds have opened, but the individual blossoms are still closed, i. e. about ten days later than (1); (3) when the last petals are falling, i. e. about ten days later than (2); (4) ten days to two weeks after (3); (5) five weeks later. The tests demonstrated the importance of applying the mixture at least twice between the time that the buds begin to open and when they are ready for the first spraying against codling moth. The amount of diseased fruit varied from 2 per cent. in sprayed trees to 59 per cent. in unsprayed trees, and was always considerably greater when certain of the sprayings were eliminated than when the full schedule was given. Of proprietary mixtures tried, 'Arboretas' did not control scab, but 'Capex' Bordeaux mixture made by the Cape Explosives Co., was very successful, being apparently better than the home made mixture in some cases. The disease, lithiasis, supposed to be of physiological origin and occurring abundantly in the localities of the tests, [see this *Review*, i, p. 11], appeared to be almost completely controlled by the sprayings.

In a note on the occurrence in South Africa of the perithecial stage of the pear scab fungus, appended to the Bulletin, the author records the discovery in great abundance of perithecia of *Venturia pirina* on the previous season's leaves of Beurré Bosc pears in September 1921. Newly infected leaves were first found on the trees in the orchard from which the perithecia were obtained on the 6th October.

Stanford (H. R.).—**Control of Peach scab.**—*Monthly Bull. Dept. Agric. California*, xi, 10, pp. 765–774, 5 figs., 1922.

During the last few years peach scab, caused by *Cladosporium carpophilum*, has been on the increase in southern California. While it is improbable that the disease will develop in California to such a severe extent as in the eastern United States, owing to the more favourable climate of the former, the author considers that control measures must be adopted to prevent considerable losses. The present paper deals with the results of investigations during the summer of 1922 on the prevalence of scab, varietal resistance, effect on grade and price, and control measures.

Of the varieties of canning peaches examined, Lovell was the most severely infected and Sims the least; Elberta and Phillips Cling were fairly free, while Muir and Tuscan varied considerably in different orchards. Orange and Lemon Clings and Salway are grown only on a restricted area in California, but those examined were free from scab.

In the orchard the disease is easily recognized in the late summer by the oval, brown lesions on the twigs. Towards autumn olive coloured patches and spots, consisting of mycelium and spores, are found on the under side of the leaves. The damage to the leaf is slight, and is important chiefly as affording greater numbers of spores for twig infection. By midsummer the infected fruit shows light spots which gradually deepen to dark olive, and may either remain separate or coalesce. Usually they occur only on the side of the fruit exposed to moisture, causing a retardation of development on that side. On late varieties the spots form cork cells, the scaling off of which has given rise to the name of scab.

The writer inspected the process of grading Lovell peaches at a cannery, and ascertained that the amount of scab in the 'C' and 'D' grades was 8·5 and 6·4 per cent. respectively. On the basis of these percentages the average result from a ten-acre orchard would be 10·4 tons of fruit placed in a low grade on account of the fungus. The corresponding pecuniary loss may be roughly estimated at $312 on the ten acres.

The life-history of the fungus is described. It overwinters beneath the surface of the twig, and therefore cannot be reached by a dormant spray. The fungus and the twig resume growth simultaneously in the spring, the epidermis of the twig being ruptured and spores formed in more or less conspicuous tufts on the surface. The spores are carried by the wind or other agents to the fruit, which is protected, however, for the first three or four weeks after setting, by its dense pubescence. After infection takes place there is an incubation period of forty to sixty days before the olive coloured spots referred to above begin to show. While the fruits are being infected new twigs are also attacked, and thus the life cycle is completed.

Experiments showed that excellent control of the disease could be secured by spraying with self-boiled lime-sulphur 32–32–200. One spray was sufficient for early ripening varieties and two for the later sorts. The fruit must be kept protected against infection from about a month after blooming until six weeks or two months before ripening. In the experiments recorded, the early ripening variety was sprayed on 16th May and the late on 23rd May and 23rd June, excellent control being obtained. The use of commercial lime-sulphur or Bordeaux mixture is not advisable on account of the injury to peach foliage caused by these fungicides.

Rabbas. **Die Rutenkrankheit der Himbeersträuche.** [The cane disease of Raspberry bushes.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 6, p. 42, 1922.

In 1921 over 70 per cent. of the raspberry crop of an extensive plantation in Anhalt was destroyed by the cane blight due to *Didymella applanata*, and the inspection of a number of other plantations showed that the disease is more widely distributed than was previously suspected. It is characterized by the appearance from the end of June onwards of bluish-brown spots on the fruit-bearing canes, followed by a longitudinal rupturing of the bark, which peels off in rings. Owing to the similarity between the natural colour of the ripening canes and the spots caused by the fungus, the latter are not easily detected at a later period of the season. Minute black dots, the perithecia of the fungus, are scattered all over the loosened bark, and the spores liberated from these the following spring disseminate the disease. Infected canes wither before the fruit ripens, sometimes even in the early spring when the disease is frequently mistaken for frost injury. Many growers also confuse it with the effects of protracted drought or with senescence.

Little is known of direct measures of control. Infected canes must be cut away and burnt, and spraying with 1 per cent. solbar, 1 per cent. formalin, 2 per cent. Bordeaux mixture, 2 per cent. milk of lime, or 0·05 per cent. colloidal sulphur is provisionally recommended. The first application should be given in the autumn, when the soil should also be treated with caustic lime ($\frac{1}{2}$ to 1 kg. per sq. m.), and the bushes lightly hilled to prevent the spread of spores adhering to the stumps. The second application of the fungicide should be given in the following spring, two or three weeks before the appearance of the leaves, repeating the process at intervals of two to three weeks if necessary. The use of fertilizers containing potash and phosphoric acid is recommended and also lime, especially where the soil is acid.

Conflicting opinions as to varietal susceptibility appear to be held. Marlborough is universally recognized as susceptible, while Superlative appears to be heavily infected in some plantations and immune in others. Comparatively resistant varieties are the Harz Jewel, Kneveth Giant, and Schaffer's Colossal.

Wilcox (R. B.). **Eastern blue-stem of the black Raspberry.**—*U.S. Dept. of Agric. Circ.* 227, 12 pp., 1 pl., 1922.

Eastern blue-stem or curly leaf, a disease which does not correspond with any previously described, is responsible for severe losses in a number of regions where black raspberries are intensely cultivated in Ohio, New York, Michigan, and Wisconsin.

The general effect produced by the disease is a gradual stunting and reduction of vigour. During the first season of infection the symptoms may be somewhat inconspicuous, the plants giving a good crop of fruit. The berries, however, are smaller and more brittle than usual, and the shoots shorter and weaker. The hindrance to food storage causes a marked reduction, during the second season, in the size and strength of the plant and in the quality and quantity of the fruit. By the third spring the canes make only a feeble growth, if any, and the plants frequently die during the following summer or winter. The average period elapsing between the first symptoms of the disease and the death of the canes seems to be two to three years. Recovery has in no case been observed.

Affected plants show a peculiar curling of the upper leaves, especially on the young, rapidly growing shoots. The margins and veins do not arch downwards as in 'yellows', but the midribs of the leaflets are hooked or recurved. A uniform mottling of the affected leaves, extremely faint and scarcely noticeable in the early stages and due to the presence of small, scattered, yellowish-green areas, usually accompanies the disease. In the Dover-Avon district of Ohio, where these investigations were chiefly carried out, a deep violet-blue discoloration of the stems of shoots is a constant symptom of the disease. This discoloration, which is confined to the green chlorophyll layer of the stem, appears in the form of dots or longitudinal stripes resembling pencil marks, irregularly placed and often confluent. It occurs commonly at or near soil-level, extends upwards on the stem to a height of 2 ft. or more, and is also found near the bases of lateral branches. On fruiting canes of diseased plants the petioles and stems of lateral branches often show short, narrow, longitudinal streaks of brown or purplish-brown. In some localities the blue discoloration, which is of great assistance in the detection of the disease, is unfortunately altogether absent. No abnormality of the root system has been observed.

Eastern blue-stem appears to be a strictly systemic disease affecting all the shoots. It is readily transmitted by planting suckers or tips from affected plants, even though they may show no symptoms. Diseased plants cut off at the ground after harvesting throw up young shoots which soon show typical symptoms. The term 'eastern blue-stem' is used in order to distinguish the disease here described from a parasitic disease of black raspberries in Washington, known locally as 'blue-stem'. It must also be distinguished from 'yellows', a term applied to the forms of mosaic and leaf curl diseases described by Rankin and others [see this *Review*, i, p. 218; ii, p. 17]. Apart from symptomatic distinctions, the host-range of eastern blue-stem differs from that of 'yellows', the former attacking only black raspberries [*Rubus occidentalis*] and, probably, blackberries, while the 'yellows' type of leaf curl affects red raspberries [*R. idaeus*], 'purple canes', the Japanese wineberry (*R. phoenicolasius*), and two varieties of black raspberry, the Cumberland and Hoosier. Of the four varieties of black raspberry grown commercially in the Dover-Avon district, the Hoosier appears to be the most susceptible, Cumberland and Plum Farmer are also seriously affected, while Kansas is the most resistant, though no variety has been found to possess a really high degree of resistance.

The characteristic deformity and mottling of the leaves, the stunting and gradual death of the plants, and the transmission of the disease to vegetative progeny, all indicate that the disturbance is of the mosaic type. Microscopic examination has failed to reveal the presence of fungi or bacteria, while there is evidence to show that neither environmental factors nor exhaustion as a result of protracted vegetative propagation are primarily responsible. Infection spreads rather slowly to other plants in the field, the means of dissemination being unknown. All attempts at artificial transmission have given negative results. The disease has been known to spread over distances of 200 to 300 yards. It has been observed to spread most rapidly in fields making vigorous growth, coming to a standstill with the cessation of active development. New infections are most frequent on tender, succulent plants.

The disease may be controlled to some extent by thorough and repeated roguing, by the immediate elimination of infected plants in young fields, and by the planting of disease-free nursery stock at as great a distance as possible from affected plantations. Selection experiments have been started with a view to securing resistant strains of commercial varieties. The application of fungicides appears to be useless.

Smith (E. H.) & Phillips (E. H.). **Studies of the so-called 'smut' of white Fig varieties.**—*Monthly Bull. Dept. Agric. California*, xi, 10, pp. 755–758, 3 figs., 1922.

'Smut' in dried figs is characterized by the appearance of a black, powdery mass in the pulp of the fruit, the mass being composed of spores of the fungus *Aspergillus* (*Sterigmatocystis*) *niger*. On squeezing affected fruits, a black cloud of spores is ejected from the eye end. Badly smutted figs can be picked out by the dark translucent appearance of the skin, but those slightly affected only show dark or yellowish spots in the pulp, with no external evidence of disease, and thus may reach the market. The loss is considerable both from culls and from the inferior quality of the packed fruit. All the white varieties of figs are affected, Adriatics perhaps most abundantly.

On green figs the rot is characteristic, starting round the eye and affecting both the skin and pulp. The tissues become dirty white to slightly pinkish in colour, remaining at first fairly firm in texture but later developing a cheesy consistency. The surface of the skin is usually clean, but a dense growth of white mycelium develops in the pulp and this finally produces masses of spores lining pockets in the interior of the fruit. In late infections the spores are formed earlier and the pulp only is affected.

Inoculations were carried out at Fresno, California, in August and September, 1921, on figs classified into ten types according to the various stages of ripening, with the object of finding out when and in what manner infection took place. Thirty inoculations were made on the trees for each of the younger stages (2 to 8), while for the older stages (7 to 10) ten of each stage were inoculated by cutting the fruit in half, placing spores inside, pressing the halves together and incubating in uncovered dishes in the laboratory. Adriatics were used throughout, together with Kadotas and Calimyrnas for the younger stages, the last-named giving inconsistent results probably on account of 'souring' which affected the trees and was found in every case to check the development of smut. Controls in the experiments on the trees remained sound.

The results may be summarized as follows. On very hard, green figs, the fungus made a start but only developed slowly. The earliest stage of natural infection appeared to be when the fruit was ripe but unshrivelled, ready for marketing fresh (stage 5). Development was most rapid in stages 4 and 5; it was uncertain in later stages when the fig was beginning to dry out; and in the latest stages, when the pulp had become dry and translucent, the spores could not be made to germinate.

Examination of the figs in the plantations showed that the rot had started in many cases as a small spot under the eye when the fruit was ripe for marketing fresh. Cultures were obtained from many sound figs at this stage, an occasional fig being found infected at a slightly younger stage, whilst figs still younger gave negative results.

The disease appears to be disseminated by insects rather than wind; ants, fruit flies, and beetles are able to make their way into green figs with closed eyes. A premature rain in 1921, however, was observed to favour the disease on trees when smut was well under way.

'Bunchy Top' disease in bananas—interesting experiments.—*Queensland Agric. Journ.*, xviii, 4, p. 307, 1922.

The owner of a plantation at Murwillumbah claims to have discovered a remedy for 'bunchy top' of bananas. In 1920–21 sulphur was applied at the rate of 8 cwt. per acre, together with 'island fertilizer'. This was followed in 1922 by the application of 8 to 10 cwt. per acre of a mixture known as 'basic super', containing 45 per cent. lime and 17 per cent. phosphoric acid. In some cases this mixture was applied round the stools to a radius of 3 or 4 ft., in others the whole surface was treated, the suckers being also well dusted with the mixture before planting. All the suckers were taken from 'bunchy top' stock, but of the 800 planted since April not one has so far contracted the disease. The stems are strong, the colouring of the foliage excellent, and the growth of the plants exceptional. Old diseased stalks similarly treated are now throwing out vigorous centre leaves.

It is believed that the previous application of sulphur rendered the phosphates readily available to the plants, in addition to its action as a fungicide in the soil.

Ludwigs. **Versuche mit 'Solbar'.** [Experiments with 'solbar'.]—*Deutsche Obstbauzeit.*, lxviii, 21–22, p. 213, 1922.

The results of trials of the proprietary fungicide 'solbar' carried out by fruit-growers and horticulturists in Brandenburg during 1921, at the request of the local Chamber of Agriculture, are summarized. The fungicide was applied at the recommended summer strength of 1 per cent. Although the tests covered too short a period to furnish definite data, the preliminary results are regarded as satisfactory on the whole. Apple mildew [*Podosphaera leucotricha*] was successfully combated in five instances, which included the susceptible varieties Landsberger Renette and Cox's Orange.

Good results were also obtained against American gooseberry mildew [*Sphaerotheca mors-uvae*], rose mildew [*S. pannosa*], vine mildew (*Oidium tuckeri*), and the mildews of *Euonymus japonica* and *Delphinium*. Used against *Fusicladium* and *Monilia* of fruit trees solbar gave conflicting results, no improvement being remarked in some cases while in others the diseases were entirely checked. In one case the leaf mould or 'rust' disease of tomatoes (*Cladosporium fulvum*) was eradicated by two sprayings with solbar. Fungous diseases [unspecified] of cucumbers were also successfully treated in a suburb of Berlin. In an experiment conducted by the Potato Research Institute at Steglitz, the percentage of scab [*Actinomyces scabies*] in tubers from 'seed' treated with 5 per cent. for 30 minutes was only 8, as against 28 in tubers from untreated 'seed'.

Salmon (E. S.) & Wormald (H.). **Hop 'canker' or 'growing-off'.**— *Journ. Min. Agric.*, xxix, 4, pp. 354–359, 2 figs., 1922.

The cause of hop canker or 'growing-off' (the latter being the descriptive name under which the disease is known in many districts of the Weald of Kent and of Sussex) was attributed by Percival (*Journ. S.E. Agric. Coll. Wye*, xi, pp. 87–89, 1902) to *Fusoma parasiticum*. The disease causes a wilt of one or more bines at each affected 'hill'. The wilted bines are usually found to be almost severed at the base and easily come away from the root-stock with a slight pull. The underground root stock is affected by a canker, the infected portions being brown and dead. The diseased bines examined by the authors, the basal parts of which had been dead for some time, were often found to bear white pustules of a fungus, with conidia of the *Fusarium* type. Bines just beginning to wilt sometimes did not show these pustules, but usually the mycelium of a fungus was to be found in the discoloured tissues of the bark and of the wood, and in cultures made with particles of such tissues on sterilized media, the fungus grew out and eventually gave rise to *Fusarium* fructifications. This evidence that the latter was the organism responsible for the disease was strongly supported by successful inoculation experiments carried out by the authors on hop sets, although the results were not quite conclusive, owing to the fact that some of the control sets also contracted the disease.

Hop canker seems to be favoured by moist soil conditions, and the general experience of hop-growers is that the disease is worse in a wet season or following a wet winter, and that the hills are likely to be more severely attacked on wet, clayey patches or in shaded parts than on lighter soil or in portions of the garden more exposed to sunshine.

Some varieties of hops appear to be more susceptible to the disease than others; among the more resistant the authors mention the varieties Fuggles, Cobbs, and Old Golding.

Direct preventive measures consist in hard 'cutting' or 'dressing' of all the hills in the affected parts of the gardens, all the brown parts of the root stock being pared away, and in the grubbing up and destruction of all dead plants. Drainage or cultivation to remove the moisture of wet land, or letting in the sun, appear to have a favourable effect in keeping the disease in check.

DUGGAR (B. M.). **The sizes of the infective particles in the mosaic disease of Tobacco.**—*Ann. Mo. Bot. Gard.*, viii, pp. 343–356, 1921 [1922].

By arranging a series of porous filters of different degrees of permeability the author sought to determine the two adjacent members of the series, one of which would freely allow the virus of tobacco mosaic to pass while the next would stop all but a small quantity of it.

These two were found to be a Livingston spherical atmometer cup and a cylindrical atmometer tube. The former was of a type found by experiment invariably to prevent the passage of the vegetative cells and spores of *Bacillus subtilis* and to be finer than the Mandler diatomaceous filter. The cylindrical atmometer tube was still finer.

The juice to be filtered was prepared by a standard method and the wetted filters were lowered into a vessel containing it, every precaution being taken to avoid accidental contamination. The filtrate was sucked into the filter at a reduced pressure of one-fifteenth to one-thirtieth of an atmosphere, about fifteen minutes being required to obtain sufficient for testing in the case of the spherical cup and 30 to 45 minutes in the case of the cylindrical tube.

The filtrate was then tested for the presence of the virus by inoculating rapidly-growing tobacco plants through wounds. In the two series reported, eighteen out of twenty plants inoculated with the filtrate from the spherical cup got mosaic within eighteen days and only one of those inoculated from the tube, in one case, and nineteen and five respectively in the other.

It was concluded that the size of the infective particles must lie between the pore sizes of the two filters mentioned, probably close to that of the cylinder. Subsequent tests indicated that the pore sizes of these two filters were sufficiently close together to obviate the necessity of seeking for an intermediate size. Tests with milk and dextrin showed that the size of the infective particles was greater than that of the colloidal particles of dextrin, but less than that of casein. Haemoglobin was selected as having particles of intermediate size. The haemoglobin colloidal solution was freshly prepared by a standard method and was found to behave just like the tobacco mosaic virus, passing freely through the spherical cup and only in very small quantity through the cylinder. It was also found that the spherical cup allowed approximately 50 per cent. of the gelatin particles from a 1 per cent. solution of gelatin to pass.

From these experiments the author states that it seems clear that with approximately equal pressures and equal time intervals the infective particles of mosaic tobacco juice have about the same capacity to pass porcelain filters as the colloidal particles of freshly prepared haemoglobin. They have apparently a greater capacity for filter passage than 1 per cent. gelatin particles. As the particles of gelatin are not apparently very much larger than those of haemoglobin the conclusion that the virus particles are about the size of the latter is strengthened.

Bechhold has indicated that haemoglobin particles are 33 to 36 $\mu\mu$ [0·033 to 0·036 μ] or less than one-thirtieth of the breadth of the majority of bacterial parasites of plants. If the infective particles of tobacco mosaic are of the same order of size as colloidal haemoglobin particles they are evidently very different from the known bacterial plant pathogens.

Smith (K. M.). **Mosaic disease in plants.**—*Nature*, cx, 2768, p. 668, 1922.

The writer records the discovery, in potato plants affected with mosaic, of the invariable presence, in some of the cells of the mosaic tissue, of an abnormal body in close association with the nucleus; this body is definitely connected with the disease and is apparently similar to the peculiar body of amoeboid appearance which was described in the cells of mosaic diseased maize by L. O. Kunkel in 1921 in Hawaii [see this *Review*, i, p. 194]. No attempt is made at present to define the nature of this body.

Ramsbottom (J.). **Orchid mycorrhiza.**—*Trans. Brit. Mycol. Soc.*, viii, 1 & 2, pp. 28–61, 6 pl., 1922.

The author reviews the work so far done on mycorrhiza, especially in orchids, and discusses the fungus-root association in *Gastrodia*, Ericaceae, Pyrolaceae, Burmanniaceae, and Gentianaceae. The endotrophic mycorrhiza of orchids is described and figured from photo-micrographs taken from preparations made by the late Mr. J. Charlesworth, whose success in the germination of orchid seeds by inoculating them with pure cultures of the appropriate fungus on a large scale is stated to have been remarkable. The method employed in using the cultures is described. In discussing the germination of orchid seeds in the absence of fungi, Noël Bernard's experiments with solutions of increasing concentrations of salep and sugar are referred to, and cases in which concentrated nutrient solutions can replace the fungus are mentioned. It is recalled that Bernard found that the *Rhizoctonia* of these mycorrhiza has the power of increasing the concentration of the nutrient medium, and this stimulation of autonomous germination by concentrated solutions is compared with the activation of certain eggs by various substances in the absence of fertilization.

With reference to the enormous number of seeds produced by orchids, the writer believes that it is in some way related to the distribution of the endophytic fungus in nature. A general survey of families of plants in which endophytic mycorrhiza are typically developed shows that it is the rule for them to have small seeds, ill-adapted for germination; this suggests that in families adapted to a mycorrhizal habit there is a tendency for the seeds to become dependent upon the fungus for successful germination, whilst there is a correspondingly greater production of seed. The writer advances the hypothesis that saprophytism has arisen by the mycorrhizal fungus taking over some of the functions necessary in germination and relieving the flowering plant of the need of excessive food production for the developing seed and thus of the necessity for carbon assimilation.

In reviewing the various theories which have been put forward to account for the fungus-root association, the author thinks that, referring only to orchids, it seems most reasonable to regard the condition as having arisen from parasitic attacks by the fungus. The ability of the fungus to transport nutrient solutions has been made use of by the flowering plant, which has turned the tables on the aggressor and ended by making use of the latter for its own needs. The facts at present known, however, are insufficient to decide between the various theories in regard to the origin and significance of mycorrhiza.

FIROR (J. W.). **Pecan rosette.**—*Bull. Georgia State Coll. Agric.*, x, 19, 12 pp., 4 figs., 1922.

The present paper antedates by several years the most recent work on pecan rosette, its publication having been delayed by war conditions. Hence Rand's view that the disease is an infectious chlorosis [see this *Review*, i, p. 440] is not taken into account. The writer regards rosette, which is extremely prevalent in Georgia, as a physiological disturbance caused by the inability of the root system of certain pecans to adapt itself to unfavourable soil conditions. Among the latter are mentioned lack of water-holding capacity; rapid leaching or evaporation of soil water during the growing season; shallow soils, especially with a hard pan in the sub-soil; and lack of suitable plant food.

In 1916-17 a block of forty-three Stuart pecan trees at Louisville, Georgia, was mulched with pine straw, the mulch remaining on the ground till the spring of 1919. In 1915 this block had eight trees free from rosette, fifteen rosetted without dead twigs, and twenty rosetted with dead twigs: in 1919 forty of the trees were completely healthy, while the remaining three showed symptoms of rosette without dead twigs. Thus there was an improvement of 400 per cent. in the incidence of the disease amongst the trees in the mulched block. In an untreated control block the conditions of the trees remained stationary during the period under review.

Before applying the mulch, the trees should be well fertilized with stable manure or 5 to 25 lb. per tree of a mixture containing 10 per cent. phosphoric acid and 4 per cent. nitrogen. In orchards comparatively free from the disease, the cultivation of heavy crops of field peas and other legumes will probably eliminate rosette without further treatment.

DUFRÉNOY (J.). **Sur la tuméfaction et la tubérisation.** [On tumefication and tuberization.]—*Comptes rendus Acad. des Sciences*, clxxiv, pp. 1725-1727, 3 figs., 1922.

The formation of tumours, which is accidental and pathological in most plants, may be habitual in certain species. Thus in various species of *Eucalyptus* the collar of the seedling is always distended by proliferation of the axillary buds of the cotyledons and of the first leaves, which, in fusing, unite with the first internodes of the stem, the hypocotylary axis, and the base of the root. A tubercle is thereby formed which is provided with roots and numerous buds, and which buries the lower stem internodes in a mass of woody parenchyma, with wide medullary rays separating bundles of twisted fibres. Similar tubers occur at the base of arborescent Ericaceae.

Nodules appear below the collar of most of the young *Arbutus unedo* trees of the Piñada d'Arcachon, and increase in size with the development of the tree. On its distended base the mature tree forms vigorous branches. The cause of the distensions is obscure; in the cambium and phelloderm of the tumours of *Arbutus* bacteria were occasionally found, but they did not develop satisfactorily in the media tried by the author.

The swellings do not appear to be essential to the life of the plant. They are not invariably found on *Arbutus*, and seedlings grown under aseptic conditions form cotyledons though no hypertrophy occurs.

In the autumn and winter these tumours accumulate in their hypertrophied and hyperplasied medullary rays large quantities of starch. Thus they possess the anatomical and physiological characters of tubers, and present an example of transition between tumefication and tuberization.

Jones (L. R.). **Experimental work on the relation of soil temperature to disease in plants.**—*Trans. Wisconsin Acad. Sci., Arts & Lett.*, xx, pp. 433–459, 4 figs., 5 pl., 1922.

The primary purpose of the present paper is to explain what is essentially a new method of attack upon a group of phytopathological problems, aimed, broadly stated, at gaining a clearer understanding of the relation of environment to the occurrence of disease in plants. In an attempt at putting the work upon an experimental basis, the relation of soil temperature to certain cases of soil parasitism has been selected because of simplicity of definition and practicability of attack, and for the sake of illustration the author briefly summarizes the results so far obtained in the work at Madison by means of the now well-known Wisconsin constant temperature soil tanks, on the *Fusarium* wilt of the tomato, the potato stem canker caused by *Rhizoctonia solani*, and the root rot of tobacco due to *Thielavia basicola*.

It is evident that this work has already defined problems which are distinctly physiological rather than pathological. Each disease results from the vital inter-relation of two organisms, the parasite and the host, both of which are affected by variations in soil temperature. The latter also induces concomitant variations in soil moisture, aeration, and other factors, though these can be eliminated, in great part, by the apparatus used. It is recognized that the methods of investigation employed cannot give all the data necessary for an interpretation of the biological principles involved sufficiently full to account for the influence of the environment on these diseases under natural conditions. Out of the mass of complex and inter-related problems only a few of the simplest have as yet been attacked. The assistance of the physiologist is required for the study of such matters as the relation of soil temperature to the rate and character of root development, the correlation between soil and air temperatures as affecting the extent and type of development of root and shoot organs, the relation of soil and air temperatures to the nutritive and reproductive processes, and consequently the proper correlation of these with the natural sequences in the plant's development, &c.

There are, however, some distinctly pathological problems for the development of which plant pathologists cannot wait for the help of others. Such are the questions of the evident and immediate influence of soil temperature and other environmental factors on the occurrence, severity, and geographical distribution of certain introduced parasites, and also the question of the relation of environment to disease resistance. The author is convinced that plant pathologists must continue to inquire with increasing precision into the relation of environment to disease development. Not only must they give to these problems some of their own best efforts, but they must seek the assistance of special workers in the related fields, physiologists, ecologists, geneticists, and plant culturists. Working thus in a spirit of correlation and co-operation, the author believes that prompt and important progress is assured, and the results already obtained [cf. this *Review*, i, pp. 243, 281, and ii, pp. 67, 76] amply justify this belief.

Jones (L. R.), McKinney (H. H.), & Fellows (H.). **The influence of soil temperature on Potato scab.**— *Wisconsin Res. Bull.* 53, 35 pp., 9 figs., 1922.

In comparing the very general prevalence and serious nature of common potato scab [*Actinomyces scabies*] in America with the situation in northern Europe, where the disease is usually of minor importance in spite of the highly intensive cultivation of potato and the abundant use of stable manure from animals fed on cull potatoes, the conclusion was reached that the development of scab must evidently be influenced by different environmental factors. Various reasons suggested that the temperature of the soil might be particularly important. The results of five series of experiments in greenhouses, using the 'Wisconsin temperature tank' method with seven gradations of soil temperature ranging from about 11° C. to 30·5° C., all other soil and air conditions (including moisture) being kept alike and approximately constant throughout each series, show that such is the case. The same strain of the parasite was used throughout, and the disease developed at all the soil temperatures used but was comparatively slight at both extremes. The optimum temperature under the conditions of the experiments is considered by the authors to lie at about 22° C., this being near the mean between the optimum (23° C.) as measured by the number of scabby tubers and the optimum (20·5° C.) as indicated by the total tuber surface scabbed. A preliminary field trial in 1919, in which three gradations of soil temperature, roughly 19°, 21°, and 25° C., were maintained in small plots by special apparatus, showed that the amount of disease increased with the temperature, the percentage of scabbed tubers being 6·25, 13·23, and 30·55 respectively.

Field observations made both in Europe and America seem to agree generally with these experimental results; they indicate that the disease is more prevalent in regions having warm growing seasons than in regions with cool summers, and that a greater amount of scab seems to develop in a given locality during a warm season than during a cool one. An examination of the weather records of the leading Wisconsin potato-growing districts showed that the mean air temperatures for July and August during the hottest seasons (when scab is most prevalent) approximate to the optimum soil temperature range for scab obtained in the experiments.

The influence of soil temperature on the disease must obviously be considered in relation to its effects both upon the parasite and upon the host. There are indications that the stimulating influence of comparatively high temperatures on the prevalence of the scab organism in the soil is cumulative from season to season, whereas the influence upon the host is immediate and temporary. The data obtained by the authors indicate that the temperature optimum for scab lies between that for the growth of the parasite in pure culture (from 25° to 30° C.) and the definitely lower optimum for the rate of tuber development, being somewhat closer to the latter. It must, however, be noted that the influence of soil temperature on the different organs of the potato plant is not uniform, and that it varies also with the stage in their development; exact data are not yet available on these points. The evidence at hand suggests that rapidly growing tubers scab more severely than slow growing ones, and that there may be certain differences in the chemical composition of the tubers developing under different conditions that may influence their relative susceptibility to infection. On the whole the immediate relation of temperature to the development of scab seems to be more closely correlated with its influence upon potato tuber development than with that upon the growth of the parasite.

Millard (W. A.). **Common scab of Potatoes.**—*Ann. Appl. Biol.*, ix, 2, pp. 156–164, 2 pl., 1922.

Common scab of potatoes [*Actinomyces scabies*], though ubiquitous in England, occurs in a virulent form only in certain circumscribed localities, such as some districts of Yorkshire, where the crop is often so severely scabbed as to be practically unsaleable. Farmers have been obliged in some cases to stop growing potatoes on land which is otherwise eminently suitable for their cultivation.

The symptoms of the disease are fully described. Mature scabs vary considerably in general appearance, some having a pitted aspect owing to the depression which is formed in the early stages of the disease never becoming filled in by the subsequent development of cork, while in other cases the scab stands out above the surface of the tuber in knob-like, corky projections. These two forms represent the chief types of the disease when it occurs in its most virulent form. In Britain, however, the commonest form is intermediate between the two extremes; it is slightly raised and is also characterized by an irregularly concentric series of wrinkled layers of cork arranged around a central core or depression.

The author isolated ten strains of *Actinomyces* from scabbed potatoes. These showed considerable variations one from another from the beginning, and further variation was found to result from differences in the culture media, age of the cultures, and the like. Still, in view of the absence of a clearly defined limitation of the species *A. scabies*, all the strains isolated were regarded as belonging to this species provided that they were capable of inducing scab.

Inoculations showed that five out of seven of the strains tested caused scab, the negative results with the other two being perhaps due to early ripening of the potato varieties inoculated in these two cases.

It is considered that common scab can be caused by various strains of *Actinomyces*, but further work is required to decide whether they should all be regarded as forms of a single species.

STEVENS (H. P.). **Sodium silicofluoride as a mould preventive.** *Bull. Rubber Growers' Assoc.*, iv, 5, pp. 227–228, 1922.

Further tests in mould prevention [see this *Review*, i, p. 263] indicated that sodium silicofluoride in the proportion of 1·8 gm. to 3,000 cc. of latex prevents all but the slightest traces of mould developing in sheet rubber during transport. Samples treated with only 0·6 gm. to the same quantity of latex (i. e. 0·02 per cent.) arrived in a mouldy condition, so that this quantity is evidently insufficient. The figures for the breaking strain and rate of cure of the samples treated with sodium silicofluoride are satisfactory, though slightly below the average.

SUNDARARAMAN (S.). **Helminthosporium disease of Rice.** *Agric. Res. Inst. Pusa Bull.* 128, 7 pp., 4 pl. (2 col.), 1922.

During 1918–19 the rice crops in the deltaic tracts of Godaveri and Kistna, Madras, were severely attacked by several pests and diseases, including leaf spot caused by *Helminthosporium*. The latter occurred principally in badly drained fields that were flooded by unusually heavy rain while the ears were forming. Spots appeared on both sides of the leaves, leaf-sheaths, and glumes. These spots measured 1 to 14 by 0·5 to 3 mm., and had brown centres with smoky black patches formed by a growth of dark brown, septate hyphae and spores. As they increased in size they frequently merged, discolouring the entire area of the leaf.

The development of the parasite is promoted by continuous heavy rain and by cloudy, close weather. Under such conditions the disease spreads rapidly from one plant to another. The nodes are sometimes attacked towards maturity and blackened with a dense growth of conidia and conidiophores. The surface of the glumes may also be covered with a black, fluffy mass of conidia and conidiophores, the grains within being shrivelled and discoloured. Generally, however, the grains and other parts of the ear are not affected.

The mycelium in the leaves consists of numerous, septate, hyaline hyphae passing from cell to cell. Dark brown conidiophores, 70 to 175 by 5·6 to 7 μ, emerge from the stomata and epidermal cells and bear the spores on knee-shaped projections. Spores are found only on old, mature spots and are few, deep olive brown in colour, with 5 to 10 septa, 45 to 106 by 14 to 17 μ, and falcately sigmoid in shape. These measurements do not agree with those of *Helminthosporium sigmoideum* or *H. macrocarpum* previously known on rice. *H. oryzae* Miyabe & Hori has been recorded on rice in Japan, but the author has not seen a description of it [see this *Review*, i, p. 414].

The fungus was isolated and grown in pure culture on rice agar and other media. In culture the conidiophore bears several conidia, formed successively, near the top [up to 8 are figured]. Germination is generally from the end cells. Inoculation experiments on the leaves, leaf-sheaths, and ears confirmed the field observations that the fungus is a weak parasite under normal conditions, the spots formed being limited in size. A serious reduction of yield on account of this disease is scarcely to be feared in ordinary seasons.

SUTCLIFFE (H.). **Disinfectants. Abridged report by the [Rubber Growers' Association] scientific staff in Malaya.**—*Bull. Rubber Growers' Assoc.*, iv, 5, pp. 224–227, 1922.

Three new disinfectants, 'Superol', 'Parakol', and 'Rustikol', and a modified insecticide, 'Solupar', have been tested for their fungicidal efficiency. The method of testing was the same as that described in previous reports (a culture medium was prepared containing 2 per cent. bovril, 2 per cent. glucose, and 6 per cent. agar, and to this was added enough of a 25 per cent. solution of the substance to be tested to give concentrations of 10, 5, and 2 per cent. For lower concentrations weaker solutions of the fungicide were used). In the present case the fungus used was a pure culture of a *Gloeosporium* isolated from dead *Hevea* branches.

'Parakol' was found to be a very good disinfectant, only giving a growth equal to the control at a concentration of 0·063 per cent. after ten days; owing to its deep green colour it would be useful in daily painting against black line canker [*Phytophthora* sp.]. 'Rustikol' is also a good disinfectant (growth equalled control in eighteen days at 0·004 per cent. concentration), suitable for treating wounds or painting the cut ends of roots or branches. 'Superol' is very similar to 'Chinosol', a clear yellow solution with a strongly acid reaction. It gave a growth equal to the control in thirty-three days at 0·008 per cent. 'Solupar' containing 1 per cent. carbolic acid was efficient at a strength between 10 and 15 per cent. Owing to the absence of material it has not been possible to test 'Solupar' as an insecticide, for which it is primarily intended.

JARVIS (E.). **Cane pest combat and control.**—*Queensland Agric. Journ.*, xviii, 4, pp. 277–279, 1922.

On the Herbert River in Queensland the most serious disease of sugar-cane appears to be the gumming disease caused by *Bacillus vascularum*. It is found chiefly in the most commonly grown variety, Clark's Seedling (H. Q. 426) but the Badila cane appears to be becoming increasingly susceptible. The variety H. Q. 409 is practically immune, but is unpopular because of its slow growth and tendency to arrow early and profusely. The chief factors which predispose to gumming are poor drainage, an impervious subsoil two or three feet from the surface, defective cultivation, and a heavy rainfall. Of these, bad drainage appears to be the most important. Little or no attention is paid to the selection of healthy canes for 'seed' purposes. The planting of sound setts and burning the trash are recommended.

LEE (H. A.) & KOPKE (E. W.). **Mosaic disease of Sugar-cane in the Philippines.**—*Philipp. Agric. Rev.*, xiv, 4, pp. 418–421, 5 pl. (1 col.), 1922.

Yellow stripe or mosaic disease was first observed in the Philippine Islands by Lyon about 1910 or 1911 and has since been reported from a number of districts.

A brief and admirably illustrated description of the symptoms of the disease is followed by a discussion of the losses, which in the Cebu Purple variety may amount to 20 per cent. Severe stunting also occurs in the H-109 and Yellow Caledonia varieties. though the latter is not often attacked, while the stunting of D-1135 is slight. The Japanese forage canes, Uba, Zwinga, &c., are immune from mosaic, but their sugar production is very poor, and their use in the Philippines is hardly to be recommended at present. The first and most essential step in the control of the disease is the selection of healthy setts for planting.

WELLES (C. G.). **A provisional list of the parasitic fungi of the Philippine Islands.**—*Philipp. Agric. Rev.*, xv, 2, pp. 149–202, 1922.

This list of the parasitic fungi known in the Philippine Islands up to 1922 contains about 260 genera and 958 species. A complete host index is appended.

DOIDGE [E. M.]. **South African Ascomycetes in the National Herbarium. Parts I & II.** *Bothalia*, i, 1, pp. 5–32, & 2, pp. 65–82, 8 figs., 1922.

These papers deal with collections of South African fungi preserved in the National Herbarium at Pretoria. The groups here considered contain a large proportion of parasitic forms, chiefly on leaves; some eighty-five species are mentioned, of which thirty-five are new. The species are either fully described, or their former descriptions are enlarged and amended following the examination of further material. The nomenclature and classification follows the recent work of v. Höhnel, Theissen, and Sydow. Four new genera are proposed, and one old genus is shown to be superfluous. *Dielsiella* was originally erected for those species of *Cycloschizon* whose spores become brown, but this is now shown to be characteristic of *Cycloschizon* itself, and so the former genus disappears. Of the new genera three belong to the group Polystomellaceae. *Macowaniella* [*M. congesta* (Wint.) Doidge on *Carissa arduina*] differs from *Hysterostomina* in the presence of free mycelium, and from *Lembosiodothis* in the absence of subcuticular bands. *Isipinga* (*I. areolata* n. sp. on *Euclea natalensis* and *I. contorta* Doidge on *Trichocladus ellipticus*) differs from *Hysterostoma* in the presence of well-developed aerial mycelium, and from *Asterodothis* in the absence of a central column or foot. *Palawaniella* (*P. eucleae* n. sp. on *Euclea macrophylla*) differs from *Palawania* chiefly in the centripetal development of the stromata, and in the epidermal, rather than sub-epidermal, hypostroma; and from *Pleiostomella* in the brown, two-celled spores, and loculi less definitely arranged in rings. Among the Stigmataceae, *Parastigmatea* (*P. nervisita* n. sp. on *Stephania hernandifolia*) only differs from *Stigmatea* in its spores being hyaline and continuous.

Van der Bijl (P. A.). **A Host list of the Polyporeae occurring in the Union of South Africa.**—*Kew Bull. Misc. Inform.* 6, pp. 177–182, 1922.

The author cites as parasitic the following species, only those hosts being noted here which are stated to be living.

Polystictus spp. are included under *Polyporus*.

Fomes applanatus (Pers.) Gill. [including *F. annularis* Lloyd, *F. leucophaeus* (Mont.) Cke, *F. vegetus* (Fr.) Cke, *F. australis* (Fr.) Cke] on *Olea laurifolia*; *F. conchatus* (Pers.) Gill. on *Melia azedarach*; *F. connatus* (Weinm.) Gill. on *Curtisea faginea*: *F. geotropus* Cke on *Ocotea bullata*, *Podocarpus* sp., and *Virgilia capensis*; *F. rimosus* (Berk.) Cke on *Acacia* sp., *Curtisea faginea*, *Elaeodendron croceum*, *Kiggelaria africana*, *Olea laurifolia*, *Pleurostyla* sp., *Ptaeroxylon utile* (a heart rot), *Rhus laevigata*, *Schotia latifolia*, *Scolopia mundtii*, and *Xymalos monospora*; *F. senex* (Nees & Mont.) Cke on *Sizygium* sp.; *F. yucatensis* (Murr.) Sacc. & D. Sacc. on *Olea* sp. and *Trema bracteola*.

Lenzites betulina (L.) Fr. (including *L. guineensis* Fr.) on *Celtis kraussiana*, *Olea laurifolia*, *Pinus* sp., and *Quercus* sp.

Polyporus fruticum Berk. & Curt. on Rubiaceous plants; *P. lucidus* (Leys.) Fr. (including *Ganoderma sessile* Murr., *P. capensis* Lloyd, and *Ganoderma fulvellum* Bres.) on *Acacia* sp., *A. mollissima*, *Albizzia amara*, *A. fastigiata*, *Olea laurifolia*, *O. verrucosa*, and *Salix* sp.; *P. patouillardii* Rick on *Scolopia mundtii*; *P. sanguineus* (L.) Fr. on *Aloe arborescens* and *A. marlothii*; *P. sulphureus* (Bull.) Fr. on *Quercus* sp. (a wound parasite); *P. versicolor* (L.) Fr. on *Prunus persica* (a wound parasite).

Trametes incondita Fr. on *Ptaeroxylon utile*; *T. obstinatus* Cke on *Acacia mollissima*, *Acacia* sp., *Citrus*, and a number of undetermined hosts; *T. subflava* Lloyd on *Celtis kraussiana*.

Bubák (F.). **Une nouvelle espèce du genre Urocystis.** [A new species of the genus *Urocystis*.]—*Bol. R. Soc. Esp. Hist. Nat.*, xxii, 4, pp. 205–207, 2 figs., 1922.

A fungus found on *Lolium perenne* near Algodor, in the Province of Toledo, Spain, in 1921, and sent to the author by Gonzalez Fragoso with the suggestion that it might be a new species of *Urocystis*, was compared with *U. occulta* and *U. agropyri*. It resembles the former in attacking the stems, leaf-sheaths, leaves, and spikes with the result that poor spikes are formed, or none at all, but the spore balls often contained 4 or 5 central spores instead of 1 or 2, seldom 3 or 4, as in *U. occulta*. The spores of the *Lolium* fungus were also slightly more flattened and considerably smaller (9 to 16 by 9 to 13·5 μ). The peripheral cells usually covered the whole surface of the spore ball, which is not the case with *U. occulta*, where the surface is dotted with isolated peripheral cells, having larger dimensions (7 to 16 as against 6 to 11 μ), a thicker membrane (2 as against 1 μ), and a smaller lumen.

The chief differences from *U. agropyri* are the larger and more complex spore balls, smaller and darker central spores, and smaller and more flattened peripheral cells. The spore mass is also darker than that of *U. agropyri* on the same host plant, while the latter is restricted to the leaf sheaths and leaves, and grasses attacked by it never produce stems.

The new fungus is named *Urocystis bolivari* Bubák & Fragoso, and a Latin diagnosis is given.

United States Department of Agriculture, Federal Horticultural Board, Service and Regulatory Announcements, January to June, 1922, pp. 17–25, 27th October, 1922.

The Plant Quarantine Conference called by the United States Department of Agriculture in May 1922, was attended by Dutch, English, Welsh, and Belgian representatives, as well as by over two hundred prominent American nursery-gardeners and a number of State officials. The primary object of the Conference was to consider whether any modification of regulation 3 of Quarantine 37, which provides for the entry under permit of certain classes of bulbs, stocks, cuttings, scions, and seeds of flowers, fruits, trees, and shrubs into the United States, was desirable. It was also hoped to promote a better understanding of the necessity of safe-guarding the major national crops against the introduction of destructive pests and diseases. At a conservative estimate, the annual loss to American agriculture from imported pests amounts to $2,000,000,000 exclusive of imported bacterial and fungous diseases of plants. Amongst the most serious of the latter are citrus canker [*Pseudomona citri*], which has cost about $2,130,000 for control work since its introduction with Japanese trifoliate orange stock thirteen years ago; pine blister rust [*Cronartium ribicola*] which was introduced from Germany with a consignment of American white pine seedlings, and now threatens to exterminate a forest stand valued at $516,750,000; and potato wart [*Synchytrium endobioticum*] now restricted to parts of Pennsylvania, Maryland, and West Virginia. Chestnut blight [*Endothia parasitica*], introduced with a small shipment of Oriental chestnut trees, has already destroyed half the American chestnut stand. New York and Pennsylvania have suffered the most serious damage, and the disease is now spreading down the Appalachian Mountains to North Carolina and Alabama, and westward into West Virginia. The present stand is valued at $58,000,000. It is stated that no important pest is known to have been imported and become established since the passage of the Quarantine Act in 1912.

A proposal made by the foreign delegates for an international agreement permitting the free movement of plants between countries under inspection and certification was rejected by the Secretary of Agriculture and the Federal Horticultural Board. It was pointed out, *inter alia*, that the United States, with their wide climatic range, would run a far greater risk of permanently accommodating imported pests and diseases than would the northern European countries where atmospheric conditions were adverse to the establishment of such organisms. Moreover, the shipments from Europe into the United States would be out of all proportion to the exporting capacity of the latter. America would therefore have everything to lose, and little, if anything, to gain by the proposed amendment.

In the report of the advisory committee of the Conference, comprising representatives of Universities and the trade, to the Secretary of Agriculture, the opinion was expressed that no material changes are necessary either in Quarantine 37 or in the regulations of the Federal Horticultural Board for its enforcement. The idea of committees representing the various interests affected by the regulations is commended in the report, as tending to promote a better understanding between the different parties concerned. In view of the serious losses to American agriculture from pests and diseases imported before the establishment of Quarantine 37, the committee declared that much greater care than formerly must be exercised to exclude them.

In reply to certain criticisms directed against Quarantine 37, Dr. C. L. Marlatt (Chairman of the Federal Horticultural Board) pointed out that every facility is given for the importation, by permit or otherwise, of all necessary plant material for food, manufacturing, or medicinal purposes. During the last two years no less than 6,000 open continuing permits have been issued for the introduction of bulbs, fruit and rose stocks, and fruit, forest and ornamental trees, which are not restricted as to quantity. Of the so-called prohibited plants, the number of which permitted entry in any single consignment is controlled, permits authorizing the importation of over twenty-nine million have been issued since 1919. At the same time he states that many European countries have closed their frontiers to corresponding material from America. The fear that European countries will 'retaliate' for the American Quarantine restrictions by closing their doors to American meat and grain exports is, he believes, absolutely without foundation. The free entry into the United States of foreign plants has been the proved cause of incalculable damage, and while its resumption is out of the question, he considers that ample provision is made under the present system for all necessary imports.

An Act to make special provision for the control of the disease of fruit and other trees known as fireblight.—New Zealand, 1922, No. 20, 16th October, 1922.

The 'Fireblight Act' 1922 replaces the previous order of 1921 declaring hawthorn a noxious weed [see this *Review*, i, p. 283] and empowers the Governor-General to declare any specified portion of New Zealand to be a commercial fruit-growing district, and to make regulations prescribing the trimming or cutting down in the manner and at the times specified of all hawthorn growing within the declared district or any part of it. If fireblight exists in the district, the complete destruction of all hawthorn growing therein within a specified time may be prescribed. The carrying out of these orders falls on the occupiers of the land. If an occupier fails to take the prescribed measures, an Inspector under the Orchard and Garden Diseases Act, 1908, or other authorized officer, may carry them out at his expense without releasing him from the penalties which are prescribed for offences against this Act.

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GÄUMANN (E.). **Ueber das Septobasidium bogoriense Pat.** [*Septobasidium bogoriense* Pat.]—*Ann. Mycol.*, xx, 3–4, pp. 160–173, 1 pl., 22 figs., 1922.

Septobasidium bogoriense occurs throughout Java and has been observed on *Coffea*, *Erythrina*, *Paritium*, *Stachytarpheta*, *Morus*, *Calosanthes*, *Fraxinus*, *Cinchona*, *Thea*, *Solanum*, *Citrus*, *Marsdenia*, *Polyosma*, and *Manihot*. It has also been found in Celebes on *Erythrina* and *Citrus*. The fungus surrounds the entire circumference of twigs and branches, extending in the direction of the longitudinal axis. On the trunks of trees it forms more or less circular or disc-shaped crusts, measuring up to 10 cm. in diameter. Occasionally it extends to the under side of the leaves.

S. bogoriense causes little direct damage to its hosts, its hyphae being incapable of penetrating into sound tissues. Even wounded tissues are invaded only to the depth of a few cell-layers. Indirectly, however, it can cause considerable injury by predisposing to the attacks of other parasites. Thus *Cephaleuros virescens*, which produces cankers on tea plants, finds optimum conditions for development in the humid atmosphere beneath its fungous mantle, while *Corticium salmonicolor* and other parasites can invade the tissues at places in the bark where *S. bogoriense* formerly occurred.

Three zones may be distinguished in the crusts formed by the fungus, especially on *Erythrina* and *Morus*: an outermost, 2 or 3 mm. in depth, thin, transparent, and pure white in colour, where horizontal growth takes place; an intermediate, only about 1 mm. deep, grey-brown or dingy purple, in which vertical development occurs; and an innermost, grey or yellowish-white on the surface, brown internally, which represents the original growth on the surface of the bark. In the early stages, the hyaline hyphae form a closely woven, more or less flat tissue, covering the bark. Large, shapeless haustoria penetrate the epidermal cells, causing no apparent morphological alterations and acting as the sole connecting link between the fungus and its host. The formation of narrow hyphal columns from the surface mycelium then begins, the columns rapidly increasing in thickness and, after they have reached a certain height, expanding at the top to form a head resembling that of a flat-topped coniferous tree, each expanded top uniting with others in the vicinity. Thus a roof is formed resting on hundreds of slender columns up to 600 μ in height and with arches between. The roof is thin at first, but later the hyphae become densely interwoven and anastomose freely to form a thick, continuous crust, the upper layers of which are composed of hyaline, the lower of brown hyphae.

The formation of these thick hyphal coverings greatly hinders the control of the fungus, repeated sprayings with Bordeaux or painting with 50 per cent. carbolineum having only a slight effect. It is impracticable in large plantations to scrape off the covering, but this appears to be the only means of removing it.

The normal structure of the fungus as described above may occasionally be disturbed by the filling up of the intercolumnar spaces with hyphae, or by a growth on the surface of the outermost crust, in response to external stimuli such as particles of soil or detritus resting thereon, of fresh layers of hyphae which grow round and enclose the foreign particles. The latter process appears to be frequent on *Solanum*.

The organs of fructification are formed in the upper, hyaline portion of the outer crust. Small lateral protuberances on the hyphae develop into 'teleutospores' [probasidia] 6 to 9 μ in diameter, which are generally irregularly distributed throughout the mycelium except in the form on *Citrus*, where they lie in clusters.

The wall of the 'teleutospores' is hyaline and somewhat thicker than that of the hyphae. Nuclear union, as in *Jola*, probably takes place in the basidia, but could not actually be detected on account of the minute size of the nuclei. Clamp-connexions are present in the mycelium.

Germination takes place after a very brief interval, by the protrusion of a rather thick, four-celled basidium, which may be short and remaining immersed in the mycelium (*Citrus*), or long and emerging on the surface of the crust (*Erythrina*). This bears, on comparatively long sterigmata, long, narrow basidiospores, 9 to 16 by 2 to 3 μ, closely resembling those of *Jola javensis*.

The fungus was successfully cross-inoculated on a number of hosts, several of which (*Solanum*, *Stachytarpheta*, and *Marsdenia*) are not indigenous to Java.

The author does not accept Raciborski's identification of this fungus with *Helicobasidium mompa* Tanaka.

Snell (W. H.). **Studies of certain fungi of economic importance in the decay of building timbers, with special reference to the factors which favour their development and dissemination.**— *United States Dept. Agric. Bull.* 1053, 41 pp., 8 pl., 3 figs., 1922.

All the five species of wood-decaying fungi studied by the author, viz. *Lenzites saepiaria*, *L. trabea*, *Trametes serialis*, *Fomes roseus*, and *Lentinus lepideus* have been found fruiting more or less commonly on timber used in mill roofs or in basements. The damage done by the first two to coniferous roof timbers is more considerable than has been reported hitherto. The annual form of *Fomes carneus*, considered by some mycologists as a distinct species, *Trametes carnea*, is of common occurrence on beams in moist basements, but it is not certain whether the perennial form also occurs. It is pointed out that the high temperature and humidity of textile and paper mills, canning factories, and the like are very favourable to the development of wood-rotting fungi. The increased use in recent years of inferior wood has accentuated the trouble. Numerous instances are given of heavy losses from this cause.

The basidiospores of all the fungi mentioned germinated readily on various agars, on red spruce wood, and in tap water, and irregularly in distilled water. Investigating the effect of temperature on the viability of the spores, the author accepted the percentage of spore germination as the best criterion of the influence of environmental conditions in the spread of infection. At 40° C. the basidiospores of *Lenzites saepiaria* gave a high percentage of germination, while those of *L. trabea* and *Fomes roseus* gave small percentages, and the germination of the spores of the other two species was totally inhibited. The optimum temperatures for rapidity of germination were: *Lenzites saepiaria* 32° to 35° C., *L. trabea* 28° to 32° C., *Trametes serialis* 30° to 32° C., *Fomes roseus* 28° to 32° C., *Lentinus lepideus* 28° C. Given sufficient time, large percentages of the spores germinated at the lower temperatures within the range of growth for each species. Diffused light was found to have no effect on the germination of the spores. An exposure of one day to direct sunlight in May and June did not affect the viability of the spores materially. An exposure of two days usually reduced the percentage of germination considerably, sometimes entirely, while three days' exposure usually killed most of the spores. The germ-tubes showed no phototropic response. In drying tests, basidiospores of *Trametes serialis* and *Lentinus lepideus* (aged 10 days and 7 months respectively) were killed by about ten weeks' exposure at 28° and 32° C., and by about a month at 36° C. At 40° C. fresh spores of *Lenzites saepiaria* survived for two months, and of *Trametes serialis* six weeks in an unfinished test. Five months old spores of *Fomes roseus* were killed in one week at the same temperature. A number of tests made upon different lots of varying ages seemed to show that alternate wetting, either with free water or by atmospheric moisture, and subsequent drying, reduced the viability of the spores. Basidiospores of *Lenzites saepiaria* gave a germination of 25 per cent. after 2 years and 10 months' storage in an ice box, those of *L. trabea* 50 per cent. after 1 year, of *Trametes serialis* 2 per cent. after 4 years and 3 months, of *Fomes roseus* less than 1 per cent. after 18 months, and of *Lentinus lepideus* less than 1 per cent. after 2 years and 7 months.

With the exception of *Fomes roseus*, all the species under consideration have been shown to be able to liberate large numbers of basidiospores within buildings. In a series of experiments to test the ability of sporophores to survive successive wetting, spore-liberation, and drying, *Lenzites saepiaria* shed spores six different times, but on the seventh attempt no visible spore-print could be obtained. A fruit body of *Trametes serialis* kept in a dark fungus pit shed spores for fifteen days successively. Observations upon sporophores of this fungus in the bottom of a closed pit showed that slight convection currents of air carried spores upward and throughout the pit. In factories, air currents caused by machinery, humidifiers, and heating pipes play an important part in the dissemination of spores cast into the air. Other observations suggested the possibility of insects and other animals also being implicated in the spread of infection.

A description of the macroscopic and microscopic characters of malt agar cultures of the fungi with a key for identification by mycelial characters is given. The cardinal temperatures for mycelial growth were found to be as follows:

	Minimum.	*Optimum.*	*Maximum.*
Lenzites saepiaria .	About 8° C.	30°–34° C.	Above 40° C.
Lenzites trabea . .		28°–30° C.	Little above 36° C.
Trametes serialis .	About 3° C.	28° C.	Between 32° and 37° C.
Fomes roseus. . .	Below 4° C.	30° C.	Above 36° C.
Lentinus lepideus .	About 8° C.	28° C.	Between 36° and 40° C.

Considerable attention was paid to the characters of the secondary spores formed by these fungi in view of their possible occurrence in nature under mill conditions. Oidia and chlamydospores were found in agar cultures of *Lenzites saepiaria* and oidia in wood cultures; both kinds occurred in agar cultures of *L. trabea*; while only chlamydospores were formed in agar cultures of *Trametes serialis* and *Lentinus lepideus*. Certain of the physiological relations of the oidia of *Lenzites saepiaria* and *L. trabea* and the chlamydospores of *Trametes serialis* were studied. The germination temperatures corresponded closely with those of the basidiospores of the respective species, except that the oidia germinated better at the higher temperature tried. Diffused light had no effect on the germination, but the latter was prevented by ten hours' exposure to sunlight in May. Both oidia and chlamydospores were usually rapidly killed by drying and by alternate wetting and drying. Only a few survived drying at room temperature for some months. The oidia of *Lenzites saepiaria* and *L. trabea* were found not to be adapted for dissemination by air currents, but they could be disseminated by insects (e.g. cockroaches) and water. This character may possibly be of some importance in case oidia are found to be produced naturally in mills. Thus far, however, the only secondary spores of these fungi found in factories are the chlamydospores of *Lentinus lepideus* that are borne on the fruit bodies.

BEWLEY (W. F.). **'Sleepy disease' of the Tomato.**—*Ann. Appl. Biol.* ix, 2, pp. 116–134, 4 pl., 1922.

'Sleepy disease' of tomatoes, which occurs in all parts of the British Isles and has been attributed to *Fusarium lycopersici* Sacc. since Massee's description of it in 1896, is shown by the author to be caused usually by *Verticillium albo-atrum*, though it can also be produced by the former fungus. Massee evidently observed both forms but considered that they were merely different stages (the *Diplocladium* stage and *Fusarium* stage respectively) of *F. lycopersici*.

Plants attacked by *Verticillium* are usually stunted, the younger internodes being badly developed. The leaves wither from the base of the plant upwards, adventitious roots develop on the stem, and ultimately the plant dies. The symptoms appear first about the middle of April and increase in intensity for a month or more, gradually subsiding to recur with renewed force at the end of September. The attacks of *F. lycopersici* occur during the hottest part of the season, in July and August in the Lea Valley, where these observations were chiefly made on plants grown under glass. It does comparatively little damage in the British Isles. Of 427 affected plants from different localities examined in 1919–20, 307 yielded *Verticillium* alone, 77 *Verticillium* and either *Fusarium ferruginosum* or *F. sclerotioides*, 26 *Verticillium* and *F. oxysporum*, and 17 *F. lycopersici* alone.

Inoculations showed that infection by *Verticillium* can occur through the stem or root but that, under the conditions of the experiments, the period from June to September was unfavourable for the development of the fungus. Inoculations through the soil were also successful and sterile seedlings grown on agar were readily attacked, the experiments indicating that penetration can occur through the unbroken epidermis. Plants with hard, thin stems, or obviously starved, succumbed most readily to attack.

Inoculations were also carried out with the four species of *Fusarium* mentioned above as having been isolated from wilted plants. *F. ferruginosum* and *F. sclerotioides* failed to produce wilt under any conditions and must be regarded as saprophytes. F. *oxysporum* caused a rot of the pith and cortex around the point of inoculation and in some cases killed root tissues. It produced a slight desiccation of the lower leaves at temperatures of 27·8° to 28·9° C., but wilt did not as a rule result from inoculation with this species. Typical symptoms of wilt were produced by *F. lycopersici* at temperatures of 28° to 29° C. but below 28° infection was uncertain.

The walls of the vessels of plants affected with sleepy disease are turned brown, and a brown, gummy substance frequently occupies the lumen. As the culture liquids in which *Verticillium* was grown were found to contain a substance capable of causing wilt when filtered free from the fungus, an attempt was made to isolate the enzymes produced during growth. No evidence was obtained that endo-enzymes capable of causing wilt were present in the mycelium, but *Verticillium* is stated to form a definite exo-enzyme which is capable of discolouring the vessels and producing wilt in seedlings when the latter are severed from their roots and placed in turnip juice filtered from germinated spores. A brown, gummy deposit was found in the wood in these cases, and the cambium was destroyed near the end of the stem. The enzyme was precipitated by absolute alcohol and found to be greatly reduced in activity by heating to 100° C. for five minutes. The fungus was found to produce amylase, inulase, emulsin, lipase, protease, erepsin, and amidase.

Considerable differences were found in the virulence of different strains of *Verticillium* studied in single spore isolations, as judged by the period required to produce complete wilt. Indications were obtained that high virulence is correlated with ability to form carbonized hyphae and microsclerotia. Amongst the hosts other than tomato that were successfully inoculated were potato, egg-plant, cucumber, and *Antirrhinum* (snapdragon). In cotton and sycamore (*Acer*) the plants were stunted and the leaves withered without wilting, while *Capsicum* sp. was stunted but the leaves remained green and only a few wilted, and in *Ulmus* nothing but slight stunting occurred.

Wilt due to *Verticillium* develops most rapidly in glasshouses kept at temperatures between 15·6° and 24° C., the optimum being 21·1° to 22·8°. It is greatly delayed at 12·5° and practically inhibited at 25° C. The minimum, optimum, and maximum temperatures for the fungus, grown in pure culture, are 4·4°, 23·3°, and 30° C. *Verticillium* wilt is a typical moderate temperature disease, which explains its greater severity in the spring and autumn. Suitable shading of the houses diminishes the intensity of the attack, the plant probably being assisted by reduced transpiration. There is no necessary relation between the disease and any special type of soil, but plants grown in cool, clay soils are more liable to attack than those in sand, and a high humus-content also appears to predispose to the disease.

Cultural methods of control have given promising results in the Lea Valley. In badly infested localities resistant varieties such as Manx Marvel or Bide's Recruit should be grown. Attempts to raise other wilt-resistant strains are being carried on by the author. Slightly soft rather than hard growth should be encouraged. On the first appearance of wilt the average day and night temperature should be raised to over 25° C. A light coating of whitewash on the glass is advisable. Watering the roots aggravates the wilting, but a light overhead sprinkling is beneficial. The base of the plants should be mulched to promote the development of new roots. In one nursery the percentage of wilted plants was reduced in a fortnight from 78 to 10 by these means. When the soil of the beds is sterilized, great care is required to avoid the reintroduction of the fungus as it develops very rapidly in sterile soil, especially if rich in humus.

The spores that develop on external mycelium at the base of the dead plants germinate and give rise to carbonized hyphae and microsclerotia capable of overwintering. All dead plants and débris should, therefore, be carefully removed as soon as the crop is picked. The baskets in which the seedlings are carried, contaminate water, and the importation of young plants from infected nurseries are all common sources of new infections. The vicinity of the nurseries should be kept free from weeds (suspected to include hosts of *Verticillium*), potatoes, *Antirrhinum*, &c. In a note at the end the author records the occurrence of a sweet-pea wilt which was found to be due to *V. albo-atrum*, and successful cross-inoculations between tomatoes, cucumbers, and sweet-peas were obtained.

WHITEHEAD (T.). **Varieties of Swedes resistant to finger-and-toe.**— *Journ. Min. Agric.*, xxix, 4, pp. 362–368, 1922.

Trials carried out in 1921 with four British varieties of swedes, together with two Danish resistant strains (varieties 4 and 25), on three farms in Carnarvonshire, indicate that the Danish varieties resist club-root or finger-and-toe [*Plasmodiophora brassicae*] to a more marked degree, and in addition keep better and have a higher feeding value than the British ones. The Danish variety 25 was more resistant under North Wales conditions than the Danish variety 4, which is the reverse of the results obtained in trials in Denmark reported by Christensen [*Tidskrift for Planteavl*, xxvi, 1, p. 68, 1917].

SCHAFFNIT (E.). **Versuch über die Empfänglichkeit verschiedener Kohlsorten für den Erreger der Kohlhernie.** [Experiments on the susceptibility of various Cabbage varieties to the organism causing club-root.]—*Deutsche Obstbauzeit.*, lxviii, 21–22, pp. 211–212, 1922.

Experiments were carried out at Bonn in 1921 to test the susceptibility to *Plasmodiophora brassicae* of ten varieties of white cabbage, three of red cabbage, one of Savoy, one of kale, two of Brussels sprouts, and two of kohlrabi. With the exception of the last-named, all the plants showed a very high degree of susceptibility to the disease, 100 per cent. of infection being observed in many cases. The kohlrabi was harvested in July, while the remaining varieties were left until August, and this may possibly explain its relative immunity.

LEHMAN (S. G.). **Pod and stem blight of the Soy-bean.**—*Journ. Elisha Mitchell Sci. Soc.*, xxxviii, 1–2, p. 13, 1922.

The fungus *Phomopsis sojae* causes serious damage to the soy-bean in North Carolina, especially in wet seasons. Pods, stems, and occasionally leaves, are attacked, the heaviest losses resulting from attacks on the pods. Very young pods drop off when attacked, while older ones remain firmly attached. The fungus penetrates the pod wall and invades the developing seed. The ovule may abort at an early stage or the seed may become more or less shrivelled according to the time and severity of infection. Seeds in diseased pods are often completely invested with a conspicuous, white, fungous covering. The minute, black pycnidia scattered over the diseased areas begin to exude small, hyaline, single-celled spores within a few days after their appearance.

The fungus has been isolated from stems, pods, and seed, and has been observed to cause the death of seedling soy-bean plants by growing from the seed coat on to the hypocotyl and causing its decay. It overwinters in diseased stems and seed. The ploughing under of diseased plants after harvest, use of healthy seed, and crop rotation are recommended.

MILBRATH (D. G.). **Control of diseases of Cucumbers in greenhouses.**—*Monthly Bull. Dept. Agric. California*, xi, 5–6, pp. 430–437, 4 figs., 1922.

During the last two years the cucumber-growing industry has made rapid progress in California, and a brief description of the more important diseases and the means of controlling them is given in this paper for the assistance of growers.

Mosaic disease is said to be controlled to some extent by destroying affected seedlings. The method recommended is to sever the main stem at the ground level and allow the vine to remain for 36 to 48 hours before further touching it. By this time the virus in the severed vine will have lost much of its strength, and the seedling may be removed with less danger of contaminating the healthy plants. Protection against the insect carriers of this disease may be effected by fumigation with hydrocyanic acid gas, but care must be taken not to use the latter when any form of copper sulphate treatment has been given. The wild cucumber (*Micrampelis lobata*) and the one-seeded bur cucumber (*Sicyos angulatus*) are both hosts of mosaic and must not be allowed to grow in the vicinity of the cultivated kinds.

Sclerotinia rot, which is stated to be most frequently introduced with organic manure and disseminated by insects, may be controlled by severing the infected laterals from the main stem and washing the resultant wound in a 1 in 1,000 solution of corrosive sublimate. *Fusarium* fruit rot may be suppressed by similar measures. Angular leaf-spot, caused by *Bacterium lacrymans*, is said to be frequently transmitted by pickers from diseased to healthy plants, and also by insects, but the most important source of dissemination is the water used for spraying the foliage. The disease is believed to be carried on the seed, and treatment with a 1 in 1,000 solution of corrosive sublimate is recommended. Powdery mildew (*Erysiphe cichoracearum*) is stated to be adequately controlled by spraying the plants with a 1 in 40 solution of lime-sulphur.

The regulation of temperature and humidity is regarded as being extremely important. The optimum temperature for the plants ranges from 60° to 75° F. High humidity favours the development of mildew, *Sclerotinia*, and *Fusarium* rot, and thorough ventilation is essential, even if the open windows necessitate a greater expenditure of fuel. Thin-leaved varieties are liable to sun-scald, followed, in severe cases, by attacks of *Alternaria* and *Cladosporium*. Washing the plants with a fine mist of water on sunny days is recommended as a preventive of this trouble.

OSBORN (T. G. B.) & SAMUEL (G.). **Notes on two Vine diseases which occurred on the River Murray in October, 1921.**—*Journ. Dept. Agric. South Australia*, xxvi, 3, pp. 225–230, 5 figs., 1922.

During the latter part of October, 1921, vine shoots showing a die-back of the tips were submitted for examination to the Laboratory of Plant Pathology at the University of Adelaide. Two diseases were found to be involved, one of fungous and the other of physiological origin.

The former, due to *Aureobasidium vitis*, caused the blackening and death of the tips of the shoots and a decay of patches of irregular shape on the leaves. Kept overnight in a moist chamber, the leaves turned black all over and the surface became rather sticky, minute, whitish dots simultaneously appearing on the affected parts.

Specimens sent in a few weeks later showed the fungus attacking the young fruit bunches. Sections through the whitish pustules revealed small heaps of spores, budded off from the fertile ends of hyphae arising from the mycelium growing through the tissues of the leaf.

A. vitis was discovered in France in 1882, its occasional attacks usually occurring in muggy weather and causing only slight losses. The species has been sub-divided into several varieties, the South Australian specimens agreeing most closely with Montemartini's var. *album*, both in the parts affected and in the nature of the spore pustules.

The majority of the affected vines were young, one and two year old plants, and there was a cover-crop of wheat growing between the rows. Possibly the presence of wheat helped to maintain the humidity necessary for infection. The hot weather at the end of October arrested the spread of the disease and the dead patches on the leaves dried out. Where the shoot tip had been killed, numbers of laterals sprang from below, making it difficult to secure good canes to form the vines. Death occurred only in the case of one or two vines which had very small shoots at the time of infection. Cases of the disease occurred in several districts, the weather conditions evidently being such as to induce a mild epidemic of what is ordinarily a parasite of little importance.

The second disease, believed to be of physiological origin, occurred in various localities along the Murray valley. Blackening and death of the tips of the young shoots was occasionally noted, but a more characteristic feature was a mottling due to the development of small angular areas of a pale green or brown colour in the leaves, producing a mosaic effect. Only three to five leaves on a shoot were thus affected, those above and below being quite healthy. The spots were usually more numerous near the veins. The fresh healthy growth shown by many vines inspected some three weeks after the first report of the disease indicated that the causal agency had operated everywhere at about the same time and then been completely removed. The development of the main shoot was often considerably impeded, and it was sometimes outgrown by strong laterals springing from the base.

All attempts to detect or isolate a fungous or bacterial parasite failed. The pathological changes in the cells of the discoloured areas—gummosis of the cell walls, rupture of some cells and the secretion of oily substances in others—agree in the main with those that follow injury by late frosts. The affected vineyards were all situated on low-lying areas where the temperature probably fell to freezing point about the time the injury occurred, while active root absorption was maintained owing to the comparative warmth of the soil. Possibly these conditions led to the pathological changes noted above.

BROWN (J. G.). **Plant pathology.** *Thirty-second Ann. Rept. Arizona Agric. Exper. Stat. for the year ended 30th June, 1921*, pp. 606–615, 4 figs., 1922.

The fungous diseases of the principal crops recorded in Arizona during the year are enumerated and those of special interest briefly described.

A serious rot of dates [*Phoenix dactylifera*], which is likely to cause trouble to Arizona date growers, is reported. It sometimes causes the loss of 95 per cent. of the crop. The disease is characterized by the appearance on the fruit either of minute, chocolate-brown spots which eventually coalesce and cover one side, becoming creamy-white in the centre, or of small, water-soaked areas which finally unite to form a blister. In both cases the protective layers of the fruit are ruptured, resulting in drying and mummification. The mummified fruit may remain hanging to the clusters or may drop. Both kinds of spots occur on the leaflets, and the brown spots are also found on the petioles and on the stalks and branches of flower and fruit clusters. Blistering does not take place on the more woody organs.

Isolations from diseased leaves and fruits gave several organisms. Of these, species of *Macrosporium*, *Alternaria*, and *Helminthosporium* were shown by inoculations to be actively parasitic on the unripe fruit. These fungi probably rupture the protective outer layers of the fruit and leaves, thereby facilitating the admission of secondary organisms. The hyphae pass through and between the cells, which are killed rapidly. The tannin layer of the fruit temporarily checks penetration towards the centre, but the hyphae spread parallel with the surface, killing the outer parenchymatous tissue and leaving a cavity under the cuticle and epidermis which becomes filled with air and produces the blistered appearance described above. After the formation of a blister, the surface soon cracks enough to cause the mesocarp to dry out, and the hyphae finally succeed in penetrating the tannin layer and thus reach the endocarp.

The very valuable Deglet Noor variety is probably the most susceptible to this date rot, but none is entirely immune. Fruit clusters sprayed in 1921 with Bordeaux mixture 4–4–40 were free from the disease at the time of writing.

Black arm and angular leaf spot (*Bacterium malvacearum*) were present in nearly every field of Pima-Egyptian cotton, the injuries to the crop including stem lesions, destruction of leaf tissue, boll spotting, premature ripening, and fibre staining. Some fields were practically ruined. The appearance of the attack supported the view that the causal organism is carried by the seed. Arizona cotton growers are unfortunately slow to adopt the method of seed treatment [see this *Review*, i, p. 383] which has effectively controlled this disease in the south. Experiments are in progress to ascertain whether the large quantities of alkali in the cotton districts of Arizona increase the susceptibility of the crop to *Bact. malvacearum*. Other cotton diseases recorded were sore shin caused by *Rhizoctonia* [*solani*], wilt (*Fusarium vasinfectum*), and root rot (*Ozonium omnivorum*).

A severe outbreak of bacterial rot of lettuce occurred in two localities in the spring of 1921. The outer leaves of the head were generally affected first, a brown discoloration of the veins and then of the entire leaves ensuing, until the head was finally transformed into a dark, slimy mass. One whole field of sixty acres was ruined.

Laboratory studies revealed the presence of two bacteria capable of completely rotting healthy heads of lettuce within two or three weeks. The identity of the bacteria has not yet been established. In the eastern states bacterial rot of lettuce has been attributed to the use of poorly rotted manure, but in Arizona no fertilizers have been used in the silt fields concerned. *Ozonium omnivorum* also attacked this crop.

Grapes were affected by a new type of rot, the cause of which is obscure. In this disease unripe fruits of white varieties are spotted with soft, brownish, semi-translucent areas, which become bronzed as shrivelling and rotting proceed, and later turn purple. Drying progresses more rapidly on one side than the other, and the tissues collapse so that the outline of the seeds can be distinguished. Often the berry remains normally green except for one sunken spot. Cultures from surface-sterilized fruit generally gave no growth, except an occasional *Gloeosporium* with much larger spores than those of any species hitherto reported on the grape.

There are numerous other records, mostly of common or well-known diseases of crops and ornamental plants.

Annual Report, Department of Agriculture, Uganda, for the year ended 31st December, 1921. 87 pp., 1922.

In addition to the Report of the Government Mycologist, which is separately noticed [see next abstract], there are various references to plant diseases of interest.

In the Report on the Government Plantation, Kampala, J. D. Snowden states that coffee leaf disease (*Hemileia vastatrix*) was extremely prevalent and exceptionally virulent on *Coffea arabica* from June to August, a large number of the trees being entirely defoliated for a time. Some varieties of *C. robusta* were also considerably damaged by the disease. The most resistant of the *robusta* types are Toro, Quilou, and three trees of *C. congensis* var. *chalottii*. All the three varieties of *C. excelsa* that were grown remained very resistant to leaf disease. *C. liberica* is also highly resistant, but is less vigorous, and gives a lower yield than *C. excelsa*.

Hevea rubber trees were attacked throughout the year by a species of *Oidium* which caused a serious loss of young foliage. 'Black thread' [*Phytophthora* sp.] was less serious than in the previous year, the percentage of affected trees being 18·33 as against 48·25. Most of the infections again occurred in series which were being tapped near the base. Painting the infected parts with undiluted ordinary Brunolinum and the disinfection of the tapping cuts with 2 per cent. Izal gave good results.

There were twenty-eight existing cases of brown bast disease of *Hevea* in May and ten new infections were found to have occurred by the following November. The important fact was noted that only 2·89 per cent. of the trees tapped on alternate days were infected, as against 18 per cent. of those tapped daily. 'Stripping' for the cure of the disease must be carried out at an early stage, as otherwise the surface of the cambium becomes badly damaged by the formation of nodules. The operation should be performed when the foliage is just mature. Trees which are 'wintering' or are full of young foliage cannot be stripped without difficulty and risk of injury.

G. T. Philpott reports that trees of *Coffea arabica* at the Government Plantation, Kakumiro, Mubendi, were remarkably free from *Hemileia vastatrix* until a severe outbreak occurred in the middle of November. Costa Rica and Bourbon coffee trees, planted in 1918, were severely attacked by root scale (*Pseudococcus citri*). accompanied by white root disease [*Polyporus coffeae*], and efforts to control the combined attack have not been very successful so far. White root disease is constantly recurring, and the use of lime or some other soil sterilizer will probably be necessary to ensure profitable coffee-growing on the Kakumiro Plantation.

SMALL (W.). **Annual Report of the Government Mycologist for 1921.**—*Ann. Rept. Dept. Agric. Uganda, 1921,* pp. 49–57, 1922.

The two best-known fungi on coffee in Uganda are *Hemeleia vastatrix* and *Colletotrichum coffeanum* [*Glomerella cingulata*], but the author points out that they are not the greatest enemies of the crop. The former is not, under Uganda conditions. so harmful or progressively weakening as had been expected, and spraying against leaf disease is never attempted nowadays. Good cultural methods can to a great extent neutralize the injurious effects of attack by this rust. *Colletotrichum* is not an aggressive parasite, but merely a common saprophyte that can attack weakened bushes. The true cause of die-back, when it occurs on a large scale, is lack of vigour due to unfavourable conditions such as over-bearing, absence of shade, weeds, and bad cultivation generally. Occasional direct attacks of *Colletotrichum* do occur, but are usually on a small scale, and affect only a few branches or young twigs. The author recommends that the term anthracnose, and not die-back, should be used for the latter form of the disease.

The brown-eye spot (*Cercospora coffeicola*) of coffee leaves and berries was more prevalent than in previous years, over 60 per cent. of the berries being affected in some cases. The only root disease of coffee reported was the white root disease caused by *Polyporus coffeae*, which has never been found as an independent parasite, but at times accompanies the coffee root mealy bug, *Pseudococcus citri.*

Of considerable interest is the record of the appearance of the powdery mildew (*Oidium* sp.) of *Hevea brasiliensis* in two localities in Uganda. This disease, previously known only in the Dutch East Indies, does not appear to be serious, causing only the death of a few twigs and the deformation and loss of a few leaves. The attack was typical of the published descriptions from Java. No case of root disease of *Hevea* was reported, though both *Ustulina zonata* and *Fomes lignosus* are known on other hosts in the colony.

Associated with orange rust of wheat (*Puccinia triticina*) is the leaf spot fungus *Leptosphaeria tritici*, while a *Helminthosporium*, provisionally named *H. sorokinianum*, is common. One case of supposed downy mildew of maize [*Sclerospora* sp.] was encountered. The leaf symptoms appeared unmistakable, though the causal fungus itself was not found. No smuts have been found on this crop in Uganda. Sorghum is attacked by head smut (*Ustilago reiliana*) and grain smut (*Sphacelotheca sorghi*), the latter being the more common.

Another disease of sorghum, downy mildew or green ear, was discovered in July, 1921, at Bukalasa. The symptoms consist of a whitening in streaks of the young leaves, followed by browning, twisting, and crinkling. The oospores of the parasite [*Sclerospora* sp.] were found in the tissues of affected leaves, but they were only half the size of the oospores of the fungus [*Sclerospora graminicola*] which induces the similar disease in India.

Several diseases of shade, fruit, and ornamental trees and plants are mentioned. Roses, *Grevillea robusta*, *Melaleuca leucodendron*, and *Spondias lutea* are added to the list of hosts of the wet root rot fungus. Further attempts to induce the latter to fruit in culture gave negative results. *Albizzia moluccana*, grown as coffee shade, succumbed to attacks of *Botryodiplodia theobromae* on the roots. The attack probably begins on very small roots while the trees are quite young; the fungus makes very gradual progress, and death occurs just when the trees are beginning to be of use for shade purposes. *B. theobromae* also causes a die-back of pruned branches of the same host, and it is recommended that the use of the latter as a coffee shade tree should be abandoned. The leaves of fig trees were severely attacked by *Uredo fici* [*Kuehneola fici*], and the fruit by a species of *Colletotrichum*.

A report on an investigation into certain fungi occurring on diseased rice in Uganda is appended. Specimens of diseased rice collected in 1920 were reported by the Imperial Bureau of Mycology to bear the following fungi: *Piricularia oryzae*, *Helminthosporium oryzae*, *Leptosphaeria michotii*. *Gibberella saubinetii*, *Graphium stilboideum*, and *Fusarium roseum*. The following further fungi have been noted on rice material: *Phoma glumarum*, *Epicoccum hyalopes*, and *Melanospora zamiae*. Of these fungi *G. saubinetii* had not previously been recorded on rice, and *Piricularia oryzae* was reported for the first time from Africa.

The writer carried out an investigation on the part played by these fungi in the disease in question, and found that the whole of the damage could be attributed to *P. oryzae*. He states that only one major disease of rice is at present known in Uganda, namely, the well-known 'blast' of this crop. Further specimens of *G. saubinetii* were not obtained in any case, and the *Fusarium* commonly present on diseased plants is regarded as not belonging to this fungus. Inoculations with it on young rice, wheat, and maize failed to produce any effect.

An account of the author's studies on another species of *Fusarium*, which causes a wilt of various plants, has been separately published, and is noted elsewhere [see below, p. 163].

WOLF (F. A.). **Studies on fermentation of rare sugars by plant pathogenic bacteria.**—*Journ. Elisha Mitchell Sci. Soc.*, xxxviii, 1–2, pp. 12–13, 1922.

Different species of pathogenic bacteria from the same host may be indistinguishable on the basis of their ability to ferment the carbohydrates of the Descriptive Chart. The fermentation of rare sugars has, therefore, been used as a means of identification of certain closely related organisms. *Bacterium tabacum* and *B. angulatum*, the causal agents of wildfire and angular leaf spot of tobacco respectively, are both able to form acid from dextrose and saccharose, but not from glycerine and lactose. The former, in addition, attacks manitol and galactose, while the latter does not affect them. A similar specialization obtains in the case of two leaf spot organisms of soy-bean, *Bacterium glycineum* and *B. sojae.*

ROSEN (H. R.). **The bacterial pathogen of Corn stalk rot.**—*Phytopath.*, xii, 10, pp. 497–498, 1922.

Bacterial stalk rot of maize [see this *Review*, i, p. 170], first described from Arkansas, and now reported from about eight different States, is caused by *Pseudomonas dissolvens* n. sp., which is briefly characterized as follows. Short, plump, rapidly growing rods, motile by means of a single polar flagellum, bluntly rounded at both ends, occurring singly, in pairs, or occasionally in short chains, 0·7 to 1·2 by 0·5 to 0·9 μ, capsules present, colonies on nutrient agar poured plates (testing P_H 7·0) round, margins entire, white, opaque, glistening, consistency of melted butter, smelling strongly of decaying vegetable matter. Gelatine and Loeffler's blood serum not liquefied; acid and gas produced on most nutrient media; diastatic action perceptible; indol and ammonia produced; nitrates reduced; coagulation of milk marked on sixth day; growth in Uschinsky's solution good. Index number, according to the most recent chart of the Society of American Bacteriologists (1920), 5322-32220-1111.

STAKMAN (E. C.) & LEVINE (M. N.). **The determination of biologic forms of Puccinia graminis on Triticum spp.**—*Univ. Minnesota Agric. Exper. Stat. Tech. Bull.* 8, 8 pp., 1 fig., 1922.

It has been shown by the present writers and others that *Puccinia graminis tritici* (Pers.) Eriks. & Henn. really consists of several biologic forms recognizable by their action on different varieties of wheat (*Triticum vulgare, T. durum, T. compactum*), emmer (*T. dicoccum*), and einkorn (*T. monococcum*). A method has been developed for the identification of the thirty-seven biologic forms now known, by their parasitic action on a selected group of varieties of *Triticum*. Little Club is susceptible, and Khapli highly resistant, to all the known forms of the rust.

Twelve 'differential hosts' of the groups referred to above are inoculated and incubated for 48 hours, the best results being obtained by keeping the plants under optimum conditions for rust development. Plenty of sunlight is essential. The types of infection are indicated by numerals from 0 to 4, the former being equivalent to practical immunity, and the latter to complete susceptibility. Fluctuations within a class are designated by plus and minus signs. Plants on which the degree of attack, as judged both by the number of sori and their size and other characters, ranges from 0 to 2 are marked immune, very resistant, and moderately resistant respectively, while those infected in the degrees of 3 and 4 are designated moderately susceptible and very susceptible. In addition to these five types, a sixth occurs when certain biologic forms are inoculated on some varieties of wheat. In this type various degrees of infection may occur apparently ranging from 1 to 4, and with all types of sori on the same leaf. Such heterogeneous types of infection are placed in a separate group X, and have to be very carefully distinguished from cases of mixed infection by two or more strains of the rust.

An analytical key is given by which each of the thirty-seven biological forms of the fungus can be recognized by its behaviour when inoculated on the differential hosts in a certain definite order.

WEBER (G. F.). **Septoria diseases of Cereals. 1. Speckled blotch of Oats caused by Leptosphaeria.**—*Phytopath.*, xii, 10, pp. 449–470, 2 pl., 5 figs., 1922.

Speckled blotch of oats, caused by *Septoria avenae* Frank, occurred to a limited extent on volunteer oats near Madison, Wisconsin, in September, 1921. Hitherto the disease (which is distinct from that caused by *Septoria gramineum* var. *C. avenae* Desm.) was only known in England and Germany. The *Septoria* lesions were rather small, circular to elongate, elliptic, killed and faded areas, 2 to 4 by 2 to 8 mm. in size, and distinguished by the black, more or less scattered pycnidia.

The fungus was isolated and single spore cultures on oatmeal agar and potato agar yielded perithecia with mature asci in 1922, as well as pycnidia. Single ascospores were transferred to culture tubes, and gave rise to pycnidia and later perithecia. Inoculations of oat seedlings with ascospores also gave typical *Septoria* spots. From this it is clear that the ascigerous stage of *Septoria avenae* has been found. It is a new species belonging to the genus *Leptosphaeria*, and the author names it *L. avenaria*, adding a full description.

The pathogenicity of the organism was completely proved by re-isolating it from artificially infected spots. The results of inoculation experiments showed that whilst no infection occurred on hosts other than *Avena*, the following species besides *A. sativa* were susceptible: *A. barbata*, *A. brevis*, *A. fatua*, *A. nuda*, and *A. strigosa*.

Detailed cultural and germination studies are described; cultures of germinating ascospores in dilute Indian ink revealed the presence of a gelatinous sheath round the spore and the older portions of the germ-tubes, which sheath may play an important rôle in infection. The cardinal temperatures for mycelial growth on agar poured plates are as follows: minimum 2° C., optimum 20° to 25° C., and maximum 32° C. The fungus grows best on a slightly acid medium; development was retarded at H-ion concentrations lower than P_H 3·8 and higher than P_H 7·0.

The method of infection was studied, and it was found that both pycnospores and ascospores lodge in the furrows between the epidermal cells and there develop germ-tubes, the tips of which apply themselves to the cuticle directly above adjoining walls of the epidermal cells. The infecting hyphae penetrate the cuticle, and grow down between the epidermal cells, after which they develop intercellularly, no haustoria being found. Pycnidia form below the stomata where the hyphae collect and become matted together.

The incubation period is from twelve to sixteen days, the first symptoms of infection (light-coloured spots on the leaves) being noticeable on the eighth or ninth day. The pycnospores remain viable over winter when retained in the pycnidia. On 1st April, 1922, 90 per cent. of the spores from diseased oat leaves collected in the previous September germinated.

Duc (L.). **L'ergot du Blé dans l'Ain.** [Ergot of Wheat in the Ain Department.]—*Journ. Agric. Prat.*, lxxxvi, 43, pp. 360–361, 1922.

In July 1922 the writer observed a 4-hectare field of wheat in the Ain Department in which there was a severe attack of ergot [*Claviceps purpurea*], confined to one variety (Carré Vaudois) of the five varieties cultivated in the field.

Clean seed was stated to have been used, but it was not treated with any fungicide before sowing. The presence of ergot could not be detected on grasses in the neighbourhood, nor did it occur on another field of Carré Vaudois a few miles distant. Reports of ergot on barley have been received from two localities in the same district.

The length of the sclerotia at harvest varied between 1 and 2 cm., the maximum weight was 155 mg., and the average weight of 10 was 22 gm. About one ear in every ten was infected.

Schaffnit (E.). **Zur Bekämpfung der Pilzkrankheiten des Getreidekorns.** [On the control of fungous diseases of cereals.]—*Mitt. aus dem Inst. für Pflanzenkrankheiten der Landwirtschaftl. Hochschule Bonn-Poppelsdorf*, in *Landw. Jahrb.*, lvii, 2, pp. 259–283, 1922.

In this paper the author discusses a large series of trials of fungicides for the disinfection of seed grain, including several recently introduced proprietary preparations, and also considers the influence of certain external factors on the incidence of cereal diseases.

Copper sulphate and formaldehyde, until recent years the two principal disinfectants of seed grain, are open to the serious objection of reducing or retarding germination. This defect becomes marked not only when the prescribed strength of the solution or duration of immersion is exceeded, but also when atmospheric conditions or the factors influencing physiological activity are unfavourable, and, generally, in the case of exotic or delicate varieties. Formaldehyde injury was considerable in experiments during the autumn and winter of 1920–21, when the low temperature combined with scanty rainfall set up unfavourable conditions. In a plot of winter wheat treated by immersion in 0·2 per cent. formaldehyde for $7\frac{1}{2}$ minutes, only 156 seedlings came up as against 1,048 in the control. Tests showed that there was no appreciable reduction in the germination power of the treated grain for a fortnight after immersion, so that it was evidently a case of delayed injury. Formaldehyde penetrates through the peripheral layers of the embryo either in aqueous solution or as a gas, and can destroy the cells of the coleorrhiza and even the entire embryo. In the former case the development of the radicle is prevented and the seedling is obliged to form adventitious roots. This explains the frequency of delayed germination after formaldehyde treatment. Phenol and codein were both found to be present in April, 1921, in the ungerminated seed sown the previous September. Formaldehyde injury is stated to have been very general in the Rhine provinces during the period referred to.

At the Bonn Agricultural College tests were made of formaldehyde, fusafine, corbin, kurtakol, uspulun, phenolsulphonic acid mercury sulphate, 777, and 778 in 1919–20; and of chinosol, formaldehyde, fusafine, germisan, kurtakol, uspulun, and weizenfusariol in 1920–21.

Against bunt of wheat [*Tilletia tritici*] the best results were given in the spring wheat crop of 1920 by fusafine (0·25 per cent. for 30 minutes), the treated crop having only 0·04 per cent. bunted. Uspulun gave 0·12 per cent.; formaldehyde, 0·14; 778, 0·34; 777, 0·63; corbin, 0·69, and the rest over 1 per cent. Corbin and 777 caused the most severe seed injury. With winter wheat in 1920–21 germisan (0·25 per cent. for 1 hour) gave the best results, completely eliminating the disease. Formaldehyde, as already stated, caused very great seed injury. Weizenfusariol gave 0·34 per cent. bunt, uspulun 0·79, and both these preparations stimulated germination. On the spring wheat in 1921 uspulun and germisan, used in solutions of 0·25 per cent. for 1 hour, gave respectively 0·43 per cent. infection and complete control, the former being slightly the better in regard to the number of plants and ears in the plot. Germisan has been found to impede germination for the first ten to fifteen days, after which the plants quickly make up for lost time.

Against the fusariose of rye [presumably *Fusarium nivale* (*Calonectria graminicola*)] germisan, uspulun, and kurtakol were used in 1920–21. The first two completely eliminated the disease, and the seed showed good germination and subsequent growth, especially after uspulun. Kurtakol was ineffective.

Winter barley was treated in 1919–20 against stripe disease [*Helminthosporium gramineum*], when corbin and chinosol completely prevented the disease but seriously impaired germination, while uspulun reduced infection to a trace and at the same time had a stimulating action. In 1920–21 germisan gave complete control and uspulun 1 per cent. disease.

Against covered smut of barley [*Ustilago hordei*] and loose smut of oats [*Ustilago avenae*] the preparations that have given the most complete control so far are formaldehyde, copper sulphate, and weizenfusariol. The first two are, however, open to the objections mentioned above. Uspulun has not been very satisfactory, probably because it does not penetrate between the glumes sufficiently to reach all the spores.

Summarizing the results of the tests in 1920–21 the author states that formaldehyde is very effective against bunt and considerably reduces the stripe disease of barley; it is not so effective against *Fusarium*. Its general value is much lessened by its injurious secondary action on the grain. The same criticism is applicable to copper sulphate and chinosol. The colloidal copper preparation, kurtakol, is effective against bunt but is worthless for checking stripe disease or fusariose. Fusafine and weizenfusariol are also useful against bunt but worthless against stripe disease. Phenolsulphuric acid mercury sulphate has no value in the control of these three diseases. Corbin controls bunt and stripe disease but causes an excessive reduction in germination capacity. Uspulun effectively controls all three diseases. Germisan, however, is, on the whole, the best of the preparations tested against these cereal diseases, its only defect being the retarding action on germination. A new modification of it, germisan T.B.S. 12, appears to have surmounted this difficulty.

The fungicidal action of germisan, uspulun, and KK10 was tested on spores of *Tilletia tritici* and *Ustilago hordei*. The strengths used ranged from 0·03 to 0·25 per cent. and the period of immersion from 5 to 30 minutes. It was found that uspulun requires a minimum concentration of 0·25 per cent. to kill the spores of *T. tritici* and of 0·12 per cent. for those of *U. hordei*. With germisan the 0·12 per cent. concentration suffices for both, so that in their germicidal effect on *U. hordei* there is little difference between the two. KK10, in which the CH_3 group of the benzene nucleus is replaced by an atom of chlorine, was found to be more powerful than the commercial germisan.

With regard to the influence of factors affecting the growth of the host on infection by *Tilletia tritici*, the author points out that the temperature during germination, the supply of plant nutrients in the soil, the physical condition of the latter, and the physiological activity of the seed after planting, all have to be considered. His observations support the work of earlier investigators who found late autumn and early spring sowings tend to increase bunt, since the temperature approaches the minimum for the germination of wheat and the susceptible period is prolonged. But the correlation between the rate of germination and susceptibility to smut requires further investigation. Good soil moisture, the use of nitrogenous fertilizers, and a loose texture of the soil favour rapid germination and are stated to reduce liability to these diseases.

In some experiments on the influence of nutrition on susceptibility to disease the author found that heavy nitrogenous manuring predisposed to the attack of *Erysiphe graminis*, but that *Colletotrichum lindemuthianum* did not seem to be in any way influenced by the nutrition of the host. His field observations do not support the statement frequently made that excessive nitrogen predisposes to the attack of *Puccinia glumarum*, except in so far that it prolongs the period of vegetative growth during which the plant is susceptible to injury by rust.

Bredemann (G.). **Versuche über Erhöhung der Keimkraft unserer Hanfsaat durch Beizung.** [Experiments in the increase of the germinating power of Hemp seed by steeping.]—*Faserforschung*, ii, 1, pp. 58-63, 1922.

In 1920 the investigations of the German Hemp Cultivation Society showed that scarcely half of the home-grown and imported Italian seed of hemp [*Cannabis sativa*] examined possessed the prescribed germinating power of 90 and 70 per cent. respectively. Experiments were accordingly undertaken in 1920 and 1921 to test the value of uspulun as a stimulus to germination. In the first series of tests (1920) the effect of steeping in uspulun (0·25 per cent. for one hour) was remarkable, the average result of five outdoor experiments with Italian seed being that for each 1,000 plants from untreated seed there were 2,254 from the seed treated with uspulun. In ten experiments with German (Russian) seed the lots treated with uspulun gave 1,086 plants for each 1,000 from the untreated controls.

In 1921 the experiments were continued at the Agricultural Research Station of Landsberg-an-der-Warthe on a more extensive scale with Italian, Chile, and German (Russian) seed. It was shown that treatment with uspulun (same strength as before) increased the germinating power of the seed by 25 per cent., while immersion in water alone reduced it by 7 per cent. Thus with a seed rate allowing for an average stand of 80 plants per square metre on normal germination, steeping in uspulun produces 200,000 stems more per hect. It has not yet been ascertained whether the action is due solely to the known stimulating effect of uspulun, or if its fungicidal properties are also involved. In any case it can be highly recommended to hemp growers as a practical and reliable means of increasing the yield from poorly germinating seed.

SMALL (W.). **On the occurrence of a species of Fusarium in Uganda.**—*Kew Bull. Misc. Inform.*, 9, pp. 269–291, 13 figs., 1922.

The species of *Fusarium* previously described by the author from Uganda [*Kew Bull.*, p. 321, 1920] as causing a wilt of carnations, *Delphinium*, *Nigella*, and *Cosmos*, has since been found attacking other plants, among which are included *Antirrhinum*, seedlings of the cashew-nut (*Anacardium occidentale*), *Grevillea robusta*, *Eugenia jambos*, and the loquat (*Eriobotrya japonica*). On carnations and *Antirrhinum* it is sometimes associated with *Heterodera radicicola* and the author believes the latter is the primary parasite in the case of the *Antirrhinum*, the *Fusarium* having on this host a degree of parasitism so feeble that it was only just removed from saprophytism.

The attack on the cashew-nut seedlings takes the form of a severe wilt which is fully described and which, in some cases, was observed to kill up to 100 per cent. of the seedlings. Of the other hosts named *Grevillea* is next in order of susceptibility, while *Eugenia* and the loquat are but little damaged.

A full description is given of the cultural characters of the fungus on various media, as well as of a large series of cross-inoculations on the different hosts. From its morphological characters and the fact that he succeeded by inoculation with his organism in inducing a wilt of the pigeon pea (*Cajanus indicus*) similar to that described by Butler in India, the author provisionally identifies the Uganda fungus with *Fusarium udum* Butl.

SNOW (LAETITIA M.). **A new host for the fire blight organism, Bacillus amylovorus.**—*Phytopath.*, xii, 11, pp. 517–524, 1922.

In this paper the author first gives an exhaustive account of all records from 1793 onwards of the host plants affected by fireblight. Up to the present the organism has been shown to be able to infect the following hosts: pear, apple, quince, service berry (*Amelanchier canadensis*), English hawthorn (*Crataegus oxyacantha*), evergreen thorn (*Crataegus pyracantha*), wild crab (*Pyrus coronaria*), cultivated crab, Cheney plum (*Prunus americana nigra*), apricot, prune, and strawberry. Burrill's statement that the Lombardy poplar is attacked is questioned, and the reports for other hosts appear to rest upon observational evidence only.

In establishing the ornamental shrub *Prunus triloba* var. *plena* as a new host for *Bacillus amylovorus*, a number of isolations were made from plants growing at Wisconsin, and two of these were selected for comparison with an isolation from the crab apple and a laboratory stock culture. The morphology and culture reactions of all these strains agreed and are described in detail. They also agreed, in the main, with the reactions quoted by other investigators, but the following exceptions may be noted. In the nitrate reduction test no nitrogen was evolved and no nitrates formed, but a moderate amount of ammonia was produced. After prolonged cultivation the power to digest casein was lost and the organism gave corresponding slight or no liquefaction of gelatine. No indol was formed.

All the strains developed a peculiar odour, which has been variously described and is difficult to characterize. Both strains isolated from the new host were pathogenic on the pear at first but lost their virulence after cultivation. The laboratory strain was non-pathogenic, whilst that from the crab remained strongly virulent after two years.

A bibliography of 34 titles is appended.

HERBERT (D. A.). **Bitter pit of Apples. The crushed cell theory.**—*Phytopath.*, xii, 10, pp. 489–491, 1922.

McAlpine's bursting cell theory of bitter pit in apples is not altogether supported by the writer's investigations.

It is generally admitted that the fluctuation in water supply is the primary cause of bitter pit, the point in question being in what manner the diseased patches are produced. The rush of sap to the apple after a fall of rain following a dry spell causes a distension of the parenchymatous pulp cells. If the cells in any particular pit area were to swell to bursting-point, wart-like bodies would be expected at affected points instead of depressions. In Dunn's Seedling the flow of sap after a rain is sometimes sufficient to burst the skin, but no bursting of the cells takes place within the apple. It is difficult to see how such bursting could occur in bitter pit, as the expansion of adjacent cells would bring the tissue into a state of static equilibrium and the only relief for the increased pressure would be a bursting of the skin or a crushing of some of the cells. Further an osmotic pressure of 100 atmospheres entirely borne by the cell may induce bursting, but this is immensely beyond anything occurring in the cells of the apple.

The vascular tissue may frequently be traced through a pit and found to be supplying healthy tissues beyond, which would not be the case if the vascular network were ruptured.

Pitting generally occurs at the time when the starch is undergoing conversion into sugar, and the theory is advanced that the affected cells have been killed by being crushed by neighbouring cells having higher osmotic pressure due to their higher proportion of sugar. With the sudden rush of sap to the apple, the cells which have already had their starch-contents converted into sugar will swell more extensively and rapidly than those still furnished with starch. On the outside the rapid distension of the cells is resisted by the skin. Their force of expansion results in the crushing of those cells of which the starch transformation is backward. This explains the presence of quantities of starch in the dead pit cells.

The immunity from bitter pit of such varieties as Yates may be due to the uniform transformation of the starch to sugar throughout the tissue. In such cases there would be no small clusters of cells far enough behind in their starch transformation to be crushed by neighbouring cells of a higher osmotic pressure.

Cunningham (G. H.). **Brown rot, Sclerotinia cinerea Schroet. Its appearance, cause, and control.**—*New Zealand Journ. of Agric.*, xxiv, 8, pp. 83–98, 8 figs., 1922.

Brown rot is common throughout New Zealand except in Central Otago, where it is apparently unknown. Since 1915 the disease has been most destructive, and is now the most serious of all fungous diseases on stone fruits, occasionally attacking also apples and pears.

In New Zealand the causal organism of brown rot is *Sclerotinia cinerea* Schroet., the related fungus *S. fructigena* not having been found as yet. Apothecia from mummied fruits are produced only during the blossoming period and when they are not covered by more than an inch of soil. The disease usually appears first on the blossoms, infection occurring before the petals unfold or shortly after they have opened, and the period of infection extends from the beginning of September to the end of October. A wet season following a cold winter is usually accompanied by blossom infection. As a rule only a small percentage of blossoms is attacked, though in exceptional cases all have been killed. Blossom infection may be directly followed by infection of the developing fruits, but usually the latter only takes place at the time of maturity of the fruits. The formation of cankers and the dying back of the shoots are described.

On the leaves the fungus produces small, brown, more or less circular, dead areas, which may later fall away, leaving perforations similar to those caused by shot-hole fungi. In extreme cases the leaves are killed and fall prematurely, and the following season's crop may be reduced by this cause.

The successful control of brown rot is only possible when rigid orchard hygiene is practised. In addition the following sprayings are recommended: (1) when the buds begin to swell, Bordeaux 5–4–50 or lime-sulphur 1–15 [also useful in the control of leaf-curl (*Exoascus deformans*)]; (2) in early pinking, lime-sulphur 1–50; (3) petal-fall, lime-sulphur 1–120; (4) one month later, lime-sulphur 1–120; (5) when fruits are half-grown, lime-sulphur 1–120; (6) immediately before maturity, lime-sulphur 1–120. The sterilization of fruit cases may be effected by immersing them for one minute either in boiling water, copper sulphate solution 1–100, lime-sulphur solution 1–50, or formalin solution 1–40. Tins may also be immersed in any of the above solutions, except copper sulphate.

WINKLER (H.). **Behandlung stark befallener älterer Pfirsichspaliere.** [Treatment of severely infected old espalier Peaches.] —*Deutsche Obstbauzeit.*, lxviii, 41, p. 375, 1922.

A row of espalier peaches 100 m. in length at Bechau (Upper Silesia) was so severely attacked by leaf-curl [*Exoascus deformans*] and cochineal insects that the entire harvest was destroyed and many branches had to be removed. An examination of the soil, which was exceedingly hard and deficient in lime, indicated that malnutrition was a predisposing factor in the severity of the attack.

After removing all diseased material and thoroughly scraping the trees with wire and other brushes, the trunks and main branches were sprayed with a mixture consisting of loam, cattle-manure, and lime in water, to which was added 2 per cent. of fruit tree carbolineum. Early in March another application of carbolineum was given (200 gm. to 10 l. of water) to destroy any remaining spores. During the winter the soil was cultivated to a depth of 1 m., care being taken not to injure the roots, and fertilized with horn splinters, basic slag, 45 per cent. potassium salt, and a quantity of lime.

The trees were then sprayed with colloidal liquid sulphur (5 gm. to 10 l. water), the first application coinciding with the swelling of the buds and the second being given immediately before flowering. From the setting of the fruit till about three weeks before ripening applications were given every fortnight, always in the evening and in dull weather. The total consumption of sulphur amounted to 100 to 125 gm.

The trees were completely cured, the shoots being vigorous and the yield on the whole excellent. Peaches under glass were treated in the same way and gave even better results.

CIFERRI (R.). **Una rara malattia delle foglie del Susino.** [A rare disease of the leaves of the Plum.]—*Riv. Pat. Veg.*, xii, 5–6, pp. 59–64, 1922.

At Macerata in Italy the under side of some leaves of a plum tree (variety 'Luther Burbank') were found to bear small, punctiform, dirty white, waxy pustules, at first discrete, but later coalescing to a single, large, slightly raised mass surrounded by small, scattered pustules. Corresponding with these, on the upper surface, irregular, whitish areas occurred, the pale colour being due to the separation of the epidermis from the palisade parenchyma by a layer of mycelium.

The fungus was identified as *Microstroma tonellianum* Ferraris, a species that differs from *M. platani* Eddelbeuttel & Engelke more biologically than morphologically. The conidiophores resemble basidia so closely as to justify the doubt whether the fungus should not be referred to the Basidiomycetes (Exobasidiales) rather than to the Mucedineae. Like other species of the genus, such as *M. album* (Desm.) Sacc. and *M. juglandis* (Bér.) Sacc., the present species diverges from the Mucedineae in the crust-like nature of the hymenium, which is covered with abundant spores adhering to one another, and also in the mycelial aggregations found especially beneath the epidermis as in many of the Exobasidiales. The manner of invasion of the leaf, with the formation of fructifications on the opposite side to that attacked, is not common in the Mucedineae. Finally the author states that he has observed clamp-connexions such as are present in the Basidiomycetes. The fungus is considered to have affinities with *Aureobasidium vitis* var. *album* Montem., differing chiefly in the characters of the spores and in the fact that they are not borne laterally on the basidia. The absence of any hypertrophy of the leaf, so characteristic of attack by many species of *Exobasidium*, is noted.

In discussing the systematic position of the genus *Microstroma*, the author states that Patouillard first united in the genus *Exobasidium* both *Aureobasidium* and *Microstroma*, the latter as a subgenus. Later on, however, he considered *Microstroma* to be a lower form of the genus *Helostroma* of the Stilbaceae. Saccardo questions whether the latter is not the perfect Hymenomycetic form of *Microstroma*. Schroeter regards the genus as belonging to the Basidiomycetes, and this opinion is shared by Brefeld and Hennings. Briosi and Cavara refer *M. album* to the Mucedineae, with some doubt whether it may not be regarded as belonging to the Tuberculariaceae or Stilbaceae on the strength of the pseudostipitate type of conidiophore and the verticillate disposition of the conidia. *M. juglandis* is, however, referred by those authors to the Melanconiales because of its sporogenous stroma developed in the substomatal chamber. This species is placed in the Mucedineae by Lindau and Niessl, while the same view is taken in regard to *M. platani* by Saccardo, Eddelbeuttel, Engelke, Ferraris, and Tonelli.

As to the damage caused by *M. tonellianum* the author thinks it unimportant and capable of control, if necessary, by spraying with Bordeaux mixture and by the destruction of affected leaves.

Ciferri (R.). **Il marciume delle Mele Cotogne.** [Rot of Quinces.] —*Riv. Pat. Veg.*, xii, 1–2, pp. 12–17, 1922.

This rot, which is due to *Penicillium crustaceum* (L.) Fries (= *P. glaucum* Link), occurs on stored quinces in several regions of Italy, when conditions of moisture are favourable. It is a facultative parasite and is known to cause the rotting of a number of fruits, though the author thinks that it has not been previously reported on quinces. On these it behaves strictly as a wound parasite, being able to infect sound fruit through any cut or abrasion of the skin, however slight, provided the moisture conditions are suitable.

In relatively high summer temperatures the green mould on the surface of infected fruits bore here and there small, black, roundish, raised, isolated bodies, having a diameter of 200 to 300 μ, which were at first taken for the sclerotial form of this fungus described by Brefeld. These were found, however, to be merely dense aggregations, dark green in colour, and composed chiefly of conidia 3 to 3·5 μ in diameter. Similar conidial aggregations are sometimes found in cultures of various species of *Penicillium*. The author also observed, but more rarely, the form which, described by Cesati under the name of *Sporisorium maydis*, was referred by Saccardo to the genus *Chromosporium* as *C. maydis*. This is nothing more than the same *Penicillium* with the conidia more or less variously arranged on the mycelium, without specialized conidiophores. The pseudosclerotia just mentioned are only an extreme development of this form. Another form, rather frequent on old rotted fruits, produces a pseudosynnema of the Stilbaceous type, $\frac{1}{2}$ mm. broad by about 1 mm. high, bearing at the top a green head consisting of a mass of conidia. This structure is formed by numerous, slightly or not branched, rather densely fasciculated conidiophores, which vary in length but usually are very long, and average about 3 μ in diameter, and which are almost always sterile except at the free end, where there is a copious production of conidia.

As preventive measures the author recommends the rejection of all fruit showing the slightest lesion, the provision of dry storage rooms, and care in not placing the fruits in contact with one another.

Lynch (W. D.), McDonnell (C. C.), Haywood (J. K.), Quaintance (A. L.), & Waite (M. B.). **Poisonous metals on sprayed fruits and vegetables.**—*U.S. Dept. Agric. Bull.* 1027, 66 pp., 1922.

In 1915 a comparative study was undertaken by the United States Department of Agriculture to ascertain the amounts of arsenic, lead, and copper remaining on fruits and vegetables treated with poisonous sprays. The spraying was done under the direction of the Bureaus of Entomology and Plant Industry, and the chemical work by the Bureau of Chemistry. Various fruit trees and vegetables, including peaches, plums, cherries, cranberries, grapes, apples, pears, tomatoes, celery, and cucumbers, were sprayed according to accepted schedules, and also with excessive amounts of material, to determine how much of the metals may be present under adverse conditions.

It was found that overspraying or late spraying sometimes resulted in comparatively large quantities of spray residues; nearly all such residues, however, were removable by peeling. When the spraying was carried out in accordance with the recommended schedules, the quantity of metal adhering to the fruit or vegetables at harvest time was negligible.

The work of previous investigators is discussed at considerable length in the earlier part of the bulletin, which contains many references to the history of fungicidal and insecticidal sprays. A bibliography of 134 titles is appended.

Horton (E.) & Salmon (E. S.). **The fungicidal properties of certain spray-fluids. III.**—*Journ. Agric. Science*, xii, 3, pp. 269–279, 1922.

As a preliminary to a study of the exact fungicidal value of a mixture of lime-sulphur and arsenate of lead, the writers carried out in 1921 two series of spraying experiments: (*a*) with solutions containing arsenic acid, (*b*) with lime-sulphur and its constituents. The fungus experimented on was *Sphaerotheca humuli*, and the stage selected for spraying was the powdery, conidial stage found on young leaves from the 3rd to the 9th node of rooted cuttings of hops (*Humulus lupulus*) grown in an unheated greenhouse. The results of the arsenate tests showed that, under the conditions of the experiments, disodium arsenate containing 0·096 per cent. As_2O_5 was fungicidal, and also killed the leaf-cells underlying the mildew patches, but did not otherwise injure the leaf: a solution containing 0·02 per cent. As_2O_5 was fungicidal without killing any leaf-cells. Trisodium, dicalcium, and tricalcium arsenates, at the concentrations of 0·077, 0·048, and 0·076 per cent. As_2O_5 respectively, proved fungicidal: the latter two at concentrations of 0·024 and 0·02 per cent. respectively were apparently just fungicidal, and at concentrations of 0·01 per cent. they were practically without action.

In the lime-sulphur experiments 1 per cent. calcium caseinate, which from tests appeared to be non-fungicidal, was added to the spray solutions to increase their wetting powers and permit more accurate results to be obtained.

The following constituents of lime-sulphur were found to be non-fungicidal; calcium sulphate, sulphite, thiosulphate, and hydroxy-hydrosulphide; calcium polysulphide was the only constituent of lime-sulphur, at the strengths at which the solution is used in practice, found to be fungicidal. A lime-sulphur solution 1 in 149, containing 0·11 per cent. of polysulphide sulphur, was completely fungicidal.

Full details of the materials used and a bibliography of 20 titles are given.

RIEHM (E.). **Die Versuche des deutschen Pflanzenschutzdienstes zur Prüfung von Pflanzenschutzmitteln.** [The experiments of the German Plant Protection Service in testing preparations for plant disease control.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 7, pp. 50–51, 1922.

Until 1919 tests of new methods of combating plant diseases were undertaken by the individual experiment stations, and the results were published in occasional reports. Different stations frequently differed in their recommendations, both as regards the merit and the methods of application of the same remedy. The resulting confusion led to a centralization of the experiments, organized by the Executive Committee of the Plant Protection Service in the autumn of 1919. Since that time numerous tests have been made of disinfectants for bunt of wheat [*Tilletia tritici*], stripe disease of barley [*Helminthosporium gramineum*], and loose smut of oats [*Ustilago avenae*]. Experiments have also been conducted in the control of gooseberry mildew [*Sphaerotheca mors-uvae*], apple and pear scab [*Venturia inaequalis* and *pirina*], and late blight of potatoes [*Phytophthora infestans*].

The tests are carried out in the same manner in each of a number of different centres, and preparations are not tested unless they have been already tried and approved by at least one of the chief stations for plant protection. Some 69 preparations are under trial in the current year.

SNELL (K.). **Beizungsversuche mit Trypaflavin.** [Disinfection experiments with trypaflavin.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 7, p. 55, 1922.

Tests were carried out in 1921 to ascertain whether the yield of potatoes could be increased by steeping the tubers in 'trypaflavin', a preparation manufactured by the firm of Leopold Cassella & Co.

of Frankfort. The varieties selected for the test were Prof. Maercker and Daber. The results obtained were not satisfactory, the yield from the rows treated with trypaflavin not being equal to that from the untreated controls. The yield from tubers steeped in diaminoacridine sulphate and diaminoacridine nitrate, other preparations received from the same firm, exceeded that obtained from the rows treated with trypaflavin, but was still not equal to the controls. Trypaflavin was not found to possess any decided fungicidal properties as judged by the amount of scab, &c., on the tubers from the treated seed.

Versuche mit Tillantin B, einem neuen Saatgutbeizmittel. [Experiments with Tillantin B, a new seed disinfectant.]—*Deutsche landw. Presse*, xlix, 97–98, pp. 600–601, 1922.

At the Laboratory of Plant Physiology attached to the dye-works at Höchst-am-Main, a new fungicide, known as 'tillantin B', has been produced for the control of bunt of wheat [*Tilletia tritici*], covered smut of barley [*Ustilago hordei*], and loose smut of oats [*U. avenae*]. The mixture is stated to contain a new copper compound and a very powerful arsenical substance, which, it is claimed, produces an increased activity of the copper and absolutely counteracts any possible injury to germination.

Laboratory experiments showed that bunt spores could be destroyed with 0·01 per cent. of tillantin in 10 minutes. In field tests carried out at Höchst the yield in one series was increased by the use of tillantin to the extent of 14 per cent. as compared with the controls and with seed disinfected with copper sulphate. In another series there was an increase in the yield of 60 per cent. over untreated seed and of 29 per cent. over seed treated with copper sulphate. In all these experiments the sprinkling method was adopted.

Another test carried out at the Giessen Agricultural Institute confirmed the results obtained by the manufacturers. The yield from seed immersed in tillantin exceeded that from the untreated controls by 23 and 32 per cent. respectively in two separate series of tests.

Müller (H. C.) & Molz (E.). **Neue Versuche zur Bekämpfung des Roggenstengelbrandes.** [New experiments in the control of flag smut of Rye.]—*Deutsche landw. Presse*, xlix, 76, p. 491, 1922.

In the autumn of 1921 disinfection experiments were carried out with rye seed grain infested with flag smut (*Urocystis occulta*). The following preparations were used: rye fusariol, 23 gm. to 15 l. water, uspulun 0·33 per cent., germisan 0·25 per cent., and kalimat 0·25 per cent. The seed was sprinkled in every case. On 15th April, 1922, the results of the different treatments were compared. The growth in all the plots was very satisfactory. As regards disinfection, the best results were obtained with kalimat supplied by the firm of Ludwig, Meyer at Mainz, the average percentage of smutted plants being only 0·5. Uspulun and germisan reduced the infection to an average of 2 and 2·5 per cent. respectively. Slightly less satisfactory results were given by fusariol, the average percentage of smutted plants being 5·5. In the untreated control plots the average of infection was 66·5 per cent.

JANSON (A.). **Bekämpfung des echten und falschen Meltaus.** [Control of powdery and downy mildew.]—*Deutsche Obstbau-zeit.*, lxxviii, 23, pp. 224–225, 1922.

Owing to the scarcity of Sicilian dusting sulphur during the war the writer made use of the precipitated ground sulphur known in the trade as 'Prä'. The results were sufficiently favourable to justify further experiments on a larger scale, and these have been undertaken since 1919. Roses (wild and cultivated), currants, gooseberries, fruit trees, vines (outdoor and conservatory), cucumbers, beans, maize, kohlrabi, cabbages, and chrysanthemums have all been successfully treated. Even in large quantities, e.g. 100 kg. per hect., precipitated sulphur is absolutely harmless to the plants. The preparation is stated to be considerably cheaper and more economical in use than other sulphur mixtures, and has the additional advantage of being an excellent insecticide.

ERIKSSON (J.). **Betningsförsök med uspulun och supersolfo såsom kampmedel emot stinksot å vete.** [Steeping experiments with uspulun and supersulphur for the control of bunt of Wheat.]—*Kungl. Landbruks-Akad. Handl. och Tidskr.*, lxi, 7, pp. 607–610, 1 fig., 1922.

The author describes experiments made in the autumn of 1921 in the control of bunt of wheat (*Tilletia 'caries'*) by uspulun and supersulphur, the latter being a dark, thick, heavy liquid, consisting mainly of calcium polysulphides, manufactured from the by-products of illuminating gas by the San Paulo gasworks in Rome [see this *Review*, i, p. 67].

Pansar winter wheat heavily infected with bunt was used, the grain being immersed in uspulun solution at a strength of 2·5 gm., or supersulphur at 10 c.c., per litre of water. Each of the treated plots received 50 gm. seed and an equal amount untreated was sown in a third plot as a control.

In the early summer of 1922 the two treated plots were higher and more advanced than the control. the supersulphur plot being in flower by 22nd June; that treated with uspulun was somewhat less advanced and the control comparatively backward. The crop was harvested on 19th August when it was found that there was 83·8 per cent. of bunt in the control, 22·6 in the supersulphur, and only 0·5 in the uspulun plot. On the other hand, a much heavier yield was obtained from the plot treated with supersulphur than from that treated with uspulun.

It is suggested that higher concentrations of supersulphur might give a better bunt control and also that a combination of the two fungicides might unite the practically complete bunt control of uspulun with the apparently stimulating effect of supersulphur.

TRUESDELL (W. H.). **Plant pathology in Crimea.**—*Phytopath.*, xii, 11, pp. 533–535, 1922.

Plant disease control is quite backward in the Crimea; power sprayers are unknown and the sprays used are, when obtainable, Bordeaux mixture and Paris green. Lime-sulphur is only known as a dormant insecticide, and self-boiled lime-sulphur as a spray against gooseberry mildew. The orchards are much neglected, no doubt because of the conditions resulting from a prolonged period of war and revolution.

Apple canker [*Nectria galligena*], apple scab (*Venturia inaequalis*), and pear scab [*V. pirina*] are serious. *Sclerotinia cinerea* and *S. fructigena* are prevalent, but only the latter is supposed to be responsible for injury to the woody parts of the trees, especially sweet cherries, advancing from the fruit to twigs and then to the main limbs and trunk. In the limestone country north of the Crimean mountains chlorosis is common in the orchards, but interesting results have been obtained by injecting into the trees a mixture of $FeSO_4$, K_2SO_4, and $MgSO_4$ through holes bored in the trunk, the foliage above the point of injection becoming green while that below remains yellow. *Gymnosporangium sabinae* is frequent on pears and *Sphaerotheca pannosa* was observed on peaches.

PEYRONEL (B.). **Sulla normale presenza di micorize nel grano e in altre piante coltivate e spontanee.** [On the normal presence of mycorrhiza in Wheat and other cultivated and wild plants.]—*Boll. mensile R. Staz. Pat. veg.*, iii, 4–6, pp. 43–50, 1922.

The author signalizes the invariable presence in a large number of wheat crops examined by him in various parts of Italy, of an endotrophic mycorrhiza agreeing in its main features with the mycorrhiza described by previous workers on many other plants. So far as he knows, the occurrence of an endophytic fungus-root association of this character has not previously been remarked on wheat, which, in common with the other cereals, oats, rye, and barley, is usually regarded as a purely autotrophic plant. In view of the variable nature of the fungus-root association as a general phenomenon he is, however, prepared to find that mycorrhiza may be absent under other conditions than those observed by him in Italy.

The fungus is characterized by its sparse development on the surface of the root, in contrast with the free growth that takes place in and between the cells of the cortex. In addition to the branched, haustorium-like 'arbuscules' present in many of the cells, large, acrogenous vesicles of varying shape are frequently formed and remind one of the zoosporangia of the Phycomycetes. In the epidermal cells and in the layer immediately under the epidermis, the hyphae are often characteristically bent in spiral or knee bends and may become divided by septa into short, barrel-shaped articulations which may even unite into small, pseudoparenchymatous stromata. The mycelium is, however, usually hyaline or pale yellow and sparingly septate. On the extramatrical mycelium the author observed the formation of large, barrel-shaped, moniliform conidia, in simple or branched chains, not separating into their component spores readily. Under suitable conditions, also, he obtained the formation of sporangium-like bodies in all respects analogous with the vesicles produced within the roots, and the similarity of these organs to the zoosporangia of the Oomycetes is emphasized though zoospores were not observed.

While in some wheat plants considerable portions of the root system are invaded by the fungus, in others it is restricted to a few rootlets. Some differences in the morphology of the endophyte were observed in different localities, and it is suggested that these may depend both on the race of wheat cultivated and on the environmental conditions (soil, meteorological factors, and the like).

The same fungus was also found associated with the roots of oats, barley, rye, and maize, as well as in several weeds of cultivated fields, eight of which are named.

During the course of his examination of the roots of various plants for the presence of this endophyte, the author has frequently encountered a Chytridiaceous fungus allied to *Asterocystis radicis*, the well-known cause of 'brûlure' of flax in France and Belgium. On wheat and other plants (especially Cruciferae) this fungus is frequently present together with the endophyte already described, but always confined to the root hairs and epidermal cells. No injury seems to result from its presence, and the author is inclined to regard it as forming a special type of mycorrhiza though with parasitic potentialities.

In a foot-note added while the paper was in the press it is stated that the endophyte has been isolated and mycorrhiza successfully synthesized in pure culture.

Foëx (E.). **La dartrose de la Pomme de terre.** [Dartrose of the Potato.]—*Comptes Rendus Acad. Agric. France*, viii, 32, pp. 844–848, 1922.

During the period from July to September, 1922, the disease known in France as 'dartrose', due to the fungus *Vermicularia varians*, caused severe damage to the potato crops in the Departments of Charentes, Vendée, Vienne, Loire, Ain, Bas Rhin, Seine, Seine-et-Oise, Loiret, Saône-et-Loire, Rhône, and Lot-et-Garonne. The symptoms, as reported by Crépin [see this *Review*, ii, p. 27] and previous workers, are described. Ducomet and others have attributed its outbreaks to excessive drought and heat, but these factors were not sufficiently marked during the past summer to account for the epidemic.

The varieties attacked were an imported Dutch variety, Richter's Imperator, Wohltmann, Fin-de-Siècle, Merveille d'Amérique, Lesquin, Saucisse, Czarine, and Institut de Beauvais. The disease is stated to be more prevalent on early than on late maturing plants of the same variety. The same seed sown in two different localities has given in the one case a healthy and in the other a diseased crop. This does not preclude the possibility that infection is introduced with the tubers, as the influence of environment on the development of the disease is manifestly very great.

Dartrose not only reduces the yield of the crop but also impairs the quality. Control measures cannot be evolved until the source of the disease and its conditions of development have been studied in greater detail. Ducomet has shown that *V. varians* can pass from the seed tuber to the new shoots, and seed should therefore not be procured from infected localities. All débris from infected crops should be burnt, while the efficacy of the methods of seed tuber disinfection employed against scab and *Rhizoctonia* deserve testing.

MAFFEI (L.). **La vaiolatura delle foglie dell' 'Arachis hypogaea' Linn. dovuta a Cercospora.** [The spotting of leaves of '*Arachis hypogaea*' Linn. due to *Cercospora*].—*Riv. Pat. Veg.*, xii, 1–2, pp. 7–11, 1922.

In this paper a leaf-spot disease of groundnut (*Arachis hypogaea*), observed in the Bereguardo district in 1921, is described. The leaves showed from 5 to 40, roundish or oval, dark chestnut brown spots of uniform colour, without a lighter centre or concentric markings. The spots bore, on both surfaces of the leaf, small dots consisting of the fructifications of a fungus. These were composed of numerous conidiophores in bundles, the individual conidiophores being geniculate, continuous (rarely uniseptate), brown, with a lighter apex, and 40 to 47 by 4 to 5 μ. The spores were borne on slight projections and were clavate, yellowish green, tapering above, at first continuous then with 8 to 12 septa, and 50 to 110 by 4 to 7 μ.

The fungus is a *Cercospora* which is considered to differ from *C. personata* (B. & C.) Ellis and *C. arachidis* Henn. in the larger spots of characteristic appearance, in the amphigenous fructifications, and in the spore characters. It comes near the latter species, however, and the author names it *C. arachidis* var. *macrospora*, a Latin diagnosis of the new variety being given.

For the control of the disease the author recommends burning the aerial parts of affected plants.

DUCOMET (V.). **Variétés de Pommes de terre et galle verruqueuse.** [Potato varieties and wart disease.]—*Journ. Agric. Prat.*, lxxxvi, 45, pp. 393–395, 1922.

After a brief discussion of the work of the potato testing stations at Ormskirk (Lancashire), Freeland (Pennsylvania), and Rostock (Mecklenburg), the writer states that, in view of the increasing danger of the introduction of wart disease [*Synchytrium endobioticum*] into France, some twenty English varieties, reported to be immune, have been under observation at the Grignon [S.-et-O.] Experiment Station for periods ranging from one to two years. Several of these varieties have been simultaneously cultivated in other parts of France. While it is too early to make definite statements as to the intrinsic value and adaptability of the English varieties, a few preliminary observations may be of interest.

In the first rank, both as regards reported resistance and general vigour, must be placed the medium-late variety Great Scot, while Kerr's Pink, Abundance, Rhoderick Dhu, Arran Victory, and Bishop also possess excellent qualities. The last-named appears to be somewhat susceptible to leaf roll, but is likely to prove a commercial success. As regards resistance to late blight (*Phytophthora* [*infestans*]), the varieties have been classified at Grignon in the following descending order: Kerr's Pink, Rhoderick Dhu, Arran Victory, Great Scot, Abundance, and Bishop.

None of the imported varieties fulfils all the French requirements, either because they are not sufficiently early or productive, or are somewhat inferior in quality. Absolute immunity from wart disease, however, outweighs a number of defects, and moreover the latter can, in all probability, be remedied by judicious crossing.

SCHLUMBERGER (O.). **Pflanzenschutz und Kartoffelzüchtung.** [Plant protection and Potato breeding.]—*Fühlings landw. Zeit.*, lxxi, 9–10, pp. 183–191, 1922.

The author, believing that as the science of crop protection advances increasing attention will be given to preventive measures as opposed to the direct treatment of disease, discusses the means of preserving the health and vigour of selected varieties of potatoes as well as the methods made use of in potato breeding. New varieties should be tested not only as regards their behaviour on different types of soil but also in order to gauge their resistance to disease. The work of Quanjer, Murphy, and Cotton is regarded as establishing that leaf roll is an infectious disease capable of direct transmission as well as of being conveyed by insects, mosaic being similar in these respects. Tests for resistance to these diseases must be carried out by interplanting with already infected crops of varieties such as Industry and Eigenheimer, which are known to be particularly susceptible to mosaic. Trials for resistance to blight (*Phytophthora infestans*) should be carried out preferably in mild and damp localities by interplanting with susceptible early varieties.

Resistance to wart disease [*Synchytrium endobioticum*] is specially important, and as the disease persists in the soil and increases in virulence from year to year, all new varieties should be subjected to tests of several years' duration before being put on the market. The western provinces of Germany are principally affected by this disease, and the resistant, yellow-fleshed varieties are in great demand there.

Questions of soil constitution and manuring also require careful consideration. In Stutzer's examination of soils carrying crops affected with leaf roll, 0·75 per cent. of free alkali was found. Soil analyses made by the author in East Havelland showed that the pronounced exhaustion of the potatoes in that district was connected with an excess of humic acid. Hiltner and Lang have recently again pointed out that the capacity to utilize and benefit fully from artificial fertilizers is confined to good varieties, poor varieties being marked by their lack of response to fertilization.

The different means of maintaining the varieties in a healthy condition require further study. According to the most recent investigations their development depends not only on the constitution of the soil, but to an even greater extent on meteorological factors. The proper temperature for the winter storage of potatoes and the correct time for harvesting are two other important questions demanding fuller investigation. The harvesting of immature tubers has been recommended both in Germany and England under certain conditions, but this has also been opposed by many.

The breeding of resistant varieties of the potato is complicated by its heterozygotic constitution. Every grower is familiar with the number of types that may arise from a single seed-berry, and the consequent difficulty of knowing what hereditary qualities are present in the parents used for crossing. Thus most of the so-called resistant varieties, at any rate in Germany, are accidental products, and in many cases their immunity has proved to be only temporary. It is, moreover, still quite uncertain whether the hereditary quality conferring resistance in the potato is absolute or merely relative. Certain varieties which are stated to be immune from particular diseases in England have proved more or less susceptible in Germany. Many attempts have been made to secure early varieties resistant to *Phytophthora infestans*, chiefly by the selection of resistant plants in infected crops, but these have generally been found to be late-maturing individuals and thus the object has been defeated.

The correlation between resistance to disease and other valuable characters in the potato is also very imperfectly understood, and it is uncertain how far breeding for resistance may be combined with breeding for productiveness. It is, in fact, generally believed that the factors of high yield and immunity are mutually exclusive. Another point of great scientific and practical importance is the unusual longevity of certain varieties, e.g. Cimbal's Wohltmann and its relatives. Possibly such varieties may represent, not pure lines, but a collection of different types, varying in their soil and climatic requirements and mutually supplementing one another under unfavourable conditions.

The various problems indicated in this paper have been deeply investigated in the case of cereals, and the same time and care must be spent on their solution in that of the potato.

Franchini (G.). **Nouvelles recherches sur les trypanosomes des Euphorbes et leur culture.** [New researches on the trypanosomes of Euphorbiaceae and their culture.]—*Bull. Soc. Path. exot.*, xv, 5, pp. 299–303, 1 fig., 1922.

The protozoa found in the latex of *Euphorbia nereifolia*, *E. caerulescens*, *E. anticurum*, *E. laro*, and an undetermined species, have been further investigated. In the last-mentioned, bodies resembling the small rings of the malarial parasite were found, and also Leishmaniform bodies and small amoeba-like organisms. In *E. nereifolia* the trypanosomes varied in form and dimensions and amoeboid types sometimes occurred.

Cultures obtained in Nöller's medium revealed transitional stages between the amoebae and the trypanosomes. There is first a small, homogeneous body with amoeboid movements. Later this increases in volume, the protoplasm becomes more differentiated, nuclei can be seen, and the amoeboid movements are more ample. A membrane, which expands and contracts somewhat rapidly, appears round the whole or part of the body. Still later the U shapes appear, the two free extremities being sometimes united by a thin membrane. Both in the cultures and in the latex of the plants the trypanosomes were very variable in size, the larger ones being less frequent and less mobile. Other amoeboid types were also seen and encysted forms were sometimes present.

Similar observations were made on the latex of *Excoecaria emarginata*, the development of the trypanosome in the host plant appearing to follow the same course as that described above from cultures. Circular and Leishmaniform shapes also occur in this host.

Franchini (G.). **Sur une amibe des Figuiers de plein air de la région parisienne et sa culture.** [Notes on an amoeba of outdoor Fig trees in the environs of Paris, and its culture.]—*Bull. Soc. Path. exot.*, xiv, 5, pp. 287–292, 3 figs., 1922.

The amoebae previously mentioned [see this *Review*, i, p. 450] as occurring in the latex of outdoor fig trees (*Ficus carica*) near Paris varied considerably in size and shape. Some were rounded and 12 to 20 μ or even more in diameter, others oval, 22 by 12 or 18 by 13 μ; smaller forms also occurred. In addition to these, very elongated flagellates, 28 by 4·5 or 22 by 2 μ, with flagella 6 to 8 μ long, were present.

Cultures of the amoebae were successfully made on Nöller's medium, the red blood corpuscles of which were ingested by the amoebae in the same way as is done by the pathogenic species of the human intestine. The forms observed in the fig tree resemble in some respects those found in exotic Urticaceae and in Asclepiadaceae and Apocynaceae, in which transitional forms between the amoebae and the trypanosomes have been seen, and the author thinks that the flagellate forms mentioned above are a stage in the life-history of the amoeba. Flagellate stages are known to occur in *Vahlkampfia* and the Myxoamoebae.

Franchini (G.). **Sur une amibe de la laitue (Lactuca sativa).** [An amoeba of Lettuce (*Lactuca sativa*)].—*Bull. Soc. Path. exot.*, xv, 9, pp. 784–787, 1 fig., 1922.

In July, 1922, the author examined near Bologna a large number of lettuces, one of which contained numerous amoebae in the thick and acid latex. The plant had a sickly appearance, which may, however, have been partly due to the excessive heat. The amoebae varied in shape and dimensions; the protoplasm was very fine, vacuoles were rare, and the ecto- and endoplasm were not differentiated.

Cultures were obtained on Nöller's medium, amoebae being discernible on the fourth day. The organisms moved freely and were very similar to those of the latex, though slightly smaller.

The new amoeba, to which the name *A. lactucae* is given, appears to belong to the group already described as occurring in various latex-bearing plants of the Apocynaceae and Urticaceae.

Franchini (G.). **Essais d'inoculation de différents protozoaires dans le latex des Euphorbes.** [Attempts to inoculate various protozoa into the latex of Euphorbiaceae.]—*Bull. Soc. Path. exot.*, xv, 9, pp. 792–795, 2 figs., 1922.

In this paper the author describes attempts to infect various species of *Euphorbia* with protozoa of known origin from insects and man, carried out in Italy in the summer of 1922.

Vigorous plants of *E. sauliana*, *E. segetalis*, *E. pilulifera*, and *E. ipecacuanha* were inoculated with cultures of the kala-azar organism [*Leishmania donovani*] from India, and these and other species with organisms from oriental sore [*L. tropica*] from Sicily. *E. geniculata*, *E. segetalis*, and *E. pilulifera* were inoculated with *Herpetomonas muscae domesticae*; and *E. geniculata* with spirochaetes and with flagellates of the *Cercomonas* and *Trichomonas* types of human origin. Finally, several species were inoculated with the flagellate from cabbage bugs (*Pentatoma*) recently described by the author [see this *Review*, i, p. 311].

All the inoculated plants with their controls were placed in a greenhouse well protected against insects, and the latex examined at intervals. One of the two plants of *E. geniculata* inoculated with *Herpetomonas muscae domesticae* showed clear signs of infection after a time, while two plants of *E. ipecacuanha* inoculated with the organism of kala-azar also became diseased, one more severely than the other. The infected plants turned yellow, the leaves fell, growth was arrested, and the shoots withered. The latex was pale, very fluid, and deficient in starch; fifteen to twenty days after inoculation it contained Leishmaniform organisms, round or oval, generally isolated, and sometimes in process of division. The other inoculations failed, except in the case of *E. segetalis* inoculated from oriental sore when very slight infection occurred.

Sanderson (A. R.). **Brown bast.**—*Bull. Rubber Growers' Assoc.*, iv, 8, pp. 380–381, 1922.

The author points out that the time during which tapping has been in progress is an important factor in the increase of the number of cases of brown bast in *Hevea* rubber trees. This increase is much more marked from the first to the sixth year of tapping, i. e. on the virgin bark and first renewal, than later, irrespective of the particular system of tapping employed. Finely developed, well-grown trees appear to be more susceptible, especially up to the age of eight years, than poorer ones, and the evidence so far available indicates that the incidence of brown bast is in direct proportion to the severity and frequency of the tapping system, but that as time goes on cases occur in trees that have been lightly tapped from the start.

The following figures are of interest as showing the increase in the percentage of brown bast with advancing age. In one case, eleven year old trees showed 20 per cent. of disease and thirteen year old trees 36·45 per cent. Another field of trees over twelve years old was twice examined for brown bast with a six months' interval between. At the second inspection there was an increase of 0·6 per cent. of new cases, the total percentage of disease being 33·75. On another estate, where treatment for brown bast has been given for some years, the first census showed 12 to 24 per cent. of disease. A second census taken eight months later showed an average increase of 5 per cent. in the number of cases, while at a third inspection after a four months' interval there was a further increase of 1 per cent. The growth and bark renewal on the estate in question were very good. In another field of 200 acres the cases of brown bast in the third year of tapping numbered 1,592 as against 1,066 in the first year.

Generally speaking, the annual increase in the number of cases of brown bast is at present relatively low, on account of the prevailing tendency to adopt a less drastic system of tapping.

The reduction in the yield of dry rubber in trees affected by brown bast is frequently disregarded, yet the loss may amount to 30 per cent. or more. In extreme cases no latex can be obtained within the usual limits as regards height of cut. The total annual loss in revenue may be very considerable and must increase yearly unless precautions are taken to check the spread of the disease.

MANEVAL (W. E.). **Germination of teliospores of rusts at Columbia, Missouri.**—*Phytopath.*, xii. 10, pp. 471–488, 1922.

During the last five years observations have been made at various dates between autumn and spring on the resting period required by teleutospores of different rusts occurring at Columbia, Missouri. The author reviews the literature concerning the effect of moisture, temperature, chemicals, and maturity upon germination, and then describes experiments in which he tested the germination of teleutospores, previously collected and usually kept at room temperature, by floating them in 10 to 15 c.c. of distilled water in a covered dish incubated at room temperature. The tests showed that *Phragmidium potentillae-canadensis*, *Puccinia asparagi*, *P. helianthi*, *P. menthae* var. *americana*, *P. ruelliae*, *P. andropogoni*, *P. peridermiospora*, *P. sorghi* [*P. maydis*], *P. sydowiana*, and *P. windsoriae*, all eu-type rusts, were capable of germination in or before December. As the season advances there is a marked increase in the percentage of spores that will germinate in a given time. For instance, teleutospores of *P. helianthi* required 103 days for a high percentage of germination in October, 11 days in December, 7 days in January, 5 days in February, and less than one day in April. Similar results were obtained with *P. menthae*, *P. peridermiospora*, and *P. windsoriae*.

The time required for germination to begin decreases with the approach of spring. Spores of *P. helianthi* tested on 10th October 1917 germinated slightly in 70 days, on 27th December 1921 in 6 days, on 27th February 1918 in 1 day, and in April 1917 and 1922 in 1 to 2 hours. *P. peridermiospora*, *P. windsoriae*, *P. menthae*, and *P. ruelliae* behaved similarly.

Germination is favoured by prolonged floating on water and by alternate wetting and drying, and after it has begun in a culture it will generally continue for a considerable time. Teleutospores of *P. helianthi* germinated feebly at 28° to 29° C. but the promycelia were abnormal and practically no sporidia were formed. Spores of *P. windsoriae*, *P. peridermiospora*, and *P. helianthi* would not germinate at 32° C. but gave positive results when removed to room temperature (about 20° C.). Spores of *P. helianthi* failed to germinate after floating on water at 38° C. for 48 hours, but withstood drying for five days at 38° C. and still germinated. Temperatures above the maximum delayed, but did not inhibit, germination.

As compared with germination in distilled water, the process was retarded in solutions with higher H-ion concentrations (P_H 4·6 and 5·4) in the cases of *P. asparagi*, *P. sorghi*, *P. ruelliae*, and *P. menthae*. On the other hand, *P. helianthi* germinated in solutions with a wide range of H-ion concentration (P_H 3·85 to 8·4), the limits for good sporidia production, however, being narrower (P_H 4·6 to 6·5).

BLUMER (S.). **Beiträge zur Spezialisation der Erysiphe horridula Lév. auf Boraginaceen.** [Contribution to the specialization of *Erysiphe horridula* Lév. on the Boraginaceae.]—*Centralbl. für Bakt.* Ab. 2, lv, 21–24, pp. 480–506, 5 figs., 1922.

The mildew on the Boraginaceae, included by Salmon in the collective species *Erysiphe cichoracearum* DC., is regarded by the author, on morphological and biological grounds, as a distinct species, *E. horridula* Lév. Although its specialization is not sharply defined, several biological races can be distinguished, each of which has its primary and secondary hosts. The former show infection regularly at the expiration of the incubation period (six to eight days). Secondary hosts are not regularly infected, and several weeks may elapse before the first symptoms appear. Infection in the latter case appears to result from conditions either very suitable for the fungus or unfavourable to the host.

The following 'formae speciales' are distinguished: *symphyti, pulmonariae, cerinthes minoris, asperuginis, cynoglossi, echii-myosotidis,* and *anchusae. Cerinthe major* is a host for all of these that have been tested and is stated to serve probably as a 'bridging species' to enable the *Oidium* on *Symphytum* to pass to *Echium vulgare*, and from *Echium* and *Myosotis* to pass to *Cerinthe alpina*. Most of these forms have several secondary hosts belonging to different genera.

E. horridula therefore differs from the forms of *E. cichoracearum* on the Compositae in its less sharply marked specialization, the latter being usually confined to a single genus, often to a few species within the genus. It differs morphologically in the frequency of 3-spored asci and in the germination of the spores. Morphologically three varieties or races of the oidial stage of *E. horridula* can be distinguished. In race *a* the conidia average 30 to 35 μ in length; this race includes the f. sp. *symphyti, pulmonariae,* and *cerinthes minoris*. Race *b* has conidia 21 to 30 μ long and includes the f. sp. *asperuginis* and *cynoglossi*. Race *c* has conidia 25 to 28 μ in length and includes the f. sp. *echii-myosotidis* and a form of unknown affinities on *Lithospermum*. It appears evident that the same host may be attacked by more than one morphologically distinct race as well as by different biological formae speciales.

BLUMER (S.). **Die Formen der Erysiphe cichoracearum DC.** [The forms of *Erysiphe cichoracearum* DC.]—*Centralbl. für Bakt.* Ab. 2, lvii, 1–3, pp. 45–60, 3 figs., 1922.

In the present paper the author continues his observations on the specialization of various races within the collective species *Erysiphe cichoracearum* [see preceding abstract]. The results of his experiments, a description of which is given, showed that the mildews on the Compositae were somewhat highly specialized, all attempts to communicate the infection to other genera than that from which the material was taken being unsuccessful. The author, however, does not regard these results as conclusive, the experiments not having been conducted on a sufficient number of plants of varying ages. Probably in many of the experiments only the primary hosts were attacked. There is some evidence that the resistance of plants to mildew decreases with age, the disease generally being most virulent in the late summer and autumn.

E. cichoracearum embraces a large number of biological races of very unequal virulence. The forms occurring on *Centaurea montana* and *C. scabiosa* are very probably confined to these hosts. Within the genus *Hieracium* are two biological forms, one of which is restricted to the sub-genus *Pilosella* and the other to the *Euhieracia*. The oidia on *Senecio vulgaris*, *Centaurea jacea*, *C. phrygia*, *C. carniolica*, and *Cirsium eriophorum* attack principally species of one section within a genus. The strains on *Arctium*, *Sonchus*, *Prenanthes*, *Eupatorium*, and *Cirsium oleraceum* attack all species within the respective genera with approximately equal virulence. Kobel has suggested [see this *Review*, i, p. 79] that in parasitic selection the chemical affinity of the proteins in the host plants may be of paramount importance. The larger the genus the greater is the probability of its chemical heterogeneity, which would be reflected in parasitic selection within the genus. In the present case the individual species of the large genera *Centaurea*, *Cirsium*, and *Senecio* react to the *Oidium* exactly in the same way as genera of the Boraginaceae [see preceding abstract]. The species of *Arctium*, however, react to the *Oidium* in the same way as the Cucurbitaceae, specialization within the genus or family being absent in both cases.

The average dimensions of the conidia of the various races of *E. cichoracearum* referred to above, taken together, were 24·40 to 35·39 by 12·55 to 20·53 μ. On *Serratula rhaponticum* and occasionally on other hosts irregular as well as normal conidia were found, the former being very reminiscent of *Ovulariopsis* Pat. & Har. (*Phyllactinia*) or *Oidiopsis* Scalia [*Leveillula taurica* (Lév.) Arn.]. According to Arnaud (Les Astérinées, ii, 1921), these irregularities would indicate reversions to primitive types.

Several of the biological races are distinguished from the others by the size of the conidia (e. g. the form on *Arctium* has conidia 34 by 20 μ) and these differences, though slight, indicate potential morphological separation. The genera *Hieracium* and *Centaurea* are each susceptible to attack by two morphologically and biologically distinct types of *Oidium*. Neger's experiments (*Flora*, xc, 1902) suggest that two distinct biological races also occur on *Artemisia*, one on *A. absinthium* and the other on *A. vulgaris*, and the author's preliminary examination has revealed possible morphological differences between these two forms.

LAFFERTY (H. A.) & PETHYBRIDGE (G. H.). **On a Phytophthora parasitic on Apples which has both amphigynous and paragynous antheridia; and on allied species which show the same phenomenon.**—*Scient. Proc. Royal Dublin Soc.*, xvii, N.S., 4, pp. 29–43, 2 pls., 1922.

In the present paper the authors describe a rot occurring in apples in Ireland. Cultural and inoculation experiments proved the causal organism to be *Phytophthora syringae* and not *P. cactorum*, the species that has usually been found to cause rot in apples and pears in other countries. Economically the disease does not appear to be important, and it would probably be easily controlled by the destruction of all infected fruits.

The decayed apples had dark brown skins, but they were more or less firm and elastic to the touch. No superficial wounds were found, nor could any external indications of fungous growth be seen, though some of the lenticels showed small white tufts of hyphae after the affected fruit had been kept under a bell-jar in the laboratory for a few days. This mycelium bore a few sporangia and in addition sexual organs, which were found in the basal portions of the tufts and were of two types, the majority of the antheridia being paragynous (i.e. lateral or near the base of the oogonium, but not surrounding, or penetrated by, the latter), while a few instances of amphigynous antheridia of the type first discovered in *P. erythroseptica* (i.e. surrounding the oogonial stalk) occurred. The flesh of the diseased apples was brown and permeated by a rather coarse, non-septate mycelium, the hyphae being both in and between the cells. The white aerial mycelium, which was present in the cavities of the core, bore neither sporangia nor sexual organs, but the latter were found embedded in the soft tissues above and below these cavities. Here again antheridia of the paragynous type predominated.

The occurrence of both types of antheridia on *P. syringae* was confirmed by means of pure cultures obtained from portions of single hyphae, from single sporangia, and from a single oospore. In all cases the fungus produced sexual organs having both amphi- and paragynous antheridia. Sporangia are not produced abundantly as a rule, but when formed are borne on long, sympodially branched hyphae. They are obpyriform when mature, with no apical papilla, and average 40 by 27 μ. Germination is by zoospores, or sometimes by a germ-tube which frequently bears secondary, tertiary, &c., sporangia after a short growth. The oogonia are borne on rather short, lateral hyphae, and are pear-shaped and about 28 μ in diameter on an average. The antheridia, when lateral, are small, irregular, terminal swellings on short stalks which may arise either from the oogonial stalk or a neighbouring hypha. Antheridia of the amphigynous type resemble those already described in *P. erythroseptica*. The oospores are usually hyaline, spherical, and average about 25 μ in diameter, with walls from 1·5 to 2 μ thick. The fungus was proved to be pathogenic to apples and pears, but had no effect on potato tubers.

Cultural studies of *P. cactorum* and *P. fagi* received from several sources were also carried out. The authors give reasons for regarding these two species as distinct both morphologically and in their parasitic capabilities. In both cases sexual organs with amphigynous antheridia were occasionally produced, though the predominant style was the paragynous. The occurrence of bodies termed 'sphaero-conidia', round, usually intercalary spores, 33 to 40 μ in diameter, and germinating by germ-tubes, is reported in both species.

With the removal of these three species from the genus *Nozema*, founded by Pethybridge for the species of *Phytophthora* with paragynous antheridia, the species *nicotianae* remains the only one in which up to the present amphigynous antheridia have not been observed. As further study may reveal their presence in this species also, the authors propose to abandon the name *Nozemia* and reunite all species in the one genus *Phytophthora*.

Based on the mode of development of their sexual organs, the 22 species contained in the genus may now be grouped as follows:

A. Species in which, so far as is known at present, the antheridia when present are always amphigynous:

1. *P. infestans* (Mont.) de Bary.
2. *P. phaseoli* Thaxt.
3. *P. colocasiae* Racib.
4. *P. arecae* (Colem.) Pethybr.
5. *P. erythroseptica* Pethybr.
6. *P. parasitica* Dastur.
7. *P. terrestris* Sherb.
8. *P. allii* Saw.
9. *P. melongenae* Saw.
10. *P. meadii* McRae.
11. *P. cryptogea* Pethybr. & Laff.

B. Species in which the antheridia are preponderatingly paragynous, but are sometimes amphigynous:

12. *P. cactorum* (L. & C.) Schroet.
13. *P. fagi* Hartig.
14. *P. syringae* Klebahn.

C. Species in which, so far as is known at present, the antheridia are always paragynous:

15. *P. nicotianae* de Haan.

D. Species in which the mode of development of the sexual organs is not fully known, or in which these organs have not yet been found:—

16. *P. thalictri* Wilson & Davis.
17. *P. agaves* Vill. (?).
18. *P. faberi* Maubl. [But see following abstract.]
19. *P. theobromae* Colem.
20. *P. jatrophae* Jens.
21. *P. fici* Rau.
22. *P. citri* Rau.

[A 23rd species, *P. palmivora* Butl., overlooked by the authors, should be added to this group.]

Of these, *P. thalictri* is probably closely allied to *P. phaseoli*, and may ultimately be found to belong to group A. *P. agaves* and *P. jatrophae* have apparently so far not been described, and the latter (which has been issued in culture form) may be identical with *P. nicotianae*. On *P. fici* and *P. citri*, which were provisionally named in 1915, nothing further has been published. *P. faberi* and *P. theobromae* are probably synonymous. The latter is said to be closely allied to *P. arecae*, which would place it in group A, but antheridia are either absent or rare, and it is not known whether they are amphi- or paragynous. [The discovery of oospores with amphigynous antheridia in *P. faberi* is now reported. See next abstract.]

Ashby (S. F.). **Oospores in cultures of Phytophthora faberi.**— *Kew Bull. Misc. Inform.*, 9, pp. 257–262, 1922.

Phytophthora faberi Maubl., the cause of pod rot, patch canker, and chupon wilt of cacao in the West Indies and most other areas where *Theobroma* is cultivated, has so far never been observed to form oospores either in nature or in pure cultures; the bodies seen by Coleman and Rorer, and believed by them to be oospores, were devoid of antheridia and are considered by the author to be probably nothing but chlamydospores. The behaviour of the fungus, however, was found to be different when grown in mixed cultures with more or less related forms. Two of these were used. One was a species of *Phytophthora* that attacks the coco-nut palm in Jamaica (causing a serious bud rot) and has been identified as *P. palmivora*, while the other was a *Phytophthora* isolated in 1922 from rotting cotton bolls in St. Vincent. Neither of these two forms produces oospores in pure culture, and they appear to be identical in their vigour of growth, mycelial characters, and asexual reproduction. The cacao fungus differs from them in growing less vigorously and in developing sporangia less luxuriantly but, chlamydospores more freely, as well as in not forming characteristic mycelial aggregates that are usual in cultures of the coco-nut form. In all other respects, including the conidiophores and shape and size of the sporangia, *P. faberi* cannot be distinguished in pure culture from *P. palmivora* and the cotton boll fungus, but these last two have not been found capable of infecting cacao pods.

The first observations on pure cultures were made by the author at Kew during the summer of 1920. Pure and mixed cultures of the cacao and coco-nut bud rot fungi, isolated in Jamaica, were grown in tubes on slants of French bean agar in an incubator at 25° C. At the end of two months the pure cultures contained no oospores, while in the mixed cultures, obtained by inoculating the slants with the two organisms at a distance of about an inch from one another so that the independent colonies of each form met and mingled in a few days, oospores developed freely throughout the colony of the cacao fungus, and as far as the centre of the other growth. The mature sexual bodies were of the *P. infestans* type, with persistent amphigynous antheridia and a golden-yellow, thickened, oogonial wall. The mean size of the oospores was 23·3 μ with a variation from 19 to 26·5 μ.

With a view to controlling these results, pure and mixed cultures, technical details of which are briefly described, were grown in 1922 in Barbados with the cacao, the coco-nut bud rot, and the cotton boll forms. No oospores could be found in any of the pure cultures, nor were they present in the mixed cultures of two isolations of the coco-nut form or in mixtures of the latter with the cotton boll form, but in all the mixed cultures containing the cacao *Phytophthora* oospores were produced with the same characteristics as described above. A persistent antheridium, usually hyaline but occasionally yellow, was also present. The oogonia and antheridia always appeared to be developed on separate hyphae, but it was not possible to trace these hyphae definitely to the same mycelium. There was mutual penetration of the two colonies, but the more vigorous coco-nut and cotton boll strains appeared to push into the colony of the cacao fungus deeper than the latter did into their zones. The latter tendency was clearly shown in a number of mixed cultures in which a colony of the coco-nut form was allowed to develop for two days before the cacao fungus was inoculated on the upper part of the slant. In these examples oospores were present up to the apex of the slant, and the mycelial aggregates of the coco-nut strain were present at the apex also, indicating that it had grown through the cacao colony.

The absence of oospores from pure cultures of the three *Phytophthoras*, their close relationship as indicated by the mycelial growth and the size and shape of the asexual spores, and the more vigorous growth of the coco-nut and cotton boll strains which appear to be identical, suggested that all may be strains of one heterothallic species, the two more vigorous strains being plus strains and the more weakly growing cacao form a minus strain. This view, however, is not supported by the fact that oospores of the same type and the same mean size and variation were also formed in mixed cultures of the cacao fungus with an unrelated species, namely, *P. parasitica*, isolated from *Ricinus communis* in India. The latter fungus is quite distinct from the other forms here mentioned both in producing oospores freely in culture and in its morphological and other characters.

The above observations show that the oospores formed in the mixed cultures are actually those of *P. faberi*: they are substantially larger than those of *P. parasitica*, but approach closely in size to those of *P. meadii* and *P. colocasiae*. The cotton boll *Phytophthora* is apparently identical with *P. palmivora*. The absence of oospores both in pure and mixed cultures of this species and some growth differences, as well as its inability to infect cacao pods, distinguish it from *P. faberi*, and the author regards it as no more justifiable to include it in one species with the latter than to unite it with *P. meadii*.

HOWARD (N. O.). **The control of sap-stain, mold, and incipient decay in green wood with special reference to vehicle stock.** —*U.S. Dept. of Agric. Bull.* 1037, 55 pp., 2 pl., 25 figs., 1922.

Green timber containing a high percentage of sapwood often suffers considerable damage during periods of transit and storage, especially during the late spring and summer months. Sap-stain may be divided into two classes, namely (1) the staining produced by chemical reactions due to the agency of certain oxidizing enzymes present in the wood itself; (2) fungous stains (blueing) caused by species of *Ceratostomella* and other fungi [see this *Review*, ii, pp. 49, 50]. The degree of susceptibility to sap-stain varies considerably in different species of timber. Among the conifers, southern and western yellow pine [*Pinus palustris* and *P. ponderosa*], sugar pine [*P. lambertiana*], and the spruces appear to be readily stained, while red gum [*Liquidambar styraciflua*], red oak [*Quercus rubra*], white oak [*Q. alba*], and hackberry [*Celtis*], among the broad-leaved trees, exhibit great susceptibility.

Superficial discoloration is caused by a number of moulds. Those recorded, either by previous investigators, or isolated during the work here reported, include 7 species of *Graphium*, 10 of *Penicillium*, 4 of *Aspergillus*, *Fusarium arthrosporioides*, *Alternaria tenuis*, *Stachybotrys alternans*, *Cephalothecium roseum*, *Chaetomium* sp., *Stemonitis* sp., *Gliocladium* sp., *Hormodendron* sp., *Hormiscium* sp., *Cladosporium* sp., *Citromyces* sp., *Clonostachys* sp., *Haplographium* sp., *Mucor* sp., *Oidium* sp., *Syncephalastrum* sp., and

Trichoderma sp. Neither the blue-stain nor the mould fungi, however, cause any appreciable dissolution of the wood fibres, so that the strength and durability of the timber are not materially affected.

The methods used in felling and handling the timber in the woods and the subsequent handling during transit and storage are briefly considered in relation to their influence on the development of moulds. Kiln drying is stated to eliminate or reduce decay, sap-stain, and moulds. Steaming the green timber is sometimes practised, and experiments carried out at the Forest Products Laboratory at Madison, Wisconsin, showed that it was effective at atmospheric pressure, when applied for not less than three hours, in killing surface fungi, but that the steamed timber moulded freely subsequently, unless piled so as to secure an ample circulation of the air.

Experiments in the chemical treatment of green wood showed that creosote dipping of red oak spokes prevented sap-staining but not the occurrence of moulds. The creosote bath was nearly as effective at 80° to 90° F. as at 150° to 155° F. Mercuric chloride (1 per cent.) was probably the best antiseptic for the control of sap-stain and moulds. Somewhat less satisfactory results were obtained from the use of 5 per cent. borax solution, and from dry quicklime, while common salt was quite ineffectual.

A further series of experiments was undertaken to determine the comparative values of various antiseptics and preservatives used for dipping red oak blocks. Where possible the solutions were made up to contain 1 per cent. by weight of the anhydrous salt. The blocks were immersed for approximately 10 seconds in the solution, drained, and then thoroughly sprayed with suspensions of the spores in water. Fifteen of the moulds above mentioned were employed. It was found that the blocks dipped in sodium carbonate, sodium bicarbonate, sodium fluoride, sodium bifluoride, ammonium fluoride, magnesium silicofluoride, zinc silicofluoride, and bleaching powder became severely moulded on exposure to a temperature of 80° F. and a relative humidity of 85 to 100 per cent. for three to four weeks. Potassium alum, potassium chlorate, and copper sulphate seemed to incite the growth of most of the fungi used in the inoculation experiments, especially *Aspergillus niger*. Borax effectively controlled sap-stain and prevented all but a slight development of mould. The efficacy of the preservatives was not increased by the addition of hygroscopic substances such as sodium chloride, calcium chloride, and glycerine. Of the organic compounds and mixtures tested, creosote and kerosene gave the best results, followed by mykantin, which, however, stained the wood yellow.

It is evident from these and the other investigations described that the prevention of sap-stain, mould, and incipient decay in green material can be best effected by a combination of remedial measures, of which the following are especially important. Care in the selection of raw stock, which should be free from fungous infections; expedition in the movement of raw stock from the felling of the logs to the stage in manufacture when the wood becomes sufficiently dry to withstand the attacks of fungi; provision for ample ventilation of the stock, thus ensuring at least surface drying; the kiln drying of the stock whenever possible; and in special cases steam treatment or the use of antiseptic dips, followed by proper piling [full directions for which are given] to ensure adequate ventilation.

SCHMITZ (H.). **Note concerning the decay of western Yellow Pine slash caused by Polyporus volvatus Peck.**—*Phytopath.*, xii, pp. 494–496, 1 fig., 1922.

This note reports briefly the frequent occurrence of *Polyporus volvatus*, especially on western yellow pine [*Pinus ponderosa*] slash, in the north-west of the United States. The fungus has not been proved to be a parasite, though the possibility has been previously suggested, and the observations recorded by the author indicate that it has at least weakly parasitic tendencies.

STEVENS (F. L.). **A fungus destructive to asphalt shingles.**—*Phytopath.*, xii, 10, p. 497, 1 fig., 1922.

A roof of asphalt shingles, the shingles consisting of felt paper (similar to that used under carpets), saturated with asphalt and backed on one side with slate, was destroyed by a Basidiomycetous fungus, the mycelium of which resembled *Merulius lacrymans*. Stock shingles in storage are reported to be sometimes similarly damaged. The hyphae were found to have penetrated the shingle, subsisting presumably on the felt paper.

GARD (M.). **Sur le dépérissement des jeunes noyers en 1922.** [On the dying-off of young walnut trees in 1922.]—*Comptes rendus Acad. des Sciences*, clxxv, 17, pp. 716–718, 1922.

During the spring and summer of 1922 a large number of young walnut trees in south-western and central France suffered from a disease the chief symptom of which was a severe die-back of twigs and branches, often reaching far down the trunk and in some cases even killing the whole tree. This condition was sometimes accompanied by various external lesions; the bark sometimes peeled off and rolled up, and wounds formed at the forks of the branches from which a blackish and foul-smelling liquid was exuded. The bark turned black either completely or, in the large branches and the trunk, partially, sometimes only on one side. Many of the cells of the cortex, phloem, and cambium were blackened, and the discoloration extended into the medullary rays of the wood, though in the larger limbs it was limited to the newly-formed layers. The vessels contained gum. No organism could be found regularly present in the affected tissues and a physiological explanation has been sought.

The author believes this disease to be the consequence of the early autumn frosts of 1921, when the trees were still in full vegetation. The fact that the less vigorously growing trees with less sap were spared though standing in the immediate vicinity of the severely affected, more robust, sappy individuals is considered to support this view. In many cases the injurious effects were not visible in the following spring, the trees giving out new, vigorous shoots which, however, died back during the summer. This sequence of events was due, in the author's opinion, to cell injuries which resulted in the slow production of toxic substances and their diffusion with the renewal of growth to the more distant parts of the tree. The disease was apparently not confined to walnut trees, various other plants such as figs, grape vines, and *Laurus nobilis* showing more or less similar symptoms.

BLIN (H.). **La maladie dite 'de l'encre' des Châtaigniers.** [The so-called 'ink' disease of chestnuts.]—*La Nature*, 2534, pp. 282–284, 1922.

The so-called 'ink' disease of chestnuts constitutes a serious danger to French sylviculture, especially in the Departments of Ardèche, Corrèze, Corsica, Gers, Lot, and Lozère. It is estimated that the disease has already destroyed more than 30,000 hect. of chestnut plantations.

Trees suffering from this disease present certain well-marked symptoms. The upper branches wither first, then those lower down. The leaves lose their brilliant green and become glaucous; their development is arrested, and they fall in August. The fruit does not ripen and adheres to the husk even after its fall. The roots become soft, spongy, and brittle, and exhibit deep purple or almost black areas, from which flows an astringent liquid with a pronounced empyreumatic odour. The tannin contained in this liquid combines with the iron in the soil to form a substance resembling ink. The small roots are withered, and their cortex becomes loosened: they are invaded by dark-coloured hyphae which penetrate the cortex and reach the medullary rays. In cases where the disease is of long standing, black patches appear on the trunk and branches shortly before the death of the tree. These patches form cankers from which exudes a liquid similar to that observed on the roots. It turns black on exposure to the air and stains the base of the tree.

Chestnut trees attacked by ink disease may languish for several years or die in a few months. No soil is exempt from the disease, which is, however, much more virulent in moist, closely packed, and impermeable soils. Trees growing on the banks of streams and in plains or valleys are usually attacked before those on slopes or in the mountains. Grafted trees are more susceptible than non-grafted, and certain varieties, amongst which are Green, Early Black, Early Red, and Corrive are extremely liable to infection. Generally speaking, coppiced trees are resistant.

Mention is made of Mangin's investigations which have led him to the conclusion that the disease is caused by a fungus, *Mycelophagus castaneae*, which destroys the mycorrhiza as they appear and induces a progressive necrosis of the roots. The latter are thickened and entirely enveloped in a fungous growth which arrests the development of the mycorrhiza and deprives the tree of the benefits normally resulting from symbiosis.

Experiments in the treatment of the disease have shown that watering the holes, before planting, with a 20 per cent. solution of iron sulphate produces excellent results. The introduction of resistant varieties is, however, the most promising method of dealing with the situation; *Castanea dentata* and *C. mollissima*, originating in Japan and China respectively, have been imported for French plantations with satisfactory results. This practice, however, has now been discontinued. or very greatly restricted [see this *Review*, i, p. 280], owing to the danger of introducing material infected by *Endothia parasitica*, the cause of a very serious chestnut disease, which is prevalent in China and Japan but is as yet unknown in Europe.

KAUFFMAN (C. H.) & KERBER (H. M.). **A study of the white heart-rot of Locust, caused by Trametes robiniophila.**—*Amer. Journ. of Bot.*, ix, 9, pp. 493–508, 3 figs., 1922.

The white heart rot of the black locust tree, *Robinia pseudo-acacia*, caused by the fungus *Trametes robiniophila*, is very common in Southern Michigan, though it does far less damage than the attacks of the locust borer or of *Fomes rimosus*. The prevalence of the disease cannot be gauged by the number of sporophores observed, since the fungus fruits sparsely and the sporophore is soon disintegrated by the effects of the weather and by insect parasites.

A detailed examination of a diseased tree, thirty-five years old, was carried out. It had borne a large sporophore the previous year and another was growing from a frost crack at the time of cutting, while there were several old scars on the trunk marking the positions of earlier fructifications. Borer attacks were numerous, and the internal condition of the wood indicated that the tree must soon have succumbed to storms, though it still bore green and vigorous leaves.

The fungus had entered through borer holes in the large upper branches and had started a rot which worked down to the trunk. The numerous borer channels contained mycelium. The apparently sound wood was sharply cut off from the rotten areas by a very fine brownish-black zone, one-fourth to one-half a millimetre in width. Inside this line was an area of slightly rotted wood, light fawn to brownish-white in colour, solid in texture, but softer and lighter in weight than the sound wood. This area of incipient decay could be cut easily without breaking. Nearer the point of origin of the rot was an area of completely decayed wood of the same colour as the last, but very dry and friable, so that it could not be cut without breaking. This area was marked in the last stages of decay by white streaks composed of delignified wood fibres.

The effects of the fungus on the elements of the wood are described in detail. In the black border zone the elements were infiltrated by a brownish substance, the cells of the medullary rays and wood parenchyma being most heavily impregnated. The wood fibres were the least affected elements in this zone. No hyphae were found, though the holes made previously by the hyphae passing from cell to cell were plentiful. The dark colour is believed to result from chemical changes in the dead cells, but the exact origin of the brown substance was not determined. In the area of incipient decay hyphae were again absent, though the perforations that had been caused by them were larger and more numerous than in the border zone, especially in the medullary rays and wood parenchyma. The cell contents of these last two tissues had entirely disappeared. All the other elements showed evidences of fungous attack, the wood fibres being still the least affected. The badly-decayed area in the centre of the rotten core was so brittle as to be difficult of examination. The bore holes of the hyphae were of still larger size, and the cell walls were in places riddled by them. The tracheids and vessels were merely a broken mass of fragments, but the fibres and medullary ray cell walls retained some degree of cohesion. In the final stages nothing was left in a recognizable form but the wood fibres, which were eroded and colourless from delignification.

In the apparently sound wood, immediately outside the dark boundary line, living mycelium was found in abundance, composed of hyaline, branched, septate hyphae, 1 to 1·5 μ in diameter. The hyphae passed from cell to cell both through the pits and through the normal wall, and were most numerous in medullary rays and wood parenchyma. The mycelium was abundant up to 7 cm. from the black line and no doubt extended much further, so that there was practically no sound wood left in this tree in a radial direction from the rotten core, and in a vertical direction for at least 2 ft. from the uppermost limit of the visible rot.

Tests of the strength of the wood were made from the apparently sound portions. In crushing tests the wood was found to stand only one-half to three-quarters (according to distance from the rotted parts) of the standard pressure per square inch which this timber should bear. The importance of this 'advance rot' is now receiving recognition in the case of other timbers, research into the cause of the loss of life during the war from weak spots in aeroplane timber having been specially directed to this matter.

The authors state that in the majority of the heart rots of trees hyphae are rare in the rotted tissues except when they occur in isolated nests or pockets. In the present case they appeared to be entirely absent from the areas of visible rot, except in the borer channels. How they disappear is not known and requires further investigation.

Scott (C. E.). **Disease of Chestnut trees new to California.**—*Monthly Bull. Dept. Agric. California*, xi, 10. pp. 740–741, 1922.

Eight year old chestnut trees in Grass Valley, California, have recently been attacked by a species of *Fusicoccum* somewhat resembling *Endothia parasitica*, the cause of chestnut blight in the eastern United States. The first symptom of the disease is a wilting or drooping of the foliage caused by the girdling of the branch or trunk by the fungus. The latter probably gains admission to the bark only through wounds. As it progresses it kills the inner bark while the tissues surrounding the dead area continue to enlarge and become elevated, leading to the production of a canker. The main advance occurs longitudinally on the infected branch, but extension also proceeds round the latter, interfering with the passage of food and killing the parts beyond the canker. The latter is more or less depressed according to its age, and may extend for several feet along the limb.

The minute spores developed in old cankers may be disseminated by means of insects, birds, implements, &c., to wounds in the bark, where the disease will be reproduced under favourable conditions.

Diseased branches should be removed and burnt, and small cankers can probably be eradicated by excising all the diseased bark. All pruning or cutting wounds should be well disinfected, preferably with the cyanide of mercury—bichloride of mercury mixture.

The growing of chestnuts in California is still in a more or less experimental stage, being intended to meet the deficiency caused by the destruction of this tree by *Endothia parasitica* in the eastern United States. Hence it is highly important to guard carefully against the introduction of diseases and pests and to attempt to eradicate or control the present outbreak.

Caballero (A.). **El Boixat, o enfermedad de los Ajos, en Bañolas.** [' Boixat ', or disease of Garlic, at Bañolas.]—*Bol. R. Soc. Esp. de Hist. Nat.*, xxii, 4, pp. 210–212, 1922.

For the last twenty years a disease, known locally as ' Boixat ', has caused considerable damage in garlic fields in the Bañolas (Gerona) district of north-eastern Spain. The intensity of its attack in bad years threatens ruin to an otherwise profitable and important industry, the loss in 1914 amounting to 300,000 pesetas or 30 per cent. of the total value of the crop.

Various causes have been put forward at different times to account for the trouble, one being bacterial infection associated with colonies of *Rhizoglyphus echinopus*, another being the attack of *Tylenchus devastatrix*, with *R. echinopus* and *Anthomia ceparum* as secondary pests. Like Fragoso, the author found *Peronospora schleideni* in association with *Macrosporium parasiticum* on specimens from the district referred to, but in all cases he also found numerous globose-depressed, very hard, greyish-black, dull, rugose bodies, up to 1 mm. in diameter, on the bulbs. The appearance suggested the attack of a fungus belonging to the Tuberculariaceae, but further examination showed that only sterile mycelium and sclerotia were present and the parasite was identified by the author as *Sclerotium cepivorum*. It is regarded as the most destructive of the garlic parasites in this district. *S. cepivorum* has been united by Voglino with his *Sphacelia allii*, and by Sorauer with *Botrytis cana*. Delacroix and Maublanc, however, obtained nothing but an abundant formation of sclerotia in all their cultures, and this has also been the author's experience.

To check the disease it is recommended to burn all diseased plants, to suspend cultivation in the most infected fields, and to steep seed bulbs likely to carry infection in a solution of formalin at a strength of 1 to 300.

The Plant Pests Control Ordinance, 1922. Seychelles, 21st September 1922.

This Ordinance gives the Governor in Executive Council powers to control the importation of all plants into the Seychelles and to order any treatment necessary on such plants as are permitted to be imported. The Head of the Agricultural Department is authorized to dispose of imported plants and their containers by destroying them, or by other methods, subject to the approval of the Governor, if he thinks necessary. The Governor may declare the existence of a pest and may regulate, on the advice of the Head of the Agricultural Department, the treatment to be adopted against such a declared pest. In the same way the Governor may declare an area to be infected, and the transport of plants to and from areas thus declared to be infected can be prevented under similar regulations. The carrying out of the regulations is entrusted to inspectors. The Governor may prohibit the transport of any plant from Island to Island in the Colony. The owner or occupier of any land suspected to be infected may be called upon by the Head of the Agricultural Department—subject to appeal to the Governor in Executive Council—to carry out any treatment deemed necessary, failing which a penalty is imposed and the treatment will be carried out by the Head of the Agricultural Department at the owner's expense. Penalties for non-compliance with this Ordinance are specified, and the prosecutions are entrusted to the Agricultural Department. Former Ordinances and Government Notices dealing with similar matters are repealed.

Plant Pest and Disease Ordinance, 1921 (No. 38 of 1921): Regulations. Dar-es-Salaam, Tanganyika, 19th September 1922.

The salient features of the Tanganyika Plant Pest and Disease (Coco-nut) Regulations, 1922, are as follows. The owner, lessee, or person in charge of any dead coco-nut palm shall immediately cut it down, burn the crown and any decayed parts, and bury the rest of the stem. An inspector may, at his discretion, prescribe the cultural measures or treatment to be adopted in the case of infection by pest or disease, and is authorized to superintend the work of destruction, if necessary, and to fix a time-limit for the execution of the prescribed measures. All dead leaves from the crowns of coconuts must be removed and burnt. No palm may be mutilated except for the purposes of tapping for the extraction of 'tembo'. Inspectors are authorized to see that each coco-nut tree is surrounded by an area not less than 5 ft. in radius free from underbush, underwood, grass, and weeds, and that these are cut down twice a year on all coco-nut plantations. The use of coco-nut stems as fence posts, in bridge building, and in other construction work (except for the interior of buildings) is prohibited. By order published in the *Gazette*, the Governor may temporarily prohibit the practice of tapping for 'tembo' in any specified area.

IMPERIAL BUREAU OF MYCOLOGY

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SOURSAC (L.). **Étude de quelques maladies de la Laitue et des moyens de les prévenir ou de les combattre.** [A study of some diseases affecting Lettuce plants and of means to prevent or check them.]—Reprinted from *Congrès pour l'avancement des sciences*, Montpellier, 1922, in *Bull. Soc. Path. Vég. de France*. ix, 3, pp. 207–213, 1922.

In this paper three diseases of lettuce are discussed. A mild form of collar rot of lettuce and chicory plants due to *Sclerotinia libertiana* has been known in the Rousillon District (Eastern Pyrenees) for 12 to 14 years, but, no doubt owing to the introduction of more intensive cultivation, the disease has recently spread considerably, its development being further helped by the adoption of the trench system of irrigation, which transports the sclerotia from plot to plot. In the United States, where Poole has studied this disease on celery [see this *Review*, ii, p. 102], seedlings under glass are severely affected, but the loss in the field crop is insignificant. This is not the case in the Eastern Pyrenees, where glass is generally dispensed with, the sowings being made in the field, and the plants resulting from the thinning-out process being used for transplanting. Whilst in the United States the maximum intensity of the disease occurs at about the period when the young plants are ripe for transplanting, in France it reaches its height when the plants are two or three months old, the original sowings and transplantings being nearly equally affected. Light soils and wet years are favourable to the development of collar rot, which is also helped by the humid conditions and heavy nitrogenous fertilization connected with intensive cultivation. In 1921 the sowings made in September were severely attacked, those of November much less, and those of the following months were practically immune. Healthy lettuce transplanted to the immediate vicinity of infected plants in March remained free from the disease. The varieties in descending order of resistance are: cos lettuce of more or less straight growth, winter lettuce ('laitue d'hiver') of more or less spreading growth, curly chicory ('chicorée frisée') and endive.

Attempts to germinate the sclerotia in various media have failed so far, probably because a sufficient resting period has not elapsed for their maturation. Measures for the control of the disease are now being tested.

Malformation of lettuce heads ('cabuchage') is a fairly frequent disease probably of physiological origin. The percentage of affected plants may reach 60 to 70. They are recognized by their folded and shrivelled leaves, which form loose and dwarfed heads.

Finally a second malformation, characterized by multiple branching, of cos lettuce plants of the variety 'romaine', is described. This condition prevents the formation of heads and renders the product unsaleable. The remedy for both these last-named diseases appears to be a rigorous selection of seed.

WINGARD (S. A.). **Yeast-spot of Lima Beans.**—*Phytopath.*, xii, 11, pp. 525–532, 4 figs., 1922.

A new disease of Lima bean seed (*Phaseolus lunatus*) was observed in October, 1921, in Virginia and has since been found to be rather prevalent and widely distributed in the State, as much as 60 per cent. of the crop being attacked in some cases.

The disease only occurs on the seed in the pod, causing numerous dark, sunken areas on the cotyledons; pods that appear to be quite healthy may contain badly affected seed. When the latter is attacked early it may die before ripening or remain undersized. The testa is usually unbroken, the infected spot being dark brown, somewhat sunken, and wrinkled, but sometimes it is ruptured, and crater-like lesions are then produced on the cotyledons. In these lesions, which are greyish-brown and granular, great masses of ascospores of a yeast and a small number of vegetative cells and young asci are found. The organism was readily isolated from several lots of beans, the platings invariably yielding pure cultures. It belongs to the genus *Nematospora* described by Peglion in 1901 (*Centralbl. für Bakt.*, Ab. 2, vii, p. 754). It differs in certain characters from the two species already described, and the author names it *N. phaseoli*, a full description being given.

The cells vary widely in form, from the elliptical and spherical types common in young cultures to mycelium-like strands, which bud at the cross walls; curiously shaped cells, like miniature tennis rackets, walking sticks, &c., are not uncommon after twenty-four hours growth. In size the elliptical cells measure 8 to 14 by 6 to 10 μ, the mature spherical cells 20 μ, and the mycelial strands 90 to 140 by 2·5 to 3·5 μ. Ascospores are produced in great numbers on bean seed and in favourable nutrient media. The asci are cylindrical with rounded ends, 60 to 85 by 10 to 12 μ; the ascospores, arranged in two groups of four, are 40 to 46 by 2·5 to 3 μ, slender, 1-septate, slightly ridged at the septum, with an acute apex, and a base extended into a slender, non-motile whip which is about one-and-a-quarter times as long as the spores. The ascospores germinate by the basal cell swelling to a sphere about 6 μ in diameter, from which either a mycelial strand is produced or spherical cells are budded off. All the stages of the organism stain readily with ordinary stains, and it is Gram positive.

It grows well on media suitable for yeasts, and the cultural characters on six media are described. On beer wort agar the colony is convex, circular, with entire margin and smooth surface, opaque, dull, cream-coloured at first, then gradually turning to brown. Asci are produced in forty-eight to seventy-two hours, and after about three weeks the colony becomes surrounded by a mycelial growth on which a second crop of asci is borne. The optimum temperature in culture and for infection of Lima beans is probably about 30° C.

The pathogenicity of the organism has been demonstrated repeatedly in the greenhouse. Negative results were obtained when the pods were sprayed with a water suspension of the organism or smeared with a pure culture, but the seed was readily infected when the pods were inoculated through punctures. The symptoms become evident within two or three days of inoculation, and are quite conspicuous within seven to ten days. The organism was not pathogenic on garden peas and only weakly parasitic on tomatoes.

JONES (S. G.). **A bacterial disease of Turnip (Brassica napus).**—*Journ. Agric. Science*, xii, 3, pp. 292–305, 1 pl., 1922.

A disease of the white turnip has of recent years made its appearance in North Wales, especially on land treated with lime or a heavy dressing of nitrogenous fertilizers.

From a casual glance affected plants looked perfectly healthy, but on closer examination it was seen that the very young leaves at the centre of the crown had been destroyed, forming a tiny wound which the fully expanded leaves effectively concealed, so that the extent of the damage was often only revealed at lifting. In section a diseased root showed a flask-shaped, soft, putrid core, surrounded by a brown zone of healthy tissue. Sometimes the apical bud had been destroyed, and three to five vigorous secondary crowns developed in its place.

The causal organism was isolated by plating out in the usual way. Fresh isolations attacked turnip blocks very rapidly, but old cultures carried over for about twenty generations were found to have lost their pathogenicity.

Infections were attempted by immersing for an hour uninjured leaves (attached to the plant) in water containing the organism in suspension. No infection resulted, and the author is of the opinion that infection is preceded by mechanical injury (e.g. leaf cutting insects or slugs). The earliest signs of disease appeared in the young leaves, but attempts to infect them by inoculations gave negative results. When the tender foliage at the growing point was pinched off and the wound inoculated, infection always resulted and typical symptoms were produced, except that when the roots were of a dry, spongy texture, the diseased core was of uniform brown colour instead of whitish-grey, the difference in colour being due to oxidation.

Microscopical examination of affected tissues showed the cells to be comparatively isolated, the cell walls, however, remaining intact.

The disintegration of the tissues appeared to be occasioned by the solution of the middle lamella.

The separation of the by-products from the bacteria was attempted, and by adding chloroform to the liquid of a vigorous culture filtered through filter paper, a product was obtained which disintegrated thin slices of turnip but which was sterile.

The causal organism, which has one polar flagellum, is fully described. It has many characters in common with *Pseudomonas campestris* E. F. Smith and with *Bacillus oleracea* Harrison, but is clearly most nearly related to *Pseudomonas destructans* Potter, from which it differs chiefly by its mode of attack, by being Gram positive, by losing its virulence on repeated culturing, and by producing ammonia on some media. The author is of opinion that it is a varietal form of the latter.

MEIER (F. C.) & LINK (G. K. K.). **Bacterial spot of Cucumbers.**—*U. S. Dept. Agric. Circ.* 234, 5 pp., 1 pl., 1922.

This paper gives a short and popular description of two affections of cucumber, the bacterial spot of fruit and angular leaf spot, both of which occur frequently in the United States and also in Canada and Europe, and are due to the same cause, *Bacterium lacrymans*.

The disease first appears on the cucumber plant in the form of water soaked, translucent, round to irregular spots on the cotyledons. The later leaves show similar but angular spots which extend along the vein and which, under moist conditions, increase in number so as to cover the entire leaf, a white, gummy exudate swarming with bacteria frequently accompanying the spot. Within about eight days the spots become dry and white or tawny; subsequently the affected tissues may be knocked out, giving the foliage a ragged appearance. The stems and petioles are occasionally attacked, becoming water soaked and covered with a bacterial exudate. On the fruit, which may be affected in the field or become contaminated during the picking and packing processes, the spots first appear as minute, circular, water soaked areas, which later become conspicuous owing to the centres taking on a chalky white colour due to the drying and cracking of the affected tissues. The spots remain shallow, but they afford entrance to organisms which are capable of producing secondary rots, and heavy losses occur in transit from this cause. The disease may cause a stunting of growth, and the reduction in leaf surface often leads to a lowering of the yield.

Hot, dry weather tends to check the disease, but rains, especially if accompanied by wind, increase its spread.

The bacteria appear to be carried on the seed, and immersing the latter in mercuric chloride, 1 in 1,000, for five minutes, then washing thoroughly in water, gives a good control. Angular leaf spot can also be controlled by spraying with a 4–4–50 Bordeaux mixture, although the seed treatment is simpler and less expensive.

HIGGINS (B. B.). **The bacterial spot of Pepper.**—*Phytopath.*, xii, 11, pp. 501–516, 2 pl., 5 figs., 1922.

A bacterial disease of chilli pepper (*Capsicum annuum*) has been very destructive in Georgia since 1920. On the leaves the spots first appear as small, circular, pale-green pimples, somewhat raised on the under surface, and usually with a slight depression on the upper. On old leaves, infection appears as dark green, water soaked spots. Usually the centre of the spot collapses in a few days, while the edges extend forming a circular or oblong, pale yellow or straw-coloured patch, 1 to 10 mm. across with a border of water soaked tissue which finally turns dark brown. Infected leaves fall, often becoming yellowish before doing so.

On the stem, the disease forms inconspicuous, raised cankers, and on the fruits more noticeable spots, which are pale green at first, but soon turn brown and become cracked and wart-like.

Isolations from infected spots yielded a yellow bacterium, the morphological, cultural, and physiological characters of which are fully described. It is a short rod, usually occurring singly or in pairs, rarely in chains. It is not very motile, but sometimes has a single polar flagellum. Capsules are present on certain media. It stains readily, but is Gram negative; grows moderately rapidly, is a strict aerobe, and liquefies gelatine. On beef extract agar with 3 per cent. dextrose or saccharose, the medium became first alkaline, then neutral, and finally acid, but with lactose it remained alkaline. The group number for this organism should be B. 211. 2222523.

Hundreds of plants have been successfully inoculated with this bacterium, and the latter re-isolated from them. The incubation period in summer is about 10 to 15 days. The exact mode of penetration of the leaf was not observed, but in early stages of infection slimy masses of bacteria were found in the stomatal cavities and adjoining intercellular spaces. The cells in contact with the mass swell and break the epidermis, the bacteria spreading in the intercellular spaces, forcing the cells apart, and finally killing them.

The identity of the organism is still uncertain. It resembles those isolated from tomatoes by Miss Doidge in South Africa and by Gardner and Hendrick in Indiana, but a comparative study of the three organisms is necessary.

The bacteria appear to be carried on the seed. Mercuric chloride (1 in 1,000) was quite effective in controlling the disease, but was liable to do severe damage to the seed, whilst spraying four times in the field with Bordeaux mixture reduced the infection considerably but did not give complete control.

Montemartini (L.). **L'applicazione degli Articoli 6 e 7 della Convenzione internazionale di Roma 4 marzo 1914 contro le malattie delle piante.** [The application of Articles 6 and 7 of the International Convention of Rome of 4th March 1914 against the diseases of plants.]—*Riv. Pat. Veg.*, xii, 1–2, pp. 1–7, 1922.

In this paper the author enumerates the difficulties connected with the practical application of Articles 6 and 7 of the International Convention for the Prevention of Plant Diseases signed at Rome in 1914.

Article 6 gives each signatory State the right to restrict the entry of plants covered by the Convention to certain selected places, and Article 7 provides for the inspection of the imported material and specifies the sanctions to be applied in case of disease being found, contrary to the certificate accompanying the consignment. In such a case the consignment is either returned or destroyed by fire at the exporter's expense, and the latter's Government is immediately advised of the steps taken.

From experience gained at the Milan office, the author questions the practical utility of these measures, chiefly owing to the extreme difficulty of satisfactory inspection. It is contended that it is impossible to examine the material as minutely as the nature of the case demands, and that the healthy state of part of a consignment does not warrant the conclusion that the remainder is fit to pass the frontier. There is also the packing to be considered; this is very complicated in some cases, such as orchids, and requires technical skill in handling which is not available at the Customs. In the case of bulbs packed in boxes the difficulties are even greater, as in practice it is impossible to examine them one by one. Some parasites are hidden in the plant tissues and do not reach their full development on the surface until the last stages of the growth of the host. Others, such as *Septoria* [*apii*] on celery and *Phoma* [*betae*] and *Cercospora* [*beticola*] on beet, are seed-borne and invisible; others, again, are disseminated by the wind and inspection is powerless to prevent them from invading a country. The disinfection of all material sent would not be practicable for technical reasons.

The author concludes that the only effective remedy is increased vigilance on the part of each individual State within its own borders, which alone can make possible the prompt detection and eradication of plant diseases; and this must be supported by strengthening the frontier organization designed to prevent the entry of undesirable material.

Nevertheless, he thinks that the Articles under discussion should be retained for cases in which the examination of one sample makes a deduction as to the state of the remainder reasonably certain.

BIERS (P. M.). **Le Polyporus (Ungulina) inzengae de Not., parasite du Peuplier.** [*Polyporus* (*Ungulina*) *inzengae* de Not., parasitic on the Poplar.]—*Bull. Soc. Path. Vég. de France*, ix, 3, pp. 166–168, 1922.

At Parc St. Maur (Seine), France, a black poplar tree (*Populus nigra*) was observed to undergo a gradual process of decay, lasting for several years, and finally to die. The stem was covered with the fructifications of *Polyporus* (*Ungulina*) *inzengae* [*Fomes fomentarius*]. Several subsequent observations on other poplars bearing the same fungus support the view that this species acts as a true parasite, entrance being probably gained, in the cases seen, through wounds caused by clumsy pruning. Its development on the poplar is slow, and external evidence of its presence is only visible in the last stages of the disease.

FERDINANDSEN (C.). **Det plantepatologiske Arbejde i Danmark.** [Phytopathological work in Denmark.]—Reprinted from *Nordisk Jordbruksforskning*, pp. 333–351, 1922.

The author gives an interesting account of the origin and development of work on the diseases of plants in Denmark. The headquarters of the Danish Plant Protection Service, a branch of the State Agricultural Experiment Board, are situated at Lyngby, ten miles north of Copenhagen. The work is under the general supervision of the Director, and is organized in three separate divisions, engaged respectively in botanical research, including fungous, bacterial, and physiological diseases; zoological research: and extension work for the distribution in popular form of the results of investigations. By co-operation with various experiment stations and agricultural organizations, arrangements are also made to conduct experiments and collect useful data in all parts of the country. These data are used in the compilation of the 'Monthly Survey of Diseases of Agricultural and Horticultural Crops', which appears from April to November.

The work of the extension or information section comprises the issue of popular leaflets on the more general and familiar diseases, replying to simple queries, procuring phytopathological material for exhibitions, lecturing, journalistic work, and the arrangement of summer meetings, excursions, and so forth.

During the last few years the standard of seed purity has been greatly improved by the State Seed Testing Station, an institution which works in co-operation with the Plant Protection Service.

In 1903, after Rostrup had shown that the annual loss to Danish agriculture from black rust [*Puccinia graminis*] amounted to Kr. 10,000,000 [about £400,000 at present], the law of 1869 providing for the extermination of the barberry was put into effect. The second plant disease law, which was promulgated in 1921, is concerned with the export and import of potatoes and has been already noticed in this *Review* [i, p. 125].

Krankheiten und Beschädigungen der Kulturpflanzen im Jahre 1920. [Diseases and pests of cultivated plants in the year 1920.]—*Mitt. biol. Reichsanst. Land- und Forstwirtsch.*, 23, 110 pp., 1922.

In the introductory section of this report Dr. Schwartz states that the annual reports of the diseases and pests of cultivated plants, formerly included in the agricultural reports published by the Ministry of the Interior, will in future be brought out in an abbreviated form by the Biological Institute at Dahlem. The publication of the reports was interrupted by the war, and it was found impossible to include the period 1913 to 1919 in subsequent issues. The reports will be devoted mainly to the enumeration of diseases and pests occurring in Germany during the year, with special reference to their economic importance.

In the present report an attempt has been made for the first time to prepare cartographic surveys of the distribution and varying intensity of some of the more important pests and diseases. Such surveys are intended to afford a basis for the systematic investigation of the correlation between the incidence of any given pest or disease and the climatic and geological conditions of the district in which it occurs. The material thus collected will in its turn serve as a foundation for the scientific researches to be conducted at the newly-established Laboratory of Meteorology and Phenology in the Biological Institute. During the period under review this laboratory was engaged mainly in preliminary work connected with the organization of the National Phenological Service, but in future the climatic conditions of the year and their influence on plant cultivation will be discussed in greater detail.

The abnormal drought which prevailed during the summer of 1920 was responsible for the very poor keeping quality of the potatoes, while in some places the storage of damp tubers owing to the rainy weather at harvest time caused decay. In the province of Oldenburg the very heavy frosts which occurred in October 1919 completely interrupted the sowing of autumn seed, with the consequence that germination was greatly retarded. A further sequel to this delay was a very severe attack of stripe disease [*Helminthosporium gramineum*] on barley sown just before the frost, 60 per cent. of the crop often being infected, while Lochow's Petkus winter rye suffered to such a degree from the snow fungus [*Fusarium nivale*] that only one-third of the stand was left by the spring.

In the special section dealing with the fungous and physiological diseases of economic crops, for which Dr. H. Pape is responsible, only those diseases are referred to which were unusually destructive, or of rare occurrence, or which presented special points of scientific interest. Amongst the numerous records the following may be mentioned:

CEREALS. Almost all the plant protection head-quarters reported losses from bunt of wheat (*Tilletia tritici*), which was particularly severe in Saxony. Loose smut of oats (*Ustilago avenae*) was also very prevalent, the attack in Pomerania being the worst ever experienced. The stripe and spot diseases of barley (*Helminthosporium gramineum* and *H. teres*) appear to be on the increase from year to year. The losses reported frequently amounted to 20 or 30 per cent. and even exceeded 60 per cent. of the crops in some cases. Numerous reports of damage from cereal foot rots (*Leptosphaeria herpotrichoides, Ophiobolus herpotrichus*, and *Fusarium* spp.) were also received.

In Westphalia the rye crops on sand and sandy loam suffered from an excessive concentration of acid in the soil as a result of the dry weather in March. Oats were also affected, and in the manufacturing districts the phenomenon was wrongly attributed to sulphuric acid injury. The plant protection experts consider that the withdrawal of lime from the soil in these cases was correlated with altered biological conditions due to lack of water.

POTATOES. Blackleg [*Bacillus atrosepticus*] was reported from nearly all parts of the country, while bacterial soft rot of the tubers was particularly prevalent in Hesse-Nassau and Bavaria. Late blight (*Phytophthora infestans*) was severe and widely distributed. Wart disease (*Chrysophlyctis endobiotica*) [*Synchytrium endobioticum*] gained a foothold in several new districts during the year, and was reported from the following localities: Rhine Provinces, Westphalia, Hanover, Schleswig-Holstein, Hamburg, Lübeck, Mecklenburg, Brandenburg, Silesia, Saxe-Weimar, Eisenach, Saxe-Meinigen, and Saxe-Gotha. Leaf roll was widely distributed, while 'Kräuselkrankheit' was reported only from Lübeck and Oldenburg and mosaic disease from Münster [Westphalia].

ROOTS. Tip rot (*Bacillus bussei* and *B. lacerans*) occurred severely in Pomerania, especially on swedes. Root rot of beets (*Pythium de Baryanum, Phoma betae*, and *Aphanomyces laevis*) was prevalent in many districts and completely destroyed certain fields in Oldenburg.

VEGETABLES. Cucumbers (outdoor and hothouse) were severely attacked by a bacteriosis [cause not specified] at Marienburg (West Prussia), and by downy mildew (*Pseudoperonospora cubensis*) in Wurtemberg. Gummosis (*Cladosporium cucumerinum*) was twice observed in the latter area, where blotch (*Corynespora melonis*) also occurred. Tomatoes in Wurtemberg were attacked by mildew (*Oidium lycopersici*) and a leaf spot caused by *Alternaria solani*, while near Hamburg *Ascochyta lycopersici* [*Didymella lycopersici*] assumed the character of an epidemic. *Sclerotinia libertiana* and *Septoria lycopersici* were each reported on this crop from two different localities. Peas in Oldenburg sustained heavy damage from wilt or St. Johannis disease (*Fusarium vasinfectum*). *Marssonia panattoniana* caused considerable losses in a salad garden in Saxony.

FRUIT. Cherries were reported to be attacked by bacterial blight (*Bacillus spongiosus*) in only a single locality, but scab (*Fusicladium cerasi*) and brown rot (*Monilia*) were unusually prevalent. Apple mildew (*Podosphaera leucotricha*) was also exceptionally virulent and caused heavy damage. In Berlin this disease was observed as early as the end of March. *Peronospora rubi* caused some injury to raspberries in Oldenburg, the variety 'Superlative' being chiefly affected; while the raspberry cane blight, which may be caused either by *Didymella applanata* [see this *Review*, ii, p, 128] or by *Coniothyrium fuckelii*, was severe in Anhalt and Saxony.

American gooseberry mildew (*Sphaerotheca mors-uvae*) is steadily extending in Germany, and there is now scarcely a district free from it. In certain areas the harvest is stated to be decreasing year by year as a result of its attacks. *Polyporus ribis* was observed on gooseberries and currants in two localities.

Downy mildew of the vine (*Plasmopara viticola*) was severe all over the vine-growing districts. In Wurtemberg the attack approximated to the catastrophic epidemic of 1906. Powdery mildew (*Oidium tuckeri*) was also severe, while in Baden the 'rotbrenner' fungus (*Pseudopeziza tracheiphila*) caused a certain amount of damage.

Amongst the numerous other records of plant diseases, mention may be made of an outbreak of *Rhizoctonia violacea* on young pines, which destroyed some 4,000 plants in a nursery in Silesia; and of a die-back of the branches of elms, attributed by v. Tubeuf to over-blossoming, but which is of interest in view of the epidemic disease of the tree in Holland recently recorded [see this *Review*, ii, p. 92].

JØRSTAD (I.). **Beretning om plantesykdommer i land- og havebruket 1920–21. I. Landbruksvekster og grønnsaker.** [Report of agricultural and horticultural plant diseases during 1920–21. I. Cereal crops and vegetables.]—Reprinted from the *Report of the Minister of Agriculture*, 79 pp., 24 figs., 1922.

This report contains a survey of the principal diseases of cereal and vegetable crops observed in Norway during the years 1920 and 1921.

Besides notes on the common rusts, smuts, &c., of cereals, there is a full discussion on seed treatment. It is recommended that the seed of oats and barley should be treated with formalin in preference to copper sulphate, except in the case of stripe disease of barley (*Helminthosporium gramineum*) when copper sulphate should be used. Wheat and rye should be treated with copper sulphate instead of formalin if the seed cannot be sown immediately after disinfection. On the whole, copper sulphate appears to injure germination more than formalin, especially when the seed has been damaged in threshing. Mercurial fungicides have been extensively used during the last few years. They include 0·1 per cent. corrosive sublimate, uspulun, sublimoform (1:400 formalin + 0.1 per cent. corrosive sublimate), and fusariol (corrosive sublimate + copper sulphate). These preparations are highly toxic and are not injurious to germination. They are primarily intended for the control of *Fusarium* and stripe disease of barley, but are useful also in the suppression of smut.

Fusarium diseases of cereals are of considerable importance in Norway. The chief are the straw fusariose caused by *F. culmorum* and the snow mould caused by *Calonectria graminicola* in its conidial stage *Fusarium minimum* [*F. nivale*].

Bright speck disease of oats [see this *Review*, i, p. 421], due to an excess of alkali in the soil, can be successfully controlled by the application of manganese sulphate at the rate of 50 kg. per hect. A similar but much less serious disease has been observed on wheat and barley. In the latter case the spots are very small, arranged close together in rows, and dark brown in colour. This is presumably the disease formerly known as 'spot necrosis'.

Another apparently physiological disease of barley is known as the 'finger-print disease'. Brown spots appear at the end of June on leaves which are already yellowing, possibly as the result of an insect attack. The exact origin of the spots has not been ascertained, but they are in all probability non-parasitic.

Of interest are the records of *Typhula trifolii* on red clover (the first for thirteen years) and *Ascochyta pisi* causing a leaf spot of lucerne. Red clover and timothy (*Phleum pratense*) were also attacked by a dry-spot disease which was apparently due to some physiological condition of the soil.

A very full account is given of wart disease of potatoes (*Synchytrium endobioticum*) and of the legislative and other measures adopted for its control in Norway. The disease extends over an area of about 30 by 10 km. in the region of Kristiansand. In 1921 the regulations in force since 1916, prohibiting the importation of potatoes from Great Britain, Ireland, and Germany, were extended to include Holland. The Ministry of Agriculture has further decreed (August 1921) that consignments of potatoes shall only be imported from other foreign countries when accompanied by a permit issued by the proper authorities of the country of origin vouching for the freedom of the consignments from wart disease.

Other potato diseases described, and in most cases illustrated, are the various types of scab, *Rhizoctonia solani*, *Sclerotinia libertiana*, blight (*Phytophthora infestans*), blackleg [*Bacillus atrosepticus*], ring bacterial disease, dry rot [*Fusarium caeruleum*], leaf roll, and mosaic.

Leaf mould or rust (*Cladosporium fulvum*), stem bacteriosis (*Bacillus solanacearum*), blossom end rot (a bacterial disease), and the black rot caused by *Phoma destructiva* and *Rhizoctonia solani*, were observed on tomatoes, the last-named not being serious. Beets were scabbed by *Actinomyces* sp. Club root (*Plasmodiophora brassicae*) occurred on cabbage and white mustard, soft rot (*Bacillus carotovorus*) on turnip, and brown rot (*Pseudomonas campestris*) was observed on all species of *Brassica*. On beans *Ascochyta boltshauseri* [*Stagonosporopsis hortensis*], *Bacterium phaseoli*, and mosaic were amongst the diseases reported. *Pythium de Baryanum* attacked seedlings of a number of different plants. Leaf spot of cucumbers (*Cladosporium cucumerinum*) did considerable damage and also attacked melons, both hothouse and outdoor plants being affected.

There are numerous other records of interest, and the report forms a useful guide to the crop diseases of Norway.

TEMPANY (H. A.). **Annual Report on the Department of Agriculture, Mauritius, for the year 1921,** 21 pp., 1922.

The Report contains the following references to matters of phytopathological interest. Root disease of sugar-cane occurred on one estate in the Pamplemousses area, but was suppressed by the treatment recommended by the Department of Agriculture. Other bacterial and fungous diseases of sugar-cane were rare, and mosaic disease has so far not been found in Mauritius.

Late planted potato fields were severely damaged by blight (*Phytophthora infestans*).

Field investigations on the 'smut' disease of filaos (*Casuarina equisetifolia*) were continued in conjunction with the Forest Department. Filao blanc was attacked by *Corticium salmonicolor*, reported for the first time on this host, though previously found attacking apples and pears.

Cultivated *Chenopodium* [goosefoot] at Réduit was attacked by downy mildew (*Peronospora* sp.).

Citrus plants at the Réduit Central Experiment Station were found to be infected by canker (*Pseudomonas citri*), and lime trees at Belle Rive and Pamplemousses were attacked by a specific bacillus which invaded the bark, causing gummosis of the trunk and the subsequent death of the trees.

Report on the Agricultural Department, Government of the Gold Coast, for the year 1921, 77 pp., 1922.

The reorganization of the department has led to the grouping of the two mycologists, two entomologists, and the chemist in a Research Branch at Aburi, Mr. R. H. Bunting, the Assistant Director for Research and Mycologist, being placed in general charge of the work of this branch. Mr. H. A. Dade joined the staff as Assistant Mycologist during the year.

The investigation of the new disease of cacao reported in 1919 under the name 'mealy pod' [a technical account of which is being prepared for publication elsewhere] was continued. It is caused by a fungus of considerable scientific interest, the systematic position of which was difficult to fix. Preliminary infection experiments indicate that the organism is sometimes capable of infecting unwounded pods which have been detached from the tree, and that wounded or weak pods are much more liable to attack in the field than vigorous ones.

A severe epidemic of black pod disease of cacao [*Phytophthora faberi*] occurred on the banks of the Birrim River, causing a decay of 99 per cent. of the pods in some plantations. Characteristic sporangia were observed on numerous pods, both harvested and on the trees. The outbreak was probably due mainly to the failure to collect the pods during the previous slump in the local cacao market, though excessive moisture may have aggravated it. Passage of the fungus from affected pods to the stem on which they are borne, with resulting canker formation and liability to reinfect succeeding crops, was demonstrated, and the importance of removing all diseased pods clearly established. The disease may be controlled by proper drainage and cultivation, thinning out, and the removal of excessive shade. Ripe pods, healthy or diseased, should be removed from the trees, diseased tissue on the stems excised, the wounds tarred, and all diseased material burnt. Empty husks should be buried as soon as possible. A circular urging native producers to take active precautions against the spread of the disease has been distributed, but legislative measures will probably be necessary to ensure co-operative efforts in this direction.

The thread blights of permanent crops were investigated in the Kibbi district. Cacao trees planted in heavy, wet soil appeared to be particularly liable to white thread. The presence of horse-hair blight is injurious on account of its interference with the natural functions of the foliage, but the question of its parasitism has not been definitely decided. These diseases may be controlled by improving soil conditions (tillage, drainage, and the like) and by cutting out and burning all affected parts.

COONS (G. H.). **Diseases of field and vegetable crops in the United States in 1921.**—*Plant Disease Bull. Supplement* 22, pp. 255–414, 21 maps, 1922.

This annual review of the diseases of field and vegetable crops in the United States has been prepared on the same lines as those of fruit and nut crops, and cereal and forage crops, already noticed [see this *Review*, i, pp. 376 and 424].

During the last few years the potato certification movement has been considerably extended in the United States and Canada, with the result that the progressive deterioration of potato varieties brought about by disease has been partially arrested. Reports from various States on the use of copper-lime dust as a substitute for liquid Bordeaux mixture showed that there is a consistent increase in yield of the dusted rows over checks. The increases, however, are somewhat smaller than those obtained from Bordeaux mixture. The experiments of 1922 indicate that copper-lime dusts afford ample protection against late blight, but that against tip burn, hopper burn, and flea beetles the protection is not so good as by spraying. Although in 1920 late blight was prevalent, the general high temperatures and drought prevailing in the early half of the growing season operated to check the spread of the disease in 1921. Mosaic, leaf roll, and allied diseases continue to be of great interest to research workers, and at present occupy the attention of many investigators.

The diseases of tomatoes, sweet potatoes, beans, onions, cruciferous crops, and cucurbits are summarized, with notes on prevalence, distribution, losses, and any special points of interest. Sugar-cane mosaic is stated by Brandes to occur in all the sugar-producing districts of the world, with the possible exception of India. In the United States the distribution is restricted to Louisiana, Alabama, Georgia, Florida, and Mississippi.

Sections on the diseases of sugar beet, tobacco, and miscellaneous vegetable crops complete the *Bulletin*, which is a mine of valuable information.

MARTIN (G. H.). **Diseases of forest and shade trees, ornamental and miscellaneous plants in the United States in 1921.**—*Plant Disease Bull. Supplement* 23, pp. 415–488, 15 maps, 1922.

This summary has been compiled from reports furnished by collaborators in the various States, specialists in the offices of Forest Pathology and Blister Rust Control of the Bureau of Plant Industry, articles in botanical journals, and special reporters. Owing to the lack of available data it has been found necessary to issue the information in list form, with only a few scattered notes on the general distribution and prevalence of the disease mentioned.

Douglas fir (*Pseudotsuga taxifolia*) was very generally and severely attacked by *Trametes pini*, causing 'conk' rot which extends throughout the tree; *Polyporus schweinitzii*, producing red-brown butt rot; *Fomes laricis*, causing brown trunk rot; and *F. roseus*, the cause of yellow-brown top rot. These four fungi are responsible for practically all the decay occurring in the Douglas fir, which sometimes amounts to 50 per cent. of the stand or more.

White pine (*Pinus strobus*) suffers chiefly from the blister rust (*Cronartium ribicola*). The co-operation between the New England States, New York, Wisconsin, and Minnesota on the one hand, and the Bureau of Plant Industry on the other, which was in force from 1917 to 1921, resulted in the development of practical local control measures. The widespread application of the latter is the object of the continued co-operation between these States and the Federal Government. Special blister rust experts have been appointed by the Bureau of Plant Industry to work in co-operation with the State Forestry Departments and the State Agricultural Extension Divisions. Under average conditions the safeguarding of pine stands can be effected by the removal of currant and gooseberry bushes to a distance of 900 ft. Cultivated black currants, however, which are the most heavily infected of all the species of *Ribes*, have been known to transmit the disease to pines more than one and a half miles away.

Poplars, especially in Utah, are being rapidly destroyed by canker (*Cytospora chrysosperma*), which is widely distributed in the south-western States. The varieties affected are *Populus alba bolleana*, *P. nigra*, *P. carolina*, and *P. tremuloides*.

This annual publication of the United States Plant Disease Survey is particularly useful in bringing together the numerous scattered records of parasitic fungi found on trees, shrubs, and ornamental plants during the year.

JARDINE (J. T.). **Director's Biennial Report: Oregon Agricultural Experiment Station, 1920–1922,** 104 pp., 1922.

In the Report of the Department of Botany and Plant Pathology (pp. 72–75), reference is made to several matters of phytopathological interest in Oregon.

Anthracnose of apples [*Neofabraea malicorticis*] is now being controlled by the use of Bordeaux mixture in one of the late codling moth sprays, thus effecting a saving of one spray application annually for 20,000 acres of bearing trees.

Tests carried out in 1921 demonstrated that excellent control of onion smut [*Urocystis cepulae*] on the most heavily contaminated beaver-dam soil could be secured by the use of formalin (1 oz. to 1 gall. water), provided a stream of not less than five-sixteenths of an inch in diameter is run into the furrow as the seed is dropped. In one plot so treated the yield amounted to 364 sacks per acre as against 88½ sacks in the untreated control.

The preliminary results of an investigation of the 'take-all' disease of wheat [*Ophiobolus cariceti*] in the Willamette Valley show that climatic conditions exercise a very great influence on the severity of the disease.

Co-operative experimental work with the Federal Department demonstrated the risk of seed injury from the ordinary formalin and copper sulphate dips used against bunt of wheat [*Tilletia*], and proved the value of a subsequent milk-of-lime bath to counteract much of the damage [see this *Review*, i, pp. 298, 378]. The results of further tests showed that practically no injury to wheat seed-grain occurs after dusting with powdered copper carbonate, which gives satisfactory bunt control. It is estimated that about 50,000 bushels of seed grain per annum are destroyed by injurious treatment in one county of Oregon alone.

Investigations of potato wilt [*Fusarium oxysporum* and *Verticillium albo-atrum*] have proved the value of crop rotation and field roguing in the control of the disease. During the growing season infection spreads from plant to plant underground, so that not only wilted plants themselves should be pulled up, but also those next in the row on either side.

Pears and apples in Oregon have been widely attacked by European canker [*Nectria galligena*], the diagnosis of which has been facilitated by the discovery of the early spore stage in young cankers [see this *Review*, i, p. 217]. The application of Bordeaux mixture previous to the autumn rainy season is beneficial, and there is reason to hope that the control of canker and anthracnose can be accomplished by one and the same application.

Астраханская Станция Защиты Растений от Вредителей. [Astrakhan Plant Protection Station.] pp. 1–26, 1922.

We have received the report on the work of this Station during 1921, from which the difficulties arising from lack of experienced personnel and shortage of material for combating insect and fungous diseases of cultivated plants are plainly apparent. Particularly serious in this part of Russia were attacks of *Ustilago zeae* on maize, *Tilletia tritici* and *Puccinia graminis* on wheat, and *Phytobacter lycopersicum* on tomatoes. With regard to the latter disease, which in some cases destroyed the whole crop, the interesting observation was made that it was most severe on land poorly irrigated owing to shortage of water supply; this appears to be in contradiction to the general opinion that dampness of soil favours development of the disease. Watering experiments made at the Station in 1921 showed that while *Phytobacter lycopersicum* freely attacked tomato plants watered from above by sprinkling, it seldom appeared in plots watered by irrigation canals.

The Station publishes monthly leaflets dealing in a popular form with the most important pests of cultivated plants in the region, of which leaflets dealing with the following have reached us: *Oidium* (*Uncinula necator*) of the vine; anthracnose (*Colletotrichum oligochaetum*) of cucurbits; *Oidium* of cucumber, melon, watermelon, and vegetable marrow; apple and pear scab (*Fusicladium dendriticum* and *F. pirinum*); and *Orobanche aegyptiaca*. The last causes much damage to cucumber, melon, watermelon, and tomato, and also attacks cabbage and eggplants more rarely.

COTTON (A. D.). **Fungus diseases of crops 1920–1921.**—*Min. Agric. Misc. Publ.* 38, 104 pp., 1922.

The Ministry of Agriculture's Report on the occurrence of fungous, bacterial, and allied diseases of crops in England and Wales during 1920 and 1921 contains information invaluable both to the scientific worker and the grower.

The cold, wet summer of 1920 and the exceptionally hot and dry summer of 1921 provided excellent opportunities of gauging the influence of weather conditions on plant diseases, and also of judging to what extent one season's weather affects the prevalence and intensity of infection in the ensuing year. The total number of diseases recorded was 391, of which 150 occurred on fruit, 82 on vegetables, 40 on cereals, and 21 on potatoes.

Of an exhaustive and detailed report of this sort it is impossible to give a brief summary, but a few points of special interest may be mentioned.

In the wet spring and summer of 1920 late blight of potatoes (*Phytophthora infestans*) was very severe in the south and west of England and Wales, 50 per cent. of the tubers being infected in many cases. The disease was reported from the Scillies on 15th April, the earliest date on record, but it did not spread extensively in England until June. The varieties that suffered least were Kerr's Pink, President, and Evergood, the first named being immune, and the other two susceptible to wart disease.

In vivid contrast to 1920, late blight appeared phenomenally late in the dry season of 1921, the first record being on 25th July, and its intensity was also exceedingly slight. The interesting fact was discovered by Whitehead that in many cases the tubers of apparently healthy plants were infected, sometimes as severely in 1921 as in 1920. Trials by Lawrence are also reported which showed that by pulling out haulms when blight was first seen in July a clean crop was secured, whereas when the haulms were pulled out later, 40 and 75 per cent. infection occurred on Edzell Blue and Arran Chief respectively. The advisability of adopting this treatment would of course depend on the date of the attack and other circumstances.

Wart disease (*Synchytrium endobioticum*) was very prevalent in the wet summer of 1920 and conspicuous by its absence in 1921. The number of new outbreaks in 1920 was the lowest for many years and that for 1921 lower still; several outbreaks, however, occurred in neighbourhoods hitherto free from the disease. A series of demonstrations was arranged in 1921 with the object of impressing upon growers the serious nature of the leaf roll disease and the value of healthy seed. The results showed that infected seed gave only from 36 to 75 per cent. of the yield from healthy seed. Both leaf roll and mosaic are more prevalent in the hot, dry parts of the country than at high altitudes and in the north. In 1921 the characteristic mottling caused by mosaic diseases was largely obscured as a result of the heat and drought. Corky scab (*Spongospora subterranea*), exceptionally bad in 1920 and almost absent in 1921, was successfully controlled at Leeds by Millard, who applied flowers of sulphur at the rate of 6 cwt. per acre, and thereby reduced the incidence of infection from 54 to 7·5 per cent. Scab (*Actinomyces scabies*) is a disease of hot, dry seasons, and was very prevalent in 1921. Millard has worked out a method of controlling this disease by the use of green manure. Pink rot (*Phytophthora erythroseptica*) was recorded for the first time in England in 1921.

Take all (*Ophiobolus graminis*) [*O. cariceti*] caused serious damage to wheat in five counties in 1920, and was present to a slight extent in all parts of the country. The characteristic brown mycelium was copiously developed at the base of the stem, at times associated with a *Fusarium*. Perithecia were obtained on specimens from Worcester in August.

A disease apparently identical with halo blight of oats (*Bacterium coronafaciens*), though the causal organism has not yet been isolated, was noticed in various localities, the damage sometimes being severe. Crown rust of oats (*Puccinia coronata*) [*P. lolii*] occurred with unprecedented severity in 1920, whereas in 1921 the attack was almost negligible. Observations show clearly that this rust overwinters in England in the uredospore stage on autumn-sown oats. The aecidial stage of the rust on *Rhamnus catharticus* is not uncommon in infected districts.

Mosaic disease of mangolds was recorded for the first time in 1920–21. The disease occurred generally in the eastern and southern counties, and appeared in the crops about August, the incidence of infection ranging from 1 to 95 per cent. Sugar-beet was also slightly attacked by mosaic in 1921 in Nottinghamshire.

A bad attack of canker on frame and ridge cucumbers was reported from Sussex in 1918, since when it has been impossible to raise a normal crop in the infected localities. The causal fungus was formerly believed to be *Mycosphaerella citrullina*, but subsequent investigation by Brooks led to its identification as a form of *Diplodina lycopersici*.

There were no fresh cases of onion smut (*Urocystis cepulae*) either in 1920 or 1921. Trials of eleven varieties of leeks at

Wylam showed all to be susceptible, but decidedly less so than onions.

Apple mildew (*Podosphaera leucotricha*) caused severe damage in both years in spite of the marked climatic contrasts, and its prevalence appears to be increasing. In Great Britain the disease has hitherto been combated almost exclusively by pruning, but it may be necessary to resort to spraying if it gains further ground. Silver leaf (*Stereum purpureum*) became increasingly menacing during the period under review, extending its ravages to the apple; many hundreds of apple trees were killed by it in some of the eastern counties. The mode of infection and course of the disease in apples correspond in all respects with those of the same disease in plums. The prevention of unnecessary wounds, the tarring of exposed surfaces, and strict attention to general cleanliness are the only reliable control measures. *Myxosporium* canker (*M. corticolum*), well known in America, was recorded in England for the first time by Wiltshire in 1920.

A die-back of plums caused by *Diaporthe perniciosa* [see this *Review*, i, p. 63] was first observed in England by Miss D. M. Cayley in 1919, and has since been under investigation. The disease produces symptoms somewhat similar to those of *Cytospora*, and it is apparently widely distributed.

Weather charts of the temperature, rainfall, and sunshine for the six meteorological provinces of England are appended, from which it is possible to judge roughly the nature of the weather experienced in any week of the year.

Melhus (I. E.), Dietz (S. M.), & Willey (Florence). **Alternate hosts and biologic specialization of crown rust in America.**— *Iowa Agric. Exper. Stat. Res. Bull.* 72, pp. 211–236, 2 figs., 1922.

Crown rust (*Puccinia coronata*) [*P. lolii*] occurring on oats and *Calamagrostis canadensis* may have as an alternate host any of the American species of *Rhamnus* (*R. lanceolata*, *R. alnifolia*, *R. caroliniana*, *R. californica*, and *R. purshiana*) together with the two imported species *R. cathartica* and *R. frangula*. The separation of *P. coronata* into two species, *P. coronata* and *P. coronifera*, by Klebahn, and of these two species into four series, by Eriksson, on the basis of the different species of *Rhamnus* used as alternate hosts, is therefore not justifiable in America. Not all species of *Rhamnus* are equally susceptible to the different biologic forms of the rust. The forms occurring on *Avena sativa*, *Calamagrostis canadensis*, and *Festuca elatior* prefer those species of *Rhamnus* most closely resembling *R. cathartica*. Crown rust on *A. sativa* produced normal aecidia on *R. cathartica* and *R. lanceolata*, both of which may serve as important agents in the spread of the disease.

In the oat-growing sections of the United States, the four most common grass hosts of crown rust are *Avena sativa*, *Calamagrostis canadensis*, *Lolium perenne*, and *Holcus lanatus*. The form of the fungus on *A. sativa* is neither highly specialized nor limited in its host range. The results of inoculation experiments showed that species belonging to sixteen genera of grasses were susceptible to it. The form on *Calamagrostis canadensis* was found to have susceptible hosts in fourteen genera. That on *Lolium* is capable of infecting thirteen genera; and eleven species in seven of these genera gave full infection with this form. It is believed to be possibly identical with that occurring on oats. On *Holcus*, on the other hand, the rust was very highly specialized, *Holcus* being the only grass fully infected amongst those tested with this biologic form.

The forms of crown rust on *Avena*, *Calamagrostis*, *Lolium*, and *Holcus* may, under certain conditions, use the same hosts, but manifest different degrees of infection. *A. sativa* was a common host, but with varying degrees of infection, for all the forms of crown rust studied.

Dade (H. A.). **'Collar crack': a new disease of Cocoa.**—*Journ. Gold Coast Agric. and Commer. Soc.*, i, 4, pp. 241–242, 1922.

Cacao plantations in Togoland were found to be attacked by an unfamiliar disease which has been named 'collar crack' on account of its very typical symptoms. Numerous radial cracks extend upwards for about 2 ft. from the collar or base of the trunk, causing injuries which generally result in the death of the tree. The cracks are marked externally by a narrow, frilly outgrowth of leathery, brown, fungous tissue. On felling the tree the cracks are found to extend to the middle of the trunk, and to be packed with compact plates of mycelium. The fructifications of the fungus, apparently a species of *Tricholoma*, appear on the collar, close to the ground. as a bunch of wet, soft, rusty-brown sporophores of the 'mushroom' type. Each sporophore is 2 to 3 in. in height and 1·5 to 2 in. across the cap.

The disease occurred on farms which were situated in hilly rain forest, and were suffering from the consequences of systematic neglect. The humidity of the atmosphere was intensified by a dense growth of low bush round the trees, which maintained the collars in a permanently soaking state.

It is recommended that infected trees should be dug out and burnt and the holes well limed. Thorough cultivation is considered to be the best preventive measure.

Griffee (F.). **Breeding Oats resistant to stem rust.**—*Journ. of Heredity*, xiii, 4, pp. 187–190, 3 figs., 1922.

In the work of breeding cereals for rust resistance at the Minnesota Agricultural Experiment Station, the purity of the F_2 plants is determined on the basis of F_3 seedling tests made in the greenhouse before the date of sowing the field plots. The method is well illustrated by the results obtained in greenhouse tests used in breeding oats resistant to stem rust, *Puccinia graminis*. In 1921, 600 F_2 plants, which appeared resistant to rust under an artificially induced field epidemic, were harvested at University Farm. These plants were part of the progeny of the crosses of White Russian, a resistant variety, with Victory and Minota, both susceptible. As shown by Garber (*Journ. Amer. Soc. Agron.*, xiii, pp. 41–43, 1921), the F_1 generation in these crosses is as resistant as the White Russian parent, while in the F_2 generation segregation is in the simple ratio of 3 resistant to 1 susceptible. A family of F_3 seedlings was grown from each of the 600 F_2 plants mentioned above, twenty-five kernels of each plant being reserved for the 1922 field planting and twenty-five or thirty of the remaining kernels planted in the greenhouse. The kernels from the same plant were planted together in a 4-inch pot. The seedlings were inoculated with stem rust, and notes were taken about a fortnight later on the type of infection obtained. Pots of White Russian and Victory seedlings were tested along with each series of hybrid material and the type of infection determined.

Under greenhouse conditions the inoculations resulted in a 4 ± type of infection [see this *Review*, ii, p. 158] on Victory, the highest obtained with any variety. With White Russian a 3 ± type was obtained, though under the most favourable artificial epidemic conditions in the field this variety never gives more than numerous small uredosori, and natural infection, even in years of severe rust epidemics, leaves it comparatively free from rust.

The number of F_3 families which bred true for resistance in the greenhouse approximated to expectations. In the cross White Russian × Victory, 82 F_3 families out of 229 tested bred true for rust resistance. This gives a ratio of 1·07 : 1·93, which is very close to the anticipated 1 : 2 ratio. In the cross Minota × White Russian and the reciprocal, 110 families out of 338 tested bred true for rust resistance, namely a ratio of 1·01 : 1·99.

Since it is possible in this manner to identify large numbers of homozygous resistant plants in the F_2 generation, the heterozygous F_2 plants may be eliminated from the field sowings.

Two methods of seedling inoculation were employed, namely ordinary inoculation and the brushing system. In the latter, which proved uniformly preferable, the seedlings are sprayed with water and brushed lightly with rusted seedlings. The incubation period is the same in each case.

WEBER (G. F.). **Septoria diseases of cereals. II. Septoria diseases of Wheat.**—*Phytopath.*, xii, 12, pp. 537–585, 4 pl., 16 figs., 1922.

In continuation of the author's studies on cereal diseases caused by species of *Septoria* [see this *Review*, ii, p. 159] two diseases of wheat, termed respectively 'glume blotch' and 'speckled leaf blotch' are described.

Glume blotch is caused by *Septoria nodorum* Berk. [*S. glumarum* Pass., *Macrophoma hennebergii* (Kuehn) Berl. & Vog.] and is known in Europe, the United States, and Australia. It is common especially in the southern and east-central States, where severe attacks may reduce the yield by 50 per cent.

All the aerial parts of the plant are subject to attack. On the glumes small, irregular, brownish spots appear, in which black pycnidia develop. Infection may spread, in favourable conditions, to the rachis and culm. On the leaves the spots are yellowish, then dry up and become lighter in colour, a few scattered pycnidia appearing on both surfaces. In severe attacks the leaf may be killed.

The morphology and cultural characters of the fungus are described in great detail. Conidia were produced laterally, usually at the septa of germinating pycnospores, on oatmeal agar, and were oblong, hyaline, 3-septate, and 18 to 32 by 2 to 4 μ. Perithecia were found in the field, and compared with other collections of an ascigerous stage found associated with *S. nodorum*, but the genetic connexion of the pycnidial and perithecial stages was not established by cultures. The perithecia probably belonged to the genus *Leptosphaeria*. The optimum temperature for growth in culture was 20° to 24° C.

The fungus proved capable of infecting all the species of *Triticum* tested, and also rye and *Poa pratensis*. The pycnospores remain viable in the pycnidia through the winter with little loss of germinating power. More than 30 per cent. germinated after eighteen months in the open. They are killed very easily by drying and by the action of direct sunlight. In Wisconsin infection of the leaves may be found from April and of the glumes from June. Infection occurs by direct penetration of the cuticle, the hyphae passing between the epidermal cells and remaining confined to the intercellular spaces of the parenchyma. Spots first appear in six or seven days and mature pycnidia, which always develop in the sub-stomatal chamber, in twelve to sixteen days. Severely infected plants are stunted and the ears empty or with only a few shrivelled grains. Infection at the nodes appears to have a marked stunting effect.

In the second disease, as the name 'speckled leaf blotch' indicates, the spots are characteristically speckled from the presence of dark brown or black pycnidia in great numbers in the light-coloured, dead tissues. These belong to the fungus *Septoria tritici* Desm., which the author considers to be quite distinct from *S. gramineum* Desm. No ascigerous stage was found. The fungus is widely distributed in Europe, Asia, Australia, and America; in Wisconsin it may be found in almost every field of winter wheat. Where infection is severe many seedlings are killed and the new tillers formed during the winter and spring are also often killed. Later in the season the losses from attacks on older parts of the plant are negligible.

On the seedlings circular or oval spots develop on the leaves, gradually spreading so as to involve the whole surface. The other parts of the plant are not attacked. Pycnidia are found in quantities on the spots or covering the entire leaf surface. On older plants the spread of the disease is usually slight and few new spots appear after the flowering stage.

The fungus is variable. In cultures the growth may be hyaline or dark, while the spores vary in size on the host plant according to the period of the year, those formed in the winter being considerably larger than the summer ones. Conidia are numerous in culture and were also found on artificially inoculated plants. They resemble the pycnospores closely. The optimum temperature for growth is 22° C. to 26° C.

S. tritici infects the leaves of the same hosts as *S. nodorum*. All the other plants tested were immune. It overwinters on winter wheat and in the pycnidial stage, the pycnospores remaining viable in the pycnidia for over a year. The incubation period is about six or seven days for the first spotting, and eleven to fifteen days for the development of mature pycnidia. The method of infection and pathological histology are much the same as in *S. nodorum*. No haustoria were found.

BRANSTETTER (B. B.). **Fungi internal to Missouri seed Corn of 1921.**—*Journ. Amer. Soc. Agron.*, xiv, 9, pp. 354–357, 1922.

Samples of 1921 seed maize from different parts of Missouri were examined for the presence of internal fungi. After surface sterilization in 1 in 1,000 mercuric chloride solution and thorough washing with sterile water, the tips of the kernels were planted in Petri dishes on potato-dextrose agar and incubated for twenty to thirty days at about 25° C. The ears from which the kernels were taken were arranged in two groups according to the severity of the disease symptoms. The first group (badly diseased ears) contained nearly twice as many kernels infected with *Diplodia zeae* and *Fusarium moniliforme* as the second group (apparently disease-free ears). The latter group, however, contained many more kernels infected with *Cephalosporium sacchari*. Only one culture of *Gibberella saubinetii* was obtained from more than 1,600 plantings.

Of the 192 seed ears examined, only nineteen appeared completely clean and healthy. Nine of these ears were disease-free when tested in culture, and only four showed as much as 50 per cent. infection. On the other hand, the ears selected for their diseased appearance generally showed 100 per cent. infection of the grain.

MELHUS (I. E.) & DURRELL (L. W.). **Dry rot of Corn.**—*Iowa Agric. Exper. Stat. Circ.* 78, 3 pp., 8 figs., 1922.

Germination tests of thousands of samples of seed maize on Iowa farms indicate that a large proportion is unfit for sowing, chiefly owing to the ravages of the dry rot fungus, *Diplodia zeae*, the life-history of which is described in this paper. In the autumn of 1921 mouldy maize was common throughout Iowa. High temperature and rainfall, which favour the development of the fungus, were combined in the central and eastern parts, where the damage from dry rot was estimated at 5 to 20 per cent.

The fungus attacks all parts of the plant. Infected roots and stem nodes exhibit a dark brown discoloration; the shanks of the ears break readily, and in some cases the fungus works up into the butt. It may also attack the tip, entering from the silk. In other cases the husks catch and hold the spores and infection results. The mycelium grows freely in the tissues of the cob, causing a brown discoloration of affected parts. Infected ears are of little use for seed, and should be kept for fodder.

There is no consistent evidence that the mycelium habitually travels from the soil to the ears inside the stalk. Recent studies showed that 39 per cent. of the infected ears were borne on healthy stalks. The fungus is only known to attack field and sweet maize. The minimum temperature for growth is 40° F., the maximum 90° F., and the optimum 80° to 86° F. When the maize is dried the fungus lies dormant, but will grow again when moisture is supplied.

The modified rag doll germinator gives very good results in tests for germinating strength, but a glass-topped sand-box germinator, though somewhat more expensive, is superior, being free from the limitations incidental to the former method. The practical application of both these methods of determining the degree of infection is described in detail.

Zade (A.). **Experimentelle Untersuchungen über die Infektion des Hafers durch den Haferflugbrand (Ustilago avenae Jens.).** [Experimental investigations of the infection of Oats by loose smut (*Ustilago avenae* Jens.).]—*Fühlings landw. Zeit.*, lxxi, 21–22, pp. 393–406, 4 figs., 1922.

The author believes that infection of oat seedlings with *Ustilago avenae* rarely occurs from spores of the fungus that have adhered to the outside of the glumes. His attempts to secure infection by heavy application of spores on the exterior of the glumes did not give an appreciable amount of smut. Further experiments, in which the spores were applied after the glumes had been removed, gave better results; it is evident that spores that have penetrated between the glumes can cause infection, though the degree of infection was not sufficient to account for the frequency of epidemic attacks of the disease.

Tests made by applying spores to the ears during flowering revealed the interesting fact that almost all the spores that fell on the stigma began to germinate in 15 to 20 hours in mild, damp weather. The promycelia formed tended to be unusually long, but were otherwise normal and bore budding sporidia. The latter gave rise to hyphae which came in contact with the inner wall of the glumes and formed a mycelium in the peripheral parenchyma of the latter. There was no evidence of flower infection such as is known in *Ustilago tritici*, the embryo remaining free from infection and only the glumes being invaded. The author believes that this mycelium and the secondary sporidia that are borne on the hyphae on the inner surface of the glumes form the most important source of infection in oat smut. For effective control by seed steeping it is essential that the fungicide should penetrate within the glumes and prevent infection of the young seedling from the fungus in this situation.

Mole (D. C.). **A new Orange pest in Arizona.**—*Monthly Bull. Dept. Agric. California*, xi, 8–9, pp. 628–633, 1922.

A recent examination of the Washington and Australia navel oranges in the Salt River Valley, where the loss from dropping of the fruit was stated to be above the normal, revealed the presence of small, pink, lepidopterous larvae, associated with black rot caused by the fungus *Alternaria citri*. The work of the larvae in the oranges somewhat resembled that of the codling moth (*Carpocapsa pomonella*) in the apple. The life-history and habits of the insect (probably *Myelois* sp.) are described. It is not yet known whether it or the fungus is the primary cause of the damage, which is serious. Pending the results of further investigations, the Arizona Commission of Agriculture has prohibited the movement of navel oranges from that State to California.

SIMMONDS (H. W.). **Bud-rot disease of Coco-nuts in Fiji.**—*Agric. Circ.* [*Dept. of Agric. Fiji*], iii, 3, pp. 39–40, 1922.

During the past eighteen months serious damage to coco-nut palms in the Fiji Islands has been caused by bud rot. The disease is almost entirely restricted to the wetter portions of the islands, being rare on the coast and abundant along the inland foothills. Trees from five to fifteen years of age are more susceptible to the disease than older ones, though in one area of excessive rainfall (Vanualevu) numerous trees of twenty to thirty-five years old were attacked.

The first symptom is generally the wilting and falling over of the central unopened leaf of the tree, leaving an outer ring of leaves and nuts which are gradually shed until only the bare pole is left. An irregular, greenish-brown or yellow spot usually occurs at the base of about the eighth leaf or flower spathe from the central core, and a patch of decay extends from this to the central portion of the stem, which is in a rotten and foul-smelling condition. Indications were observed that infection starts at the leaf bases and penetrates inwards, not through the outer, overlying leaf sheaths. On the infected material submitted to the Imperial Bureau of Mycology, a fungus agreeing in its mycelial characters with the parasitic species of *Phytophthora* described as the cause of coco-nut bud rot in other countries was found ramifying between the cells. Exact identification was impossible in the absence of fructifications.

It is suggested that the spread of the disease is likely to be assisted by the hurricanes which are frequent in Fiji. The spraying of young trees, especially at the leaf bases, with a strong Bordeaux mixture is recommended as a preventive. Once the tree is actually attacked, however, it should be cut out and the head burnt immediately.

ELLIOTT (J. A.). **A new Ascochyta disease of Cotton.**—*Arkansas Agric. Exper. Stat. Bull.* 178, 18 pp., 4 pl., 1 fig., 1922.

The disease previously attributed to *Phoma* in a preliminary paper which has already been noticed [see this *Review*, i, p. 59], has now been found to be due to *Ascochyta gossypii* Syd., hitherto only recorded from Kashmir, where it was collected in 1908.

The blight attacks all the aerial parts of the plant except the blossoms, and is capable of infecting leaves, stems, or bolls without any apparent previous wounding of the tissues. Under very humid conditions the fungus invades the leaf tissues very rapidly, advancing 1 cm. or more in twenty-four hours, and producing greyish, water soaked spots which, under slight pressure, break down into a pulpy mass resembling vegetables destroyed by bacterial soft rot. In drier weather the outer edge of the spot is reddish-brown, the cortex being of a lighter colour.

The spots on the bolls and stems are generally darker than on the leaves. Stem infections were much the most conspicuous during the 1920 epidemic. The liver-coloured spots occurred mainly at the bases of the leaf petioles, and seemed to centre round the stipules. Longitudinal extension rapidly followed, the leaves dying when the base of the petiole became involved. The girdling of the stem resulted in desiccation and death of the parts above the lesion. As the spots enlarged the centres disintegrated and fell out, leaving only the bast fibres of the bark crossing the lesions.

The spots on the bolls are usually similar to those on the stem, except for the darker centres of the former. Shredding of the diseased tissues is also less marked on the bolls. A dark green, water soaked area occurs when there is a rapid advance of the fungus, otherwise the border of the spots is dark brown. Drought may check the external advance of the spot while the internal attack continues, sometimes causing the sudden collapse of the bolls. Mature lint is easily destroyed and, in half-open bolls, may be full of the grey fruiting bodies of the fungus. In 1920 there were no natural infections of the bolls, but artificial infections were readily obtained by needle pricks. The resulting spots were found to be identical with those occurring naturally on diseased cotton plants collected in Arkansas in 1915 and preserved in the pathological laboratory.

An extensive series of inoculation experiments was carried out under varying conditions, the first spots appearing in from one and a half to five days, and pycnidia about three days later. In the field, leaf infections were successful only in a very humid atmosphere. Natural infections took place during rainy weather in October on the plants which had previously been inoculated, and on those adjacent to them, the remainder of the crop not being affected.

During the winter the fungus was found to develop saprophytically on the infected plants, the pycnidia and their spores being morphologically similar to those of the parasitic fungus. In the following spring spores from these saprophytic colonies were capable of infecting healthy seedlings on inoculation. Later on in the summer of 1921 the disease became epidemic in the experimental plot, and vigorous plants succumbed to the attack almost as rapidly as pear twigs suffering from fireblight.

Examination of the tissues of the diseased plants showed that the host cells gave normal staining reactions up to the limit of the advance of the mycelium, while the middle lamellae were also apparently unchanged. The main advance of the fungus was intercellular, but the cells were subsequently invaded and destroyed by the hyphae, and in young tissues the tracheae and wood cells were also killed. The action of the fungus appeared to be identical on the tissues of all parts of the plant. The older parts of the lesions revealed very little mycelium, and nothing in the nature of a stroma was formed. The mycelium was apparently most abundant near the outer limit of advance through the host tissues. Closely behind the outer limit the host tissues were collapsed and pycnidia occurred in various stages of development. These results indicate a somewhat narrow zone of parasitism, and may explain the dependence of the fungus upon weather conditions.

The disease apparently occurs only in central and west central Arkansas. As the fungus can overwinter on dead stalks in the field, the growth of some other crop for at least one season is recommended on infected land. It is improbable that the disease is carried over from year to year on the seed, as in the case of anthracnose [*Glomerella gossypii*].

Brown (J. G.). **Black-arm of Cotton: a successful method of control.**—*Arizona Agric. Exper. Stat. Timely Hints for Farmers* 142, 8 pp., 4 figs., 1922.

Black-arm of cotton (*Bacterium malvacearum*) is the cause of extensive losses to growers, the reduction in yield from the disease in the United States being estimated in 1920 at 213,000 bales. Affected plants may be recognized by the water soaked areas on the stems and leaves of seedlings; in older plants the bolls are also attacked. The spots or lesions, which darken with age, exude a bacterial slime and the growth of the plant is checked. On the stems the spots are generally longitudinal, and their appearance has given rise to the term 'black-arm'; on the leaves they are triangular or quadrilateral, hence the name 'angular leaf spot' by which the disease is also known. On the bolls the spots are usually circular and depressed at first, but later the shape is irregular.

The bacterium is carried on the seed, and its development is favoured by warm, moist weather. The Egyptian and Sea Island varieties are the most susceptible, while the upland types are comparatively resistant.

The disease may be controlled by immersion of the seed in sulphuric acid for fifteen minutes. For each 100 lb. of seed, approximately 3 galls. of concentrated sulphuric acid, chemically pure, specific gravity 1·84, are required. This treatment has proved extremely successful under Arizona conditions, one treated, 14-acre field in the Salt River Valley being practically free from black-arm, while another field on the same farm was so badly infected that 238 diseased plants were counted in one row, 35 rods in length. The treatment also accelerates germination, and its general adoption is strongly recommended.

Brandes (E. W.). **Onderzoek op grooten afstand betreffende de verwelkingsziekte der Bananen.** [An investigation at a distance of the wilt disease of Bananas.]—*Teysmannia*, xxxiii, 7–8, pp. 294–297, 1922.

Referring to Gäumann's belief that the vascular or Panama disease of bananas is caused by a bacterium, identical with or allied to his *Pseudomonas musae* [see this *Review*, i, p. 225], the author maintains the view that *Fusarium cubense* is the primary agent. He considers it evident from the published account of the Java disease that the author is not familiar with the much more serious wilt of the West Indies, and that the attempted comparisons in his paper are based on insufficient study of the publications dealing with Panama disease. Various statements regarding the latter, as for instance that Brandes did not mention the existence of bacteria in the diseased tissues, that he did not succeed in inoculating the underground parts of the banana with *F. cubense*, that he used diseased bananas for his experiments, and so on, are based on a complete misunderstanding, as may be seen by reference to the original paper in *Phytopathology* (ix, p. 339, 1919). Gäumann's isolation of a weak bacterial parasite from wilted bananas in Java is not in any way evidence that a bacterium is the primary cause of the Panama disease.

Replying to the above criticisms (pp. 297–300), Gäumann refers to his successful inoculations of the rhizome, aerial stem, and leaves of bananas with *Ps. musae.* and contrasts them with his own and Brandes's (*Ann. Rep. Mich. Acad. Science*, 1918, p. 273) failure to secure the same results by direct inoculation of the above ground parts with *Fusarium.* If the latter is really the primary cause of Panama disease, why have all investigators failed in their attempts at direct inoculation of healthy plants with the organism? It is suggested that *F. cubense* is unable to develop in healthy tissues and appears only when the latter are already discoloured by the action of the bacterium. It may, therefore, be regarded as a secondary organism, the strongly toxic properties of which produce the typical symptoms of the later stages of the disease.

FERDINANDSEN (C.). **Ueber einen Angriff von Krebs (Fusarium willkommii Lindau) an Apfel- und Birnfrüchten.** [An attack of canker (*Fusarium willkommii* Lindau) on Apple and Pear fruits.]—*Angew. Botan.*, iv, 4, pp. 173–184, 3 pl., 1922.

In the autumn of 1919 fruits of pears in Denmark were attacked by an unusual disease characterized by depressed, sharply defined, brown spots originating on scab [*Venturia pirina*] wounds, and spreading thence over the greater part of the fruits. In the spots were numerous spore layers covered with hairs, white at first, afterwards bare and greyish, and turning brownish when dried. Microscopical examination showed that the fungus was indistinguishable from *Fusarium willkommii,* the conidial stage of *Nectria galligena.* In 1920 the same disease was found on apples from two different localities.

Inoculation experiments with conidia from naturally infected pears, and also from pure cultures, produced the typical depressed and rather dry, brown and soft rot on pear and apple fruits of several varieties. In all cases the skin of the fruit was more or less injured prior to inoculation. Further inoculations with pure cultures of the fungus from pear and apple fruits were carried out on branches, the fungus from each host being tested on both apple and pear. They produced typical canker wounds bearing the fructifications of *F. willkommii.* The inoculations were made through deep cuts on the branches. The fungus was re-isolated from the artificially infected pear branches, and inoculated into pear and apple fruits, on which it again produced the typical soft rot. Re-isolated from infected apple branches, the fungus produced soft rot on pears, but the apples used in a similar experiment were destroyed by *Penicillium glaucum.*

A further series of experiments with *F. willkommii* isolated from natural canker wounds on an apple tree, showed that the fungus was able to produce a decay, corresponding to the soft rot here described, on apple and pear fruits.

COLBY (A. S.). **Limiting factors in Illinois Raspberry culture.**—*Trans. Illinois State Hort. Soc.*, lvi, pp. 337–341, 1922.

Raspberry culture in Illinois has been declining in importance for a number of years, partly as a result of disease. Crown gall [*Bacterium tumefaciens*] is rapidly suppressing the cultivation of both black and red raspberries [*Rubus occidentalis* and *R. idaeus*].

The disease cannot be controlled by spraying, and infected nursery stock is responsible for disseminating it widely. Nursery inspection is fundamentally unreliable, as the disease does not necessarily appear externally during the first season of attack. Anthracnose [*Gloeosporium venetum*], though widespread and destructive, can be satisfactorily checked by two applications of lime-sulphur, one of dormant strength when the leaves have expanded about one-quarter of an inch, and one of summer strength when the shoots are 6 to 8 inches in height. In a series of experiments at Peoria in 1922 the 'Rex' brand of lime-sulphur was used (1 in 8 winter and 1 in 40 summer strength). The mixture was applied very thoroughly with a short spray rod (Myers hand pump) and Vermorel nozzle. Owing to the peculiarities of its bark, the blackcap [*R. occidentalis*] is difficult to spray, and the addition of a spreader, such as casein, is recommended.

Eastern blue stem [see this *Review*, ii, p. 128] was observed for the first time in Illinois during 1922. The field where the disease was noticed was planted with Michigan nursery stock purchased some years ago. Judging by the severity of the disease in Michigan, a serious situation is likely to arise in Illinois, especially as infection cannot be held in check by spraying. The berries produced are small and of inferior quality, and 10 per cent. more fruit is required to fill a quart box from a diseased than from a healthy bush. In order to prevent the further spread of the disease a system of drastic roguing must be followed. The Michigan authorities are making every effort to stamp out the disease in that State.

Roberts (J. W.) & Pierce (L.). **The bacterial spot of Peach.**—*Trans. Illinois State Hort. Soc.*, lvi, pp. 78-87, 1922.

Bacterial spot of peach [*Pseudomonas pruni*], the symptoms of which are described, occurs in most of the peach-growing areas of the United States, being especially severe in the southern districts. Almost all varieties are attacked, the most susceptible being J. H. Hale, Elberta, Carman, Champion, and Waddell. The control of the disease presents considerable difficulties owing to the liability of the trees to spray injury. Bordeaux mixture suppresses the disease, but damages the foliage more severely than the bacillus itself. Lime-sulphur compounds do not give control. The results of the authors' experiments in Arkansas showed that losses from the disease can best be reduced by careful attention to pruning and cultivation, and by fertilization with nitrate of soda (2 or 3 lb. per tree). Treatment with bone meal and acid phosphate, though not nearly so satisfactory as the nitrate applications, somewhat lessened the amount of infection.

Britton (W. E.), Zappe (M. P.), & Stoddard (E. M.). **Experiments in dusting versus spraying on Apples and Peaches in Connecticut in 1921.**—*Conn. Agric. Exper. Stat. Bull.* 235, 17 pp., 6 pl., 3 figs., 1922.

Dusting experiments in comparison with spraying were conducted in Connecticut in 1921 in four apple orchards and two peach orchards. In each case two treatments were given after blossoming on apples, and three on peaches.

The dusts used in the apple orchards were the sulphur-lead, sulphur-lead-nicotine, and Sanders' dusts, while the liquid spray used for comparison in all apple orchards contained liquid lime-sulphur, lead arsenate, and nicotine sulphate. In one apple orchard comparative tests were made between dry lime-sulphur and liquid lime-sulphur, B.T.S., and Bordeaux mixture, with lead arsenate added to each. All the tests are described in considerable detail. In nearly all cases the best results were obtained from the sprayed plots, and the sprays were more effective than the dusts in controlling fungous diseases. Both sprays and dusts adequately suppressed codling moth and other chewing insects; neither controlled curculio. In the sprayed orchard, dry lime-sulphur gave a larger percentage of good fruit than liquid lime-sulphur, B.T.S., or Bordeaux mixture. During 1921 the principal fungous diseases of apples in the orchards under observation were scab [*Venturia inaequalis*], black rot [*Physalospora cydoniae*], fruit speck, and sooty blotch [*Leptothyrium pomi*].

On peaches the only spray used was atomic sulphur, and the dusts were sulphur and sulphur-lime-lead arsenate. In all the peach orchards the dusted plots gave slightly better fruit than the sprayed ones. Peach scab [*Cladosporium carpophilum*] and brown rot [*Sclerotinia fructigena*] were controlled by both dusting and spraying. Dusting is more costly than spraying both in peach and apple orchards.

HÖSTERMANN. **Versuche über die Eignung neuer Pflanzenschutzmittel zur Bekämpfung des Apfelmehltaues (Podosphaera leucotricha).** [Experiments on the efficacy of new plant protection methods for the control of Apple mildew (*Podosphaera leucotricha*).]—*Ber. höh. Gärtnerlehranst. Berlin-Dahlem, 1920–21*, pp. 96–97, 1922.

During 1920–21 apple mildew occurred with unprecedented severity in Germany. Dormant spraying was carried out with various fungicides early in March in an orchard of ten year old espaliers, Landsberger Renettes grafted on Doucins. When the buds opened the sprayed trees were found to be quite as badly infected as the untreated controls. These negative results were probably due to the inability of the spray to penetrate the buds and thus reach the overwintering mycelium, rather than to any lack of fungicidal efficiency in the large number of mixtures used.

The summer treatment, which also comprised the principal up-to-date fungicides, was applied in two separate series, on pruned and unpruned trees. The effect on the latter was practically nil, but a certain improvement was noticeable in the former, especially after the use of solbar, colloidal sulphur (now known as 'cosan'), and lime-sulphur.

In a spraying experiment conducted in the Dahlem Horticultural College orchard in the summer of 1920, colloidal sulphur (0·05 per cent.), 'Bordola' sulphur (0·05 per cent.), and 'Prae' sulphur (0·05 per cent.) gave satisfactory results, while uspulun not only failed to control the disease, but also burnt the foliage.

The author concludes from the above results that winter spraying against apple mildew is merely a useless expense, and that summer treatment must be preceded by thorough pruning. The use of resistant varieties appears to be the only permanent means of control.

Swingle (D. B.) & Morris (H. E.). **The brown bark spot of fruit trees.**—*Montana Agric. Exper. Stat. Bull.* 146, 22 pp., 6 figs., 1921. [Received 1923.]

The disease termed brown bark spot causes severe damage to apple and pear trees, and has also been observed on peach, plum, prune, and cherry, though it is seldom serious on stone fruits. It has been known throughout western Montana since 1910, and also occurs in Idaho, Oregon, and Washington. Recently specimens of what is apparently the same disease have been received from Japan.

The chief symptoms are the death of the buds on certain branches, the appearance of elevated brown spots on the bark, which is killed, and ultimately the death of the aerial parts of the tree. When the buds of the apple are swelling and opening, a certain number are found small, shrivelled, and dead. They may be confined to a single shoot or extend over the whole tree. Those that die without opening have a conspicuous, dark brown streak, running down through the centre to the base. Frequently the bark around the bud dies and becomes sunken. The fibro-vascular bundles that extend through the bark from the leaf scars are blackened. A week or two later small, raised, pimple-like spots, about $\frac{1}{8}$ inch in diameter, appear on the bark of the youngest shoots. These are at first of the same colour as the normal bark, but the centre soon assumes a green, water soaked appearance and then turns brown. The bark on the smaller diseased twigs shrivels and dies, but that on larger branches (above $\frac{1}{2}$ or $\frac{3}{4}$ in. in diameter) may remain alive and green for several weeks, though growth is checked.

Some weeks after these early symptoms, the brown spots typical of the disease develop on the larger branches and trunk up to 5 in. in diameter. The spots are nearly circular and from $\frac{1}{2}$ to 3 inches across. They are elevated ($\frac{1}{16}$ to $\frac{1}{8}$ inch in height), rather spongy in texture, reddish-brown at the margin and mottled pale green and brown inside. Later in the season they often crack away from the surrounding bark. Above the spotted areas the branches may be either entirely leafless or remain for some time apparently normal and fully provided with leaves. Ultimately the bark dies back progressively from the tips of the branches. Red-brown streaks can usually be found in the cambium and inner bark long before any external discoloration is visible. Sometimes young trees are killed to within a few inches of the ground in a single season. In less severe cases only a few limbs may be affected in the first season, and partial recovery occurs occasionally. Complete recovery is extremely rare. The bark of the root system is quite free from any symptoms of the disease, and the roots are the last part of the tree to die.

On pear trees the symptoms of brown bark spot differ in some respects from those on the apple. After the death of the buds both small and large spots appear on the bark, the colour of the large ones being a very dark grey. The inner bark turns almost black, and the cambium of limbs $\frac{1}{2}$ to 2 inches in diameter is often blackened in streaks 1 to 3 feet long. The discoloration extends outward half way through the bark as a mottling, the black mingling with the normal whitish colour of the tissues.

In stone fruits the symptoms are generally similar to those described above, but much less conspicuous owing to the fact that the normal colour of the bark is almost identical with that of the spots.

Repeated attempts to isolate a causal organism from the diseased tissues have given negative results, and the inoculation of healthy trees with diseased bark also completely failed to reproduce the symptoms. This evidence, though not absolutely conclusive, strongly suggests the absence of any infective agent, and the fact that affected trees are usually either isolated or in small groups favours the theory that the disease is due to some fault in the chemical composition of the soil.

It is difficult to suggest intelligent control measures without more definite knowledge of the cause of the disease, but the authors are convinced that, at any rate, the factor of contagion can be dismissed from consideration. On the hypothesis that the disease may be due to infertility of the soil in respect of certain requisites of plant food, possibly nitrogen and phosphorus, the application of these elements is recommended. Top-working by means of grafting and budding gave good results in certain cases. The disease occurs both in irrigated and non-irrigated land, so that soil moisture can be ruled out as a determining factor, and the same may be said of climatic conditions. The chemical composition of the soil is at present being investigated by the Chemistry Department of the Experiment Station.

HÖSTERMANN. **Versuche zur Bekämpfung der Kohlhernie (Plasmodiophora brassicae).** [Experiments in the control of club root of Cabbage (*Plasmodiophora brassicae*).]—*Ber. höh. Gärtnerlehranst. Berlin-Dahlem, 1920–21*, pp. 100–103, 1922.

Experiments in controlling *Plasmodiophora brassicae* by means of uspulun were carried out in the summer seasons of 1920 and 1921. In the 1920 trials uspulun was applied to the infected soil of the frames in the form of powder and its effect tested by growing the following plants in the treated soil: mustard (*Sinapis alba*), head cabbage, Brussels sprouts, kale, kohlrabi, red cabbage, cauliflower, and stocks [*Matthiola*]. Excellent results were obtained by the application of 0·25, 0·5, 1, and 1·25 gm. of uspulun per litre of soil (each frame containing 16 l. of soil), barely a trace of infection being found in the first two cases and none at all in the others. Quite satisfactory results also followed the application of only 0·1 gm. uspulun per litre of soil, the percentage of healthy plants being very high as compared with the untreated controls, all of which, except the stocks, were severely infected.

In 1921 uspulun was applied to the soil in the form of a liquid spray ($1\frac{1}{2}$ l. of a 0·25 per cent. solution per 8 l. of soil), the test plants comprising red cabbage, kohlrabi, head cabbage, and mustard. The results were not nearly so good as in the previous year, probably because the uspulun salts were retained in the upper layers of the soil. In the case of mustard, the fungus appears to act as a stimulant to growth, which is further promoted by the uspulun treatments. The growth and seed production of diseased mustard plants, especially when treated with uspulun, greatly exceeded those of healthy ones.

Mustard was the most susceptible of the plants tested and stocks the least. Head and red cabbage were the most resistant cabbage varieties. Further tests in 1921 showed that when grown in heavily infested, untreated soil the percentage of diseased plants of wallflower was 85, of stocks nil, and of shepherd's purse (*Capsella bursa-pastoris*) 62. The latter should therefore be eradicated from the fields during the rotation.

JUNGE (E.). **Praktische Massnahmen zur Bekämpfung tierischer und pflanzlicher Feinde.** [Practical measures for the control of animal and vegetable enemies.]—*Ber. höh. staatl. Lehranst. für Wein-, Obst-, und Gartenbau zu Geisenheim-am-Rhein 1920–21*, pp. 28–29, 1922.

Fungous diseases were on the whole held in check in 1921 by the protracted heat and drought. Apple mildew [*Podosphaera leucotricha*], however, was extremely severe, scarcely a single variety being free from damage. The excision of affected shoots during the winter proved useless, and the application of 10 per cent. carbolineum in the middle of March also had no effect.

At the end of May experiments in the control of apple mildew with solbar were begun. The leaves were then fully developed and severely infected. A preliminary 1 per cent. application was followed by spraying with a 2 per cent. mixture at fortnightly intervals. Though not completely suppressed, the development of the fungus was satisfactorily checked, and absolute control would probably be ensured by starting the applications of solbar while the trees are still dormant.

Both solbar and potassium sulphide gave good results in the control of American gooseberry mildew [*Sphaerotheca mors-uvae*].

HÖSTERMANN. **Zur Frage der Ueberwinterung des Apfelmehltaues. (Podosphaera leucotricha).** [The question of the overwintering of Apple mildew (*Podosphaera leucotricha*).]—*Ber. höh. Gärtnerlehranst. Berlin-Dahlem, 1920–21*, pp. 97–98, 1922.

In January, 1922, shoots of espalier apple trees which had suffered severely from mildew in the preceding summer were gathered, immersed in warm water (35° C.), and then immediately sprayed with 'cellocresol' 2·5 per cent. (Saccharinfabrik, Magdeburg), solbar 5 per cent. (Bayer, Leverkusen), 'Nosperal' 2 per cent. (Meister, Lucius & Brüning Dyeworks, Höchst-am-Main), a new [unnamed] organic copper preparation 2 per cent., and 'Dendrin' 2·5 per cent. (Avenarius). The shoots were then placed in a greenhouse where re-infection with apple mildew was extremely improbable. Under these conditions the buds opened and most of them were attacked by mildew, irrespective of the fungicides used.

This confirms the results of previous tests [see above p. 220], which indicate that winter spraying is of no avail, the mycelium being situated in the interior of the bud, and therefore out of reach of the fungicide.

Gehring (A.) & Brothuhn (G.). **Ueber die Wirkung verschiedener Beizmittel auf Rüben. I. Beizversuche mit Germisan.** [The effect of various disinfectants on Beets. I. Disinfection experiments with germisan.]—*Fühlings landw. Zeit.*, lxxi, 15–16, pp. 281–289, 1922.

The results of repeated tests in the disinfection of beet seed against root rot (*Pythium de Baryanum* and *Phoma betae*) carried on at the Brunswick Agricultural Experiment Station, showed that in sandy soil, steeping in germisan considerably delayed germination, whereas in clay soil it accelerated germination at a strength of 0·1 per cent., and did not appreciably delay it at any concentration up to 0·5 per cent. Root rot was very satisfactorily controlled by germisan (0·25 to 1 per cent.) and uspulun (0·25 per cent.). 'Segetan' also gave good results, especially in respect of increased germination; it did not control root rot quite as completely as the other two disinfectants.

Oberstein. **Saatbeizapparat-Ausstellung.** [Exhibition of seed disinfection apparatus.]—*Angew. Botan.*, iv, 4, pp. 185–190, 2 pl., 1922.

At a special exhibition of seed disinfection apparatus at Breslau in May 1922, several interesting machines were shown. It is pointed out that a good apparatus must absolutely free the grain from unbroken bunt balls, which are a common source of reinfection of wheat with *Tilletia tritici*. It must also remove the air from the hairs and furrows of wheat and from between the glumes of oats. Not only must light grain be separated (particularly necessary in seed treatment against *Fusarium* and *Helminthosporium* diseases), but also the seeds of certain weeds that are so light as to be difficult to remove by sifting. Finally it must be easily adjusted for the prescribed periods of treatment and be easy to clean.

Two chief types of construction appear to have been exhibited. In one the grain is fed in and removed either by a continuous screw or a scoop; in the other it is placed in an inner, tipping, vessel which can be dipped into and removed from the outer vessel filled with the steep.

In all cases the best results in removing unbroken bunt balls, light grain, and weed seeds are got when the container is first filled to overflowing with the liquid and the grain then fed into it, a large surface being provided for the overflow which carries off the light seed and débris. The grain must on no account be poured in before the container is filled, as once the bunt balls have been completely immersed they do not rise so readily to the surface.

For removing air the continuous screw apparatus provided sufficient movement in some machines, while in others the grain is stirred vigorously with a horizontal bladed paddle or a stream of compressed air blown through it.

In timing the treatment the screw principle is the easier, but gives less accurate timing and less thorough work than the double container, and this advantage of the latter may be considered to balance the extra trouble in working it.

No details of the construction of the machines are given.

RUTH (W. A.) & KELLY (W. W.). **Recent advances in spraying.**—*Trans. Illinois State Hort. Soc.*, lvi, pp. 90–103, 3 figs., 1922.

Amongst the improvements in spraying practice that the authors are convinced, both from an examination of the work of other investigators and their own extensive laboratory experiments, are most urgently needed are the use of heavier applications of the spray fluid and the finding of a substitute for lime-sulphur. The latter is stated to be proving injurious in many cases.

The use of spreaders has already done much to overcome difficulties in application due to lack of adhesion of the spray to the surface sprayed. By the addition of casein-lime to lime-sulphur a perfect covering for peaches is formed, and this spreader also increases the adhesiveness of Bordeaux mixture on plums. More spray also adheres to apple shoots dipped into winter strength lime-sulphur when casein-lime is added. It was found that immersion of peach shoots for one minute in the lime-sulphur and casein-lime solution ensured greater adhesiveness than when the immersion lasted about a second. Similar time effects, as well as increased adhesiveness from the use of casein-lime, were observed when sections of radish leaves were immersed in Bordeaux mixture. The results of orchard experiments on Ben Davis, Winesap, and Grimes apples showed that the addition of casein-lime to the lime-sulphur mixture appreciably reduced the amount of spray necessary. It also greatly assisted in the formation of a film over the fruit, which was most difficult to secure without it. The authors' experimental work has shown, however, that, on most surfaces, casein-lime does not noticeably increase the proportion of spray retained unless prolonged drenching is practised. It may just as well be omitted from light or moderate applications.

Another recent development of some importance is the introduction of 'wettable' sulphur, made by adding casein-lime to very finely ground sulphur. This will be used extensively in eastern peach-growing districts as a substitute for self-boiled lime-sulphur. Probably only sufficient lime should be used to dissolve the casein (about twice the dry weight of the latter) as there are good reasons to suppose that lime itself sometimes causes injury by increasing fruit drop.

CHEVALIER (A.). **Sur une maladie de la Lavande cultivée.** [A disease of cultivated Lavender.]—*Rev. Bot. appliquée*, ii, 13, pp. 482–483, 1922.

In June 1922 the author found an interesting disease in a plantation of lavender (*Lavandula vera*), about 20 hect. in extent, situated at an altitude of 750 m. near the mouth of the Rhone. Both aspic (*Lavandula latifolia*) and true lavender (*L. vera*) occur in a wild form in the neighbourhood, and some plants of *L. fragrans* and *L. delphinensis* have been imported into the district.

The affected plants were found to be completely withered. On the surface of the large roots, bundles of white mycelial hyphae could be observed, and similar hyphae were found invading all the underground portions of the plant. The fructifications of a small Agaric were found on one of the tap-roots on a slight protuberance near the collar. The fungus was identified by Patouillard as *Pholiota praecox*, a species which has not hitherto been known to cause damage to cultivated plants.

It is suggested that the disease may be controlled by thorough sanitation, including such measures as burning the affected plants and draining the low-lying parts of the plantation.

Revue bibliographique des travaux mycologiques publiées en 1920. [Bibliographical survey of mycological works published in 1920.]—*Bull. Soc. Myc. de France*, xxxviii (Supplement), 123 pp., 1922.

By means of a subsidy granted by the Fédération française des Sociétés de Sciences naturelles, the Mycological Society of France has arranged to publish an annual bibliographical survey of French and foreign mycological literature. The present fascicle, which is the first of the series, contains classified lists of mycological literature published during 1920. New genera and species are mentioned and brief abstracts are given of most of the papers cited.

Shear (C. L.). **Life-history of an undescribed ascomycete isolated from a granular mycetoma of Man.**—*Mycologia*, xiv, 5, pp. 239–243, 3 figs., 1922.

The author gives a short description, with a diagnosis, of a pleomorphic fungus which was isolated in 1921 by Dr. M. F. Boyd, Galveston, Texas, from a granular mycetoma in a human ankle, and was sent to him for identification. The lesion had lasted, with intervals of temporary healing, for about twelve years, and was the result of a wound inflicted by a thorn in the sole of the foot. As the fungus does not appear to be an anaerobic organism, it is not quite clear how it could live and develop within the tissues during the long periods when the wound was closed. Inoculation experiments with pure cultures conducted by Dr. Boyd on guinea-pigs were not successful in producing pathological effects of the mycetoma type.

The fungus develops readily on ordinary culture media, and in a few weeks produces all the spore forms. On cornmeal agar the colonies are white at first, then grey and with a radiate, fimbriate margin. As conidia develop the colour becomes greenish-ochre, then smoky brown. The first conidia are borne on loosely branched, byssoid hyphae, on short lateral or terminal sporophores. They are of the *Cephalosporium* type, with hyaline (later yellowish-brown), continuous, rather variable conidia, 8 to 15 by 4 to 7·5 μ, borne in groups at the tips of the conidiophores. Later a coremial stage of the *Dendrostilbella* type develops, with a dark brown synnema, 200 to 300 μ in height, and with a subglobose fertile head bearing conidia like those of the first form. Perithecia are found in numbers on the surface of the medium, and are globose, membranous, dark brown, without ostiole, and 100 to 200 μ in diameter. The asci are globose, thin-walled, evanescent at maturity, 8-spored, and measure 10 to 20 μ; paraphyses are absent. The ascospores are globose or somewhat ovoid, continuous, smooth, pale yellowish-brown when ripe, and 7 by 7, or 5·5 to 7 by 4 to 4·5 μ.

The fungus is most closely related to the organism described by Costantin (*Bull. Soc. Bot. France*, xl, 2nd ser., 15, pp. 236–238, 1893) as *Eurotiopsis gayoni*, and renamed by Saccardo *Allescheria gayoni.* It is regarded as a new species, and named *A. boydii*, the names *Cephalosporium boydii* and *Dendrostilbella boydii* being given to the two conidial stages described.

Nelson (R.). **The occurrence of protozoa in plants affected with mosaic and related diseases.**—*Michigan Agric. Exper. Stat. Tech. Bull.* 58, 28 pp., 18 figs., 1922. [Received March 1923.]

This interesting paper records the occurrence of biflagellates in bean and clover plants affected with mosaic, and of trypanosome-like organisms in tomatoes with mosaic and potatoes with leaf roll. It is copiously illustrated with photomicrographs depicting the different organisms described and their situation in the tissues.

In a brief introductory summary the author alludes to the general belief in the filter-passing nature of the organisms causing mosaic diseases, to the recent discoveries by Matz, Kunkel, and Palm of foreign bodies in the cells of affected plants, and to the indication that the phloem is the region where the exciting cause is situated. He considers that there is little justification for the belief that filterable forms alone represent the stages of the parasites that are capable of producing these diseases, in view of the possibility that they are caused by protozoa, and the known extreme polymorphism of many of these.

The main object of the investigations was to determine if any organism could be demonstrated in the phloem tissue of mosaic plants. Bean mosaic was readily obtainable owing to the investigations of this disease carried on at the station for several years past. Clover and tomato mosaics were plentiful in the neighbourhood, while sufficient potato leaf roll for preliminary work was also available.

In all the early work the ordinary botanical methods were followed, but they revealed nothing. Protozoological methods, modified for plant material, were then adopted and applied to longitudinal sections, a departure from the customary technique of examining transverse sections which the author believes would have illuminated the mosaic problem if employed earlier.

In bean mosaic the sieve tubes were found to be remarkably free from staining particles, and to afford excellent material for study. Longitudinal sections of affected stems or petioles, fixed in various standard solutions of mercuric chloride and stained with Heidenhain's iron-alum haemotoxylin, show the constant occurrence of biflagellate organisms scattered throughout the sieve tubes and phloem parenchyma. Tissues of healthy plants showed no such organisms.

Various forms have been observed in diseased tissues. (1) The most common type were large, elongated, tapering, or cigar-shaped individuals resembling *Leptomonas* in shape, but with two flagella, one at each pole. (2) Ovaliform biflagellates of the same type. (3) Deep-staining, slightly elongated, or almost spherical, sometimes paired, bodies, surrounded by a lighter envelope which is penetrated by the flagella. (4) Very small, elongated flagellates, probably very young forms of type (1). (5) Deeply stained, oval bodies with degenerate flagella and outer envelope, perhaps encysted forms. (6) Small, elongated, non-flagellate bodies varying very much in size and occurring in great numbers in the degenerate chloroplasts of the subepidermal cells or filling the lumen of these cells.

Most of these flagellates lie close to the nucleus and parallel to the long axis of the host cell, although smaller forms sometimes lie obliquely. The flagella, which may be medial or slightly lateral, and which appear to be attached to deeply staining granules, are usually extended, but may be coiled round the nucleus. Degenerate nuclei are often found in diseased tissue.

The biflagellate forms divide by simple, longitudinal, binary fission. First the basal granules divide, next the flagella split, a V-shape slit appears in each end of the body, and division then occurs. Other forms of division probably exist, but have not been observed.

The organisms have been demonstrated in living material by cutting thin longitudinal sections through the phloem, mounting immediately in boiled water, and examining under high-power, dry lenses with minimum illumination. The flagellates were seen actively motile in the sieve tubes, whirling rapidly but without much displacement of position. Rarely more than one individual occurs in a cell, and many cells have none.

The juice expressed from short pieces of petiole was also examined as hanging drops under oil immersion lenses. Occasionally organisms were seen to flash across the field, but they were not located easily.

The size of the flagellates is very variable: type (1) ranges in length from 18 to 5 μ (average 13·5) and in breadth from 3·9 to 0·3 μ. The flagella may vary from 18 to 7·2 μ.

Mosaic of clover (transmissible from bean and vice versa) is also associated with the presence of flagellates of the same type as those found in bean mosaic. Non-flagellate forms were more frequent than flagellate ones, while besides type (1) the small biflagellate forms, and occasionally the broad form, found in the bean were also demonstrated.

No great difficulty was encountered in locating, in the sieve tubes of tomato mosaic material, organisms with a deep staining, long, sinuous, tapering body of trypaniform nature, with one or both ends drawn out to a fine point, and usually with one end larger than the other. The organisms hold haematoxylin tenaciously, and usually lie close to the nucleus. They are not so numerous as those in the bean, seeming to occur in 'nests', the larger forms undoubtedly splitting into a number of smaller individuals. Binary fission was observed in several cases, but only of small forms.

Besides the long, sinuous type of organism, shorter and broader forms also occur, while many show only a slight undulation and others are almost straight. The phenomenon of agglomeration (two or more organisms attached to each other by their posterior ends), common among trypanosomes, has been observed in the organisms in tomato mosaic.

In size the tomato organisms vary widely, the average being 15·3 by 2·8 μ. The largest individual seen was 27 by 6 μ, and the smallest 6·2 by 0·5 μ. The small forms have been seen passing through the perforations in the sieve plates. No definite flagella have been demonstrated, but an undulating membrane has sometimes been seen faintly stained and running nearly the entire length of the body. A nucleus can be made out in the centre of the organism, and deeply staining granules near the extremities.

In potato plants showing only leaf roll symptoms, long trypanosome-like organisms were found in the sieve tubes of the petioles and stems. They vary, but are nevertheless characteristic and constant for this disease. They tend to distribute themselves along only certain of the sieve tubes, but when present they usually occur in a succession of cells. They are frequently in intimate contact with the nucleus, although they may lie free in the cell, usually parallel to the long axis, or, in the case of the smaller forms, obliquely. In size they vary from 35 to 11·3 μ or less in length, and 3·0 to 0·9 μ in breadth, the average being 23·6 by 1·8 μ. The organisms appear to possess a distinct undulating membrane, especially in certain extremely sinuous individuals, and occasionally a long flagellum at one end of the body has been seen. Distinct, dark staining granules occur at each end of the body and are probably blepharoplasts.

In conclusion, the author discusses the nature of the organisms found, emphasizing their protozoon characters, and on the present evidence tentatively suggests that the bean and clover organisms belong to a new genus related to the species of *Leptomonas* found in the latex of Euphorbiaceae and Asclepiadaceae, but distinguished by the bipolar flagella, whilst the resemblance between the organism of tomato mosaic, and especially that of leaf roll of potato to trypanosomes, is unmistakable. As regards the ability of viruses to pass bacterial filters, some of the very slender forms of the bean flagellate might pass medium filters, and there is the possibility of 'symplastic' forms occurring in the life-cycle.

Franchini (G.). **Essais d'inoculations aux souris blanches du latex parasité de différentes espèces d'Euphorbes.** [Inoculation experiments on white mice with parasitized latex from different species of Euphorbiaceae.]—*Ann. Inst. Pasteur*, xxxvi, 12, pp. 873–881, 1922.

Of about thirty mice inoculated in the peritoneum with the latex of various species of Euphorbiaceae containing trypanosomes and amoebae, only seven were slightly infected. The animals were subsequently destroyed, and an examination of the organs of the infected individuals revealed a few Leishmaniform or oval bodies, some provided with a short flagellum, while others contained several nuclei and centrosomes. The organs of a mouse inoculated with the latex of *Excoecaria emarginata* contained more protozoa than the others. The organisms were free or, rarely, intra-corpuscular. Cultures on Nöller's medium yielded a large number of protozoa of various kinds, especially some with pseudopodia and pronounced amoeboid movements. Phagocytosis of the red corpuscles occurred in some instances.

Franchini (G.). **Essais d'inoculation au chat d'amibes du latex de plantes.** [Inoculation experiments on the cat with amoebae from the latex of plants.]—*Bull. Soc. Path. exot.*, xv, 10, pp. 931–933, 1 fig., 1922.

In the summer of 1922 three young cats were inoculated with cultures of amoebae from the latex of *Acokanthera veneneta*, *Plumeria alba*, and *Ficus carica* respectively. In the two first cases slight infection resulted, with phagocytosis of the red corpuscles by some of the amoebae. Both the animals were indisposed for a short time. The third experiment gave entirely negative results.

These observations corroborate those of Musgrave and Clegg, who successfully infected two out of three monkeys at Manila with cultures of amoebae from lettuce leaves.

Nisikado (Y.) & Miyake (C.). **Studies on the Helminthosporiose of the Rice plant.**—*Ber. Ohara Inst. landw. Forschungen*, ii, 2, pp. 133–194, 9 pl., 1922.

A brief historical account of the rice disease caused by *Helminthosporium oryzae*, which is common in Japan, is given. The first mention of a *Helminthosporium* on rice in Japan was made in 1895 by Miura, who attributed the disease to *H. macrocarpum* Grev. In 1901, however, Hori stated, as a result of his investigations, that the disease was caused by a new species, *H. oryzae* Miyabe and Hori. The present authors are satisfied that the fungus with which they have worked is identical with *H. oryzae* M. & H., and that Miura's species was the same. In 1918 Hara suggested that the name *H. oryzae* Breda de Haan should take precedence of *H. oryzae* M. & H. on grounds of priority, Breda de Haan's description having been published in Java in 1900. Although it has not been possible definitely to ascertain that the Java species is identical with that occurring in Japan, available data indicate that this is the case. The name *H. oryzae* Breda de Haan has therefore been adopted in the present paper. Apart from *H. macrocarpum*, which is sufficiently like *H. oryzae* to have led to confusion, but which differs in the size and shape of the conidia and conidiophores, there are two other allied species parasitic on rice, namely *H. sigmoideum* Cav. and *H. maculans* Catt., both of which, however, are easily distinguishable morphologically from *H. oryzae*.

The symptoms of the disease appear first on the foliage, whence they rapidly extend to all the aerial parts of the plant. Numerous small brown spots, the size of a pin's head and more distinct on the lower than on the upper surface, develop. The spots, which are first visible 24 to 48 hours after infection, gradually enlarge and become dark brown, measuring at this stage 1·5 to 2 mm. by 0·5 to 0·75 mm. in diameter, and being surrounded by a yellowish halo. They finally attain a length of 5 mm. and assume irregular shapes owing to coalescence. The central part of the spot turns grey, and heavily infected leaves gradually die back from the tip. The dead portions of the leaves have a velvety appearance caused by the conidiophores of the fungus. Seedlings are attacked as soon as they reach a height of 2 to 3 cm. The tips of the first leaves turn brown, and spots appear on the blades. In the authors' germination tests 12·5 per cent. of the seedlings were affected in this way. Serious infection at an early stage results in a blight of the culms, which turn yellow and then dark brown, the surface being covered with velvety conidiophores. In such cases the heads are sometimes unable to emerge from the leaf-sheaths. In later infections, after the ears develop in the early autumn, lesions are observed on the lowest joint of the rachis, the brown or greyish-brown spots being up to 40 mm. in length. These neck lesions resemble those due to *Piricularia oryzae*, but may be distinguished from the latter by their lighter colour, velvety surface, and the wider curve of the infected head. On the glumes, the lesions generally begin near the joint of the outer and inner glumes, and spread over the entire surface. Infected glumes are covered with blackish-brown hairs.

The morphological characters of the fungus are fully described. On the host, the conidiophores are stout, erect hyphae arising in tufts of two to five or more, usually through a stoma, but sometimes through the epidermis or from mycelial hyphae on the surface of an infected grain or leaf. They are constricted at the point of passage through the epidermis or at the point of branching from creeping hyphae, and expanded into a swelling above the constriction. They are occasionally branched at the base, very slightly constricted at the septa, dark olive below and paler towards the apex, sometimes curved, and geniculate. Their size ranges from 68 to 688 μ in length, mostly from 172 to 473 μ. In width they range from 7·6 to 20 μ at the base, and the minimum and maximum number of septa observed were 2 and 26 respectively.

Conidia are produced singly on the tips of the conidiophores. They vary in length from 15 to 132 μ and in width from 10 to 26 μ, the mean being about 74 by 17 μ. They are generally obclavate, rounded at the basal end, attenuated towards the apex, and curved to one side, but they may be cylindrical or long elliptical and straight. The septa vary from 1 to 12 in number, and the colour from deep olive-buff to greyish-olive. The basal end of the conidium is marked by a small dark scar, where it was inserted on the conidiophore.

In culture the number of conidiophores and conidia produced by the various strains varied greatly. From one to ten or more conidia may be borne on the conidiophore. They attain their full size within two days. The cultural characteristics of the fungus on a number of different media are described at some length. Good growth was obtained from a culture two years and seven months old.

The results of inoculation experiments showed that a large number of grasses can be successfully infected by *H. oryzae*. In the authors' experiments and those quoted from other Japanese publications, some fifty species belonging to thirty-two genera were found to be susceptible. These included maize, sorghum, barley, *Coix lacryma-jobi*, *Panicum crus-galli*, *P. miliaceum*, *P. sanguinale*, *Eleusine indica*, *Setaria italica*, *S. glauca*, and *Cynodon dactylon*.

The mechanism of penetration was studied. It was found that the germ-tubes from germinating conidia are surrounded by a thick, mucilaginous sheath which causes the germ-tube to adhere to the epidermis of the host plant or, when grown in culture, to the glass. Appressoria are formed at the tips of the germ-tube within three hours after germination. The tips swell up and become lobed or variously branched. Penetration can occur either through the stomata or through the cuticle and epidermal wall, by a thin infective hypha arising from the appressorium. The latter is often not well marked in the case of stomatal infections.

The optimum temperature for the germination of conidia was found to be between 25° and 30° C., the minimum and maximum temperatures being 2° and 41° respectively. The optimum temperature for mycelial development was 27° to 30° C. The thermal death point in ten minutes' exposures was 50° to 51° for conidia and 48° to 50° for the mycelium.

As the control of the disease by seed treatment has been dealt with in an earlier paper, only a brief discussion of the fungicidal effects of various substances on the conidia of *H. oryzae* is given. The following showed a comparatively high degree of efficiency: mercuric chloride, silver nitrate, copper sulphate, calcium hypochlorite, formaldehyde. and phenol. Particulars are given of the concentrations required in each case, and the length of exposure necessary for the destruction of the fungus.

SHARPLES (A.). **A consideration of recent work on the brown bast problem.**—*Malayan Agric. Journ.*, x, 6, pp. 155–170, 1922.

After a brief reference to the formation in 1918 of the Brown Bast of Rubber Investigation Committee in Malaya, the author gives a comparative résumé of the work done contemporaneously by the Committee in Malaya and by Rands in Java who, in many cases, followed parallel lines of investigation [see this *Review*, i, pp. 137–142].

In the course of experiments carried out by members of the Committee a large number of different organisms, a list of which is given, was isolated from tissues of *Hevea* affected with brown bast. The total failure, however, of numerous inoculation trials and attempts to transfer brown bast by transplanting and grafting diseased bark on to healthy trees, even though successful grafts were obtained, tends to support Belgrave's view, shared also by Rands, that brown bast is a non-infectious disease of physiological origin. Keuchenius has steadily supported the opposite view of a possible bacterial origin of the disease [see this *Review*, i, p. 263]. In this he is evidently much influenced by the results of experiments in which he made forty inoculations with bacteria isolated from the diseased tissues and kept forty controls. In both, discolorations progressing from the point of inoculation were obtained, the total length of the discolorations in the inoculated series being 177·5 cm., against 59·5 cm. in the controls. An analysis of these results shows, however, that twenty of the bacterial inoculations showed an increase in the length of discoloration as compared with the controls, while in sixteen there was no difference from the controls, and in the remaining four the length of discoloration was actually less than in the controls. The author therefore suggests as the only logical conclusion that such results cancel out and need not influence the work of other investigators. Furthermore Rands failed to get any positive results with bacteria supplied by Keuchenius, and the various bacteria isolated from diseased bark in Malaya have equally failed to reproduce the disease.

A series of experiments set up by the Committee to test the comparative effect of tapping daily, on alternate days, and every third day on a full spiral, a half spiral, and a quarter cut, the results of which are given in tabular form, confirmed the evidence collected by Rands that heavy tapping raises the percentage of brown bast very considerably. The alternate day tapping resulted in much lower percentage of the disease than daily tapping, while tapping every third day gave still less. It was further observed that a single cut of extreme length, as for instance on a full spiral, gives similar results to a number of shorter cuts.

The evidence supplied by experiments carried out during a period of two years in Malaya, some details of which are given, does not support Rands's assumption that the resistance to brown bast sometimes observed in high-yielding trees, which he believes are generally the most susceptible to the disease, might be due to specific immunity, and that it might be possible by selection to breed a strain of *Hevea brasiliensis* immune to the disease. From the Malayan work it would appear that there is little relation between yield and the number of trees attacked by brown bast, though the progress of the disease is slow on bad soil (e. g. old tapioca land) where growth is poor and the cortex is tough. The existence of specific immunity is likely to be difficult to establish in view of the fact that general conditions of growth affect the percentage development of brown bast to a very great extent, and that the progeny of trees selected for their resistance may, therefore, vary in their susceptibility according to the set of conditions under which they are grown. Moreover, in seed selection as so far practised on rubber plantations, little attention has been given to the possibility of the male parent influencing the results.

The remainder of the paper is a short review of the methods of prevention and treatment of brown bast advocated in Malaya and elsewhere, and a consideration of the histological features of diseased tissues in which the opinion is expressed that too much importance has been assigned to the phloem changes observed by Farmer and Horne [see this *Review*, i, p. 144].

WAKSMAN (S. A.). **A method for counting the number of fungi in the soil.**—*Journ. of Bact.*, vii, 3, pp. 339–341, 1922.

The probable error involved in the determination of the numbers of soil fungi by the ordinary plate method is so great as to render the results quite worthless, the development of most of the fungi being prevented by that of the large number of bacteria on the plate when sufficient concentrations of soil to ensure the presence of fungi are used. The following synthetic medium has therefore been devised, its reaction being sufficiently acid to inhibit the development of the species of *Actinomyces* and the majority of bacteria: glucose 10 gm., peptone 5 gm., KH_2PO_4 1 gm., $MgSO_4.7H_2O$ 0·5 gm., and distilled water 1,000 c.c. Dissolve by boiling, add enough N/1 acid (H_2SO_4 or H_3PO_4) to bring the reaction to $P_H = 3{\cdot}6$ to 3·8 (12 to 15 c.c. of N/1 acid per litre of medium). Add 25 gm. of agar, boil, filter, run into tubes, and sterilize as usual. The final reaction should be $P_H = 4 \cdot 0$.

The soil should be diluted only one-fiftieth or one-two-hundredth as much as the dilutions used for the determination of bacteria (e. g. instead of a dilution of 1 to 200,000, 1 to 4,000 or 1,000 should be used), and plates are prepared in the regular way and incubated for 72 hours at 25° C. To obtain an accurate count and a low probable error ten plates should be prepared in each series. The colonies may be counted after 48 and again after 72 hours, by which time the spreading forms, occurring in soils rich in Mucorales, tend to overgrow the plate.

McWhorter (F. P.). **The nature of the organism found in the Fiji galls of Sugar-cane.**—*Philippine Agriculturist*, xi, 4, pp. 103–111, 2 pl., 2 figs., 1922.

After a brief reference to the work of other investigators, the author describes successful preliminary attempts to cultivate the organism found in the galls of the Fiji disease of sugar-cane. Hanging-drop cultures were made in cane juice from thin sections containing the cysts of the organism. The percentage that germinated under such conditions was, however, very low, only about 2 per cent. giving really good germination.

The organism can first be demonstrated in the cells of the developing galls, where it appears in the form of irregularly shaped, lobed, amoeboid bodies, varying greatly in size and composed of granular protoplasm in which the granules are more or less equally distributed with little or no differentiation of ectoplasm. One to six bodies are present in each cell, three being a very frequent number. One (or sometimes more) is generally attached to the host nucleus and remains so until a fairly advanced stage in the life-history of the organism; in some cases, however, the host nucleus may disintegrate as maturity is reached. The larger individuals in the cells may fragment into several smaller ones or, more frequently, divide by a primitive mitotic division into two equal parts. Stained preparations of this stage show that the fragmenting bodies contain nuclei without any nuclear membrane and in a stage of chromidial fragmentation typical of amoebae. During this amoeboid stage the galls continue to develop. The division of the organism is accompanied by the division of the host nuclei; the latter being more frequently amitotic than mitotic. As the galls get older and their walls begin to thicken, the amoeboid bodies cease to divide; they then begin to show vacuoles in their cytoplasm, and finally all sizes round up into cysts. During the early stages of vacuolation, the small cysts resemble certain of the 'ring stages' developed by the sporozoa, and are strikingly similar in appearance to young *Entamoeba coli*. The author observed no indication that the large amoebae divide into a mass of spores. Each cyst is formed from a single amoeba, and since the amoebae differ in size, so do the cysts. The mature cyst is a hollow structure, composed of highly vacuolate protoplasm with a firm but not brittle wall.

Besides bearing galls, plants suffering from Fiji disease are dwarfed, and show other symptoms of disease. In such plants it is not difficult to demonstrate various forms of the organism in other parts besides the galls. Partially encysted stages may be occasionally found in the metaxylem; the author has found them in the metaxylem of the roots in plants with a very typical reduced root system. In swollen places on these roots, which are really galls, the organism often occurs in abundance.

When germinating, the wall of the cyst softens, generally irregularly so that lobes are formed as in a moving *Arcella*. Then the granules composing the walls of the vacuoles are rearranged, and the cyst becomes transformed into a typical motile amoeba, with one or more slowly contractile vacuoles and both rounded and pointed pseudopodia. There is little differentiation into ectoplasm and endoplasm, but in all cases a distinct, highly refractive body, probably a nucleus, is present. Since each cyst changes into only one amoeba and each amoeba has a single nucleus, it is likely that the cysts are uninucleate, though this point requires further investigation. Although the wall of the cyst must contain much metaplasm, the organism was never observed, when germinating, to make any attempts to shed the wall, which becomes part of the motile amoeba's protoplasm. Movement is sluggish, and the amoebae show a tendency to become pointed in culture, though nothing resembling a flagellum has been seen. The amoebae that develop from the large cysts differ but little from the smaller ones, except in size. The maximum length observed was about 15 μ, but the average is only about 5 μ. When dividing, the smaller forms frequently assume a peculiar trypanosome-like shape. Figures showing the amoebae dividing into two of approximately equal size are given from cultures. Summing up, the life-cycle of the organism is simply amoeba—cyst—amoeba. The cysts represent a resting, non-motile stage in the life-history of the organism, and cannot be considered a method of reproduction.

Discussing the classification of the organism, the author states that it differs widely from the genus *Plasmodiophora* in showing no tendency to coalesce into a true plasmodium, in the absence of a zoospore stage, in the spores (cysts) being large, variable in size, and absorbing their membranes when germinating. Among the Chytridiaceae, the fungus *Asterocystis radicis*, causing flax root-blight, has spores that might be mistaken for cysts of the Fiji organism, but the fact that it reproduces chiefly by means of numerous swarm spores clearly differentiates it from the latter. The author concludes that the organism in the Fiji galls is an amoeba related by its characteristics and method of encystment to the section *Lobosa*, although he can find no previous record of such an organism parasitic on plants. The Fiji amoeba resembles *Entamoeba coli*, but differs from the genus *Entamoeba* by its nuclear behaviour and the germination of its cysts. Since there is apparently no existing genus wherein it may be placed, he proposes the generic name *Phytamoeba*. Lyon's name *Northiella sacchari* [see this *Review*, i, p. 187] is not accepted.

The following is the diagnosis of the organism: *Phytamoeba* g. nov. Small intracellular amoebae capable of living in a free state. Little differentiation of ectoplasm. Pseudopodia lobose, blunt. Reproduction by gemmation and simple fission. Cysts form in host cell. Each cyst develops into one amoeba. No zoospores. *P. sacchari* sp. nov. Small intracellular amoeba, capable of living in free state. Size variable, seldom more than 12 μ. When intracellular, pseudopodia are lobose or pointed. Vacuoles present, more or less contractile in extracellular type. Nucleus organized or distributed. Cysts small, rounded, highly vacuolate, walls smooth. Cysts germinate into amoebae. Reproduction by gemmation and simple fission. No zoospores. No coalescing of amoebae to form large plasmodia. Host *Saccharum officinarum* Linn.

Inoculation experiments are in progress. With regard to the path of the organism there is evidence that it passes partly through the metaxylem and partly through certain cells of the pericycle lying between the xylem and phloem. This would help to account for the fact that the galls generally develop from that region of the pericycle. The author has little doubt that the disease is insect borne, though this important point remains to be demonstrated.

WILBRINK (G.). **Een onderzoek naar de verbreiding der gelestrepenziekte door bladluizen.** [An investigation of the transmission of yellow stripe disease by green-flies.]—*Meded. Proefstat. Java Suikerind.*, 1922, 10. [Reprinted from *Arch. Suikerind. Nederl.-Indie*, xxx, pp. 413–456, 1922].

After a preliminary account of the symptoms and distribution of yellow stripe or mosaic disease of sugar-cane, the author describes certain investigations and experiments bearing on Brandes's discovery that the disease is transmissible by insects from sorghum to sugar-cane and maize.

In January, 1921, attempts were made to get the disease to pass from sugar-cane, maize, and sorghum plants infested with *Aphis adusta* (*A. maydis*) to healthy sugar-cane plants, but all the experiments gave negative results. In January, 1922, however, *A. adusta* was again observed on young sugar-cane interplanted with maize, and the author found that by interplanting the cane with any of the favourite hosts of *A. adusta* the transmission of the disease could easily be secured. In addition to the hosts of *A. adusta* already enumerated in the literature [see this *Review*, ii, pp. 33–34], the following have recently been found: *Saccharum spontaneum*, *Dactyloctenium aegyptiacum* [*Eleusine aegyptiaca*], and *Pennisetum macrostachyum*. Under Java conditions the insects appear to prefer *Panicum colonum* to any other host.

A. sacchari attacks primarily the Black Cheribon, White Preanger, Black Borneo, and EK 28 varieties of sugar-cane, and, in contrast to *A. adusta*, inhabits by preference the older leaves. The only alternative host in Java appears to be sorghum, on which the insects are present in enormous numbers. A pink variety of *A. sacchari*, however, was also found to attack *Panicum colonum*.

In June, 1921, sorghum plants growing close to infected sugar-canes became diseased, and in the autumn of 1921 and 1922 further cases of infected sorghum were observed, both among the plants adjacent to diseased sugar-canes and in those planted next to diseased sorghum. Neither the infected sorghum plants nor the wild hosts were seriously affected by the disease, growth being unimpaired and the setting of seed normal. Maize interplanted with diseased sugar-cane in December 1921 became infected in January 1922. The light and dark spots were small at first, but the former rapidly extended so that the leaves finally showed scattered green spots on a yellow or light green ground. Development was not appreciably impaired, and the seed of the diseased maize gave healthy plants, as was also the case with sorghum.

The results of a series of comparative experiments, in which infected and healthy sugar-cane seedlings were enclosed in cages with *A. sacchari* and *A. adusta*, respectively, showed that, in the case of the former, transmission of the disease from infected to healthy plants occurred only in one instance (the authenticity of which was questionable), while in the latter series transmission occurred very generally (100 per cent. of the healthy plants becoming infected in one case) and the rôle of *A. adusta* in the process was unmistakable. These results confirm the work of Brandes, and also show that the disease is transmissible from infected to healthy sugar-cane, as well as from sorghum to cane and maize.

The bearing of this work on the incidence and control of the disease is discussed at length. Damp and cloudy weather indirectly favours the propagation of *A. adusta* by promoting the growth in the cane fields of the wild grasses among which it finds so many hosts. Similar results are produced by light and fertile soils. Now that the infectious character of the disease has been fully established, the most stringent measures must be adopted to secure the cultivation exclusively of disease-free setts. The nurseries from which cane for planting out is obtained [see this *Review*, i, p. 187] should be carefully watched, and every case of the disease immediately removed and destroyed. The growth of grasses should be prevented in all nurseries. Susceptible varieties, if cultivated at all, should be restricted to absolutely isolated fields, but it is better, whenever possible, to replace them by resistant varieties, amongst which 100 P O J appears to be one of the best, while 247 B, E K 2, and E K 28 are also mentioned.

TANAKA (T.). **New Japanese fungi. Notes and translations. XII.**—*Mycologia*, xiv, 5, pp. 282–295, 1922.

This number of the series contains the diagnoses in English, together with notes, of several Japanese species of *Gymnosporangium* that have been described in publications written in Japanese. In each case the synonymy and full bibliographical references are given.

Gymnosporangium asiaticum Miyabe forms its teleuto stage on *Juniperus chinensis* and *J. chinensis* var. *procumbens* (*sargenti*) and the aecidial stage on *Pyrus sinensis* and *Cydonia vulgaris*. The *Roestelia* form of this fungus (*R. koreaensis*) causes the very destructive rust of the Japanese sand-pear, but European pears suffer little from natural infection though they can be inoculated. Some Japanese authors mention *Pyrus toringo* and *Cydonia sinensis* as further hosts. *Gymnosporangium yamadae* Miyabe has its teleuto stage on the same hosts as the last, while the aecidial stage causes an apple rust that has menaced the apple cultivation of northern Japan. It also attacks *Pyrus spectabilis* and *P. toringo*. *Gymnosporangium idetae* Yamada is found in the teleuto stage on *Juniperus rigidus* and in the aecidial form on *Amelanchier asiatica*. *Gymnosporangium hemisphaericum* K. Hara occurs on *Juniperus littoralis* (*J. conferta*) and *J. chinensis* in the teleuto stage and on *Pyrus zumi* in the aecidial. *Gymnosporangium shiraianum* K. Hara forms teleutospores on *Juniperus littoralis* and aecidia on *Pyrus sinensis*. Sand-pear cultivation in the Mikatagahara region had to be abandoned owing to the virulence of this rust.

The paper terminates with a synopsis of the Japanese species of *Gymnosporangium* hitherto recorded.

HARA (K.). **On Witches' Broom of the Sasa spiculosa.**—*Journ. Agric. Soc. Shizuoka-ken*, 300, 5 pp., 2 pl., 1922. [Japanese.]

A new witches' broom is described and figured on the *Sasa* bamboo. The English diagnosis is as follows: *Epichloe sasae* Hara n. sp. Stroma surrounding the young sheath, cylindrical or conical, pointed at the top, 1·5 to 4 cm. long, 3 to 5·5 mm. thick, black, pulvinate, hard when dry; perithecia immersed, elliptical or ovate, 250 to 350 μ high, 110 to 200 μ broad, with projecting ostiola; asci cylindrical, eight-spored, 200 to 250 by 6 to 7 μ; spores filiform, hyaline, 190 to 240 by 1 to 1·5 μ, septate at maturity, separating at the septa into short segments, 12 to 17 μ long. Hab. on *Sasa spiculosa* (Province Idzu, Nekko, 1922).

SOUTH (F. W.). **Regulations controlling the importation of plants into the Straits Settlements, the Federated Malay States, and Johore.**—*Malay Agric. Journ.*, x, 9, pp. 228–233, 1922.

The object of this article is to present in a concise form the various regulations controlling the importation of plants into the Straits Settlements, the Federated Malay States, and Johore. The regulations which have appeared at irregular intervals in different Government Gazettes are not readily accessible.

The entry into the Straits Settlements of the following plants is subject to control.

COCO-NUTS. The importation of all coco-nuts and other palms from Ceylon, Sarawak, and the Philippine Islands is prohibited. This regulation does not apply to nuts of the coco-nut or betel-nut palms or to the husks or oil of coco-nuts from Sarawak. Dried copra and oil of coco-nuts from the Philippine Islands are also exempt from control.

RUBBER. The landing in the Straits Settlements of any plant of Pará rubber (including all species of *Hevea*) from any place outside the Colony is prohibited, except with the written permission of the Secretary for Agriculture, S. S. and F. M. S.

SUGAR-CANE. The importation of sugar-cane (*Saccharum officinarum*) from any place outside the colony is prohibited except under the following conditions: (1) All shipments shall be confined to material for planting purposes only and shall be accompanied by a certificate, signed by a competent authority of the country of origin, to the effect that the said material was taken from healthy plants and was, as far as could be ascertained at the time of packing, free from pests. (2) All shipments of cane plants shall be inspected on landing and before delivery by an Inspecting

Officer who shall be empowered to destroy any diseased plants or packing materials, or to order their disinfection, at his discretion. (3) All imported cane plants shall be quarantined in nurseries, from which they shall not be removed without the written permission of an Inspecting Officer.

In the Federated Malay States and Johore, the plants of which the importation is controlled include only Pará rubber and sugar-cane and the regulations are identical in substance with those of the Straits Settlements.

The author points out that the rules at present in force do not ensure adequate control over the importation of plants. Cotton and possibly other plants should be added to the list, and coconuts should not be allowed free entry into the Federated Malay States and Johore. Without unduly interfering with trade, it is most important to safeguard valuable cultivations from the danger of new pests introduced with commercial consignments from other countries. The Agricultural Department is now in the habit of requesting permission for its inspectors to examine any new plants likely to be grown on a commercial scale in the Straits Settlements or Federated Malay States, in order to ensure that the imported plants are healthy. It is hoped to secure further improvements in the present rules in the near future.

Restrictions on import of plants and seeds into India.—*Agric. Journ. of India*, xvii, 5, pp. 511–515, 1922.

By Notification No. 580–240, dated 26th June 1922, in supersession of that of 7th November 1917, of the Government of India in the Department of Revenue and Agriculture, the importation into British India of any living plant or part thereof by means of letter or sample post is prohibited, with the exception of sugar-cane for planting intended to be grown under the personal supervision of the Government Sugar-cane Expert, Coimbatore. All plants coming by sea, other than fruits and vegetables for consumption, potatoes, and sugar-cane, must be fumigated with hydrocyanic acid at one of the prescribed ports, namely, Bombay, Calcutta, Danushkodi, Karachi, Madras, Negapatam, Rangoon, and Tuticorin; plants infested with living parasitized insects and intended for the introduction of such parasites are exempted from this fumigation if accompanied by a special certificate from the Imperial Entomologist to the Government of India. Potatoes imported by sea must be accompanied by a certificate from the consignor stating fully the country and district in which they were grown and guaranteeing the absence of wart disease [*Synchytrium endobioticum*] from the farms of production, and by an official certificate that no case of wart disease of potatoes has been known during the twelve months preceding the date of the certificate within five miles of the place where the potatoes were grown. Importation of rubber plants by sea is allowed only if they are accompanied by an official certificate that the estate from which the plants originate or the individual plants are free from *Fomes semitostus* [*F. lignosus*], *Sphaerostilbe repens*, and *Fusicladium macrosporum* [*Melanopsammopsis ulei*]. Sugar-cane from any country other than the Fiji Islands, New Guinea, Australia, and the Philippine Islands (from which the importation is prohibited absolutely) may be imported by sea only if accompanied by an official certificate that it was examined and found free from cane borers, scale insects, aleurodes, any form of root disease, pine-apple disease (*Thielaviopsis ethaceticus*), sereh, and cane gummosis, that it was obtained from a crop free from mosaic, and that the Fiji disease of sugar-cane does not occur in the country of export; if the sugar-cane is imported direct by the Government Sugar-cane Expert, Coimbatore, or by the Agricultural Chemist, United Provinces, and intended to be grown under their personal supervision, such certificates shall be required only in respect of the Fiji disease.

The importation of coffee and *Hevea* rubber plants and seeds by sea from America (including the West Indies), except by the Madras Department of Agriculture, is prohibited. Flax and 'bersim' (Egyptian clover) seeds are not to be imported unless under a licence from a Department of Agriculture in India. Cotton seeds imported by sea must be fumigated with carbon bisulphide at a prescribed port as above. A schedule is appended giving the authorities in the exporting countries empowered to issue the official certificates referred to in the Notification.

Modification of nursery stock, plant and seed quarantine. Amendment No. 1 to regulations supplemental to notice of quarantine No. 37 (revised).—*U.S. Dept. Agric. Fed. Hort. Board Leaflet*, 2 pp., 1922.

As a result of representations made by the nursery trade, the regulations requiring that the roots of all plants imported into the United States should be freed from sand, soil, or earth 'by washing' has been modified to read 'by washing or other means'.

It was found that the washing of plants in the country of origin sometimes resulted in injury, and it has been agreed that the earth may be removed by shaking or other means in such cases.

Any importation not satisfactorily cleaned from sand, soil, or earth by some means will be refused entry.

Prohibition of importation of Sugar-cane in Guadeloupe and Martinique.—*Agron. Colon.*, vii, 57, p. 307, 1922.

A decree of the Minister for the Colonies, dated 16th August 1922, and published in the *Journal officiel de la République française* of 24th August 1922, prohibits the entry into, and transit across, Guadeloupe and Martinique of plants, cuttings, and seeds of sugar-cane of whatsoever origin. [In the preamble it is stated that this measure is taken chiefly because of the danger of introducing the mosaic disease of sugar-cane.]

In the interests of the colony, however, the Governor is at liberty to authorize the importation of plants originating in countries from which he is satisfied that there is no danger of infection.

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Mosaic disease of Sugar-cane.—*Louisiana Planter*, lxix, 25, pp. 442–443, 1922.

In the report of the Committee in charge of the Experiment Station of the Hawaiian Sugar Planters' Association for the year ending 30th September, 1922, Lyon gives an account of the investigations of mosaic disease carried on during the year by Kunkel.

The latter found mosaic on several cultivated Gramineae, including maize, sorghum, and Sudan, Tunis, Guatemala, and Wonder Forage grasses, and also on the common wild goose grass [*Eleusine indica*] and bristly foxtail grass [? *Setaria*]. Experiments resulted in the actual transference of the disease from Sudan grass to sugar-cane and to bristly foxtail grass, while there is strong evidence that the disease has been transferred from sugar-cane to both maize and sorghum. In his experiments on the transference of the disease from one sugar-cane plant to another and from other plants to sugar-cane, Kunkel has found only one natural agent of transmission, namely the maize aphis [*Aphis maidis*]. The latter does not feed on the sugar-cane by choice, but thrives on all the other cultivated grasses mentioned above. Mosaic disease in the cane fields can therefore be greatly restricted by limiting the cultivation of susceptible grasses in their vicinity and by the elimination of the wild grasses liable to infection. Any measures directed against the maize aphis should likewise tend to control the spread of the disease. Kunkel's experiments have also shown that the mosaic of sugar-cane can be transmitted by inoculation from diseased to healthy plants. Quite recently he has demonstrated the presence of foreign intracellular bodies in the diseased tissues of mosaic cane similar to those which he previously discovered in maize [see this *Review*, i, p. 194], Chinese cabbage [*Brassica chinensis*], and *Hippeastrum*. These are believed to represent a stage in the life-history of the agent causing the disease. In the sugar-cane they are to be found in necrotic areas only a short distance below the growing point, and they become obscured at an early stage in the development of the cane tissues through the breaking down of the cells in which they lie. They cannot, therefore, be demonstrated in the older tissues.

In recent experiments Kunkel has found that when very young leaves of diseased cane are exposed to bright sunlight, through the removal of the older leaves, they develop a solid green colour and show no signs of mosaic. Presumably the sun's rays destroy the causative agent. The partial recovery of old leaves when exposed to the light is well known, and experiments to test the effect of exposure to X-rays are in progress.

It was definitely proved by a series of experiments on four different plantations that none of the standard canes grown in Hawaii can produce maximum results while infected with mosaic disease. The loss in sugar production due to this disease is very great. The following control measures, in addition to those mentioned above, are recommended: the use of seed cane from healthy plants; the destruction of diseased canes; the use of resistant varieties where the surrounding area cannot be freed from the disease; the propagation of seedlings resistant to, or immune from, the disease; and the prevention by quarantine measures of the introduction into Hawaii of other insects likely to act as agents of transmission.

Büren (G. v.). **Weitere Untersuchungen über die Entwicklungsgeschichte und Biologie der Protomycetaceen.** [Further investigations on the life-history and biology of the Protomycetaceae.]—*Beiträge zur Kryptogamenflora der Schweiz*, v, 3, 94 pp., 2 pl. (1 col.), 27 figs., 1922.

This important work is divided into four sections, dealing respectively with the forms of the genus *Protomyces* inhabiting the Umbelliferae; those inhabiting the Compositae; the genus *Protomycopsis*; and the genus *Volkartia*.

In the species occurring on Umbelliferae, morphological observations and a series of experiments resulted in the establishment of seven 'formae speciales' of *Protomyces macrosporus*, namely: f. spp. *aegopodii, heraclei, chaerophylli, chaerefolii, carvi, ligustici*, and *laserpitii*. The 'collective host' for *P. macrosporus* is the parsnip, *Pastinaca sativa*. In cross-inoculation experiments, f. sp. *aegopodii* was transmitted to *Carum, Selinum, Angelica*, and *Laserpitium latifolium*; f. sp. *heraclei* to *Laserpitium latifolium* and *L. siler*, and f. sp. *ligustici* also to *L. latifolium*. The f. sp. *laserpitii* infects *Peucedanum* and *Thapsia*. Neither the collective nor the secondary hosts were found to be infected under natural conditions in the neighbourhood, presumably on account of a deficiency of moisture in their habitat.

In the case of the Compositae, specialization is much stricter than in the forms inhabiting the Umbelliferae. There is no record of any form of *Protomyces* on a genus of the Compositae being transferred to another genus of the same family. Only the form occurring on *Crepis biennis* (*P. crepidicola*) appears to have a few secondary hosts within the genus *Crepis* (*C. aurea* and *C. pontana*). The latter were very mildly attacked and infection was probably only rendered possible by the favourable conditions prevailing during the experiment. The following species of *Protomyces* occurring on the Compositae were studied: *P. pachydermus* on *Taraxacum officinale*; *P. kreuthensis* on *Aposeris foetida*; *P. kriegerianus* n. sp. on *Leontodon hispidus*; *P. picridis* n. sp. on *Picris hieracioides*; *P. crepidicola* n. sp. on *Crepis biennis*; and *P. crepidis-paludosae* n. sp. on *Crepis paludosa*.

Various morphological differences, such as the dimensions and colour of the spores and shape of the sporangium, characterize the species of *Protomyces* parasitic on the Compositae. The only certain means of identification, however, is the observation of germinating chlamydospores.

The investigation of the genus *Protomycopsis* presents considerable difficulties owing to the low germination percentage of the resting spores. Four species of the genus were studied. *P. chrysanthemi* n. sp. attacks *Chrysanthemum alpinum* in damp places on the mountains, causing the formation of whitish-yellow, flat callosities, mostly on the under side of the leaves, but occasionally also on the pedicel. The resting spores are formed terminally on the mycelial ramifications within the leaf parenchyma, and the vascular bundles are free from the fungus. The membrane of the young chlamydospore is covered with small warts, and in profile also exhibits a ring of extremely fine rod-shaped structures in the thickness of the wall. Both these features are absent from the mature chlamydospores, and there is nothing to distinguish a *Protomycopsis* resting spore from that of *Protomyces* except the thicker membrane of the former. The diameter of the chlamydospores ranges from 28·5 to 46·5 μ (average 36 to 37 μ) and the pale buff-coloured membrane is 4·5 μ thick. The sporangia measure 55 to 60 by about 50 μ. *Protomycopsis leucanthemi* was found capable of infecting only *Chrysanthemum leucanthemum*, though the experiments were few in number. A form which is referred to the same species was also found on *C. atratum*. Cross inoculations showed that *P. leontodontis* n. sp. is transmissible from *Leontodontis autumnalis* (on which it was found) to *L. montanus*, while *P. arnoldii*, collected on *L. montanus*, infected *L. autumnalis*, though in a very mild degree.

In 1916 the author showed (*Mitt. naturforsch. Gesellsch. Bern*, pp. 112–124, 1917) that *Volkartia* is perennial in the underground portions of its hosts, whence it annually renews its attacks on the young shoots. Subsequent experiments with *Volkartia umbelliferarum* on *Heracleum sphondylium* showed that the mycelium also invades the floral organs; it can penetrate the pollen sacs and cause degeneration of the pollen grains, and it also enters the ovules, sometimes reaching the embryo sac and checking the development of the embryo.

The author concludes by a short discussion of the systematic position of *Volkartia*, in which he expresses a doubt regarding the separation of this genus from *Taphridium*. Of the two species, *V. umbelliferarum* and *V. rhaetica*, hitherto described, the latter (and possibly also the former) agrees with *Taphridium* in the mode of spore formation, earlier accounts of the process having been based on incorrect observations. He expresses himself as being in entire agreement with Juel that the series of the Hemiascaceae:

Protomyces, *Protomycopsis*, and *Volkartia-Taphridium*, leads directly to the Exoascaceae (*Taphrina*).

MASON (F. A.). **Micro-organisms in the leather industries. III. Species of the genus Penicillium and their identification (contd.).**—*Bull. Bureau of Bio-Technology* (Murphy & Son, Ltd., Sheen Lane, London), 6, pp. 161–175, 5 figs., 1922.

Of the four species of *Penicillium* named by the author in his previous paper [see this *Review*, i, p. 44] only two, *P. expansum* and *P. decumbens*, are found at all frequently on leather, the last being the more common. They belong, respectively, to the *Eupenicillium* and *Aspergilloides* groups, so that they can be readily distinguished.

P. expansum is found much more frequently on old de-natured leather, such as worn-out boots and leather scraps, than on newly tanned articles; in the author's experience, skin, limed pelts, and fancy leathers are free from it. Tan liquors contain the mould in a small amount, and it develops slowly in tanning extracts prepared from valonia and quebracho; it has not been met with in the dust of these substances. On old leather it occurs usually in bright blue, velvety spots up to 1 cm. in diameter, the colour being darkest in the centre and shading off to white at the edges.

P. decumbens has been found on all kinds of leather, including both vegetable and chrome tanned goods, on limed pelts, and on sheepskins from the soaks. Its effect is to obliterate the grain, the rather large, effused, indeterminate colonies spreading rapidly. Its appearance differs with age; the first effect resembles a stain, but later on a woolly appearance develops as the spot turns greyish-green. Ultimately it becomes a dark green, velvety patch, without any white boundary zone. On tanning materials the fungus occurs frequently, having been isolated from the dust of sumach, valonia, and quebracho; in the green scum from the tan liquors it was found to be the dominant organism.

P. lanosum was found on leather as a secondary organism in conjunction with *Aspergillus luchuensis*. It grows in small, grey-green colonies, at first rather similar to those of *P. expansum*; but the subsequent production of long, aerial filaments gives it a much more woolly appearance. It was not found on tanning materials, but grew slowly on valonia and quebracho extracts, with a darkening effect on the liquid.

P. viridicatum has not been recorded on leather, but was isolated by the author from a mixture of organisms collected from a tan liquor. Growth was slow in valonia and quebracho extracts, the liquids becoming darker in colour and a dark brown precipitate being formed.

A table giving morphological data (from cultures on wort agar) for the identification of the four species of *Penicillium* referred to is appended.

FROMME (F. D.) & WINGARD (S. A.). **Blackfire or angular leaf spot of Tobacco.**—*Virginia Agric. Exper. Stat. Tech. Bull.* 25, 43 pp., 2 col. pl., 18 figs., 1922.

The blackfire disease of tobacco caused by *Bacterium angulatum* is prevalent in almost all the tobacco-growing sections of Virginia, a survey conducted in 1920 revealing its presence in 85 per cent. of the fields. Blackfire and wildfire (*Bacterium tabacum*) both occur in the seed-bed, the former being found in 70 per cent. of the beds inspected during three seasons, and the latter in only 13 per cent.

The causal organism of blackfire is seed borne, and seedling infection may usually be traced to the use of contaminated seed or plant-bed cloth, on which also the pathogen may overwinter. Tobacco refuse and, to some extent, the soil, are further sources of infection. Raindrops are the chief means of dissemination, and excessive rainfall also predisposes the plants to disease by inducing a succulent and vigorous growth. The most rapid spread is during the period of most rapid growth of the host, and the greatest injury is caused to the most vigorous plants. The use of phosphatic fertilizers indirectly promotes severe infection by increasing the size and vigour of the plants. The difference in severity of infection at the different heights of topping is also very marked, plants topped at a height of eight to eleven leaves being more susceptible than those topped at a height of twelve to fourteen leaves. These observations are believed to indicate that the pathogenicity of the organism is closely related to the metabolism of its host. All the varieties of tobacco grown in Virginia are susceptible to the disease, and none of the eight tested in 1919 showed a sufficient degree of resistance to promise effective control by varietal selection. So far no evidence has been found that *B. angulatum* can attack any other plant but tobacco. Seed disinfection by soaking in a 2 to $2\frac{1}{2}$ per cent. formaldehyde solution for fifteen minutes or 1 in 1,000 corrosive sublimate for ten minutes has given very satisfactory results as regards control of the disease, but the former treatment slightly impedes germination. As soon as the crop is harvested, the ground should be ploughed to suppress the further growth of the plants and prevent the accumulation of infective material.

WEBER (ANNA). **Tomatsygdomme.** [Tomato diseases.]—66 pp., 3 pl. Copenhagen, N.C. Rom., 1922.

The principal diseases of tomatoes are enumerated, together with a brief account of the symptoms, effects, and distribution of the more important, and appropriate measures of control. The list of diseases due to fungi, bacteria, and physiological conditions includes the following: Potato blight (*Phytophthora infestans*), foot rot (*P. cryptogea*), buck-eye rot (*P. terrestris*) [*P. parasitica*], *Sclerotium* blight (*Sclerotinia sclerotiorum* and *Sclerotium rolfsii*), *Phoma* fruit rot (*Phoma destructiva*), canker (*Diplodina lycopersici*), leaf blight (*Septoria lycopersici*), anthracnose (*Colletotrichum phomoides*), stem-end rot (*Botrytis* sp.), wilt or sleepy disease (*Verticillium albo-atrum*), rust (*Cladosporium fulvum*), *Macrosporium* rot (*Macrosporium tomato*; *M. solani*), *Fusarium* wilt (*F. lycopersici*), *Rhizopus* fruit rot (*R. nigricans*), and diseases caused by *Pythium de Baryanum*, *Rhizoctonia* (*Hypochnus*) *solani*, *R.* sp., *Verticillium lycopersici*, *Isaria clonostachoides*, *Melanconium* sp., *Fumago vagans*, *Fusarium erubescens*, *F. orthoceras*, *F. oxysporum*, *F. sulphureum*, *F.* sp., *Puccinia pittieriana*, *Synchytrium endobioticum*, and *Spongospora subterranea*.

Of bacterial diseases the following are mentioned: bacterial spot (*Bacterium exitiosum*), Grand Rapids disease (*Aplanobacter michiganense*), streak (*Bacillus lathyri*), and bacterial wilt (*Bac. solanacearum*).

Of the above the following have been observed in Denmark: *Phytophthora infestans*, *Sclerotinia sclerotiorum*, *Sclerotium rolfsii*, *Diplodina lycopersici*, *Septoria lycopersici* (not serious), *Botrytis* sp. and *Verticillium albo-atrum* (both noticed for the first time in the summer of 1922), *Cladosporium fulvum*, *Macrosporium solani* (of no economic importance), *Phytophthora cryptogea*, *Fusarium sulphureum*, *Hypochnus solani*, and *Bacillus lathyri*. Reports of the occurrence of *Bacillus solanacearum* are probably due to a confusion with *B. lathyri*.

Mosaic, leaf roll, blossom-end rot, hollow stem, cracking of unripe fruit, and green bark, which are regarded as diseases of physiological or unknown origin, have all been observed in Denmark. There is a table for the identification and treatment of the chief diseases, and a bibliography of 113 titles is appended.

BADOUX (H.). **Ennemis du pin Weymouth.** [Enemies of the Weymouth Pine.]—*Journ. forest. suisse*, lxiii, 6, pp. 101–104, 1922. [Abs. in *Monthly Bull. Agric. Intell. and Plant Diseases*, xiii, 7, p. 919, 1922.]

Cenangium abietis, which usually occurs on various conifers as a simple saprophyte, has been known to cause serious, and even fatal, damage to pines of all ages from five years upwards. Between 1914 and 1918 *C. abietis* attacked the white or Weymouth pine [*Pinus strobus*] in several parts of Switzerland (Zürichberg, Horgen, and Rothenburg), and in 1921 it occurred in a closely packed stand of sixty-year-old pines on alluvium in the Hinterholz forest. The diseased trees died off from the top downwards within a radius of 100 acres. The infected wood was found to be very brittle, while the blackish discoloration rendered it unfit for commercial purposes. Of the 587 c.m. felled in 1921 only 90 c.m. could be utilized in building, &c. The stand has been thoroughly cleared to prevent the spread of the attack.

C. abietis also occurred as a parasite in 1921 in Pomerania [see this *Review*, i, p. 332].

RANDS (R. D.). **Streepkanker van Kaneel, veroorzakt door Phytophthora cinnamomi n. sp.** [Stripe canker of Cinnamon caused by *Phytophthora cinnamomi* n. sp.]—*Meded. Inst. voor Plantenziekten*, 54, 53 pp., 6 pl. (1 col.), 1922. [English summary].

The present paper deals with the author's recent field and laboratory investigations of a bark canker of cinnamon (*Cinnamomum burmanni*) trees in the uplands of the west coast of Sumatra, which for some years past has caused considerable losses. The disease is particularly severe in badly drained inland plantations where the trees are set far apart and interplanted with other crops. In seven such plantations examined the estimated percentage of disease varied from 1 to 42, and it may even reach 90 in certain cases. Its economic importance cannot be readily assessed, since the canker is frequently accompanied by insect attacks. Susceptible trees succumb to the combined effects of the fungous and insect parasites within a year after attack, and generally before they attain the most profitable age for harvesting.

The most striking symptom of the disease is an irregular vertical stripe of dead bark, 1 to 5 cm. in width, originating at or below soil level and reaching sometimes to a height of 10 to 15 m. The stripe is deeply depressed, and often bounded by callus at its base, and is thus more conspicuous than higher up on the trunk. The normal greyish-white colour of the bark remains unchanged, except at the rapidly advancing upper extremity of the canker, on the surface of which drops of an amber or wine-coloured exudate, which soon hardens, appear. On susceptible trees the lateral growth of an active root canker sometimes produces fresh infections, which extend vertically close to the original stripe. On scraping off the outer layers of the diseased bark, it will be seen that the phelloderm, which is dark brown or red in colour, is sharply divided from the adjacent healthy tissues by a narrow black line, irregular and curving in the outer bark and nearly straight in the inner. The middle and inner layers of bark exhibit, at regular intervals of about a centimetre throughout the length of the canker, a succession of zones (generally fifteen to twenty-five) separated by thin layers of brown, gummed tissue. Rapidly spreading cankers were found to extend about 1 cm. daily and to develop one new zone each day. The secretion of gum apparently begins at night. Zonation was equally well marked under conditions in which the material differences between day and night, as regards temperature, light, and air, were eliminated, and also in cankers isolated from the rest of the tree. The rhythmic spread of the fungus is, therefore, probably correlated with some habitual periodicity in the physiological processes of the tree.

A species of *Phytophthora* has been repeatedly isolated from the margins of spreading cankers, and has invariably reproduced the typical symptoms of the disease on inoculation into healthy trees. It is believed to be capable of life in the soil. Two distinct strains from widely separated localities on the west coast were compared, and a consistent difference in their relative virulence observed. The more virulent strain produced cankers one-third longer on an average than the less virulent. Negative results followed the inoculation of *Erythrina lithosperma*, *Theobroma cacao*, *Hevea brasiliensis*, and *Carica papaya* with pure cultures of the more virulent strain. Conversely the species of *Phytophthora* occurring on the first three of these plants failed to produce appreciable lesions on *Cinnamomum burmanni*. The cinnamon *Phytophthora* is thus apparently strictly limited in its parasitism and distinct from other oriental species. On *Cinnamomum zeylanicum*, *C. camphora*, *C. culilawan*, and *C. sintok* the inoculations resulted in very slight infection.

The characters of the fungus in the host tissues are not described. No fructifications were observed either in nature or in the ordinary culture media, except chlamydospores. Conidia were, however, obtained in profusion by the following special method. An eight to ten-day old pea-juice culture was emptied into a sterile Petri dish, the peas removed, the culture fluid drained off, and the mycelium washed for four to six hours in three changes of sterile water. The culture was allowed to stand in the last water for twelve to twenty-four hours, after which the water was drained off and only enough fresh added just to cover the mycelium. After another twenty-four hours thousands of conidia were found on the surface. They were of the usual *Phytophthora* type, except that they exhibited the phenomenon of internal proliferation similar to that which is found in *Saprolegnia,* but only known previously in a single species of *Phytophthora* [*P. cryptogea*].

The following diagnosis of the fungus is given. *Phytophthora cinnamomi* n. sp. Irregular, sparingly ramified, inter- and intra-cellular mycelium permeating bark and outermost layers of wood; occasional chlamydospores in the tissues; aerial hyphae on oat agar, hyaline, slender, 5 to 7 μ in diameter, later thick-walled and septate; haustoria not observed. Chlamydospores thin-walled, globose to pyriform, mostly 31 to 50 μ in diameter (average 41 μ), terminal on short lateral branches, abundant in artificial cultures, often in grape-like clusters of three to ten, germinating by three to eleven germ-tubes. Conidiophores undifferentiated, simple or sympodially branched. Conidia terminal, ovoid to ellipsoid or elongated, hyaline, thin-walled, with a broad, flat papilla on the end opposite point of attachment, mostly 38 to 84 by 27 to 39 μ (average 57 by 33 μ); later conidia produced on branches of the conidiophores in successive sympodial fashion and also by internal proliferation; wall of the conidium partially collapsing after discharge; conidia germinate in water by liberation of zoospores or occasionally by a germ-tube or the formation of secondary conidia. Zoospores bean- or kidney-shaped, with two flagella of unequal length attached to concave side; about 11 by 18 μ while swimming and 10 to 11 μ in diameter when at rest; germinating after about an hour by a germ-tube. Oospores not observed.

The control of the disease can be effected to some extent by the prevention of wounding and the maintenance of good soil drainage. These conditions are most nearly realized at present in the so-called 'forest cultivation', where the trees are closely planted on steep, rocky soil, and not continually wounded by the tillage of intercrops or by grazing stock. The trees are not susceptible to canker before the age of two to three years, during which period intercrops may be cultivated if desired. In the vicinity of farms or villages the wounding of exposed roots by animals is almost inevitable, and the planting of cinnamon trees in such localities should be discontinued.

The results of experiments in the control of the disease by excising the diseased tissues and applying hot coal-tar, 'Papco' (consisting of asphalt dissolved in carbon disulphide), or a paraffin-solignum solution, showed that the last-named effectually prevented further extension of the cankers, but caused severe injuries to the cambium. There is reason to believe that washing the wounds with a disinfectant before applying coal-tar or 'Papco' would promote the efficacy of these preparations. For the present, simple excision of diseased tissues, the harvesting of affected trees, and the improvement of general sanitary conditions on the lines indicated above, are recommended.

Sundararaman (S.). **A new Ginger disease in Godavari district.** —*Mem. Dept. Agric. India*, Bot. Ser., xi, 9, pp. 209–217, 4 pl. (2 col.), 1922.

During the heavy rainfall in August 1920, ginger crops in the Godavari district, India, were attacked by a leaf disease which spread rapidly and caused considerable damage.

The first symptom of the disease was the appearance of light yellow, round and oval spots, 2 to 3 mm. in diameter, on both the upper and lower surfaces of the leaves. Some of the spots coalesced, forming large, discoloured patches with minute, black dots in the centre, where the tissue afterwards dried up and fell out, leaving a hole. In the final stages, minute, dark dots appeared in irregular, concentric rings in the diseased region. These dots consisted of the stromata of a fungus, with large clusters of hyphae and masses of spores and setae. When the central shoots are affected the entire surface may be studded with these dots. The edges of affected leaves roll up and the tips bend and droop down. In very severe cases the petioles and the scaly leaves on the rhizomes are attacked.

The disease appears to be favoured by wind and damp, close weather subsequent to heavy rainfall. The rain washes the spores to lower portions of the plant, and the wind carries them from leaf to leaf and from plant to plant. With the return of dry weather many plants recover. The practice of close planting indirectly favours the disease by the exclusion of light and air.

The fungus was identified as a *Vermicularia* for which the name *V. zingibereae* n. sp. is proposed. The sporodochia are in dense clusters, circular or oval, 50 to 140 μ in diameter, and provided with numerous erect, dark brown, septate setae, 85 to 168 μ in length. The spores are subfusoid, curved, with blunt ends, hyaline, guttulate, and 17·5 to 24 by 3·1 to 4·2 μ. Chlamydospores [appressoria] of the *Colletotrichum* type are formed on the germ-tubes. It differs from the species of this genus that attack chillies and turmeric in India in the measurements of the sporodochia and the formation of chlamydospores, but is otherwise very similar to these forms. Cross-inoculations on chillies and turmeric gave negative results. The parasitism of *V. zingibereae* was definitely proved by repeated inoculations from pure cultures in the laboratory. Typical disease symptoms are produced in fifteen days when the inoculated plants are kept under humid conditions, but if kept dry infection does not result.

Spraying with Bordeaux mixture (5–5–50), first when the disease was fairly distributed and again six weeks later, increased the value of the yield by Rs 160 per acre.

Gibson (F.). **Sunburn and aphid injury of Soybeans and Cowpeas.**—*Arizona Agric. Exper. Stat. Tech. Bull.* 2, pp. 41–46, 2 pl., 1 fig., 1922.

During the autumn of 1920 the writer observed a spotting of the leaves of cowpeas and soy-beans near Mesa, Arizona. Investigations carried out in the following spring showed the injury to be due to sunburn and aphid attacks, succeeded by infection with a species of *Alternaria*. The symptoms of sunburn and aphid injury were similar, namely the appearance of brick-red spots which enlarged, turned brown in the centre, and later were often covered with a sooty black growth of *Alternaria*. The fungus, which is briefly described and for which the name *A. atrans* n. sp. is suggested, was weakly parasitic, growing in needle puncture inoculations in healthy plants, in leaves punctured by aphids, and in sunburned areas.

Loss of leaves in the Virginia soy-bean is very severe, and seriously diminishes the value of the plant for purposes of green manure, cover, and forage. Biloxi appears to be the most resistant variety. The other varieties attacked were Otootan, Barchet, Shanghai, Tokio, and Peking soy-beans and Blackeye cowpea.

Bewley (W. F.). **Anthracnose of the Cucumber under glass.**—*Journ. Min. Agric.*, xxix, 5, pp. 469–472 and 6, pp. 558–562, 1922.

The anthracnose of cucumbers caused by *Colletotrichum oligochaetum* Cav. is at the present time the most important leaf spot disease of the cucumber in England, and is responsible for heavy losses each year to the growers. In former years *Cercospora melonis* [*Corynespora melonis*] caused great destruction in the Lea Valley, but the introduction of the immune variety Butcher's Disease Resister, in 1903, together with improved methods of soil sterilization, led to its ultimate elimination. At present it is found only in isolated parts of the country.

The symptoms of anthracnose are briefly described. Isolation of the causal organism is easy, and it has been cultivated on a wide range of artificial media. Investigations made by the author showed that *C. oligochaetum* can live as a saprophyte on decayed woodwork, timber, paper, and other organic matter in the glasshouse, and is thus able to tide over the winter period. A further important source of infection has been proved to be the straw manure from the houses and also manure coming from towns, which is doubtless infected from diseased fruit discarded from street stalls and the like. In no case was the fungus found in stable manure fresh from the country.

Infected glasshouses should be cleaned by thoroughly spraying the interior woodwork with an emulsion of cresylic acid and potash soft soap, the formula for preparing which is given. High-power spraying machines should be used and the ventilators must be closed after the spraying in order to retain the strong vapours. A fortnight after the treatment, the houses may be replanted, but as a final precaution every cavity in the woodwork should be filled with putty and painted over. During the growing season the disease may be controlled by spraying the plants at weekly intervals with solutions of liver of sulphur or lime-sulphur, to which flour paste is added as a 'spreader'. Four formulae for the preparation of the spraying liquids are given and recommended as having been tested in commercial nurseries with satisfactory results. To be quite effective they should be used in the early stages of the disease before the fungus has attacked the leaf-stalk and stem tissues. On the following day after spraying every spotted leaf should be removed and burnt. Dusting with sulphur has been extensively tested, but it has never been found to control the disease completely.

Good cultural methods and thorough (even drastic) ventilation of the glasshouse go a long way towards preventing or controlling the disease.

ANDERSON (P. J.). **Development and pathogenesis of the Onion smut fungus.**—*Mass. Agric. Exper. Stat. Tech. Bull.* 4, 34 pp., 6 figs., 1921 [1922].

Since 1918 the author has conducted an investigation of onion smut (*Urocystis cepulae*), the most destructive of all onion diseases in New England, primarily with a view to discovering effective control measures. This necessitated an exhaustive study of the life-history of the causal organism, the results of which are given in the present paper.

Laboratory tests showed that mature fresh spores germinate in onion decoction, sugar solutions, and various agars, but not in tap, distilled, or soil water. The presence of the onion or any substance derived therefrom is not necessary to germination, but sugar is apparently one of the most important stimulants. Freezing does not hasten or increase germination, but this effect is produced to a marked degree by free access of air and also by a period of rest in damp soil. When seedlings with unopened lesions were buried in sterile soil, mycelium of the fungus grew out freely into the soil, but whether it came from spores or from the vegetative hyphae in the tissues was not ascertained. Spores frozen in the ground are not killed. In the soil the spores become progressively prepared for germination; a few begin to germinate in three to six days under favourable conditions, and others germinate from time to time for many months. This period may be shortened artificially by the use of substances such as cane sugar.

The germination process resembles that of other species of *Urocystis*. A short, hemispherical promycelium develops, and from this arises a whorl of branches which grow indefinitely in the form of a mycelium without bearing sporidia. Septation appears early and the new branches generally arise below the septa. The older cells gradually lose their protoplasm, which becomes concentrated in the growing tips. The cells are easily broken apart, and detached segments, capable of further growth, are commonly found. *U. cepulae* lives and grows as a saprophytic mycelium in the soil for an indefinite period, probably for years, especially where there is an abundant supply of organic material. It enters the soil in the form of spores or mycelium from the buried parts of diseased onions, and can be widely disseminated by detached mycelial cells carried by wind, rain, implements, &c. The number of years which must elapse before onions can safely be grown on infested land must be decided by the duration of this saprophytic mycelial existence, since the author has never observed sporidia nor have spores ever been found in culture. Cultures exposed for two months to severe winter weather still grew luxuriantly when brought back to the laboratory.

The range of media upon which the fungus will grow is almost unlimited. A list is given of those used by the author, together with details of the behaviour of the fungus on each, and the microscopic characters of the mycelium are briefly described. Sugar in the media was found greatly to increase development, and is probably responsible for the rapid growth of *U. cepulae* in the onion. Starch furnishes a very poor source of carbon, and a small amount of acid checks growth. At an early stage the mycelium disintegrates into short, plump cells which probably take the place of sporidia as a means of dissemination.

Infection of the onion seedlings by the spores or mycelium in the soil occurs from the second day after germination till the appearance of the first leaf on the side of the cotyledon, namely, a period of about twelve days in the greenhouse. Infection occurs only through the cotyledon, any part of the epidermis of which may serve as the point of entry, and many infections may take place on the same cotyledon. The infecting hypha bores through the outer wall of the epidermal cell, inside which it forms a hyphal coil from which branches then pass through the inner wall into the intercellular spaces, where they continue during the whole of their subsequent development. Under favourable greenhouse conditions the incubation period to the first externally visible symptoms of infection is about five days. Large, complicated haustoria are sometimes formed in the host cells. Infected plants may recover if the fungus fails to reach the growing zone, but if the latter is once invaded most, if not all, of the leaves subsequently formed will contain lesions.

The approach of sporogenesis is first indicated by the massing of the mycelium in dense tangles between the cells of the mesophyll. Hyphal 'nests' are thus formed from which the spores develop in sori. The spore begins as a lateral or terminal branch which curves back on itself in the form of a crozier and may continue to grow into a spiral. Branches arise from this curved hypha to form a close covering around its terminal cell which becomes the fertile central cell of the spore ball. By adhesion of the cells of the covering hyphae and rapid expansion of the fertile cell, the enclosing hyphae are separated into the scattered elements which appear as the sterile covering cells of the mature spore. The fertile cell contains a single, large nucleus, probably the result of fusion as in allied species, though at what stage the latter occurs was not determined ; and each sterile cell has a single, small nucleus. As the sorus develops the host tissues above it dry out and may split open to liberate the mature spores.

Interim Report of the Dominion Botanist for the year ending March 31, 1922.—*Dominion of Canada Dept. of Agric., Divn. of Botany*, 73 pp., 3 figs., 1922.

This report contains an account of the work of the Dominion Division of Botany by H. T. Güssow, Dominion Botanist, and also of that of the Field Laboratories of Plant Pathology at Charlottetown, Prince Edward Island, by J. B. McCurry, at Fredericton, New Brunswick, by G. C. Cunningham, at St. Catherine's, Ontario, by W. H. Rankin, at Saskatoon and Indian Head, Saskatchewan, by W. P. Fraser, and at Summerland, British Columbia, by H. R. McLarty.

Among the items of interest the following may be mentioned. An account is given of the outbreak of white pine blister rust [*Cronartium ribicola*] in British Columbia [see this *Review*, i, p. 455], where fortunately the susceptible native pines, *Pinus monticola*, *P. flexilis*, and *P. albicaulis*, only form about 0·8 per cent. of the total stand of timber. Only the coastal region has as yet been found infected and legislative steps are being taken to prevent further dissemination of the disease.

During 1921 the work of seed potato inspection and certification was carried on as usual, the first inspection being made when the plants were in bloom, and the second just before they reached maturity. A considerable extension of territory was included in the year's activities, notably in Saskatchewan and Alberta. The total area of fields inspected throughout the country comprised nearly 8,000 acres, of which rather less than half passed the two inspections. Thirty inspectors were employed on the work for varying periods during the year. Full details of the standards employed in grading the crop are given.

An important feature of the report is the detailed account of leaf curl and mosaic of raspberries by Rankin and Hockey (pp. 30–60), which supplements their previously published studies on these diseases [see this *Review*, i, p. 218 and ii, p. 17.]

In a preliminary report on the strains of stem rust of wheat (*Puccinia graminis*) in Manitoba, Alberta, and Saskatchewan, W. P. Fraser states that Strain XVII was much more common and widely distributed during the period 1919–21 than any other. The occurrence of Strains III, IX, XI, XII, and XVIII, however, was also reported. As in previous years, the disease appeared first in the south and later in the north. No evidence of overwintering on grasses was obtained, the observations indicating that the spring attack appears first on the wheat and only spreads later to the grasses.

Experiments were carried out to test the efficacy of dusts for the control of cereal smuts under Western Canada conditions and to compare it with formalin treatment. Marquis wheat was shaken in a container with spores of the stinking smuts of wheat (*Tilletia tritici* and *T. levis*). Part of the infected grain was then dusted with anhydrous copper sulphate, with and without the addition of calcium carbonate or lime. It was found that both copper sulphate and lime (1–1), and copper sulphate and calcium carbonate (1–1) reduced the amount of smut to a trace (0·65 and 0·78 per cent. respectively), but were slightly inferior to formalin (1–320), which completely eliminated the disease. In a similar experiment with oats the seed was dusted with spores of *Ustilago avenae*. Copper sulphate and lime, and copper sulphate and calcium carbonate reduced the infection to 0·03 and 0·02 respectively, which again was not quite equal to the results obtained by the use of formalin. Copper carbonate, which has been found to be effective elsewhere, was not available at the time of testing.

Smut of western rye grass (*Agropyron tenerum*) was effectively controlled by the ordinary formalin treatment. The smut closely resembles that of brome grass (*Ustilago bromivora*) in morphological characters. To test their biological identity, commercial seed of *A. tenerum* was heavily dusted with spores of *U. bromivora* from *Bromus ciliatus* but the resulting crop was no more heavily smutted than that from the balance of the commercial seed. This result indicates that these smuts may be biologically distinct.

Experiments in the control of bunt of wheat by the dry formalin method (1 part of 40 per cent. formalin to 1 part of water applied at the rate of 1 quart to 50 bushels of grain) have been reported frequently to result in reduction of germination. Experiments during the period under review on Marquis wheat showed no injury to the seed, but the treatment is not recommended on account of the possible dangers under certain conditions.

Leaf rust of wheat (*Puccinia triticina*) appeared early in Saskatchewan and Alberta in 1921, and was very severe in the former province. In south-eastern Saskatchewan the losses from this and stem rust are estimated at 20 per cent. of the crop.

There are numerous other records of general interest for which the report itself must be consulted.

LÜSTNER (G.). **Ergebnisse der Prüfung neuer Mittel gegen Peronospora, Oidium und Heu- und Sauerwurm in den Jahren 1920 und 1921.** [Results of the testing of new methods for the control of *Peronospora*, *Oidium*, and Vine moth in the years 1920 and 1921.]—*Ber. höh. staatl. Lehranst. Wein-, Obst-, und Gartenbau zu Geisenheim-am-Rhein, 1920–21*, pp. 79–85, 1922.

Excellent results were obtained by the use of kurtakol [see this *Review*, ii, p. 44], a copper compound in colloidal form manufactured by the firm of Dr. Kurt Albert at Biebrich. The copper content of the mixture is about equal to that of Bordeaux mixture, but kurtakol works out in practice at a cheaper rate owing to the smaller quantities required and the absence of lime. Experiments extending over a period of five years have shown that kurtakol is quite as effective as Bordeaux mixture against *Plasmopara viticola*. In 1920 only two applications were given, on 7th and 28th June respectively, the mixture on the first occasion consisting of 500 gm. kurtakol to 100 l. water, and on the second of 660 gm. to 100 l. The vines remained healthy throughout the summer and autumn. Comparative tests with Bordeaux mixture and nicotine gave somewhat inferior results. Kurtakol is very easily prepared for use; it does not clog the spraying apparatus or burn the foliage, and may altogether be most highly recommended.

Perocid (0·5 and 1 per cent.), also prepared by Dr. Albert's firm, was applied on 8th and 17th June and 5th August. *Plasmopara* was satisfactory controlled, but, as with Bordeaux mixture, the autumnal discoloration of the leaves set in earlier than after the use of kurtakol.

Nosperal 1781 and 1782 (Dyeworks, Höchst-am-Main) contain 8 per cent. copper against 24 per cent. in copper sulphate. They are somewhat cheaper than copper sulphate (although the initial outlay is approximately equal) on account of the smaller quantities required, namely, 1 per cent. at the second and third applications as compared with 1·5 and 2 per cent. of copper sulphate. The mixtures are prepared by dissolving the powders in water and neutralizing them on the following day with pit lime. Three applications were given, on 7th and 24th June and 7th August, with excellent results. Nosperal 1781 was slightly superior to 1782, chiefly in its physiological effects, the foliage remaining exceptionally luxuriant in colour and development.

A lye derived in large quantities as a by-product at an aniline dyeworks had good adhesive properties but caused severe burning of the foliage.

A preparation named 'Kupferpasta-Bosna', supplied by the Bosnian Electricity Company in Vienna, gave very good results after two 1 per cent. applications on 11th and 24th June respectively.

Oidium tuckeri on Portuguese vines was adequately controlled by four applications, on 5th and 24th June and 7th and 30th July, of colloidal sulphur (3 and 6 per cent.) from Dr. Thiele's chemical works, Berlin. The untreated controls were very severely attacked. In 1920 it was successfully applied in conjunction with Bordeaux mixture for the simultaneous control of *Plasmopara* and *Oidium*.

The summer of 1921 was very unfavourable for the continuation of the experiments, *Plasmopara* being entirely absent on account of the drought. The control of *Oidium* with sulphur was complicated by the formation of sulphuric acid on the sprayed foliage and fruit, due to the brilliant sunshine. A new preparation from the Höchst Dyeworks, known as 'Elosal', produced very good results, but requires further testing.

Forty-seventh Annual Report of the Ontario Agricultural College and Experimental Farm 1921.—*Ontario Dept. Agric.*, 55 pp., 1922.

The section of this report devoted to botany (pp. 34–39) contains various references of phytopathological interest. Smuts and rusts of cereals were extremely prevalent and caused heavy losses. The damage caused by oat smut [*Ustilago avenae*] in some of the fields examined was estimated at 15 per cent. Leaf rust of oats [crown rust, *Puccinia lolii*] was so severe that many crops were entirely destroyed. In the eastern sections of the Province apple scab [*Venturia inaequalis*] was very severe, and the value of spraying was again demonstrated, 80 to 95 per cent. of the fruit in thoroughly sprayed orchards being free from the disease. Other prevalent diseases were plum pockets [*Exoascus pruni*], maize smut [*Ustilago maydis*], stem blight of asters, and strawberry leaf scorch [*Mollisia earliana*]: the latter was particularly severe in the Ontario Lake Shore District on the varieties Glen Mary, William Belt, and Ruby.

Investigations carried on to determine the best source from which to obtain seed potatoes free from leaf roll and mosaic showed that the lowest average percentage of leaf roll occurred in Green Mountain potatoes from Northern Ontario and Maritime Provinces stock (·5 and ·6 per cent. respectively) and the highest in Irish Cobblers from Old Ontario common stock (8·2 per cent.).

Spraying experiments in the control of late blight of celery [*Septoria apii*] have been conducted for the past nine years with a variety of fungicides, of which only liquid Bordeaux mixture has given uniformly satisfactory results. Bordeaux dust was effective, but less so than the liquid mixture.

The results of four years' trials with dry formaldehyde for the control of oat smut [see this *Review*, i, p. 436 and above, p. 254] have proved uniformly satisfactory. In no case has there been more than a trace of smut in any of the fields sown with treated seed, whereas in the control plots the average incidence of infection was 4·32 per cent. The advantages of this method over those in general use are simplicity, rapidity, and facility of application.

Winter blight (also locally known as 'streak') is a common disease of greenhouse tomatoes in Ontario, and is in some cases severe enough to interfere with the production of a profitable winter crop. The disease also occurs in heavily manured fields. The results of experiments conducted every year since 1914 indicate that the disease is due to soil conditions and not to any parasitic organism. Satisfactory control has been obtained by the addition of phosphoric acid and potassium to the soil.

Division of Plant Pathology and Physiology.—*Thirty-fourth Ann. Rept. Texas Agric. Exper. Stat.*, 1921, pp. 17–19, 1921. [Recd. 1923.]

Blossom-end rot of watermelons was found to be due to a *Diplodia* which did not differ essentially from *D. tubericola*, causing the so-called 'Java black rot' of sweet potatoes. Numerous cross-inoculations of the *Diplodia* isolated from the watermelon on the sweet potato and vice versa indicated that the two strains were identical and may readily pass from one host to the other. The two crops should therefore not be allowed to succeed one another. Cross-inoculations with the anthracnose fungus of watermelons, *Colletotrichum lagenarium*, showed that the latter readily infects cucumbers, cantaloupes, squashes, gourds, and citrons. The fungus from any of these hosts is easily transmissible to the others.

Investigations of the Texas root rot fungus, *Ozonium omnivorum*, during 1921 tended to verify the assumption that the fungus hibernates on susceptible roots which remain alive in the soil. The value of crop rotation for reducing the incidence of the disease is definitely indicated, and absolutely clean culture is essential. The hosts of the fungus are being determined, and a full report on the disease is in preparation.

A *Fusarium* from rotted stored potatoes was repeatedly isolated, and found to cause 100 per cent. infection when inoculated into healthy potatoes. The fungus in some respects resembled *F. oxysporum*, the cause of wilt disease, but further investigations are necessary to determine its systematic position.

It has been ascertained that the causal organism of tomato wilt (*Fusarium lycopersici*) reaches every part of the plant, and it was even isolated from the fruit.

Cabbage in the Rio Grande Valley was severely attacked by *Fusarium conglutinans*, while downy mildew (*Peronospora effusa*) was the chief disease of spinach observed. An apparently new and undescribed disease, probably of bacterial origin, attacked lettuce, causing a burning of the outer edges of the foliage and penetrating into the inner leaves of the head, where it led to the development of numerous small spots.

Russell (H. L.) & Morrison (F. B.). **New pages in farming. Annual Report of the Director, 1920–1921.**—*Wisconsin Agric. Exper. Stat. Bull.* 339, 142 pp., 40 figs., 1922.

In the section of the *Bulletin* devoted to plant pathology (pp. 32–48) the following references are of interest. The investigations of wheat scab and blight [*Gibberella saubinetii*] carried out by J. G. Dickson were chiefly concerned with the temperature and moisture relation of the disease. The results of greenhouse and outdoor experiments both indicated that the disease is most severe in wheat at relatively high soil temperatures (61° to 75° F.), whereas in maize it is worst at lower temperatures (46° to 68° F.). It was also shown that wheat flourishes best at low temperatures unfavourable to the development of scab (46° to 53° F.), while maize requires for its optimum growth higher temperatures than the fungus (68° to 82° F.). A study of the influence of soil moisture on the disease showed that in fairly dry soil, containing 30 per cent. of the moisture-holding capacity, over 40 per cent. of the inoculated wheat seedlings blighted at a temperature ordinarily unfavourable to scab (46° F.), as compared with a complete absence of blight at the same temperature where the soil moisture was 60 per cent. of the water-holding capacity. Disease-free seed at 30 per cent. moisture made very good growth.

Field observations during the past two seasons have shown that the scab fungus, after infecting the anthers of the wheat flowers, develops in the adjacent tissues in the glumes surrounding the growing kernel. The percentage of scab was found to depend on the number of anthers remaining enclosed in the glumes. The important commercial varieties of winter wheat, Turkey, Kharkov, Kanred, Fultz, and others showed high percentages of anthers remaining within the glumes, which was correlated with severe infection. Specific attempts were made, therefore, to select individual plants with open anthers from the varieties in which this character was normally absent. Three strains of Turkey wheat were obtained with the required anther formation and the resulting plants showed only 2 or 3 per cent. of scab as against 30 to 40 per cent. in the control plots.

Root rot of maize (*G. saubinetii*, *Diplodia zeae*, and *Fusarium moniliforme*) is a most important and dangerous disease throughout the maize-growing section of the United States, a conservative estimate of the total loss in 1919 being over 125,000,000 bushels, and since that date there has been no decline in the severity of the disease. Dry ear rot (*D. zeae*) is prevalent chiefly in the warmer localities, but the wheat scab organism, as shown above, is more destructive in the cooler sections of the maize-growing areas, such as Wisconsin.

Owing to the dry spring and summer of 1921 the incidence of apple scab [*Venturia inaequalis*] was so slight that the results of a series of comparative spraying experiments carried out by G. W. Keitt are of doubtful significance. Bordeaux mixture (4–4–50), caused a serious russeting of the fruit, but a full schedule of [liquid] lime-sulphur (1–40) and dry lime-sulphur (4–50), gave more satisfactory results. Generally speaking, the dusts, of which sulphur-lead arsenate (90–10), copper-lime-lead arsenate (10–80–10) and sulphur-dry lime-sulphur-lead arsenate (75–15–10) were tested, were slightly inferior to the sprays.

Cherry disease investigations were continued, especially with a view to the control of leaf spot [*Coccomyces hiemalis*], which was very severe in 1921 owing to the heavy rains during the latter part of August. Three applications of Bordeaux mixture (3–3–50), gave the best results, the treatment being carried out (1) just after the petals fell, (2) about a fortnight later, and (3) soon after harvest. In general, dust treatments (with the same dusts as for apple scab) did not give very satisfactory control. The results of the investigations showed the necessity of increased attention to the control of leaf spot after harvest.

Anthracnose of black raspberries [*Gloeosporium venetum*] is particularly severe on the Cumberland variety, and has greatly reduced the Wisconsin crop. The results of experiments carried on at Madison by L. K. Jones showed that the disease could be adequately controlled by the application of the following sprays; (1) delayed dormant spray, lime-sulphur (1–10), or Bordeaux mixture (6–6–50), plus an adhesive, such as glue, gelatine, or casein-lime, after the unfolding of the first few leaves, (2) a summer spray, lime-sulphur (1–40), or Bordeaux mixture (3–3–50), with an adhesive, about one week before blossoming.

Trials were carried out by W. B. Tisdale with three early varieties of yellows-resistant cabbage, namely, Copenhagen Market, Ball Head Early, and Glory of Enkhuizen. The first selections were made in 1919 from 'cabbage sick' fields, and in 1920 seed was produced from a few self-pollinated plants. Plants from this seed set in 'sick' soil in 1921 showed a high degree of resistance to yellows, together with other desirable qualities. Further experiments with these strains are in progress.

J. Monteith's studies on the relation between club root of cabbage (*Plasmodiophora brassicae*) and soil temperature and humidity showed that the disease developed through a wide range of temperature (48° to 86° F.), the most active growth taking place at about 68° F. Club root did not develop in most of the soils used when they were maintained with a moisture content below one-half of their water-holding capacity. At a higher moisture content the disease appeared in a severer form. Poorly drained land, therefore, should not be used for cabbage culture, when club root is prevalent.

McRae (W.). **Report of the Imperial Mycologist.**—*Agric. Res. Inst. Pusa, Scientific Reports 1921–22*, pp. 44–50, 1922.

Piricularia oryzae, the cause of the destructive 'blast' of rice in other countries, has been recorded from many parts of India, but the damage to the crop is not usually considerable. In Madras and Bihar fifty per cent. of the seedlings in the seed-bed may be infected slightly, but after being transplanted the plants may ultimately become almost free from disease. Infection experiments, and the available meteorological records, indicate that a high moisture content of the air and a definite temperature are the most important factors that influence the spread and severity of the disease. Species of *Piricularia* similar to that on rice have been found on *Eleusine coracana* (on which it sometimes occurs in epidemic form with a resulting loss of grain that may amount to 50 per cent.), *Panicum repens* (a wild grass common in the rice 'bunds' and water channels), *Setaria italica*, *Paspalum sanguinale*, *Triticum vulgare*, and *Panicum ramosum*. Cross-inoculation experiments and field observations indicate that, although the morphological and cultural characters of the different forms are not very distinct, their behaviour on different hosts under Pusa conditions shows definite biological peculiarities: thus the forms on *Oryza*, *Panicum repens*, and *Paspalum* are each restricted to its own host, while those on *Eleusine*, *Setaria*, and *Triticum*, although interchangeable among themselves, will not infect the first three hosts. The strain on *Panicum ramosum* has been but recently found and its behaviour has not yet been tested.

Two other diseases of rice were investigated. One of them is due to a sclerotial fungus which has not yet been identified and which causes light yellow-brown spots on the leaf sheath, sharply demarcated by a dark reddish-brown line. Under favourable conditions the fungus spreads over the whole plant, which is rapidly killed. Its morphological characters, as well as the symptoms of the disease caused by it, closely resemble those of the 'Djamoer Oepas' disease of sugar-cane in Java and India; work is in progress to determine whether the fungi are identical in both cases. The second disease, resulting in a failure of the plant to produce grain, and recorded from Burma, Assam, and the Central Provinces, is possibly caused by a species of *Cephalosporium*, although there are indications that soil conditions may be the predominant factor in determining the incidence of this fungus as a parasite.

Preliminary experiments have shown that the smut, *Tolyposporium penicillariae*, of 'bajra' (*Pennisetum typhoideum*) is amenable to seed treatment with hot water (10 minutes at 60° C.) or hot formalin vapour (20 seconds at 98° C.), though these treatments slightly reduce the percentage of germination. The presence of the mycelium has been traced in apparently normal grain, occupying the scutellum and the seed coat near the embryo, thus confirming field observations which suggest that the disease is carried in the seed. Experiments to ascertain whether infection takes place through the flowers indicated that this is not the case. Considerable annual losses are caused by the smut of this important cereal in India and control measures on a larger scale are being tested.

Other cereal diseases under investigation include those caused by *Fusarium*, *Diplodia*, and *Acrothecium* on 'bajra' and maize, and by *Helminthosporium* on rice, barley, wheat, sugar-cane, and millets. The *Helminthosporium* work, in general, confirmed the results previously reported [see this *Review*, i, p. 160].

The interesting smut *Urocystis coralloides* again appeared in the same field on the roots of Indian mustard [*Brassica*]. The infected plants are stunted and branch feebly. Attempts to germinate the spores failed.

The study of *Macrophoma corchori* was continued both at Pusa and at Dacca. This fungus causes a stem rot of jute, which is most severe in soils deficient in potash. Applications of sodium sulphate appear to have a considerable influence in reducing the incidence of this parasite. The pycnidial stage appears only on the host plant; in artificial culture the fungus remains sterile and produces small, black sclerotia, in which form it appears to be identical with the organism previously described in India as *Rhizoctonia solani* Kühn [*Mem. Dept. Agric. India*, Bot. Ser., iv, 6, 1912].

McDonald (J.). **Annual Report of the Mycological Division.**—*Ann. Rept. Dept. of Agric. Kenya for the year ending 31st March, 1921*, pp. 81–82, 1922.

A few diseases of minor importance were observed for the first time. Amongst these may be mentioned 'red mould' of wheat, due to the fungus *Fusarium culmorum*, which was reported from the Kericho district, where its occurrence was associated with excessive humidity.

Ustulina zonata, which frequently attacks the roots of tea, coffee, rubber, &c., on old forest land, caused numerous deaths among pear and peach trees planted under similar conditions. Cases of flax wilt (*Fusarium lini*) were reported from all the principal flax-growing centres.

Report on the Department of Agriculture, Barbados, for the financial year, 1921–22, 19 pp., 1922.

The Director of Agriculture, Mr. J. R. Bovell, reports the occurrence of mosaic disease of sugar-cane, which was first observed in a small plot in October 1920. In spite of attempts to eradicate the disease, it spread with great rapidity and at present exists practically all over the island.

The Assistant Director, Mr. B. A. Bourne, furnishes a report on the entomological and mycological work of the Department. Amongst the fungous diseases studied most attention was given to root disease of sugar-cane, and the results of this investigation led to the following conclusions. Root disease occurs both on typical black and red soils, ratoon canes being particularly susceptible. In typical cases either *Rhizoctonia solani* or *R. pallida* was found associated with freshly diseased and dying roots, and in advanced stages of the disease the tissues of the basal portions of the stem were infected by one or other of these fungi. A species of *Fusarium* may also be present. *Marasmius sacchari* has only been isolated from dead roots. Inoculation experiments proved conclusively that both *R. solani* and *R. pallida* are parasitic and capable of causing root decay and reproducing the typical symptoms of the disease, including stunting of the plant and yellowing of the leaves. Similar tests with *M. sacchari* and the *Fusarium* gave negative results. In the field the disease appears to be favoured by a high soil temperature combined with absence of humidity. The following control measures are recommended: planting of resistant varieties and of healthy cuttings from disease-free plants; suitable rotation of crops; proper tillage and drainage; and thorough trashing of fields of young plants and ratoon canes in order to conserve the soil moisture and keep down the temperature.

The usual fungi, *Colletotrichum falcatum* and *Cephalosporium sacchari*, associated with red rot of sugar-cane; *Leptosphaeria sacchari* causing ring spot of the leaves; *Thielaviopsis paradoxa* producing pineapple disease, and *Cercospora vaginae* responsible for a red spot of the leaf sheath, were observed on several occasions. The fungus associated with eye spot of sugar-cane leaves, which is new to Barbados, was isolated in pure culture and found to agree with the description of *Helminthosporium sacchari*, except in the much greater length, often up to 75 μ, of the spores. The writer believes that *Colletotrichum falcatum*, which was frequently found to be associated with the diseased spots, was largely responsible for the rapid death of the leaves subsequent to attack by *H. sacchari*. Another fungus not previously recorded from Barbados was commonly found to be associated with dead and dying cane leaves and leaf sheaths, namely *Rhizoctonia grisea* (*Sclerotium griseum*). The writer isolated this fungus from single sclerotia from a dying cane leaf sheath of the variety Ba. 6032.

Imphee (*Andropogon sorghum saccharatus*) suffered from a root disease believed to be due to the attacks of *Rhizoctonia ferrugena*. Pure cultures developed numerous reddish-brown sclerotia about 4 mm. in diameter.

A tree of lignum vitae (*Guaiacum officinale*) was found suffering from what appeared to be a fungous disease. All along the stems and twigs, both green and mature, minute pycnidia could be seen embedded in the epidermal tissues. Two fungi were isolated from the diseased tissues, one of which was a species of *Phoma*, and the other *Phomopsis stewarti*, which is stated to be parasitic on *Cosmos* in the United States. The pure cultures of the latter agreed with Stevens's description, and produced on sweet potato agar both *Phlyctaena*- and *Phoma*-like spores.

Report on the Agricultural Department, St. Lucia, 1921.—*Imper. Dept. Agric. W. Indies*, 31 pp., 1922.

This publication contains (pp. 8–9) a copy of a report by S. F. Ashby, on a banana disease which has been known in the island since 1912, and which chiefly affects the Gros Michel variety. As a result of successful attempts to isolate the causal organism, it is now stated that the disease is identical with the well-known Panama disease due to *Fusarium cubense*. It appears to be confined to the north-western districts. Attention is called to the danger of transmitting this disease to Barbados, where it is as yet unknown, with the banana trash that might accompany shipments of Gros Michel fruit.

WELLES (C. G.) & ROLDAN (E. F.). **Solanaceous wilt in the Philippine Islands.**—*Philipp. Agric.*, x, 8, pp. 392–398, 3 pl., 1922.

Bacillus solanacearum causes the most serious disease of tomato, eggplant, tobacco, and other solanaceous plants in the Philippine Islands. Young tobacco seedlings attacked by this organism show a slight wilting of one or more leaves, followed within twenty-four hours by the collapse of the entire plant, which subsequently dries up. The stunting and more or less permanent wilting, without killing, of larger plants is common. The annual loss varies from 5 to 15 per cent. of the crop.

Eggplant seedlings are more resistant than tobacco or tomato. The diseased plants first show wilting of the old, outer leaves, followed within a few days by the death of the entire plant. In older plants the course of the disease is very gradual and is never accompanied by total collapse owing to the support of the woody stems. The fruits frequently become wilted and swarm with bacteria.

Tomato seedlings, especially after transplanting, are very susceptible to this disease, total loss of the crop being common. The older leaves wilt first, followed within twenty-four hours (or a few days in wet weather) by the collapse of the plant. In large plants one or two branches are first attacked, the infection rapidly spreading over the entire growth. The fruits are also frequently attacked.

Castor bean (*Ricinus communis*) exhibits similar symptoms to those described above. No plants over 1 metre in height were observed to be affected.

In *Chrysanthemum coronarium* (apparently a new host) the attack does not result in the collapse of the plant but kills the green parts, leaving a tall, leafless stem. In this case the organism has not yet been studied in sufficient detail to warrant a definite statement concerning its identity, but it is believed to be *B. solanacearum*, though it produces a somewhat lighter pigment in culture than that from wilted solanaceous plants.

Attempts to control the disease by applications to the soil of copper sulphate, calcium oxide, calcium phosphate, and potassium chloride gave negative results. The only absolute method of control in infected soil appears to be a five years rotation of crops in which all hosts of *B. solanacearum* are excluded. The eggplant, however, may safely be planted during the rainy season, very few losses being sustained under Philippine conditions if it reaches maturity by the beginning of December.

MUNERATI (O.). **Osservazioni sulla recettività del Frumento per la carie.** [Notes on the susceptibility of Wheat to bunt.]—*Rend. Acc. Lincei*, xxxi, ser. 5 a, 1 sem., 3, pp. 125–129, 1922.

The author was induced to publish the present note, giving the result of his researches in the period 1912–1917, by Heald's paper on the relation of the spore load to the per cent. of stinking smut appearing in the crop [see this *Review*, i, p. 169].

Several series of experiments (a summary of which is given) to test the influence on infection by *Tilletia*, of the soil temperature at the time of germination of the wheat, and of the distribution of the spores on the integuments of the grain, led the author to the following conclusions, in agreement with those previously advanced by him.

The presence of even a very considerable load of *Tilletia* spores on the grain is not in every case sufficient to determine the infection of the seedlings, the latter being much more a function of the course and duration of the germination process of the grain. A rapid germination gives the plant a better chance to escape infection than a slow one. Seed disinfection, always advisable, is therefore of particular importance when sowing has to be done late in the autumn or early in the spring.

The theoretical probability of infection depends more on the distribution of the spores on the integument of the grain than on their total number. The further the spores are localized from the embryonal zone, the less the risk of the plants becoming infected. If, in practice, the possibility of infection does depend to a certain degree on the total spore load, this is due merely to the fact that the larger the number of spores, the greater the probability that some may find their way to the embryonal zone at germination. If the spores remained strictly localized to the apical zones of the grain, the seedlings would escape all possibility of auto-infection. In this connexion the little brush of hairs found at the pointed end of the grain, far removed from the embryo, is of considerable importance. Under natural conditions of infection the greater number of the spores lodge in these hairs, but they may become distributed over the rest of the grain by rubbing or other mechanical means. In the author's experiments it was found that grain to which spores were fixed by gum or paste was very heavily infected at low temperatures when the spores were attached to the embryonal zone, and lightly infected when the spores were fixed near the apical end. At higher temperatures the attack in both cases was slight, but the same differences in degree were observed.

It is clear from the above considerations that, when testing varieties or races of wheat for resistance to the fungus, or the efficacy of a method of seed treatment, the trials should be made under controlled conditions. In field experiments, the material should be sown at different dates during the presumably critical period, in order to ensure that in one series at least the host is in a condition of maximum susceptibility to the parasite. It is also important to ensure that an adequate amount of the infective material reaches the embryonal zone of the grain.

SMALL (W.). **Diseases of cereals in Uganda.**—*Dept. Agric. Uganda Circ.* 8, 19 pp., 13 figs., 1922.

In his introduction the author draws attention to the fact that the present list of cereal diseases in Uganda is necessarily incomplete, owing to the very limited time available for their investigation. Several of the parasitic fungi mentioned, such as maize rust and the red leaf spot of sorghum (*Colletotrichum graminicolum*), are constantly present in varying degrees, but cause little serious damage. Others again, such as the two wheat rusts (*Puccinia glumarum* has not yet been observed) and blast of rice (*Piricularia oryzae*) consistently reduce the yield of the crop. Direct remedial measures are impracticable in Uganda, and it is, therefore, all the more necessary to attend strictly to general sanitary measures—the burning of refuse, good cultivation, and the like. Scientific plant breeding to ensure the cultivation of disease-resistant varieties is also very desirable. The instruction of the natives in even the most elementary principles of plant pathology is stated to have proved extremely difficult, but the present account is written in such a form as to help in the spread of information regarding the chief cereal diseases which are described. These are as follows:—

SORGHUM. Downy mildew (*Sclerospora* sp.), rust (*Puccinia purpurea*), red leaf spot (*Colletotrichum graminicolum*), leaf blight (*Helminthosporium turcicum*), grain smut (*Sphacelotheca sorghi*), and head smut (*Ustilago reiliana*).

MAIZE. Downy mildew (*Sclerospora* sp.), rust (*Puccinia sorghi*) [*P. maydis*], and leaf blight (*Helminthosporium turcicum*).

WHEAT. Black rust (*Puccinia graminis*), orange rust (*P. triticina*), loose smut (*Ustilago tritici*), leaf spot (*Leptosphaeria tritici*), mould (*Cladosporium herbarum*), and *Helminthosporium* leaf spot (? *H. sorokinianum*).

BULRUSH MILLET (*Pennisetum typhoideum*). Rust (*P. penniseti*), and *Sphacelia* disease. The latter is known from Tanganyika Territory on *Pennisetum spicatum*, and is common in Uganda on *P. purpureum* as well as on the bulrush millet, but all attempts to find its perfect stage have failed.

CROWSFOOT MILLET (*Eleusine coracana*). Leaf spot (*Phyllachora eleusines*).

RICE. Blast (*Piricularia oryzae*).

HEALD (F. D.) & SMITH (L. J.). **The dusting of Wheat for bunt or stinking smut.**—*Wash. Agric. Exper. Stat. Bull.* 171, 28 pp., 5 figs., 1922.

Copper carbonate, first used as a seed disinfectant by Darnell-Smith in New South Wales in 1915, has been submitted by the authors to a series of critical experiments designed to ascertain its efficacy.

Preliminary experiments were carried out in the spring of 1921 on the wheats Blue Stem and Jenkins Club, the grain being thoroughly dusted with 1 gm. of bunt [*Tilletia*] spores to 100 gm. of seed. The infected seed was divided into small lots, each of which received a specified treatment, before sowing. The results showed a relatively low percentage of bunted heads in the controls (13·6 and 3·2 respectively) owing to the weather conditions at planting, but they also showed a perfect control by copper carbonate dust (2 and 4 oz. per bushel) and by equal parts of finely powdered anhydrous copper sulphate and powdered calcium carbonate used at the rate of 2 oz. of the mixture per bushel. Copper sulphate gave 0 and 0·4 per cent. bunted heads, and formalin 0 and 0·7 respectively. Sulphur (10 lb. and 20 lb. per bushel) gave similar results, but is costly, and its efficacy is still open to question. Copper sulphate reduced the percentage of germination from 84·25 and 89·5 for the untreated to 67 and 65·5; formalin to 38·5 and 53·5; whilst copper carbonate dust (4 oz. per bushel) raised it to 98·5 and 96·5 respectively.

In similar experiments started in the spring of 1922 varying proportions of copper carbonate were used in order to ascertain the minimum quantity necessary to give effective protection. Three varieties were used, Marquis (resistant), Blue Stem (susceptible), and Jenkins Club (very susceptible), and the seed was dusted with bunt spores in three degrees, 0·1, 0·4, and 1·0 gm. per 100 gm. of seed. The most heavily contaminated seed gave an average of 0·97 per cent. bunted heads for the treated seed against 40·57 per cent. for the controls. The following amounts of copper carbonate, $\frac{1}{2}$ oz., 1 oz., 2 oz., and 3 oz. were added per bushel and the average results of the three varieties were 0·55, 0·09, 0·30, and 0·0 per cent. of bunted heads respectively. A mixture of equal parts of copper carbonate and hydrated lime used at the rate of 1 oz. and 2 oz. per bushel yielded 0·81 and 0·76 per cent. bunted heads respectively.

Experiments were also made with anhydrous copper sulphate mixed with equal quantities of calcium carbonate or hydrated lime. The former mixture (1 oz., 2 oz., and 4 oz. per bushel) gave an average of 1·15 per cent. bunted heads, and the latter (in similar quantities) 1·65, the controls yielding 23·26 per cent. The average for all copper carbonate tests was 0·41 per cent. bunted heads as contrasted with 1·4 per cent. for all tests with anhydrous copper sulphate. It seems therefore that anhydrous copper sulphate is not equal to copper carbonate, and that hydrated lime is not so satisfactory for mixing with the former as calcium carbonate.

A proprietary copper carbonate compound 'Corona' was tested and appeared to have a better protective action than pure copper carbonate carrying an equal amount of copper. 'Seed-o-San', an organic mercury compound, was not as efficient as the copper dusts.

In 1922 tests were carried out to show the comparative value of various seed and soil treatments in preventing bunt originating from wind-blown spores. Treatment was carried out with sulphur (200 lb. per acre and 20 lb. per bushel), copper sulphate (sprinkle of 1 lb. to 1 gall.), copper carbonate (2 oz. per bushel), anhydrous copper sulphate with calcium carbonate (1 oz. of each per bushel), copper sulphate (1 in 5) with or without a lime bath, and formaldehyde (1 in 40). All the treatments except sulphur (200 lb. per acre) and formaldehyde were effective to some extent, but the differences were not sufficiently pronounced to justify any conclusion as to the superiority of any particular treatment. A second similar series, but with the soil artificially infected, indicated that all the copper treatments brought about a reduction in the amount of bunt.

Tests were also carried out with copper sulphate, formaldehyde, and copper carbonate on different farms, and the latter gave the lowest average percentage of bunted heads.

The question as to whether wheat may be dusted with copper carbonate some months previous to seeding time without suffering injury was tested by treating four varieties with 2 oz. copper carbonate per bushel, ascertaining the percentage germination at intervals, and comparing the results with those of untreated seed. Treated seed was not injured by being kept eight months, but on the contrary showed a higher germination than the untreated samples. The stimulating effect of the copper carbonate treatment is often seen in the greater vigour of growth in the fields, even in the early spring.

On the basis of completed trials, the authors recommend the use of at least 2 oz. of finely powdered copper carbonate per bushel, but also state that 3 oz. per bushel is worthy of trial for autumn seeded grain. The powder should test at least 50 per cent. metallic copper, and should be fine enough to pass through a 200 mesh sieve: the heavy copper carbonate for the metallic trades should be avoided. Too heavy seeding after using copper carbonate should be guarded against, as dry grain feeds faster than moist.

The wearing of some form of respirator during the treatment is recommended, and if this is unavailable then treatment must only be made out of doors, the apparatus being so arranged that the wind will carry the dust away from the operator. The application of the dust may be made in various ways, but a special dusting machine, consisting essentially of a rotating drum, is described, which keeps the dust enclosed while securing an even distribution on the grain. A blue print showing the dimensions of the machine can be had from the Station, Pullman, Washington, for 25 cents. Ordinary mixing by shovelling over the dusted grain is not recommended, as the dust is less evenly distributed and more easily inhaled than when shaken in a closed container.

Atwood (W. M.). **Physiological studies of effects of formaldehyde on Wheat.**—*Bot. Gaz.*, lxxiv, 3, pp. 233–263, 12 figs., 1922.

The tests described in this paper were undertaken in order to determine the exact nature of the effect of formaldehyde treatment on the physiological processes of seeds, as shown by wheat. Ordinary commercial formalin [termed formaldehyde throughout by the author, as by many recent American workers] was used, containing 39·3 parts per hundred by volume of formaldehyde gas.

In the first series of experiments the period of steeping in formalin at the strength usually recommended (1 : 320) was varied from 5 to 300 minutes. One-third of the seeds treated were grown in blotters in the customary manner, one-third in soil in porous clay germinators indoors, and one-third outdoors in pots of soil exposed to the weather and to a temperature of between 40° and 60° F. The graphs show that a dip of from 20 to 40 minutes only slightly reduces germination, but beyond 40 minutes the descending curves of germination are somewhat steeper, although the drop in most cases is not great. The seeds germinated in soil showed a somewhat greater percentage of injury than those grown in blotters. This phenomenon has also been observed by other workers, and an explanation of it has been suggested by Wallden on the ground that injuries to the coleoptile, while impeding progress in the soil, need not interfere with germination of the seeds in blotters.

In another series of tests the concentrations of formalin were varied from 1 : 40 to 1 : 320, and the treatment was applied for ten minutes at 20° C. As compared with the controls there was little injury apparent at the usual concentration of 1 : 320, but with a concentration of 1 : 160, the germination curves began to fall, and at 1 : 40 the germination was reduced by 40 to 60 per cent., both in the blotters and in the soil. As in the previous series the injury was greatest in the outdoor soil, less in the indoor soil, and least in the blotter tests.

Formaldehyde readily forms various polymers, but means for their identification are not satisfactory. The flocculent, white precipitate which forms when the commercial solutions are concentrated is ordinarily referred to as paraformaldehyde. If wheat is dusted with this precipitate, serious injury results, and tests with Turkey Red showed that germination was thereby reduced to only 9·5 to 15 per cent. The polymers persist on grain for many months, even if exposed to the air.

In the tests designed to determine the permeability of the seed coats to formalin, the grains were sealed one at a time to the end of a glass tube, into which formaldehyde solution was poured. After contact lasting three to four days, the dry tip of the grain, exterior to the tube, was sectioned and treated directly with the Schryver formaldehyde reagent. With long periods of exposure to high concentrations of formalin (1 : 8) penetration appears to be possible at either tip of the grain or on either face. Another method employed by the author was to measure the degree of semi-permeability of the seed coat indirectly by noting the weight increase of the seeds when soaked in distilled water and in formalin respectively, the latter in a high concentration (1 : 8) in order to render more conspicuous the difference. The results of these experiments lead to the conclusion that formaldehyde slowly penetrates the seed coat, and that when the grain is subsequently transferred to water, the formaldehyde gradually diffuses outward again.

Tests to determine the effect of formaldehyde on starch digestion in the grain are described and illustrated by graphs. They showed that diastatic activity is not entirely inhibited, but is retarded, and a reduction in the amount of starch digestion was noted corresponding with a rise in the concentration of the formaldehyde originally used in the treatment of the seed. It would, therefore, appear to be certain that formalin treatment lessens the availability of carbohydrates to the germinating seedling.

Attempts to determine the effects of formalin treatment on the amino acids of the grain failed, owing to difficulties of technique.

The elaborate respiration tests which were carried out demonstrated that formalin has a marked influence on the respiratory rate in concentrations of 1 : 80, the effect decreasing down to 1 : 320, the usual concentration in seed treatment. At concentrations from 1 : 400 to 1 : 1000 the effect on metabolism was negligible.

The effect of formalin treatment on the catalase activity of wheat is to depress the latter ; as the concentration of the solution is increased, catalase activity as measured by oxygen yield from peroxides falls. The effect wears off to a certain extent with time, and it is suggested that the injury is due more to exterior members retaining the formaldehyde which had been in part volatilized, than to a permanent injury to the embryo having resulted from the treatment.

Speaking generally, the author thinks that the conclusions of Miss Hurd [see this *Review*, i, p. 25] that a polymer of formaldehyde is deposited on dried, treated wheat, and subsequent injury to the grain is incidental to the liberation of formaldehyde gas from the precipitate, are in harmony with his results. But he emphasizes the facts brought out in his experiments as indicating the possibility of a reduction in the vitality of the seedling, even when germination is not diminished, by formalin treatment.

Bruner (S. C.). **'La muerte de los Cocoteros.'** ['The death of Coco-nut trees.']—*Rev. Agric. Com. y Trab.* [*Cuba*], v, 1, pp. 9–10, 1922.

This is a critical review of a work by Celestino Bencomo with the above title, published in Havana in 1921, in which coco-nut bud rot is attributed to the activities of *Oryctes rhinoceros*. The reviewer completely disagrees with this view, as according to present knowledge no species of *Oryctes* exists in Cuba, and even if one accepts Bencomo's statement that *O. rhinoceros* is synonymous with *Strategus anachoreta* (this, and a very similar species, *St. titanus*, are not of very frequent occurrence in Cuba), the fact remains that the writer, in examining the first phases of the disease *in situ* has found no trace of these, or any other insects.

Although the writer is not convinced that a bacterium may not cause bud rot, he states that he has never accepted as conclusive the evidence pointing to *Bacillus coli* as the causative agent. The red ring disease, which in its effects resembles bud rot, but which is due to a nematode, *Aphelenchus cocophila*, probably exists in Cuba. *Phytophthora faberi* Maub., which Reinking considers the cause of bud rot in the Philippines, has been also proved by the writer to be pathogenic to young coco-nut palms in Cuba. Ashby in Jamaica found a similar fungus attacking coco-nuts and referred it to *Phytophthora palmivora* Butl., a species which causes a very serious disease of palms in India. According to Ashby, a similar disease exists in the western part of Jamaica. These diseases, which correspond closely in their characters to the disease as known in Cuba, have all been described since bud rot was attributed to *B. coli*, and further experimental work, which the writer has in hand, will be necessary before the true cause of death of the palms in Cuba can be established.

Ballard (W. S.), Magness (J. R.), & Hawkins (L. A.). **Internal browning of the Yellow Newtown Apple.**—*U.S. Dept. Agric. Bull.* 1104, 24 pp., 2 col. pl., 1922.

Certain varieties of apples, including Yellow Newtown, Red and White Pearmain, Yellow Bellflower, and Missouri, grown in the Pajaro Valley of California, where two-thirds of the apple crop of the State are produced, are apt to develop in cold storage a brown discoloration of the flesh, known as 'internal browning'. The discoloration may appear at any point in the flesh of the apple, from the core outwards. In very mild cases a cross section reveals only a faint brown spot in the angle between two adjacent seed cavities. In more advanced cases the brown areas round the core may be accompanied by discoloured patches, of varying dimensions and intensity, in the outer flesh of the fruit. There are no external symptoms of the disease, and it does not develop in the fruit while on the tree or if the apples are kept at room temperatures after picking.

Prolonged investigations have shown that internal browning is a physiological disease, due to nutritional disturbances which affect the fruit. Light crops of large, coarse-textured apples of the type commonly produced by the cool temperature, high humidity coupled with frequent fogs, and fertile soil of the Pajaro Valley, are particularly liable to the trouble. In the foothills and interior valleys, where the temperature is higher, there is more sunshine, fewer fogs, and lower humidity, the fruit produced is so little liable to the disease that it has no commercial importance. In seasons of very high crop production the trouble appears to be practically non-existent. During the years when browning was prevalent, the fruit from trees bearing heavy crops was much less affected than that from trees with a low yield. A light crop associated with good leaf production is usually affected with extensive browning in storage. Experiments showed that heavy thinning of the fruit, combined with girdling of the branches, produced fruit with a high sugar and acid content and a tendency to brown severely, while partial defoliation of well-loaded branches, which lowered the sugar and acid content of the fruit, gave sound apples. On the whole, all the evidence obtained supports the conclusion that browning is associated with the carbohydrate nutrition of the tree, being most marked in trees which normally produce fruit of rather low sugar content whenever circumstances tend to increase that content. Heavy applications of stable manure increased the percentage of browning, as was also the case with nitrogenous fertilizers, except where the crop was very heavy.

Internal browning has been proved to develop most extensively in cold storage at a temperature of 32°F. On withdrawal from storage there is usually a marked increase in the percentage of browning, which is therefore much more severe by the time the fruit reaches the consumer. By maintaining the temperature of the cold storage chambers at 36° to 38°F. the danger of internal browning may be largely eliminated, and since 1917–1918, when most of the apple storage houses in California were raised to a temperature of 36°, little loss has been incurred from the disease.

Osterwalder (A.). **Weitere Versuche zur Bekämpfung des Apfelmehltaues.** [Further experiments in the control of Apple mildew.] *Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 833–834, 1922.

The author claims that apple mildew (*Podosphaera leucotricha*), which has proved refractory to spraying in repeated experiments with various fungicides at Wädenswil, can be sufficiently held in check by persistent pruning.

From a susceptible Boiken apple, 122 infected shoots were removed in 1916, and 31 in 1917, since when the attack has been negligible.

Müller-Thurgau (H.). **Eine durch ein Gloeosporium verursachte Krankheit bei Cyclamenpflanzen (Cyclamen persicum).** [A disease of Cyclamen (*Cyclamen persicum*) plants caused by a *Gloeosporium*.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 824–826, 1922.

Nearly 30,000 cyclamen plants belonging to a large commercial nursery-garden at Zurich were attacked by a disease which resulted in the death of the young leaves and blossoms. A species of *Gloeosporium* was isolated from the affected parts. The spore masses were reddish in colour and the unicellular spores about 15 μ in length by 2·6 to 5·4 μ in thickness. The morphological characters of the fungus resemble those of *Glomerella rufomaculans* var. *cyclaminis*, which attacks cyclamens in the United States. The symptoms of the Swiss and American diseases, however, are widely divergent, and the causal organisms are believed by the author to be quite distinct.

ANDERSON (H. W.). **Orchard practice for the control of blister canker of Apple trees.**—*Illinois Agric. Exper. Stat. Circ.* 258, 16 pp., 12 figs., 1922.

Notwithstanding the efforts of Illinois fruit growers to exterminate blister canker [*Nummularia discreta*], the losses from the disease have increased annually. Blister cankers occur on the large limbs and trunks of trees, especially near large wounds; when old they are easily recognized by the presence of 'nail heads', the characteristic fruiting bodies of the fungus. When the bark is worn away, the nail heads, which constitute the ascigerous stage of the fungus, stand out about one-quarter of an inch from the wood. On younger cankers the fruiting bodies accumulate under the bark and cause small, blister-like protuberances, which later split open in the form of stars. The ruptured segments curl backwards, exposing the conidia of the fungus in a dust-coloured mass. The inner bark of affected trees may, early in the disease, present a characteristic mottled appearance, due to the development of annular black lines in the tissues.

The spores of the fungus may be washed down the bark and infect the lower parts of the tree, or may be carried to other trees, sometimes miles distant, by birds or insects. The implements of workmen are frequent agents of distribution. Dissemination by air currents appears to be slight. Spores alighting on healthy tissues or small wounds rarely cause infection, ideal conditions for which are furnished by large, exposed wounds, such as those caused by the sawing or breaking off of large branches. The fungus grows down into the heartwood, usually causing definite brown streaks, and gradually becomes distributed throughout the woody portion of the tree, even into the roots. Within a year the typical external symptoms of the disease are visible. The conidia play a relatively unimportant part in the distribution of the disease, their capacity for infection being very limited. The mature nail heads containing the active ascospores may take two or more years to reach maturity. Young trees, under six years of age, are rarely attacked, and no special precautions are necessary in the pruning of the trees up to ten years old, except when they are in the vicinity of older, cankered orchards or when the pruning tools have been used on cankered trees.

Blister canker occurs on nearly all the commercial varieties of apple in Illinois, Ben Davis being particularly susceptible. The cultivation of this variety in Illinois should therefore be discontinued, especially as the orchards are already overstocked with it. Its elimination would imply an almost total eradication of the disease, which on moderately susceptible varieties, such as Yellow Transparent and Chenango, can be controlled by appropriate sanitary measures.

One of the most important preventive measures is the immediate dressing of wounds on the older trees with a coat of shellac and then with a layer of gas tar. The same treatment may be applied to areas of the bark injured by sun-scald, &c. All tools used in the excision of cankers, pruning, or other operations, should be sterilized with mercuric chloride (1 in 1,000) or copper sulphate. The removal of cankers, which should be carried out in the winter, defers the spread of the disease for several years if a good callus is formed round the edge of the wound. The orchards should be regularly inspected every winter and the necessary surgical treatment, exact details of which are given, carried out. Badly infected trees are both unsightly and unprofitable, and should be removed and burnt. There is no danger of infection to the new trees planted in their place.

Departmental Activities: Botany.—*Journ. Dept. of Agric. S. Africa*, v, 4, p. 306, 1922.

Apple branch blister, caused by *Coniothecium chomatosporum*, has been observed on a number of apple and pear twigs sent to the Department for examination. As a rule the branches are not seriously affected, but unless preventive measures are taken the fungus spreads to the fruit, causing cracking and russeting. On the twigs and branches numerous dark specks, generally in groups, are formed, and frequently reddish-brown, irregularly raised blisters develop. All affected twigs should be removed and destroyed, and a winter wash (1 lb. of copper sulphate to 25 gallons of water) applied before bud-bursting time. Spraying with Bordeaux mixture (4–4–50) before the flower-buds open and again soon after the blossoms fall is recommended, and this should be followed by a third application when the fruit is well set.

PUTTERILL (V. A.). **The biology of Schizophyllum commune Fries, with special reference to its parasitism.**—*Sci. Bull. Dept. of Agric. S. Africa*, xxv, 35 pp., 5 pl., 5 figs., 1922.

The occurrence of sporophores of *Schizophyllum commune* on living apricot trees in the Cape Province, and the fact that the wood was found to be permeated by its mycelium, led the author to investigate the parasitism, often assumed but never experimentally proved, of this fungus. He found *S. commune* occurring commonly on dead wood, and also apparently as a wound parasite on stone fruit and sometimes on apple trees. Sporophores were generally found on parts of the tree suffering from sun-scald, but also occurred scattered generally over quite unwounded branches. Injuries were generally found in such cases on some other part of the tree. The practice of slitting the bark to prevent a bark-bound condition, and the injuries inflicted on the roots in the process of cultivation, afford a possible means of entrance to the fungus, but probably the most common mode of infection is through areas in which the bark has been killed and where the healing process is protracted indefinitely, as in sun-scald cankers. The time taken by the wounds to heal and the vigour of the trees are factors that influence infection to a certain extent, while a deficiency of lime in the soil, such as is characteristic of the Western Province where these observations were made, seems to increase the rate of growth of the fungus within the host.

The diseased wood was marked by dark, radiating streaks, but, though brittle, its hardness was not impaired and it was difficult to cut when dry. Hyphae were abundant except in the older areas of infection, where they seem to become disorganized and to disappear, as is known to occur in other similar cases. The vessels, wood fibres, and medullary rays were frequently blocked by gum, probably formed as a result of the traumatic stimulus given by the growing parasite to the living cells of the wood, which secrete the gum into the fibres and vessels. In its action on the cell walls *S. commune* attacks primarily the cellulose, and does not cause delignification. Starch is absent from the cells of the invaded tissues. The mycelium, when grown in pure culture in a liquid medium, produced cytase, diastase, emulsin, invertase, maltase, and lipase. It did not produce peroxidase, gum-hydrolyzing, or delignifying enzymes.

The fungus was readily isolated from diseased wood, and grew vigorously on a large number of media, the cultures being described in detail. On media favouring growth the mycelium is at first white and cottony, but later becomes more compact, and finally felty, taking on a pink-buff colour; on others, as for instance potato agar, growth is slow, there is little aerial mycelium, and the latter is almost colourless. Sporophores, which are produced in the light on a number of media in about 20 days, do not develop in darkness although mycelial strands and foliar outgrowths, probably representing abortive fructifications, are formed. The hymenium faces downwards whatever the direction of the surface of the medium, and positive heliotropism was observed in the sporophores in one of the experiments. In a comparison made between isolations from a parasitic and a saprophytic strain of *S. commune*, the author found sporophore formation much less marked in the latter than in the former. Pure cultures, completely dried out, remain viable for at least two years. Indications were found that wounding the mycelium had a stimulating effect on sporophore production.

Spores from a fresh spore-print germinated readily in a nutrient solution, but very feebly in distilled water. When fresh spores were treated with 1 : 1000 copper sulphate solution for 7·5 minutes germination was reduced by about 50 per cent., and it was almost completely inhibited when the solution was strengthened to 1 : 500. After twelve days, spores sown in nutrient solutions gave little or no germination, but they germinated vigorously again as soon as copper sulphate, diluted to 1 : 5000 and 1 : 7000, was added, germination being even better than that of fresh spores in a nutrient medium alone.

Inoculation experiments carried out at Pretoria are fully described. These proved that *S. commune* is able to grow in living wood, which it kills, when inoculated through wounds. Of sixteen inoculations on stone-fruit trees, twelve were successful, while four made on the roots, green shoots, and stems of young almond trees were not conclusive. In every instance the fungus was recovered from the discoloured wood, but a sporophore was only once produced. Growth within the wood was slow under the conditions of the experiments, reaching only about eight inches from the point of inoculation after two years and four months. The author concludes that though the harmful effects of this fungus may not be immediately apparent, the total damage caused by it must be very considerable owing to the insidiousness of its action and the wideness of its distribution.

OSTERWALDER (A.). **Phacidiella discolor (Mont. & Sacc.) A. Poteb. als Fäulnispilz beim Kernobst.** [*Phacidiella discolor* (Mont. & Sacc.) A. Poteb. as a rot-producing fungus in core fruit.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 852–853, 1922.

During the winter of 1919–20 stored apples and pears were attacked by a black rot which differed in various respects from that caused by *Sclerotinia fructigena*. The causal organism was isolated and identified as *Phacidiella discolor*, and inoculation experiments on different varieties of apples and pears produced the typical symptoms of the rot, which include the formation on the skin of small, oval spots and the development of a leathery consistency in the fruit. This is believed to be the first occasion on which the fungus was observed on Swiss fruit.

WATERS (R.). **Fireblight.**—*New Zealand Journ. of Agric.*, xxiv, 6, pp. 350–357, and xxv, 4, pp. 209–214, 9 figs., 1922.

Fireblight (*Bacillus amylovorus*) has spread continuously since first reported in New Zealand [see this *Review*, i, p. 22], but is still confined to the North Island. The stone fruits, mountain-ash (*Sorbus*), juneberry (*Amelanchier*), and *Pyrus japonica*, all of which are occasionally attacked in North America, have not so far shown signs of the disease in New Zealand. Pears are the most seriously affected fruit trees, and with them the problem of control is more complicated than in the case of apples. With the latter the chief difficulty is the liability of reinfection from diseased hawthorn, which is extensively used for hedges in fruit-growing areas. The eradication of hawthorn from these districts is an essential factor in the control of the disease.

The symptoms of the disease and characters of the causal organism are described. Field experiments have shown that the effects of blossom inoculation may not immediately be manifested, but they become apparent in the blackening of the calyx-cup when the young fruits begin to form. Initial infection very commonly takes place on the blossoms, and in some districts the disease is known as 'blossom blight'. The discoloration may extend from the immature fruit through the stalk to the spurs or twigs, while any soft growth is liable to infection through the punctures of sucking or biting insects. The disease progresses more rapidly in pears than in apples, having been known to kill large trees outright in a single season. The young bark of apple trees is more easily penetrated than the tougher bark of old trees.

The formation of cankers and the overwintering of the bacilli in the so-called hold-over cankers are discussed, and it is pointed out that while excision of such cankers is naturally a most important method of control, the difficulties connected with this operation in New Zealand appear almost insuperable, chiefly in view of the fact that the organism has been shown to be capable of wintering over in hawthorn cankers as well as in those of fruit trees.

Direct sunlight has been proved to have a very destructive effect on the bacilli, which begin to succumb to the action of the rays in less than an hour. They can withstand ordinary desiccation, as in thin, dry films of water-diluted ooze, for about eight days. Furthermore, all strains are not equally pathogenic, and temperature has an influence on successful infection.

On the whole, the author does not consider that the organism is likely to possess the power of surviving in an actively infective condition when transported over long distances by natural agencies. On the other hand, he has found that the bacilli can live for nine months in pure water without entirely losing their power of infection. Fireblight can only have been introduced into New Zealand, and carried over the long distances to which it has spread within the confines of that country, by human agency. Every precaution must be taken to ensure, firstly, that the disease shall not cross Cook Strait, and, secondly, that it is confined within the notified boundaries to infected areas. The legislative measures taken with a view to defining the infected areas and securing treatment within these areas are mentioned [see this *Review*, ii, p. 144], but legislation must be supported by the co-operation of the people if fireblight is to be prevented from reaching all parts of the country.

The only satisfactory method of controlling fireblight is the complete removal, well before the blossoming period, of all diseased portions of the affected tree. The wounds made by cutting and scraping should be disinfected by swabbing with a 5 per cent. solution of formalin or lysol, or one part each of cyanide of mercury and bichloride of mercury to 1,000 parts of water. After sterilization, the wound should be painted with a mixture of creosote and tar, or with white lead paint, preferably the former. The sterilization of all implements in one of the above-mentioned disinfectants is also essential.

JACKSON (H. S.). **Pear blight control is feasible.**—*Amer. Fruit Grower*, xlii, 8, pp. 3, 27, and 29, 1 fig., 1922.

The solution now most commonly recommended for the disinfection of the wounds caused by the excision of the cankers of pear blight [*Bacillus amylovorus*] is one part of corrosive sublimate and one part of cyanide of mercury to five hundred parts of water. The solution must not be kept in metal containers, but should be carried in a bottle and applied with a sponge. It may also be used for the sterilization of the tools.

It is now becoming generally known that the following varieties of pears, in addition to the Kieffer [see this *Review*, ii, p. 125], are resistant in the southern States: Garber, Tyson, Seckel, and Konnce. The so-called Japanese seedling, *Pyrus serotina*, has come into general use as a root stock, and for the same purpose the highly resistant *P. ussuriensis* may be used, while a very promising

Chinese species is *P. calleryana*. These desirable foreign varieties, however, are available only in limited quantities as yet and will probably have to be grown on a larger scale in the United States.

Osterwalder (A.). **Versuche zur Bekämpfung de Weissflecken-krankheit der Birnbäume und Blattbräune der Quitten.** [Experiments in the control of white spot disease of Pear trees and brown leaf of Quinces.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 839–841, 1922.

White spot disease of pear trees [*Mycosphaerella sentina*], which is greatly on the increase in Switzerland and attacks a number of well-known commercial varieties, can be satisfactorily controlled by two applications of 1·5 to 2 per cent. Bordeaux mixture, the first given during the latter half of May and the second two or three weeks later.

Similar treatment was also found effective in the control of *Entomopeziza soraueri* Kleb. [*Fabraea maculata* (Lév.) Atk., *Entomosporium maculatum* (Lév.)], which has caused severe damage to quinces during recent years.

Cunningham (G. H.). **The significance of apothecia in the control of brown-rot of stone-fruits.**—*New Zealand Journ. of Agric.*, xxv, 4, pp. 225–230, 1 fig., 1922.

The apothecial stage of *Sclerotinia cinerea* was found for the first time in New Zealand in 1922. Between the 11th and 30th September numerous specimens were obtained on mummied peaches and nectarines. The trees were in blossom the whole of this period, blossom infection first becoming noticeable on 30th September. On 15th September plum mummies in an orchard near Christchurch also developed apothecia. Blossom infection was observed in this case on 29th September. Some of the mummies were those of the preceding season's fruit, while others appeared to be more than one season old.

Details of the structure of the mummies and apothecia are given, the microscopic characters of the latter being stated to agree in most respects with the descriptions of the European form.

On 15th September ascospores were isolated and inoculated into apple fruits, half of which were rotted at the end of ten days. No conidia appeared on the surface until eighteen days later, the fruits meanwhile turning dark and assuming the characteristic appearance of brown rot.

Showery weather, accompanied by warm days and cold nights, appears to favour the development of apothecia. Their number decreased with the depth in the soil at which the mummies were buried. At a depth of 3 in. only one apothecium was produced, so that a depth of soil exceeding this amount may be regarded as a directly inhibiting factor. All the specimens were found in hard and compacted soil, these conditions seeming to be essential to their production; recently cultivated soil did not yield any apothecia.

In addition to the treatment by spraying already advised [see this *Review*, ii, p. 165], the removal, during pruning operations, of all mummies, cankered limbs, and sickly laterals, which should be burnt whenever possible, is recommended, and also cultivation of the soil after pruning but before blossoming, compacted soil being broken by hand if necessary.

HAMMOND (A. A.). **Spraying experiments for brown rot of stone fruit (Sclerotinia fructigena).**—*Journ. Agric. Victoria*, xx, 3, pp. 182–189, 1922.

The following preparations were used against *Sclerotinia fructigena* in a series of comparative experiments on plum, peach, and cherry trees in an orchard at Seville, Australia. (1) Bordeaux mixture used at a strength of 12–8–80 for pre-blooming, and of 3–9–50, 3–3–50, and 3–3–40 for late sprayings. (2) Woburn Bordeaux, i.e. 13·75 galls. clear lime water, and 1 lb. bluestone, made up to 80 galls. with fresh water. (3) Acetate of copper 1 lb. to 13 galls. water for pre-blooming spray, and 10 oz. to 40 galls. and 15 oz. to 40 galls. for late sprays. (4) Home-boiled lime-sulphur, 26° Baumé (specific gravity 1·220), used 1 in 9 as a pre-blooming spray. (5) Self-boiled lime-sulphur 15–15–80 used as a late spray. (6) Sulphur sprays, including atomic sulphur, atomized sulphur, and home-made sulphur wash (casein, skimmed milk, and flour paste being used as spreaders in the last named). For cherries 1½ galls. of lime-sulphur (26° Baumé) were added to the home-made sulphur and skimmed milk wash. and for late spraying for peaches 1 gall. lime-sulphur was added. The home-made sulphur washes contained 10 lb. of dry sulphur to 80 galls. water, an average of 2·75 galls. being used per tree.

None of the spray mixtures caused any injury to fruit or foliage except Bordeaux mixture on peaches. No difference was observed in the efficacy of any of the sulphur sprays without lime, which have the advantage of being clean, safe, and suitable for use late in the season. They do not, however, adhere as well as lime-sulphur, and are therefore better adapted to hairy-skinned fruits, such as peaches and apricots, than to cherries or plums. Bordeaux mixture or boiled lime-sulphur may safely be used for the first spray for all stone fruits except apricots. Cherries should receive their first spraying when 10 per cent. of the blossoms are open, being very susceptible during flowering to the attacks of the fungus. The second application should be given immediately after the fruit sets. Peaches and plums do not appear to be liable to attack during blossoming. All kinds of fruit are apt to become infected about ripening time, and the final applications of the sprays should be given as late as possible consistent with clean fruit at harvesting. Copper acetate, besides being the most expensive of the preparations tested, was also the least effective. Exclusive of labour and fuel the approximate cost of 80 galls. of self-boiled lime-sulphur was 3 shillings, while the same quantity of copper acetate worked out at 7 to 9 shillings according to the strength used. Sulphur wash and casein (home-made) cost only 1*s.* 10*d.* per 80 galls., while atomic and atomized sulphur each cost 8*s.* 4*d.*

The writer believes that the control of the fungus by spraying in a wet season would be extremely difficult owing to the rapidity of fructification and spread. It should be attacked and eradicated in dry seasons unfavourable to its development.

MÜLLER-THURGAU (H.). **Weitere Beobachtungen über die Blattbräune der Kirschbäume.**—[Further observations on leaf scorch of Cherry trees.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 822–824, 1922.

Leaf scorch of cherry trees, caused by the fungus *Gnomonia erythrostoma*, varies considerably in prevalence and intensity according to the locality. Generally speaking, the disease is more severe in valleys than in elevated, sunny situations. Meteorological conditions during the spring, however, play an important part in the development of the fungus. The perithecia contained in the dead leaves which remain hanging on the tree all the winter require periodical showers for their development and for the liberation of the spores. Hence after a dry spring there may be only very slight infection compared with that resulting from wet weather during the growing season.

The symptoms of the disease are also very variable, ranging from the typical large, yellowish-brown spots to a reddish discoloration. The latter occurs when the fungus penetrates the petiole only, presumably through the glands, with the result that the sugar cannot pass through the petiole to the branch and therefore accumulates in the leaf. In such cases the leaves, not being directly attacked, are able to continue their functions for a time but gradually disturbances in metabolism arise which cannot be overcome.

It was observed in various cases that trees which had been severely injured in one year completely recovered in the next. Atmospheric conditions not being sufficient to account for the change, the matter was investigated with the result that *Gnomonia erythrostoma* was found to be attacked by *Trichothecium roseum*, which had completely destroyed the perithecia of the leaf scorch organism. Experiments are in progress to ascertain whether this valuable means of biological control can be utilized on a large scale.

OSTERWALDER (A.). **Ein Versuch zur Bekämpfung der durch Pseudopeziza ribis verursachten Blattfallkrankheit der Johannisbeersträucher.** [An experiment in the control of leaf fall disease of Currants caused by *Pseudopeziza ribis*.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, p. 833, 1922.

Excellent results were obtained in the treatment of this disease in 1918 by the application of 1·5 per cent. Bordeaux mixture to susceptible White Versailles currants. The sprayed bushes remained completely healthy and green until October, in striking contrast to the untreated controls, which lost their leaves at the beginning of September.

MANARESI (A.). **La 'Sphaerotheca mors-uvae' (Schw.) Berk. nell' Emilia.** [*Sphaerotheca mors-uvae* (Schw.) Berk. in Emilia.]—*Riv. Patol. Veg.*, xii, 7–8, pp. 83–84, 1922.

American gooseberry mildew (*Sphaerotheca mors-uvae*) was first observed in Italy in 1914, when it was found in the Pavia district. In 1920–21 it spread to the district of Novara and in 1922 Asti and Casale were reached. In July of the same year the author found the fungus on gooseberry and currant bushes in Emilia, where they are cultivated chiefly for jam-making purposes. It is thought that the disease was introduced on plants imported from other regions of Italy two years previously. Although many bushes are affected it does not seem to cause as much damage as elsewhere. This is believed to be due to the energetic control measures carried out by growers, which consist of frequent pruning, and several sprayings with lime-sulphur or Bordeaux mixture (4 to 5 per cent.) during the resting period, followed by the application of more dilute solutions during the growing season.

OSTERWALDER (A.). **Versuche zur Bekämpfung der Didymellakrankheit an Himbeerruten mit Bordeaux- und Schwefelkalkbrühe.** [Experiments in the control of the *Didymella* disease of Raspberry canes with Bordeaux mixture and lime-sulphur.]—*Landw. Jahrb. der Schweiz.* xxxvi, 6, pp. 848–849, 1922.

No satisfactory method of controlling the die-back of raspberry canes due to *Didymella applanata* has yet been devised. The results of experiments at Wädenswil with copper sulphate, Bordeaux mixture, and lime-sulphur were all negative.

WEISS (C. O.). **Diseases and pests of Raspberries.**—*Better Fruit*, xvii, 6, pp. 7–8, 1922.

This article contains notes on the principal diseases of raspberries in the State of Washington. Crown gall [*Bacterium tumefaciens*], the symptoms of which are described, is increasing in severity every year, and can only be controlled by the use of absolutely pure stock for planting. Under Quarantine No. 6 of the Washington State Department of Agriculture it is a misdemeanour to take any plants from infected fields.

Mushroom rot (*Armillaria mellea*) causes considerable damage in the older fields, the plants being attacked at the crown and roots. The progress of the disease is slow, and several years may elapse before the actual death of the plants. The rhizomorphs of the fungus frequently grow through the soil from hill to hill along the row. The disease is most prevalent on newly cleared land, on which raspberries should not be planted for at least three years. Affected bushes should be burnt and the soil where each plant stood removed to a depth of two feet and a diameter of two to three feet. This hole should be refilled from some other part of the field where the disease does not occur.

Anthracnose (*Plectodiscella veneta*) [*Gloeosporium venetum*] has not yet caused such serious losses in the north-western as in the eastern districts, and may generally be controlled by cutting out the diseased canes. In severe cases, however, spraying should be carried out as follows: (1) before the opening of the buds, Bordeaux mixture 5–5–50 with 1 lb. of resin fish-oil or whale-oil soap; (2) a fortnight after flowering (when the fruit is about half grown) Burgundy mixture ($CuSO_4$ 2 lb., Sal soda 3 lb., water 100 gallons), also with the addition of the soap. Stock from infected fields should on no account be used.

Spur blight (*Mycosphaerella rubina*) is a common trouble on the red raspberry, especially the Cuthbert and Antwerp varieties. The first symptom is the appearance of chocolate-coloured or purplish-brown areas on the young canes, usually just below a bud. In the winter the affected bark turns white and becomes shredded and loose. About mid-winter the spores of the fungus develop on the bark, in readiness to start the new infections in the spring. The disease may be controlled by three applications of Bordeaux mixture 2–3–50, plus 2 lb. of fish-oil soap, starting when the new shoots are 6 to 8 inches in height.

Agati (J. A.). **Banana stem and fruit rot.**—*Philipp. Agric.*, x, 9, pp. 411–422, 1922.

From 1919 to 1921 investigations of the stem and fruit rot of bananas caused by *Gloeosporium musarum* were carried on at the Los Baños College of Agriculture, where some thirty varieties, mostly foreign, were attacked. Of the native varieties the sweet bananas were generally the most susceptible. About 15 per cent. of the bunches were infected. The fungus was found not only on unripe fruit but also on stored bananas, especially if the skin of the latter was bruised or moist. The infected fruit was sour in flavour and had a characteristic smell.

The earliest external symptom of the disease consists in the appearance of small, black, circular specks on the skin at the distal ends of the 'hands'. Similar spots may also develop on the flowers, and later on the stalk of the bunch becomes infected. The specks become sunken and merge into one another, thus forming larger spots, which, in severe cases, may cover the entire fruit. In these confluent, dead areas bright red groups of spores develop, at first moist, but later hardening and becoming dry. Infected fruits ripen prematurely, turn black, and decay. The stem becomes stunted and dry, and the leaves droop and shrivel.

Inoculation experiments with pure cultures were conducted both in the field and in the laboratory, and showed that the fungus readily attacked wounded fruit, but the incubation period differed according to the variety of banana tested. In susceptible kinds it was usually 6 to 11 days, whereas in the more resistant varieties symptoms did not appear in some cases until after 24 days. In needle-prick inoculations a longitudinal black streak develops from the wound, and the surrounding areas become watery. Immature fruits, especially when on the bunch with the inflorescences still attached, were found to take the disease more readily than mature fruit from which the inflorescence had fallen. Humidity favours infection. Natural infection may take place through the wounds caused by cutting the bunches.

The morphological characters of the fungus are described. In form, structure, and colour the spores corresponded closely with the description given in text-books, but they measured 13·5 to 15·5 by 5·5 to 7·5 μ instead of 10 to 12 by 4 μ, as previously stated. There were slight differences in the growth of the fungus on the various media used, but the spores and mycelium produced were microscopically identical in all cases. In cultures on the same medium the organisms isolated from different varieties of banana were indistinguishable.

The following precautionary measures are recommended. In the absence of facilities for immediate transport and consumption only resistant varieties, the names of several of which are given, should be planted. Resistant varieties should be spaced 3 by 3 metres apart, and susceptible varieties 4 by 4 metres. Resistant and susceptible varieties should not be interplanted. Sweet varieties should be planted, whenever possible, in separate fields, and the planting of the susceptible foreign sweet varieties should be discontinued. The fruit should be stored in a well ventilated room, the susceptible and resistant varieties being kept apart. In gathering, the rachis must not be cut close to the fruit, and the cuts should be smooth and clean. Great care must be taken not to bruise the fruit. Ants and other insects should be kept away from the fruit, as they may act as carriers of the spores. Spraying the fruit with Burgundy mixture is beneficial.

ORTON (W. A.) & MEIER (F. C.). **Diseases of Watermelons.** —*U.S. Dept. Agric. Farmers' Bull.* 1277, 31 pp., 21 figs., 1922.

A brief popular account of watermelon diseases in the south-eastern States is given, a description of the symptoms and appropriate measures of control being furnished in each case. Wilt (*Fusarium niveum*) necessitates strict attention to cultural measures, the most important of which is to keep infected soil free from watermelons for a period of ten or twelve years, or even longer. The use of organic manure should be avoided and care taken to prevent drainage water from infected fields reaching the crop. Resistant varieties, e. g. Conqueror, have been bred, but they are not recommended for general use at present.

Gummy stem blight (*Mycosphaerella citrullina*) is increasing in importance in the Middle West as well as in the south-eastern States, being particularly severe under conditions of abundant rainfall and high temperature. There are indications that the disease may be reduced by seed treatment, but its control has not been adequately studied. Ground rot (*Sclerotium rolfsii*), so called because it affects the side of the fruit next the ground, is the cause of considerable losses in Georgia, Florida, and South Carolina. It also attacks the roots and causes wilting and death of the whole plant. Seed treatment and crop rotation are recommended, but the latter is troublesome on account of the large number of hosts of the fungus. Anthracnose (*Colletotrichum lagenarium*) may be controlled by spraying the vines with Bordeaux mixture 4–4–50 and by seed treatment with 1 in 1,000 corrosive sublimate solution.

Stem-end rot (*Diplodia* sp.) [*D. tubericola*, see above, p. 256] has caused very serious losses in transit during recent years. Thorough field sanitation and stem-end disinfection with starch paste and copper sulphate are the best measures of control.

Minor diseases which are occasionally encountered include leaf spot (*Macrosporium* [*Cladosporium*] *cucumerinum*), bacterial wilt (*Bacillus tracheiphilus*), downy mildew (*Pseudoperonospora cubensis*), leaf spotting due to lack of potash, and blossom-end rot caused by the same *Diplodia* that produces stem-end rot, and also by other fungi.

DORAN (W. L.). **Laboratory studies of the toxicity of some sulphur fungicides.**—*New Hampshire Agric. Exper. Stat. Tech. Bull.* 19, pp. 3–11, 1922. [Abs. in *Exper. Stat. Record*, xlvii, 3, p. 243, 1922.]

Investigations were conducted to determine the conditions necessary for lime-sulphur solutions to exhibit a fungicidal action, since these solutions have been found to vary in their toxicity to apple scab (*Venturia inaequalis*) in New Hampshire. Different concentrations of lime-sulphur were sprayed on glass slides, allowed to dry for 24 hours, and then conidia of *V. inaequalis* suspended in distilled water were sown on the slides. On examination 24 hours later, it was found that the lime-sulphur had not prevented the germination of the spores.

It is stated that lime-sulphur, when dried on a tree, remains on the sprayed surface in the form of free sulphur, calcium thiosulphate, calcium sulphite, calcium sulphate, and calcium carbonate. The toxicity of calcium sulphate, calcium sulphite, sulphur, and precipitated sulphur was tested, and it was found that calcium polysulphide decomposed most rapidly and decreased in fungicidal efficiency when dried slowly. Sulphur was toxic only in the presence of oxygen, and its toxicity increased with rise of temperature and length of exposure. Precipitated sulphur proved more toxic to the conidia of *V. inaequalis* than finely ground sulphur, and acted at lower temperatures. Fungi were found to vary in their susceptibility to the toxic action of the sulphur.

Zur Saatgutbeizung. [On the disinfection of seed.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 10, p. 88, 1922.

According to a statement issued on September 13, 1922, by the Bavarian Ministry of Agriculture, the winter rye seed sown last autumn was attacked in an unusually severe degree by *Fusarium*. Samples examined by the National Institute for the Cultivation and Protection of Plants at Munich showed 80 to 90 per cent. of infection. The following fungicides are recommended for rye seed disinfections: fusariol (Fikentscher, Marktredwitz, Bavaria), germisan (Saccharinfabrik, Magdeburg), and uspulun (F. Bayer & Co., Leverkusen).

KASAI (M.). **Ueber den auf der Binse parasitisch lebenden Pilz Cercosporina juncicola sp. n.** [The fungus *Cercosporina juncicola* sp. n. parasitic on the Rush.]—*Ber. Ohara Inst. landw. Forschungen*, ii, 2, pp. 225–231, 3 pl. (1 col.), 1922.

The rush *Juncus effusus* var. *decipiens*, which is extensively cultivated in Japan for the manufacture of mats, has been attacked for at least the last twenty years by a stem spot disease. In the summer of 1921 the author visited one of the principal affected localities (Bingo, in the province of Hiroshima), and also examined a number of diseased specimens submitted to him. In the following summer the causal organism, which was constantly present on the affected stems, was identified as a species of *Cercosporina*.

The author states that the only allied fungus known on the rush is *Cercospora juncina* Sacc. from Ontario, but the species discussed in the present paper differs from this in the symptoms of the disease which it causes, as well as in the structure of the conidiophores, dimensions of the conidia, &c. About twenty years ago, Hori found fructifications of a *Cercospora* on diseased rushes in Japan and proposed to name the fungus *C. junci*. This, however, he did not do, and as it is highly probable that Hori's fungus was identical with the present one, the author names the latter *Cercosporina juncicola* Hori & Kasai sp. n.

The disease, which is confined to half-grown plants, does not appreciably disturb their metabolism, since the mycelium does not extend far from the point of infection, and large portions of the stem, between the spots, remain quite green and healthy. Affected stems continue to grow without bending, and are normal in appearance except for the spots. The damage caused by the disease is noticeable chiefly in the finished product. The mats woven from diseased rushes are spotted and unsightly, and this greatly detracts from their commercial value.

The spots are irregularly distributed over the middle portion of the stem. At first they are extremely minute and invisible to the naked eye, but later they increase in size and become somewhat depressed owing to shrinkage of the affected tissues. They are very variable in shape, often confluent, whitish to ashy-grey in the centre, and surrounded by a dark-red or brown edge. The central portion, on which the conidiophores are borne, may measure up to about 7 by 3 mm.

The mycelium is ordinarily hyaline and profusely septate, but in places the hyphae often swell into brown, vesicular cells or groups of cells. This appears to represent a perennial mycelium, and a similar development is also found in pure cultures on rush decoction.

The conidiophores may be observed on almost all diseased plants. They are yellowish-grey in colour, and emerge from the stomata in expanding clusters. They are sometimes elongated, measuring 10 to 28 by 4 to 5 μ, somewhat thickened at the base, generally 1- or 2-, and occasionally 3-septate; and sometimes short and bulbous, only 4 to 6 by 4 μ, and non-septate. In very moist air much longer conidiophores, with numerous septa, are formed; the separate segments in this case often break off and resemble spores.

The conidia of the fungus, which are sparsely developed, and are extremely difficult to detect on dried specimens, are borne partly on the apex of the conidiophores and partly on sub-apical lateral protuberances. At first they are narrow, clavate, and non-septate, but later they become pointed and 3-septate, and are somewhat thickened at the basal end, where a button-shaped, rudimentary 'foot' also occurs. They are hyaline, or occasionally very pale green, and measure 23 to 48 by 2 to 3 μ. The length may increase to two or three times the normal in a humid atmosphere, but the breadth remains unaltered. They are very easily detached from the conidiophores, and germinate in a few hours in water. The germ-tubes penetrate through the stomata.

The best means of controlling the disease is to collect and burn all infected material at harvest time, and to use only healthy cuttings for propagation. If the cuttings have been exposed to infection, the stalks (but not the roots) may be immersed for a few minutes in Bordeaux mixture.

Ricerche e studi compiuti o in corso presso la R. Stazione di Patologia vegetale. [Research work and studies, completed or in progress, at the Royal Station of Plant Pathology.]—*Boll. mensile R. Staz. Pat. veg.*, iii, 10–12, pp. 120–124, 1922.

A brief account is given of further work by Peyronel on mycorrhiza. He has extended his investigations from cereals to a large number of cultivated and wild plants, particularly herbaceous ones; no list of these is given, however. He finds that in nearly all mycorrhiza-bearing roots two distinct mycelia are to be found, at least in the epidermal region. One of these resembles in its morphological characters some of the Phycomycetes, and is, he thinks, the more important of the two, judging from its development and behaviour in the radical tissues, but it has so far not been possible to grow it in culture. The other is a *Rhizoctonia* which he considers probably identical with *Rhizoctonia solani*, and perhaps also with a fungus which seems widespread in northern countries, especially Germany, where it is supposed to damage garden plants, and which is known by the name of 'Vermehrungspilz' (*Moniliopsis aderholdi* Ruhland). The *Rhizoctonia* in question has been isolated from many plants and grown in culture. On potato tubers it resembles typical *Rhizoctonia solani*; in culture its behaviour is the same as that of the endophytes of orchid roots, and like these it produces a quantity of *Monilia*-like conidia, such as described by Petri on the mycorrhizal mycelium of the vine and olive. *Asterocystis radicis* was found frequently on the roots of a number of herbaceous plants.

Besides these fungi, which Peyronel regards as probably truly mycorrhizal, inasmuch as no pathological effects are produced by their growth in the roots, several others were nearly always met with, especially in the older root-hairs and epidermis some distance from the growing apex. Particular mention is made of a *Fusarium*, a Hyphomycete not yet determined resembling *Didymopsis omnivora*, and a *Pythium*. Though probably only semi-parasitic, it is possible that these fungi may under favourable conditions penetrate into deeper tissues and do some damage.

From observations in the valleys of Piedmont, Peyronel considers that some ectotrophic mycorrhiza of trees, such as that found on *Larix decidua*, are represented by a *Rhizoctonia* identical with, or similar to the one already discussed. On *Alnus viridis* he has also found an ectotrophic mycorrhiza in addition to the characteristic tubercles. These he proposes to discuss in a future paper.

DEMAREE (J. B.). **Kernel spot of the Pecan and its cause.**—*U.S. Dept. Agric. Bull.*, 1102, 15 pp., 5 figs., 1922.

The kernel spot of pecan, a common disease in the southern States, was attributed by Rands to *Coniothyrium caryogenum*, and by Turner to insect punctures. The author carried on a series of experiments with two varieties of pecan encased in wire cages, in which the effect of southern stinkbugs (*Nezara viridula*) on the nuts was determined. The results of the tests led him to the conclusion that the pecan kernel spot is due to the action of the insect in mechanically rupturing the host cells, sucking the plant juices, injecting toxic substances into the tissues, or all three types of injury combined.

Hasenöhrl (R.) & Zellner (J.). **Chemische Beziehungen zwischen den höheren Pilzen und ihren Substraten.** [Chemical relations between the higher fungi and their substrata.]—*Monatshefte für Chemie*, xliii, pp. 21–41, 1922.

The water content of a fungus is generally higher than that of its host. K and PO_4 are the principal mineral constituents, Ca low, Na very low, except possibly in some coprophilous fungi, and Fe always present, though sometimes in very small quantities. The constitution of the substratum does not influence the composition of the ash in fleshy fungi. New ash analyses are given of the following: *Polystictus microloma*, *Polyporus fomentarius*, *P. borealis*, and *Auricularia mesenterica*. In these K is lower and Ca higher than in fleshy forms. In *Trametes suaveolens*, *Polyporus igniarius*, and *P. fomentarius* $CaSO_4$ is specially high, while *Polystictus microloma* is very rich in NaCl.

A number of experiments were conducted to compare the osmotic pressure in different fungi and their hosts, and in almost every case the osmotic pressure of each soluble constituent present was higher in the fungus than in the host.

Experiments carried out with a view to detecting cellulose- or lignin-splitting enzymes in *Polyporus igniarius*, *P. hirsutus*, *Trametes suaveolens*, *Lenzites saepiaria*, and *Armillaria mellea* gave negative results. Analyses were made of a specimen of oak on which *P. igniarius* had been parasitic. The tree had lost 74 per cent. of its weight and the whole of its starch, sugar, and tannin. Otherwise its composition did not differ in the relative proportions of the different constituents of the cell membranes, &c., from that of the healthy oak, showing that the material of the oak was taken up equally by the fungus, without selective attack on any particular substance.

Kentish Wright (O.). **The action of yeast-growth stimulant.**—*Biochem. Journ.*, xvi, 1, pp. 137–142, 1922.

Wildiers' observation that certain yeasts can only grow at the expense of ammonium salts provided a heavy inoculation is employed, or a small quantity of organic material ('bios') added to the medium, has been confirmed by Williams and Bachman [1919]. These authors suggest that 'bios' is identical with the water-soluble *B* or anti-beri-beri vitamin, but the case for the identity of the two principles is not generally regarded as proven.

Lemon juice freed from citric acid added to a mineral nutrient solution in small quantities enables a yeast to grow which could not develop in its absence. The amount of water-soluble *B* vitamin in lemon juice being very small compared with that in yeast extract, an investigation was undertaken to ascertain its effects on the growth of yeast in mineral nutrient solutions.

A series of tubes was prepared containing the following solution with increasing percentages of lemon juice: saccharose, 20 gm.; $(NH_4)_2SO_4$,3 gm.; KH_2PO_4,2 gm.; $CaCl_2$,0·25 gm.; $MgSO_4$, 0·25 gm.; and distilled water 1,000 cc. A similar series of tubes was prepared omitting the $(NH_4)_2SO_4$. The yeast employed was a pure culture of a baker's yeast. It was found that no growth took place in the mineral nutrient solution unless 5 per cent. or more of lemon juice was added. The rate of growth was more or less directly proportional to the amount of lemon juice used, up to about 15 per cent. After the yeast reached a concentration of five or six million cells per cc. it was able to continue growing freely in the $(NH_4)_2SO_4$ tubes without the appearance of involution forms and with no film formation. When the concentration had not reached this point after six days, involution forms began to appear in the $(NH_4)_2SO_4$ tubes and by the ninth day a heavy film was produced. Apparently after six or seven days the cells in smaller concentrations than five or six million per cc. are able to adapt themselves to the use of $(NH_4)_2SO_4$ but only so that film formation results.

Another series of tubes was prepared with increasing percentages of aqueous yeast extract instead of lemon juice. It was found that the yeast extract was about ten times as effective as lemon juice in promoting growth, although its nitrogen content is more than thirty times as great. The yeast experiment confirmed the previous one in showing that the rate of growth is independent of the presence of $(NH_4)_2SO_4$ during the early period of the cultures and depends on the concentration of the 'bios' until the yeast has reached a concentration of about five or six million cells per cc., after which it proceeds further in the presence of $(NH_4)_2SO_4$.

Before proceeding to investigate the general question of vitamins by studying the biological processes in a yeast on these lines, it is necessary to be satisfied that 'bios' is actually a vitamin. The present investigation, however, suggests that 'bios' does not enable the yeast to assimilate $(NH_4)_2SO_4$ simply by its presence, or by being consumed simultaneously, but merely that the yeast grows solely at the expense of the 'bios' until it reaches a certain degree of concentration, after which it is able to use the $(NH_4)_2SO_4$.

Atanasoff (D.). **Stipple-streak disease of Potato.**—*Meded. Landbouwhoogeschool, Wageningen*, xxiv, 5, 32 pp., 5 pl., 1922. [Dutch summary.]

Stipple-streak disease of potatoes, which occurred very severely in Holland in 1921, especially on the early variety Schotsche Muis (Victory), is allied to the degeneration or 'running out' group of diseases, which includes leaf roll, mosaic, and crinkle. The distribution of the disease is very general in Western Europe and North America, and a number of important commercial varieties are affected, including Green Mountain, Ninetyfold, President, Ashleaf, and Irish Cobbler. In the author's opinion, detailed grounds for which are given in a separate publication ['A study into the literature on stipple-streak and related diseases of potato.'—*Meded. Landbouwhoogeschool, Wageningen*, xxvi, 1, 1922], the older references to potato 'leaf curl', 'Krul-' or 'Kroeszickte', 'Krause-' or 'Kräuselkrankheit', 'Frisolée', and 'Pirve' in various European countries, all mean the disease described in the present paper, whereas of recent years these names have been indiscriminately applied to other diseases such as leaf roll, mosaic, and the like. With stipple-streak the author also identifies Sorauer's 'Stippelfleckenkrankheit', Horne's 'Leaf blotch', Miss Dale's 'Blindness', Orton's 'Streak', Appel's 'Schwarzflecken- und Streifenkrankheit', Güssow's 'Leaf-streak', and Murphy's 'Leaf drop', while Appel's Bakterienringkrankheit was a combination of this and a bacterial soft rot of the tubers. The Dutch name 'Stippel-streepziekte' was first suggested by Quanjer, and the author advocates the use of this name in Dutch, of 'Streak' or 'Stipple-streak' in English, and of 'Schwarzflecken- und Streifenkrankheit' in German. He thinks the French may accept the English name.

During the 1921 epidemic in Holland a few of the potato crops were affected to the extent of 75 per cent., while 20 per cent. of infection was fairly common. In its primary form, stipple-streak is an easily recognizable disease, but secondary stipple-streak plants, i.e. those that arise from the tubers of primarily diseased plants, are often almost indistinguishable from those infected with crinkle or mosaic.

The first symptom of primary stipple-streak, which is most marked on early, succulent, and light green varieties, is the development of dark brown spots between the veins of the lower or middle leaves of the plant. The spots have a distinctly angular outline, the number of angles varying from three to five (usually the latter) or more. The spots are generally less than 0·5 cm. in diameter, uniform in colour and texture, and slightly depressed. In warm weather this preliminary symptom is succeeded by the appearance of black spots near the veins of the young leaves, just below the growing point. These spots are elongated, small, and very numerous. At this stage there is already a suggestion of mottling, and the affected plants somewhat resemble those attacked by mosaic disease. Dark, olivaceous-green to brown stripes are found on one or more sides of the stem. Sometimes the affected side of the stem and the spotted leaves on it are completely destroyed, while the opposite side continues to grow, causing a bending of the whole shoot to the diseased side. These stripes represent groups of dead or severely diseased cells and tissues, beneath the still normal epidermis and sub-epidermal layer. Their borders are not clearly defined and they have a water soaked appearance. Both stems and leaves begin to wilt from the top downwards. The disease usually spreads to all the shoots within two or three weeks, killing the plant. The first cases in Holland were observed in May, but the disease continued to appear throughout the growing season.

Affected tubers show on the surface distinct, slightly elevated blisters on and near the eyes and at the stem end. The blisters soon shrink and leave only dark brown or cinnamon-coloured spots. When they appear on young tubers, the cork layer and cortex split in various directions. The tubers of infected plants, even those which appear quite healthy at harvest time, may become blistered and discoloured in storage. Internally affected tubers can be recognized by their uneven and granular surface and by the deep-lying, brown blotches visible through the periderm. Sometimes the eyes of the tubers are completely and permanently destroyed.

When infected tubers are planted out they either fail to develop or produce stunted plants with small, crinkled leaves and short petioles. This is the secondary type of the disease. The leaves are slightly mottled and show the typical symptoms of stipple-streak described above, the brown spots, however, being less numerous than in the primary form. The stems are covered with brown stripes and are split crosswise. The whole plant is extremely brittle, and the lower leaves fall, till at length only a few are left at the top. The plants generally die during the first month after their appearance. New sprouts may be formed once or twice after this, but they pass through the same phases as the first ones. The seed tuber usually persists without rotting, and one or more small, new tubers, discoloured and covered with blisters and splits, may also be found. They seldom sprout if planted, and when they do it is only to produce diseased shoots which die without bearing tubers.

In its secondary form stipple-streak differs from mosaic, crinkle, and leaf roll mainly in its severity, accomplishing in two or at most three generations from the first attack what the others achieve after a much longer period. It most closely resembles crinkle, but can usually be distinguished by a careful comparison of the symptoms, the differences being set out by the author in tabular form. It is also rather like a still undescribed disease, for which Quanjer has proposed the name leaf-drop-streak, except that there is no spotting of the leaves in the latter. Like other 'running-out' diseases, stipple-streak is systemic, spreading into all the shoots produced by the same tuber.

The pathogen of the disease, no suggestions regarding the nature of which are given, does not leave the plant under ordinary conditions and very likely dies with it. Healthy Schotsche Muis tubers stored in a damp cellar with 95 per cent. of heavily infected tubers of the same variety gave absolutely healthy plants. In another case healthy and diseased tubers were planted side by side in the same pot, with the result that the former gave healthy plants and the latter diseased ones. These and other experiments prove conclusively that the pathogen cannot pass from plant to plant through the soil, water, or air. Attempts to infect healthy plants with the sap from diseased ones also gave negative results. By establishing an organic connexion between a healthy and a diseased plant, however, it was possible to transmit the infection. This was done in two ways: by joining the cut surface of healthy tubers with that of infected ones so that an organic union was formed, and by grafting infected plants on healthy ones. In this respect also stipple-streak resembles leaf-roll, mosaic, and crinkle. Field observations indicate that natural spread of the disease from plant to plant occurs, but the manner of this is not known though insect transmission is evidently suspected. Temperature has a marked effect on the appearance and development of stipple-streak. Experiments showed that a temperature between 5° and 10° C. retarded the development of the disease and enabled the plants to make a normal growth without, however, destroying the source of infection, as the disease reappeared when they were again placed in a hot-house. Higher temperatures accelerated the progress of the infection.

Experiments in the treatment of infected tubers with 2 per cent. copper sulphate for one and two hours and 2 per cent. mercuric chloride for half an hour and one hour gave absolutely negative results. Tubers heated in dry air at a temperature of 44°

to 46° C. for 5, 15, and 24 hours also gave secondary stipple-streak plants in all cases. It is evidently impossible to destroy the pathogen of stipple-streak in the tubers without injuring the latter. It seems highly probable, however, that the disease can be controlled by the elimination of infected tubers and young plants, and this can be much more readily effected than in the case of the other running-out diseases, since the yield of tubers from infected plants is negligible in the second generation from infection.

DUBOYS. **La lutte contre la 'dégénérescence' des Pommes de terre dans l'Ouest de la France.** [The campaign against 'degeneration' of Potatoes in the west of France.]—*Rev. de Bot. appliquée*, ii, 14, pp. 586–589, 1922.

None of the potato varieties cultivated in Brittany, the chief centre of seed potato cultivation in France, is immune from leaf roll and mosaic, though the early varieties grown along the coast appear to be relatively less subject to these diseases. The selected early varieties Fluke (Géante de St.-Malo) and Fin-de-Siècle (Up-to Date) show a very low percentage of attack, apparently on account of the scrupulous care on the part of the local growers in the choice of their seed. Any plants deviating at all from the normal type in stature, shape of the leaves, colour of the flowers, and the like, are discarded. The practice of 'greening' and sprouting in trays exposed to air and light has also the advantage of enabling the growers to discard any seed tubers with abnormal (spindly) sprouts.

Unfortunately the late-maturing varieties grown inland do not receive the same attention, and the yield obtained from them is correspondingly lower. L'Institut de Beauvais is almost everywhere attacked by leaf roll, only one or two isolated plots in the north-east of Mayenne and the west of Sarthe being found free from it. The Saucisse (Rouge Plate) suffers much more from mosaic and leaf roll in Mayenne, Sarthe, and Vienne than in Brittany.

L'Industrie is also very subject to these diseases, except in Morbihan, where there is a sufficiency of healthy material to allow of selection in order to obtain a regular supply of disease-free seed. Early Rose and Chardonne, cultivated in the Côtes-du-Nord mainly for export, are other varieties mentioned as equally liable to leaf roll and mosaic.

The author again insists on the importance of systematic selection of the seed crop, and outlines a scheme for the establishment in every department of special 'selection fields' for the use of growers, accompanied by the distribution of awards and certificates for healthy seed.

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SANDSTEN (E. P.) & TOMPKINS (C. M.). **Degeneration in Colorado Potatoes.**—*Colorado Agric. Exper. Stat. Bull.* 278, 15 pp., 8 figs., 1922.

The results of an investigation of the degeneration of Colorado potatoes, carried out during a period of four years with the Russet Burbank and Brown Beauty varieties, at three localities in the State, are described. The potatoes were divided into three series: best hand-selected seed, best culls, and poorest culls obtainable. In 1918 at Del Norte, where the soil is a well-drained, sandy loam, the highest yield in both varieties was obtained from hand-selected seed, followed by the best culls. In 1919, when the experiments were transferred to the heavy clay soil of Paonia, the hand-selected Russet Burbank again gave the best yield; with Brown Beauty, however, the good culls gave the highest yield and the hand-selected seed the lowest. In 1920 at Del Norte the inferior culls of both varieties out-yielded the hand-selected seed. In 1921, at Eagle, where soil and climatic conditions are ideal for potato growing, the best yield was obtained from the hand-selected seed.

The disease factor was almost entirely eliminated in the foregoing experiments, less than 1 per cent. being present in any of the plots during the period. Under Colorado conditions, therefore, degeneration appears to be largely influenced by environmental relations. Degenerate tubers planted in fertile soils in a favourable climate will, with proper attention, produce a superior crop.

It is recommended that every grower should have a special seed plot from which the tubers of high-yielding and disease-resistant plants are dug before the main crop each season and saved for next year's seed plot, the balance or major portion of the seed harvested every year from the seed plot being used for general planting.

GRAM (E.). **Forsøg med avlsstedets indflydelse paa Kartoffelens bladrullesyge.** [Experiments in environmental influence on the leaf roll disease of Potatoes.]—*Tidsskrift for Planteavl*, xxviii, 5, pp. 769–806, 4 figs., 5 diag., 1922.

Experiments were carried on from 1915 to 1920 in various parts of Denmark under the supervision of the phytopathological service to test the influence of environment on the incidence of leaf roll disease of potatoes. A brief historical account of the disease, together with a full description of its symptoms, pathological anatomy, and the various theories as to its cause, is given in the present paper, and the previous work on its relation to soil, climate, and the like is summarized. The view that the disease is due to an ultramicroscopic organism is accepted. The Danish tests were carried out with one healthy and one diseased strain of Magnum Bonum potatoes, which were cultivated at eleven experiment stations on a variety of different soils. Every autumn samples of each strain from all the stations were forwarded to Kvistgaard in the north of Zealand for further growth and comparison in the following year.

The results of the experiments are described in considerable detail. Tables are given showing the percentage of leaf roll plants each year in the Kvistgaard plots, yield, and other details. Graphs showing the effect of cultivation on the disease, at the different stations are also given. In some of the stations the diseased strain showed a tendency to recover; in others the healthy strain became diseased. On the whole peat soils exerted the most favourable influence on the crop, both as regards yield and freedom from the disease. Sandy soils generally gave excellent results, almost equal to the peat, while both the yield and condition of the crops were adversely affected on light clay, except at one station, where a satisfactory stand was obtained. Heavy clay soils were considerably more favourable than light ones. Possibly the beneficial effects of the peat and sandy soil were due in some measure to the earlier maturity of the plants grown on them, which did not give time for the passage of the virus from the aerial part of the plant through the stolons to the tubers.

The influence of the soil, however, was not found to be the only, or even the most decisive factor in the health or disease of the potato crop. Meteorological conditions played an important part, indeed the influence of climate on the disease appeared to be the predominant factor. Any departure from the normal during the period covered by the experiments was carefully noted. The conditions governing the incidence of aphid attacks and the consequent transmission of leaf roll are discussed. It was observed that damp, cold weather in May and June was followed by a decrease in infection in 80 per cent. of the cases. The absence of disease in the peat soils was probably largely due to the spring and autumn night frosts in these situations, which retarded development in the autumn. and in the spring frequently killed not only the young growth but also the invading aphids. The districts in which these so-called 'sanatorium' soils occur experience an average summer temperature of less than 15·5° C.

The quantity of dry substance present in the tubers is regarded as a further point of some importance. A reduction in the dry substance, believed to result from storage in warm cellars, was frequently associated with a corresponding loss from 'degeneration' in the next year's crop. This is, however, apparently a distinct phenomenon from leaf roll.

Leaf roll may be controlled by procuring seed tubers exclusively from healthy fields, especially from parts of the country where there is little infection. Such methods as field selection and the use of large tubers are unreliable, at any rate in cases of severe infection. The indirect control of the disease by combating the aphids which are responsible for its transmission, the potatoes being sprayed in early summer with Bordeaux mixture and nicotine, is regarded as a promising line of attack. Early lifting of the tubers to prevent infection through the stolons, and the selection of resistant varieties are also worth further investigation.

SHARPLES (A.). **A preliminary account of the fungi causing 'brown root' disease.**—*Malayan Agric. Journ.*, x, 7, pp. 181–183, 1922.

During 1920 numerous cases of brown root disease were observed on *Hevea* rubber trees on a Malayan estate. The chief symptom was the well-known incrustation of the roots with masses of earth and stones. Previous to 1917 the causal fungus of this disease was referred to *Hymenochaete noxia*, but during that year Petch obtained numerous fructifications of *Fomes lamaoensis* from tea and rubber plants killed by brown root disease, and stated that the so-called *Hymenochaete* was merely the result of abortive attempts at the development of the *Fomes* sporophore.

Pure cultures on rubber wood blocks were obtained by the author from the diseased roots mentioned above. At the same time the fungus causing brown root disease of camphor (*Cinnamomum camphora*), a large patch of which has been slowly dying out for years at Kuala Lumpur, was isolated. The cultures were so distinct that they could scarcely be regarded as belonging to the same fungus as the last. Further cultures were obtained from typical specimens of brown root disease of *Hevea* rubber roots received from Ceylon, and these again gave a fungus obviously different from the other two. In every feature the three sets of cultures were readily distinguishable from one another, except that they had the peculiarity in common of secreting mucilage by the hyphae when in contact with water. There can be little doubt that this process accounts for the typical symptoms of brown root disease, the secretion of mucilage causing the binding together of the encrusting mass of earth and stones.

Thus there are at least three morphologically different, though physiologically comparable, fungi associated with brown root disease. The camphor and the Ceylon rubber brown root fungi in their final stages exhibit characters considered typical of the genus *Hymenochaete*, while the Malayan rubber brown root organism appears to be forming fructifications resembling those of a *Corticium*. Further details regarding these fungi will be published subsequently.

OSBORN (T. G. B.) & SAMUEL (G.). **Some new records of fungi for South Australia, Part II, together with a description of a new species of Puccinia.**—*Trans. Roy. Soc. S. Australia*, xlvi, pp. 166–180, 1 pl., 4 figs., 1922.

In this paper records are given of fifty-one fungi new to the

South Australian flora, of which one, *Puccinia semibarbatae* on *Bulbine semibarbata*, is new to science.

Amongst species parasitic on cultivated plants the following are of interest:

Phoma macrophoma, *Diplodia citricola*, *Septoria depressa*, and *Coniothecium scabrum* on orange, the first on the twigs, the other three causing scabbing of the fruit; *Phyllosticta brassicicola* on *Brassica oleracea*; *Septoria lycopersici* on tomato; *Vermicularia circinans* [*Colletotrichum circinans*] on onion; *V. varians* ('black dot' or dartrose disease) on potato; *Gloeosporium ribis* on gooseberry canes and leaves; *Cercospora apii* causing a leaf spot of parsnips (*Pastinaca sativa*); *Coniothecium chomatosporum* causing cankers on twigs of apple and pear, scabbing of fruit has so far not been recorded in South Australia; *Pseudomonas juglandis* on stems, leaves, and fruits of walnut (*Juglans regia*), a serious disease which has spread to almost all places where walnuts are grown, and which makes it impossible to obtain a marketable crop from many trees; *Bacterium mori* causing angular, black spots on the leaves of mulberry (*Morus nigra*).

Plasmopara viticola, which appeared first in Australia at Rutherglen, Victoria, in the season 1916–17, spread eastward, reaching Queensland in 1920–21. Its progress to the west was slow, its occurrence in Mildura being only reported in the season 1920–21, and from thence it spread down the Murray to Renmark, Berri, and Watervale. It is possible that infection may have been conveyed by human agency as there is regular motor traffic between Mildura and Renmark, but the spread is thought to be more probably due to air-currents, though the distances involved are considerable, varying from 100 to 230 miles. The attacks in South Australia have so far been slight, and it is not thought that climatic conditions will favour the development of the fungus.

Osborn (T. G. B.). **A note on the pathological morphology of Cintractia spinificis (Ludw.) McAlp.**—*Trans. Roy. Soc. S. Australia*, xlvi, pp. 1–5, 1 pl., 5 figs., 1922.

This smut causes certain interesting pathological changes in the host [*Spinifex hirsutus* Labill].

In the male inflorescence, instead of the normal spikelet composed of two sterile glumes, or three sterile and one flowering, and with each floret consisting of glume, palea, two lodicules, and three stamens, the smutted spikelet has two sterile glumes and two florets, the latter being without lodicules. The anthers of the smutted flower contain no pollen and the filaments do not elongate. Above the point of insertion of the stamens an irregular conical mass, 1 to 7 mm. in length, is produced, consisting of a central core of host tissue coated, in the ripe smut gall, with a spore layer. Other changes are the greater elongation of the internodes of smutted inflorescences, reduction in the number of secondary axes in the inflorescence, closer aggregation of spikelets, and increase in their number per secondary axis.

The main divergences of a diseased female inflorescence from the normal are elongation of the internode below the terminal head, complete absence of the long sterile spines which are so marked a feature of the normal inflorescence (a few sterile spines may be present, but these are shorter than the fertile spines, of which the head is largely built up), insertion of the spikelets on the fertile spines at a distance of 1·5 to 4 cm. from the base instead of being borne at the extreme base, and increase in length of the spines themselves up to 15 cm. in length (i. e. half as long again as normal). The smutted female spikelet consists of two sterile and two fertile glumes, as against three sterile glumes (or two sterile and one abortive male flower), and one fertile glume in the normal spikelet. The lower floret, normally an abortive male, behaves like a female in the smutted heads and is indistinguishable from the upper, fertile one. The smutted flower has glume and palea, both longer than usual, the latter being often involved in the smut gall, but no stamens have been recognized, the whole of the floral axis above the palea being an elongated, rarely bifurcated, smutty mass.

The smut galls in both the male and the female inflorescences are similar, except that the former is usually somewhat smaller. Owing to the extensive modifications produced by the gall formation, however, it is not safe to conclude that ovaries are actually produced in male flowers as a result of the attack, as has been reported in the case of certain other smuts.

TROTTER (A.). **Osservazioni intorno ad alcuni Erisifacei italiani meno noti.** [Notes on some less-known Italian Erysiphaceae.] —*Ann. R. Scuola Sup. di Agric. in Portici*, 2nd ser., xvii, pp. 3–11, 1922.

Notes are given on three Erysiphaceae of economic importance as well as of scientific interest, observed in Italy.

The appearance and wide dissemination of the oak mildew in Europe is described, and the records of the discovery of its perithecial stage in various parts of Europe discussed. The author has examined perithecia found in Sicily late in 1920, and states that they agree with previous French and Italian records, except in the somewhat smaller size of the asci and ascospores. He identifies the fungus as *Microsphaera quercina* (Schw.) Burr., a species grouped by Salmon under *M. alni*, and referred by Neger to *M. alni* var. *quercina*. The almost simultaneous appearance of the ascigerous stage in France, Germany, and Italy he regards as being due not to any special climatic influences, but to internal causes in the fungus itself, probably connected with its acclimatization.

American gooseberry mildew (*Sphaerotheca mors-uvae*) appears to have been actually first recorded in Italy by Voglino in the province of Turin in 1904, but this record has escaped most recent writers. The fungus is now present in Turin, Pavia, Milan, Venetia, Novara, and other districts, and even far to the south in Avellino. The cultivation of gooseberries is, however, so limited and scattered that serious economic losses are not to be anticipated.

Apple mildew has received scant notice in Italy, though it is present not only in the north of the country, but also, apparently of recent introduction, in Avellino. There is no doubt that the disease is widely diffused in its conidial form in Italy. The ascigerous stage appears to be seldom developed, and there is accordingly some doubt as to the species concerned. It is not improbable that the two fungi, *Podosphaera leucotricha* and *P. oxyacanthae*, occur in Italy, but in the Avellino cases examined by the author the conidial stage could not be referred to the latter, and *P. leucotricha* was probably concerned. The disease appears to be increasing in Italy, its spread being assisted by the use of infected wild apple seedlings from northern Italy as stocks. It was noticed that wild apples grown from seed were severely attacked whereas after grafting they were almost immune.

NANNIZZI (A.). **Sulla forma ascofora dell' Oidium quercinum Thüm.** [Notes on the ascigerous form of *Oidium quercinum* Thüm.]—*Riv. Patol. Veg.*, xii, 7–8, pp. 87–90, 1922.

The author records the finding of perithecia of the oak mildew in the Sienna district. He agrees with views expressed by some other Italian observers that their development was induced by a sudden lowering of the temperature after a prolonged heat wave. They were chiefly on mature leaves, which were covered with them, but numerous examples occurred also on young leaves at the tips of the shoots. Only *Quercus pedunculata* bore them, *Q. sessiliflora*, *Q. cerris*, and *Q. ilex* having no perithecia, though their leaves bore the conidial stage.

The perithecia, which are referred to *Microsphaera quercina*, agreed in their main characters with the previous Italian descriptions.

PETCH (T.). **Some diseases of Tea.**—*Trop. Agric.*, lix, 4, pp. 243–249, 1922.

A leaf disease due to *Cercosporella theae*, which was not observed between 1909 and 1919, has attracted much attention in up-country districts in Ceylon, since the latter date [see this *Review*, i, p. 331]. The disease, which is almost invariably found in the neighbourhood of acacias, appears towards the end of the monsoon rains, first on the acacias and then spreading to the tea; it is found mostly at altitudes above 4,000 ft. Numerous black spots are produced on the young leaves, and in wet weather the whole leaf may become black and rotten. On older leaves the spots are at first black, and then may turn grey, with a raised, purple border. Full-grown leaves are marked with large, diffuse, mottled brown patches, which turn grey with age and have a narrow, purple-black, marginal band. In severe cases the bush may be almost defoliated. Attacks on the green stems occur in the form of purple, sunken areas. The fungus is visible as a fine, white web over the spots and on the surrounding areas of the under surface of the leaf. The long, rod-shaped spores are borne on this superficial mycelium in white clusters. The return of fine weather after the rains arrests the disease.

A stem disease caused by *Aglaospora aculeata*, formerly somewhat rare, appears also to be on the increase. It is believed to be confined to the up-country districts. The fructifications of the fungus are formed beneath the bark, the outer layers of which eventually crack as a result of pressure from within. The apices of the fructifications protrude through the fissures as conical, black thorns, arranged in straight lines or circles. The wood of infected branches is dark brown in colour, and brittle but not soft. Unless checked, the fungus spreads into the main stem and may even travel down to the roots, ultimately killing the bush. Infection is conveyed by means of spores extruded from openings at the apices of the thorns. The stems are apparently infected at pruning cuts. Tea is so far the only known host of the fungus. The dead branches should be removed and burnt, but the complete eradication of the fungus often involves collar pruning.

Red root disease (*Poria hypolateritia*), the symptoms of which are described in detail, is very common in young clearings, originating on the stumps of Bombu [*Symplocos spicata*], Doon (*Doona zeylanica*), and other jungle trees. Directions are given for the eradication of the fungus, which has been known to destroy over two thousand bushes in an area of twenty-six acres in six years.

Acacia stumps are liable to attack by various large root and stem fungi, e. g. *Fomes applanatus*, *Armillaria fuscipes*, and *Irpex destruens*, all of which are capable of attacking tea. Acacias are now extensively used for interplanting with tea, and, in view of the danger of infection by these fungi, the stumps should be extracted whenever possible if it becomes necessary to remove the trees.

Sidenius (E.). **Verslag van het Deli Proefstation over 1 Juli 1921—30 Juni 1922.** [Report of the Deli Experiment Station from 1st July 1921 to 30th June 1922.]—*Meded. Deli Proefstat. te Medan-Sumatra*, Ser. 2, xxiv, 64 pp., 1922.

Experiments were conducted to test the value of *Mimosa invisa* when used as a green manure for tobacco in reducing the incidence of slime disease [*Bacillus solanacearum*]. Observations and investigations of many years' duration had already shown that *M. invisa* not only improves the soil but also suppresses the development of the hosts of *B. solanacearum*. It has the further advantage of being easily and inexpensively cultivated, though it is subject to sporadic attacks from *Sclerotium rolfsii*. The recent tests showed that no marked improvement can be expected unless the *Mimosa* is grown for a year or more before being ploughed under. The effects on the slime disease of liming the soil were also studied. Negative results were obtained, except in one plantation of loose red soil containing quartz, where the application of three tons of lime per bouw [1·79 acre] reduced the infection from 33 per cent. to 6 per cent. The incubation period of slime disease on tobacco was found to be approximately six days for seedlings about 5 cm. in height, ten days for seedlings ready for transplanting, and eleven to thirty days for plants in the field.

The practice of hilling is frequently held responsible for the aggravation of slime disease, but experiments proved that this is not the case. Hilling was, moreover, found to be indispensable to the proper development of the crop. Seedlings from healthy beds sown in infected ground were found to be considerably less susceptible to slime disease than apparently sound and strong seedlings from infected beds (30·8 per cent. of infection as against 41·1 per cent.). Tests of varieties selected for resistance to this disease were continued. Promising results were obtained with one of the selections, and it is proposed to carry out extended tests of this strain.

Phytophthora [*nicotianae*] was prevalent on tobacco seedlings ready for transplanting, probably on account of the heavy rains while the plants were in the seed-bed. *Ricinus communis* was attacked by an allied and possibly identical species of *Phytophthora*.

Specimens of field tobacco submitted for examination were found to be attacked on the stalks by a species of *Pythium*. On two estates the epidemic was so severe that scarcely a single plant remained healthy. Both the sites in question were formerly occupied by cattle-sheds. The application to the transplant holes some days before planting of a 1 : 500 solution of formaldehyde greatly reduced the infection. Treatment with uspulun was ineffectual.

RAMSEY (G. B.). **Basisporium gallarum Moll., a parasite of the Tomato.**—*Bot. Gaz.*, lxxiv, 3, pp. 325–328, 11 figs., 1922.

A rot of ripe tomato fruit shipped from California in 1919 was found to be due to *Basisporium gallarum*, a fungus originally observed by Molliard on dead larvae of *Lipara lucens*, within galls which this insect produces on *Phragmites communis*. Although the presence of *Basisporium* in cultures from maize, wheat, and dewberries has since been reported, no parasitic activities appear to have been attributed to it previously. Inoculation experiments indicate that it is a vigorous wound parasite which produces soft, red, blister-like lesions on ripe tomato fruits. The lesions may reach a diameter of two inches in four days. Green fruits react to the inoculation, but in a lesser degree, while a temperature of 9° to 10° C. inhibits the development of the fungus even on ripe wounded fruit. An abundance of pale, smoke-coloured mycelium develops on the fruit when the latter is kept in a humid atmosphere after inoculation.

Cultural experiments are described, which show that the extreme temperatures for growth are approximately 10° and 35° C. Although the Californian fungus exhibits a few minor morphological differences from the description of Molliard's form, and the substrata on which the two were found differ widely, the author does not feel justified in creating a new species for this tomato parasite.

TROTTER (A.). **Intorno al seccume degli aghi ed agli altri fenomeni patologici del Pino domestico (Pinus pinea L.).** [Notes on needle blight and other pathological phenomena of the Stone Pine (*Pinus pinea* L.)]—*Riv. Patol. Veg.*, xii, 7–8, pp. 91–106, 4 figs., 1922.

The needle blight of the stone pine (*Pinus pinea*) in Campania may be due to physiological causes (as in the vicinity of Vesuvius, where the gases emitted from the crater affect the trees) or to the attack of parasitic fungi. The author describes a case of the latter from near Avellino, where it is sometimes epidemic. Towards the end of spring the needles turn light green in colour, later becoming yellow, and then brown as they dry up. Those situated near the tips of the twigs are most affected, and a high proportion of shoots is usually involved, so that the disease is very noticeable. The symptoms on the individual needles vary: the apex may be yellowed and withered, the base remaining green for a time; the needles and their sheaths may dry up uniformly; there may be nothing more than a slight contraction of the tissues or a discoloured spot resembling a bruise; drops of resin may exude, especially towards the base and on the sheaths; and finally, the presence of blackish dots may be observed on the surface of the needle and its sheath and on the adjacent epidermis of the twig. These dots are the fructifications of two distinct fungi, a *Pestalozzia* and a *Cladosporium*. The former is considered to be a new form, f. *pini-pineae*, of *Pestalozzia hartigii*, resembling most closely *P. truncata* Lév. amongst the other species of this genus found on conifers. Its mycelium penetrates the needles as fine, hyaline hyphae, 2 to 2·5 μ in diameter and much more sparingly septate, less tortuous, and less branched than those of the *Cladosporium*. The conidia are borne on a stromatic layer of gelatinous, interwoven hyphae, and are difficult to find.

The *Cladosporium* is regarded as a new form, f. *pini-pineae*, of *C. laricis*, previously only known on the larch. It differs from the normal type chiefly in attacking the sheaths, and sometimes even the twigs, as well as the needles, which alone are attacked in the larch. Fructifications are found more readily on the sheaths than on the needles; on the latter usually only small stromata, occupying the substomatal cavities and protruding very slightly from the stomata, are formed. The mycelium is confined to the outer parenchyma of the needles.

The exact part played by these fungi in the production of the needle blight described in this paper has not been established. Frost is believed by the author to be an important factor in the disease, which is much more prevalent at an altitude of 600 m. than near the town of Avellino, which is only 300 m. above sea-level.

An annotated bibliography of fifty-nine references to diseases, pests, and teratological phenomena affecting the stone pine is appended.

Steup (T.). **Een ziekte (Aecidium cinnamomi Rac.) van den Tedjo (Cinnamomum iners Bl.).** [A disease (*Aecidium cinnamomi* Rac.) of Tedjo (*Cinnamomum iners* Bl.).]—*Tectona* [Buitenzorg, Java], xv, 4, pp. 348–350, 1922.

Tedjo (*Cinnamomum iners*) trees at Batoe Raden examined in 1919 were found to be in a withered and dying condition. The leaves, petioles, and branches, especially of the upper part of the tree, and sometimes also the trunk, were affected. The diseased leaves and twigs exhibited a black discoloration, the latter also becoming noticeably swollen.

All the affected parts were covered with the orange-coloured aecidia of *Aecidium cinnamomi* Rac. Unless subsequent investigations prove that the form occurring on *C. iners* is biologically restricted to that host, there is every likelihood that the disease may spread to the cultivated cinnamon [*C. zeylanicum*]. Pending further investigations, the only control measures which can be suggested are the excision and burning of all affected parts.

SAMUEL (G.). **Notes on forest pathology from South Australia.**—*Australian Forestry Journ.*, v, 7, pp. 189–192; 8, pp. 223–226; and 9, pp. 253–254, 7 figs., 1922.

The author, while stating that at present parasitic diseases are of no great importance in South Australian forests, calls attention to the neglect throughout Australia of forest pathology which may well lead to the introduction of new pests from abroad or to the dangerous development of hitherto negligible diseases already present in the country. He advocates, therefore, the appointment of at least one qualified forest pathologist, whose duty would be to protect the interests of sylviculture.

The main interest of these papers lies, however, in the description of a remarkable disease, locally known as 'curly-needle disease', of *Pinus muricata* and *P. insignis* observed at Kuitpo, South Australia, but stated to exist also in Victoria and Western Australia. The most characteristic symptom is the effect on the leaves. The three needles in each group are often fused together, curved, and shortened; the thickened compound needle may be not more than a third of an inch in length. Sometimes the needles are united without being shorter than usual, and the different degrees of deformity may be found, together with normal needles, on the same tree or even on the same year's growth. A less constant symptom is the elongation and greening of the bracts subtending the needle bunches; this is less frequent and less pronounced in *P. insignis* than in *P. muricata*, in which the bracts may become 1½ in. long and ⅛ in. wide at the base. In the latter species the dead male cones are often retained in large numbers on the affected trees for a considerable time. The disease develops in trees up to six years old, after which age they appear to be immune. The symptoms frequently arise in trees apparently growing strongly, but the result is invariably to arrest or greatly retard further growth. Old cases have a peculiarly tufted appearance due to copious branching of the lateral shoots. In *P. insignis* the leading shoot and some of the side branches may be killed outright. There seems to be no regularity in the distribution of affected trees; although occasionally two or three may occur together, it is far more usual to find a diseased tree surrounded by perfectly healthy ones. No correlation has so far been established between the occurrence of the disease and soil or other environmental conditions, and its cause is as yet entirely unknown. It has been suggested that it is the result of the attacks of *Chermes*, and that an aphis is embedded in the tissue at the base of each curly-needle bunch, but the author was unable to discover any grounds for this belief. He was also unable to find any fungus constantly associated with the disease, and many of the symptoms are directly at variance with those usually connected with fungous diseases. The disease is considered to have points in common with the group of physiological diseases of which tobacco leaf curl is a type; the latter is hereditary and transmissible by insects and inoculation, though it is not caused by any known fungus or bacterium.

Brief notes are also given on the effects of the 'smothering fungus' *Thelephora terrestris* (*T. laciniata*) and of *Armillaria mellea* on *Pinus insignis*, as well as a short account of a shoot disease associated with a fungus of the *Fusicoccum* type.

Birmingham (W. A.). **Disease of Pinus insignis at Strickland State Forest, Natara.**—*Australian Forestry Journ.*, v, 8, pp. 206–211, 5 figs., 1922.

The author gives a detailed description of a disease of *Pinus insignis*, found at Natara, New South Wales, which is evidently, in part at least, the same as that referred to in the above abstract as 'curly-needle'. Inoculation experiments made with two species of fungi (*Sphaeropsis* and *Pestalozzia*) that were common on the dead needles gave negative results, and the disorder is believed to have a physiological origin. An additional symptom besides those mentioned by Samuel is the development of a long main axis free from lateral growth and with a mop-like head. A profuse development of needles along the main axis may also occur.

Müller-Thurgau (H.). **Die Gloeosporium-Krankheit der Holunderbeeren.** [The *Gloeosporium* disease of Elderberries.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 826–828, 1922.

The causal organism of a widely distributed disease of elderberries (*Sambucus nigra*) was isolated and found closely to resemble *Gloeosporium fructigenum* [*Glomerella cingulata*], which produces bitter rot of apples. Cross-inoculation experiments with the elderberry organism and *G. fructigenum* were undertaken, the results of which showed that the elderberry *Gloeosporium* was incapable of infecting apples. Elderberries inoculated with *G. fructigenum* from apples were eventually infected, but only when their skin had become ruptured after standing in water for some time. Ripe berries of *Sambucus ebulus* were also proof against the attacks of the elderberry *Gloeosporium*.

Notwithstanding the morphological agreement between *G. fructigenum* and the elderberry organism, the author thinks that the latter must be regarded as a biological variety, for which the name *G. fructigenum* var. *sambuci* is proposed.

Lindfors (T.). **Studier över Fusarioser. II. Om Fusariumangrepp på späda Barrträdsplantor.** [Studies in Fusarioses. II. *Fusarium* attacks on Conifer seedlings.]—*Centralanst. för försöksväsendet på jordbruksområdet Medd.* 238, 24 pp., 1 col. pl., 4 figs., 1922. (German summary.)

After a brief discussion of previous work on the damping-off of conifer seedlings, the author describes his experiments with *Pinus sylvestris* in 1916 and 1917. In the first isolations made from material submitted for examination from Osby [south Sweden], only one species of *Fusarium* (a form resembling *F. redolens* except that it produced sporodochia and pionnotes sparingly, had many 4- to 5-septate conidia, and bore chlamydospores) was found. In a later experiment with seedlings grown in sterile soil in pots, a spontaneous outbreak of *Fusarium* occurred and five species of the genus were isolated from twenty seedlings, namely, *F. metachroum* from ten plants; *F. subulatum*, *F. solani*, and *F. macroxysporum* n. sp. each from three; and *F.* cf. *sclerotioides* from two. This last species agreed in the main with *F. sclerotioides* var. *brevius* (*F. blasticola*), but differed in the production of 4- and 5-septate conidia, and in the size and number of the sclerotia. The new species, *F. macroxysporum*, of which a Latin diagnosis is given, is allied to *F. euoxysporum*, from which it differs in the greater breadth of the conidia, and also to *F. aurantiacum*, from which it may be distinguished by the rarity of conidia with more than three septa and the absence of blue sclerotia. Its mycelium rapidly becomes covered on most substrata with a layer of conidia resembling pionnotes. The few sclerotia which occur are light brown in colour. On rice and wheat flour cake the plectenchyma assumes a diffuse purple coloration. The conidia are generally 3-, but sometimes 4- and 5-septate, while in older cultures micro-conidia occur, continuous or with one or two septa, and chlamydospores, both intercalary and terminal, are also formed.

Inoculation experiments with these six species and also *F. culmorum* and *F. subcarneum* were carried out on pine seedlings grown in sterilized soil in pots. The most severe attacks were caused by *F. metachroum*, *F. subulatum*, *F. culmorum*, and *F. macroxysporum*, but in all the inoculated pots the number of diseased seedlings was greater than in the controls. The author isolated from various soils all the pathogenic species of *Fusarium* mentioned above, with the exception of the species resembling *F. sclerotioides* and *F. redolens*, while infection was also proved to be transmitted by the seed. Steeping the seed for fifteen minutes in 0·1 per cent. formalin reduced infection from this source to a minimum. Further experiments were undertaken to ascertain the effect of soil sterilization both on the host and on the parasites used in the above experiments. The germination of the seed and growth of the seedlings was found to be, if anything, improved when sterilized soil was used, and some of the fungi also grew better in the extract from sterilized than in that from unsterilized soil. In inoculation experiments with *F. macroxysporum* a much larger number of seedlings became diseased in the former than in the latter soil.

The methods of control advocated by other investigators are summarized, no work on these lines having been undertaken by the author himself. They include disinfection of the soil with sulphuric acid, formalin, copper sulphate, or zinc chloride, all of which have given satisfactory control in various places, and steeping the seed in copper sulphate, corrosive sublimate, or formalin. From statements in the literature it would appear that *Abies concolor*, *Pinus ponderosa*, *P. sitchensis*, *P. pungens*, *Picea engelmannii*, and *Larix leptolepis* are very susceptible to damping-off, while *Picea excelsa* is almost immune. Neger's statement that the common pine (*P. sylvestris*) is also almost immune is contradicted by the present investigations in which it proved extremely susceptible.

MORQUER (R.). **Sur un nouvel hôte du Trametes hispida (Bagl.).** [On a new host of *Trametes hispida* (Bagl.).]—*Bull. Soc. Myc. de France*, xxxviii, 3, pp. 170–172, 1922.

The author describes the occurrence of *Trametes hispida* [*T. trogii* Berk.] on *Schinus dependens*—apparently a new host—in the Botanical Gardens of Toulouse. The mycelium was found to follow the axis of the trunk to a considerable distance (about 1 metre) occupying the medullary region and penetrating radially into the surrounding wood for 2 to 3 cm. from the pith. This resulted in the formation of a continuous strand composed of wood fibres interwoven with the mycelium. At certain points the latter reached the surface and produced fructifications. The affected areas were yellowish-white, in contrast to the pale pink of the healthy wood.

The diseased wood was spongy in texture, the fragments softened by the action of the fungus possessing a certain amount of elasticity; the wood fibres were also easily dissociated. At the margin of these softened areas, brown, sinuously concentric zones were formed, probably as a result of the action of oxydizing enzymes whose presence was demonstrated by the author.

The fungus was successfully isolated and grown in culture, details of which are given. Sporophores do not appear to have been formed in culture.

Manns (T. F.). **Cabbage wilt and stem rot in Delaware.**—*Delaware Agric. Exper. Stat. Bull.* 132, 24 pp., 13 figs., 1922.

Cabbage wilt or yellows, due to *Fusarium conglutinans*, and stem or foot rot (*Phoma lingam*) have caused heavy losses to Delaware growers during recent years. The symptoms of the diseases are described and figured, the trouble in both cases being traced to the seed-bed. Investigations were carried on from 1914 to 1917 to ascertain whether the yellows resistant strains selected by L. R. Jones in Wisconsin from the variety Ball Head were of any value in Delaware. The results of these experiments were, on the whole, not very promising. It was found, however, that desirable wilt-resistant strains, of both early and late varieties, could be produced on wilt-sick land by the following method. Duplicate seed-bed rows were planted forty-two inches apart, the non-resistant seedlings being thinned out until a uniform stand of highly resistant plants was secured. The latter were finally thinned out to a distance of one foot apart. The varieties that gave good results under these conditions were Jersey Wakefield, Drumhead Frost Proof, and Nokor or Volga. Resistance to wilt does not ensure the absence of stem rot.

The following control measures are recommended: rotation of crops, disinfection of the seed with corrosive sublimate, and a liberal application of well rotted manure combined with a potassium fertilizer.

Milbrath (D. G.). **Alternaria from California.**—*Bot. Gaz.*, lxxiv, 3, pp. 320–324, 2 figs., 1922.

A disease of cabbage, cauliflower, and broccoli, confined to a district of California where high relative humidity and a uniform temperature prevail, was found to be due to an apparently undescribed species of *Alternaria*. Its chief symptom is the appearance, generally on apparently vigorous leaves of all ages, of numerous circular, somewhat sunken, purplish-black spots, the centres of which are darker than the margins. The zonation characterizing the lesions produced on leaves of cabbage by *A. brassicae* is lacking. Sporulation of the fungus is sparse on still vigorous leaves, but becomes profuse on yellow and detached leaves.

Cultures were readily obtained and the disease reproduced by inoculation. Under dry conditions in the field only a small speck developed, but large spots up to 1 to 1·5 cm. were produced in seven days in plants kept in a very moist atmosphere. In view of the differences in morphological characters between this fungus and *A. brassicae*, and its different effects on the host, the author names it *A. oleracea* n. sp., a full English description being given.

OSTERWALDER (A.). **Ein Rotbrenner-Bekämpfungsversuch.** [An experiment in the control of 'Rotbrenner'.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 831–832, 1922.

As a rule the liberation of the spores of the 'rotbrenner' fungus (*Pseudopeziza tracheiphila*) takes place during the latter half of May. A severe epidemic of the disease in 1918 led to a series of experiments in its control in the following spring, especially on the susceptible Müller vines. It was found that spraying with 1·5 per cent. Bordeaux mixture reduced the amount of infection to a minimum. The application of the mixture took place on 6th June 1919, but such a delay was only possible on account of the dry, hot weather of that year. In general, about the 20th May would be an appropriate date in the Wädenswil area.

MÜLLER-THURGAU (H.), OSTERWALDER (A.), & JEGEN (G.). **Pflanzenphysiologische und pflanzenpathologische Abteilung.** [Department of Plant Physiology and Pathology.]—*Ber. Schweiz. Versuchsanst. für Obst-, Wein-, und Gartenbau in Wädenswil. 1917–20. Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 774–784, 1922.

This short review of the diseases of orchard, vineyard, and garden crops observed in Switzerland during the years 1917–1920, contains many records of interest.

Amongst fruit diseases it is stated that the quince disease caused by *Sclerotinia linhartiana*, which was formerly very prevalent, appears to be declining in importance, while *Entomosporium maculatum* [*Fabraea maculata*] seems to be on the increase and causes considerable damage to this host. Quince mildew (*Oidium cydoniae*) was also recorded. *Xylaria polymorpha* was found on the collar of a diseased pear tree, and the white spot disease of pear due to *Mycosphaerella sentina* is increasing greatly, and on certain varieties causes a premature leaf fall. *Fusarium putrefaciens* was found causing a core rot of apples. The raspberry cane blight caused by *Didymella applanata* has steadily increased in Switzerland of recent years.

The control of downy mildew of the vine (*Plasmopara viticola*) is improving and also that of the 'rotbrenner' disease (*Pseudopeziza tracheiphila*) and scab ('grind') as these diseases become better understood. White or livid rot (*Coniothyrium diplodiella*) was only once reported, while *Botrytis cinerea* did considerable damage, not only by rotting the grapes but also by attacking the pedicels and causing them to dry up during damp weather in the autumn.

There was one interesting case of a bacterial disease of tomatoes which almost destroyed a considerable area under this crop in the canton of Ticino. The affected plants were wilted, and on examination the tissues bordering on the medulla were found to be disorganized. On sectioning the diseased stems, drops filled with bacteria exuded. The characteristic green, transparent areas on the leaves ('oil spots') were also swarming with bacteria. The infection of the stems is believed to be secondary to that of the leaves, in which case an early application of Bordeaux mixture would be beneficial. Bean and pea seedlings, lettuce, and mangolds were also attacked by unspecified bacterial diseases, and tobacco leaves by *Bacillus maculicola.*

A long list of the parasites recorded on potatoes and the principal vegetable crops is given, mostly common or well-known troubles. The roots of pea plants submitted for examination were found to be infected by *Thielavia basicola.*

Amongst the miscellaneous diseases observed were attacks of *Phytophthora omnivora* on calceolarias, asters, and gooseberries.

Division of Botany, Department of Agriculture [Canada]. Survey of the prevalence of plant diseases in the Dominion of Canada, 1922.—*Third Ann. Rept.*, pp. iii + 1–63 and 184–192, 1923. [Mimeographed.]

This record of the prevalence of plant diseases in Canada during 1922 is based on the reports of collaborators in the various Provinces, edited by F. L. Drayton, Plant Pathologist at Ottawa. The report on potato diseases, which is separately issued, is noticed elsewhere [see below, p. 332]. The following summary covers some of the more important points.

Stem rust (*Puccinia graminis*) caused very little damage to wheat in Alberta and Saskatchewan, the losses from the disease being the slightest recorded since 1915. In Manitoba the rust was very severe on wheat growing within a 30-yard radius of some barberry shrubs at the Agricultural College, Winnipeg. Pycnidia were observed on the barberry on 15th May, and open aecidia three days later, about a fortnight earlier than the previous year. The wheat in the adjoining plots showed rust spots on 25th June. Beyond the 30-yard radius, infection occurred only on the leaves until after 12th July. Severe infection was observed in fields entirely out of reach of the barberry infection centre, and also occurred in some other parts of the Province, while the rust was absent from some areas. In New Brunswick the disease was general but not very severe. Heavy losses were reported from Prince Edward Island. On late oats, stem rust was very severe in all the provinces. Crown rust (*Puccinia coronata*) [*P. lolii*] was very prevalent in the aecidial stage on buckthorn (*Rhamnus cathartica*) in southern Saskatchewan in the early summer and was responsible for very heavy losses in the oat crops of southern Saskatchewan, Manitoba, and Ontario. Leaf rust of wheat (*Puccinia triticina*) was less prevalent than in 1921, while leaf rust of rye (*P. dispersa*) was common but not severe.

Bunt of wheat (*Tilletia tritici* and *T. levis*) was on the whole less prevalent and severe than loose smut (*Ustilago tritici*), except in Wentworth County, Ontario, where it caused most serious financial losses. Loose smut of oats (*Ustilago avenae*) was very bad in some parts of Ontario, and was general in New Brunswick and Prince Edward Island. Covered smut (*Ustilago laevis*) was not of much importance. Wheat scab (*Gibberella saubinetii*) was widespread in New Brunswick and Prince Edward Island. Glume spot (*Septoria nodorum*) has caused a severe reduction in the New Brunswick wheat crops since 1918, and no control measures have given promising results. Dawson's Golden Chaff is highly resistant to this disease. Crinkle joint of wheat, due to an unknown cause, and characterized by a kinking of the lower internodes of the stem, occurred in Alberta and Saskatchewan. Head blight and stem rot of wheat (*Helminthosporium sativum*) was common in Saskatchewan. Leaf spot or scald of barley (*Rhynchosporium secalis*) was reported at Edmonton, Alberta, for the first time in Canada in 1921, and again occurred in 1922. Other cereal diseases reported were of minor importance.

Powdery mildew (*Erysiphe polygoni*) was extremely widespread and severe on clover in Ontario, New Brunswick, and Prince Edward Island. Flax rust (*Melampsora lini*) caused considerable injury to the fibre qualities of plants at the Ottawa Central Experimental Farm, while wilt (*Fusarium lini*) was very prevalent in some parts of southern Saskatchewan. *Sclerotinia* wilt of sunflowers (probably *S. libertiana*) was severe and widespread in Quebec, and also caused the death of 45 per cent. of the plants grown for seed at the Central Experimental Farm, Ottawa. Rust (*Puccinia helianthi*) was very common on this crop, but did not generally do much harm.

Apple scab (*Venturia inaequalis*) was common everywhere except in British Columbia, but was well held in check by spraying. Fire blight (*Bacillus amylovorus*) of apples and pears was very serious in British Columbia and Ontario. Collar rot of apples (*Armillaria mellea*) was very severe in British Columbia, where it results in the loss of thousands of trees annually. Rust of currants (*Cronartium ribicola*) was recorded for the first time on Prince Edward Island in a plantation of black currants, where 90 per cent. of the leaves were infected. White pines [*Pinus strobus*] in the vicinity showed no signs of the disease.

Root rot of pears, due to various fungi, caused a loss amounting to $12,000 in one county of Ontario alone. Wilt and blight of canning peas, probably due in part to a species of *Fusarium*, also caused heavy losses. A rusty browning of asparagus tips, the cause of which is obscure, rendered much of the crop unmarketable in New Brunswick, Quebec, and Ontario.

Many other diseases besides those mentioned above are recorded on cereals, fodder, fruit, and vegetables, and the report terminates with a survey of the diseases of ornamental plants and of shade and forest trees.

NICHOLLS (H. M.). **Annual Report of the Government Microbiologist.**—*Agric. & Stock Dept., Tasmania, Rept. for 1920–21*, pp. 10–14, 2 pl., 1922.

In the section of the report devoted to the fungous diseases of plants it is stated that club-root of cabbage (*Plasmodiophora brassicae*), which occurs mainly on acid soils and is aggravated by the use of acid chemical fertilizers, appears to be on the increase in Tasmania, though it can be controlled by liming the soil. A similar organism has been found attacking the roots of hops in some parts of the island. The only previous record of the latter disease is from New Zealand, where it was described under the name of *Plasmodiophora humuli.* The roots of the plants decay and are finally destroyed, the hops becoming sickly and unproductive for some time before they die. The spores are spread by the water used for irrigation in the hop-gardens. *P. humuli* strongly resembles *P. brassicae,* and would probably yield to similar measures of control.

In October 1919 potato seed of the Brownell variety was heated to a temperature of 125° F. for four hours with the object of destroying various seed-borne diseases. The potatoes were then planted in an acre of new ground and twice sprayed with Bordeaux mixture 4–4–40, the first application being given when the plants were nine inches high, and the second when they were fully developed. Only a small proportion of the resulting yield was unfit for use ($2\frac{3}{4}$ out of 45 bags). The following year the potatoes from the experimental plot were planted in a paddock with untreated Brownell seed, to ascertain whether the effects of the heating would extend to a second generation. During the growing period there was a marked difference between the two lots of seed, the plants in the heated plot being recognizable a mile away by their regularity and vigour. The yield from the heated plot amounted to 5·019 tons per acre as compared with 3·585 tons per acre from the untreated controls. The adoption of the heating process as a regular feature of seed-farm routine is advocated. Estimating the average increase derived from heating at 1·5 tons of potatoes per acre, there would be an annual increase of 42,000 tons on the 1919–20 statistics. The heating process should supply an easy and inexpensive means of controlling Irish blight [*Phytophthora infestans*] which is readily destroyed by four hours' exposure to a temperature of 104° F. It may be calculated that one acre of heated seed will produce enough seed for ten acres, the average size of the crop on most Tasmanian farms.

THOMAS (P. H.). **Annual Report of the Assistant Fruit Expert.**—*Agric. & Stock Dept., Tasmania, Rept. for 1920–21*, pp. 18–19, 1922.

The results of spraying experiments on the Lord Wolsey variety of apple, which was severely attacked by powdery mildew (*Podosphaera oxyacanthae*), were very satisfactory, especially those carried out with atomic sulphur. Considerable improvement was also observed in the sections treated with iron sulphide. The application of a manurial spray consisting of caustic soda and nitrate of soda resulted in an increased yield.

WHETZEL (H. H.). **Report of the Pathologist for the period 10th June to 31st December 1921.**—*Repts. Board and Dept. of Agric. Bermuda, 1921*, pp. 30–64, 1922. [Received 1923.]

The loss from disease in Bermuda crops is stated to be probably higher than in most other countries, owing to a combination of various factors favouring the development of pathogenic organisms. Foremost among such factors is the continuous growing season, the rainy winters being particularly favourable to nearly all the disease-producing organisms. At a conservative estimate the annual loss in Bermuda crops from diseases and pests (chiefly the former) amounts to 50 per cent. In this report notes are given on the diseases and pests observed by the writer, during the time he spent in the island, to affect the more important crops, the latter being arranged in alphabetical order.

In avocado pears continuous defoliation caused by a species of *Oidium* resulted in an almost complete absence of fruit. Beans were attacked by anthracnose (*Colletotrichum lindemuthianum*), blight (*Bacterium phaseoli*), *Sclerotinia* rot (*S. libertiana*), powdery mildew (*Erysiphe polygoni*), and mosaic. Black rot (*Bacterium campestre*), frequently followed by soft rot (*Bacillus carotovorus*), occurred on cabbage, turnips, kohlrabi, kale, and other cruciferous plants. *Sclerotinia* rot was very destructive to cabbage. Celery was severely attacked by leaf blight (*Septoria petroselini* var. *apii*), black heart (believed to be due to an excessive use of fertilizers containing soda and kainit), and damping off (*Pythium* sp. ?). In lettuce heavy losses were caused by drop (*Sclerotinia libertiana*), which also attacked endive. A peculiar lettuce disease known as 'stunt', which has recently also attracted attention in the northern United States, was observed. The affected plants are stunted and produce only a few long, weak leaves, with a reddish or white discoloration according to the variety. The disease is caused by a species of *Pythium*, and can probably be controlled by disinfecting the soil of seed-beds. In Bermuda infection appears to occur in the seedlings before transplanting.

Lilies suffered severely from stump rot, due to a species of *Phytophthora*, which attacks the bulbs just as the shoots are beginning to come through the soil, or shortly after. The entire stalk may be destroyed, or only the growing tip may be killed, leaving a stump with a rosette of leaves. The fungus inhabits the soil, and spores produced on the surface are splashed by rain into the crowns of the plants. Spraying with Bordeaux mixture, dusting with copper-lime, or disinfecting the soil with formalin are recommended.

Pink root (*Fusarium malli*) is at present the only important disease of the Bermuda onion crop, though *Peronospora schleideni* is said to have caused considerable damage from time to time. In the papaw [*Carica papaya*] the yellow leaf disease (*Pucciniopsis caricae*) has been found to affect the development and ripening of the fruit and to cause premature defoliation. Powdery mildew, due to one of the Erysiphaceae, causes severe damage to papaw seedlings. It may be controlled by the application of a sulphur dust. The few peach trees left in the Colony are very susceptible to the rust *Tranzschelia punctata* [*Puccinia pruni-spinosae*], which causes continuous defoliation and prevents the setting of the fruit.

Potatoes are attacked by early and late blight (*Alternaria solani* and *Phytophthora infestans*), leaf roll, mosaic, scab caused by *Actinomyces chromogenus* [*A. scabies*], *Fusarium* stem end rot, and wilt (*F. oxysporum*). The writer states that the excellent system of seed potato field inspection and the complete control of imports of seed tubers maintained by the Bermuda Board of Agriculture probably gives the growers the best grade of seed potatoes, as far as disease is concerned, of any similar group of potato growers in the world.

Leaf blight (*Septoria lycopersici*) of tomatoes, which greatly reduces the size and numbers of the fruit, may be controlled by the frequent application of Bordeaux mixture with the addition of fish-oil soap (3 lb. per 50 gallons).

Notes on numerous other diseases observed by the writer are given.

WATERHOUSE (W. L.). **On the production in Australia of the aecidial stage of Puccinia graminis Pers.**—*Journ. & Proc. R. Soc. New South Wales*, lv, pp. 278–288, 1 pl., 1921 [1922].

The author gives a brief description of a set of experiments carried out in 1921 at the Sydney University, in which he succeeded in inoculating two plants of *Berberis vulgaris* with sporidia of *Puccinia graminis* obtained from Wales. Inoculation of the same two plants under similar conditions with viable teleutospores from Glen Innes, New South Wales, also gave positive results. Previous attempts to infect barberry in Australia appear to have failed, though McAlpine used germinating teleutospores. In both the author's cases, spermogonia and aecidia were produced, and aecidiospores from the latter, inoculated on wheat, produced typical uredosori. No marked difference was noticed in the aecidial stage produced by the Australian and British material. These results, although obtained in highly artificial conditions, show that *Puccinia graminis* on wheat in Australia has not lost its power of producing the aecidial stage on the barberry, as believed by various workers, and the author concludes that the cultivation of barberry should be discontinued in Australia, where no native species are known, though several introduced species are grown as ornamental shrubs.

HOWARD (A.), HOWARD (GABRIELLE L. C.), & RHAMAN KHAN (A.). **The Wheats of Bihar and Orissa.**—*Memoirs Dept. Agric. India*, Bot. Ser., xii, 1, 20 pp., 1922.

In this paper, dealing with 122 of the unit species (agricultural types) of wheat isolated by the authors since 1909 from the province of Bihar and Orissa, India, is included an account of their behaviour in regard to the three rusts which attack wheat at Pusa. These are, in the order of their appearance, brown rust (*Puccinia triticina*), yellow rust (*P. glumarum*), and black rust (*P. graminis*). All the types belong to common wheat (*Triticum vulgare*), and they can be grouped in twelve botanical varieties. In the same botanical variety, agricultural types occur which differ more in their degree of susceptibility to rust than in any other character. In several instances, two types almost identical in field characters exhibited great differences in resistance to brown rust. Some of the types, particularly those belonging to the new variety *nigricans*, are very resistant to all the three species of rust.

The bulk of the paper is a description of the characters of each of the 122 types, in which the authors have adopted Eriksson's numerical notation for the degree of rust resistance.

Salmon (E. S.) & Wormald (H.). **A safe method of preventing 'bunt' in Wheat.**—*Journ. Min. Agric.*, xxix, 8, pp. 722–728, 1922.

The authors, after calling attention to the prevalence of bunt in certain parts of England, give examples showing that the traditional method of treatment by steeping the seed grain in copper sulphate (10 per cent. is frequently used) may cause a reduction of 30 to 40 per cent. in the germination of the seed. The strongest solution (2·5 per cent.) that their experiments showed could be used without injury to germination does not satisfactorily control bunt, over 5 per cent. of the crop being bunted in some trials. They, therefore recommend that the copper sulphate treatment be abandoned.

The use of dilute solutions of formalin is strongly recommended. Tests with many strengths showed that 1 part formalin to 480 parts water (1 pint formalin to 60 galls. water) gives as good control as the 1 in 320 (1 pint to 40 galls.) usually recommended. At greater dilution than 1 in 480, formalin is less efficacious.

There is no injury to germination if the solution of 1 to 480 is used by sprinkling it over the seed wheat at the rate of one gallon to two bushels of seed, so that every grain is wetted but pools are not allowed to form under the heap of grain. The treated seed should be covered for four hours, not more, with sacks soaked in the formalin solution, and then spread out to dry in a thin layer on a dry clean floor, previously disinfected with formalin if it has been used for untreated wheat. The dried seed should be put in thoroughly disinfected sacks and sown as soon as possible.

Hopkins (E. F.). **Wheat scab.**—*Missouri Agric. Exper. Stat. Bull.* 197, p. 48, 1922.

In this Bulletin, which is the report of the Director for the year ending 30th June 1922, is included a note by E. F. Hopkins giving the results of further experiments on the effect of hydrogen-ion concentration on the wheat scab organism (*Gibberella saubinetii*) [see this *Review*, i, p. 340]. These showed that the greater the hydrogen-ion concentration the greater the number of conidia produced on potato agar plates. Seven of the fifty-one varieties of wheat tested for resistance to scab during the year were altogether free from the disease and five others showed only a trace of infection.

Kulkarni (G. S.). **The smut of Nachani or Ragi (Eleusine coracana Gaertn.).**—*Ann. of Appl. Biol.*, ix, 3 and 4, pp. 184–186, 2 figs., 1922.

In 1918 the writer observed a smut of Nachani (*Eleusine coracana*) in the Bombay Presidency, India. The smut sori develop only in some of the grains in the head, either singly or grouped in patches of varying size. They are round or occasionally elongated, and occur in the ovary, projecting beyond the glumes, and often exceeding the diameter of the normal grains by one to six times, being 3 to 8 mm. in diameter when round, and 4 to 15 mm. in length when elongated. When fresh they are green (or occasionally pinkish) in colour, but on drying they turn chocolate-brown or dirty black. On rupturing the membrane, to which the light colour is due, a deep brown to black, powdery spore mass is found. The dark brown spores are round, 6·6 to 12·1 μ in diameter, and with spiny walls. They germinate readily in nutrient media, forming a thick, hyaline, septate promycelium with freely budding, fusiform sporidia.

In order to determine whether the disease was seed-borne, a small quantity of Nachani grain was infected with the spores of the smut and divided into two lots, one of which was treated with 2 per cent. copper sulphate solution for ten minutes. Smut appeared on a few plants in the plot raised from infected seed, while in the treated plot all were free from the disease. The smut therefore appears to be carried by the seed and to be amenable to treatment with copper sulphate.

No smut of this host having previously been recorded, the name *Ustilago eleusinis* is proposed for the fungus, English and Latin diagnoses being given.

BURGER (O. F.) & GOMME (W.). **Black rot of Oranges.**—*Florida Agric. Exper. Stat. Press Bull.* 343, 2 pp., 1922.

Black rot of oranges (*Alternaria citri*) begins at the blossom end of the fruit, and causes premature ripening. Underneath the small brown spot on the rind at the blossom end, the tissues show a brown, later greenish to black discoloration, which may extend right through the fruit to the core. In advanced cases the spot at the blossom end expands and turns dark green or black, by which time the interior of the fruit is black and the cells beginning to break down. This condition exists in the field (where it often escapes detection), and also develops in transit.

The disease was first observed in 1902 on California navel oranges, and during 1922 it was reported to occur on the varieties Ruby Blood, Parson Brown, Pineapple, Jaffa, Tangerine, and Valencia. The writers found from 5 to 25 per cent. of infection in groves inspected in November 1922.

Infected fruit should be buried and late varieties, such as Valencia, should be sprayed with 3–3–50 Bordeaux mixture with oil, a coating of which at the blossom end acts as a preventive. The crops should be shipped as soon as they are ripe.

SAMUEL (G.). **On the control of the brown rot disease of Oranges.**—*Journ. Dept. Agric. S. Australia*, xxvi, 4, pp. 322–324, 1 fig., 1922.

During 1922 the brown rot disease [*Pythiacystis citrophthora*] caused considerable damage to oranges in the low-lying river districts of South Australia. The severity of the disease was probably largely due to the excessively heavy rainfall, and the resulting epidemic has probably served to spread the disease to places where it was unknown before.

Affected oranges, which usually drop prematurely, have a dull brownish, rotten patch on one side, which gradually spreads until the whole orange is a shrunken brown mass, with a characteristic sickly sweet odour. The skin remains comparatively firm. Oranges near the ground are more susceptible than those growing higher up. In storage, even the most minute patches gradually cause complete rotting, which may spread from the diseased oranges to those in contact with them.

The disease may be controlled by removing and burning or burying (with lime) all fallen oranges. The latter should not be thrown into the rivers, as the organism can live in water. The lower limbs of the trees should be pruned so that no foliage or fruit touches the ground, and the surface of the soil should be frequently cultivated during the spring and summer, especially under the trees. Irrigation can best be effected by means of trenches, which must afterwards be filled up in order to keep the surface of the soil dry. Spraying with Bordeaux mixture is a troublesome and expensive process, which should not be necessary if the above measures are carried out. It is absolutely essential that the soil be kept dry.

All oranges showing the slightest sign of brown rot should be discarded at picking time if possible, or in any case before packing. If the oranges require washing, copper sulphate (1 oz. in 60 galls.) should be added to the water.

CAMPANILE (GIULIA). **Ulteriori osservazioni sulla malattia delle frutta di Mandarino dovuta a Cytosporina citriperda Camp.** [Further notes on the disease of Mandarin Oranges due to *Cytosporina citriperda* Camp.]—*Le Staz. Sperim. Agrarie Ital.*, lv, 10–12, pp. 497–502, 2 figs., 1922.

This disease of mandarin oranges, first described by the author [see this *Review*, i, p. 426], has since been observed by Montemartini on material from Catania. According to this worker, the mycelium of *Cytosporina citriperda* penetrates the epicarp without leaving much trace, and reaches its full development only in the endocarp and in the membrane of the segments, where alone it finds favourable conditions. The depression and alteration of the overlying rind is regarded by him as a secondary phenomenon. The present author has found, however, that during certain stages of the disease a well-marked spot is formed without any corresponding growth of an internal stroma, while the mesocarp underneath the diseased area is invaded by the mycelium, which sends hyphae into the glandular cavities. This can, she thinks, only be interpreted as indicating that the alteration in the rind is not a secondary phenomenon in such cases, which, as already stated, include the first-formed spot. The later spots may be produced by an outward growth of the mycelium in the interior of the fruit. The first spot, in many cases the only external sign of the disease, is believed to represent the point of entry of the fungus.

Inoculation experiments showed that the disease can be caused by placing a small piece of stroma with pycnidia on the unwounded surface of fruit kept in a damp chamber. After fifteen days a red spot of about 4 mm. diameter became visible underneath the inoculum, and this rapidly increased to a size of 1 by $1\frac{1}{2}$ cm. On the spots the characteristic stroma developed and pycnidia were subsequently formed on the epicarp. In a variant of this experiment, where the moisture was provided by adding a drop of water to the inoculum daily, the first spot to appear was a little below the point of inoculation, but a normal spot afterwards developed underneath the inoculum. The former was evidently caused by spores washed down from the pycnidia.

A description of the cultural characters of the fungus is given. On mandarin juice agar development is very rapid and pycnidium formation starts after forty-eight hours. The pycnidia may be found full of spores before their walls are completely formed. In Petri dish cultures small, hemispherical pustules of a diameter of 2 mm. are formed after five days. They consist of masses of hyphae, and contain numerous pycnidia provided with well-developed black walls. The hyphae, olive-coloured at this stage, are generally swollen in the vicinity of the septa, and anastomoses are very frequent. During their growth the colonies become surrounded with a grey-green halo consisting of aerial hyphae possessing thin, whip-like, hyaline tips. After the formation of pycnidia the hyphae unite in massive cordons, which gradually increase in thickness and give the stroma its almost cartilaginous consistency. The usual mode of fructification is by means of pycnidia, but in certain circumstances endogenous, oval, slightly fuscous conidia, measuring 3·5 by 2·3 μ are formed, especially in the aerial hyphae. The germination of these has not been observed. Perithecia were not found. In material nearly a year old, some of the mandarin oranges had been transformed into a pseudosclerotial mass, while in others stromata were found only on the surface of the pulp, and the rest of the fruit was literally filled with a white, cottony mycelium which had taken the place of the dried pulp.

Bud-rot in Taveuni.—*Agric. Circ.* [Dept. of Agric., Fiji], iv, 4, p. 57, 1922.

In connexion with the coco-nut bud rot regulations [see this *Review*, i, p. 365], a tour of inspection of the coco-nut estates in Taveuni was made by Mr. M. A. Forsyth in June 1922.

In his report he stated that bud rot of coco-nuts had appeared throughout the island with more or less severity, most of the cases being found among comparatively young trees growing at some distance from the sea. Active measures are in progress to exterminate the disease, the danger of which is fully recognized by most of the European planters. Very little has been done, however, on the native-owned estates. Otherwise the health of the coco-nuts on the whole is described as very satisfactory, particularly as regards freedom from insect pests.

Speare (A. T.). **Natural control of the Citrus mealybug in Florida.**—*U.S. Dept. of Agric. Bull.* 1117, 18 pp., 1 pl., 2 figs., 1922.

The chief factor in the natural control of the citrus mealy bug (*Pseudococcus citri*) in Florida is stated to be unquestionably the fungus *Entomophthora fumosa* n. sp., first observed in 1920 at Orlando. It appears to be closely related to *Empusa lecanii*, which has been observed on *Coccus viridis*, a coffee pest in Java, but differs in the possession of resting spores and in the characters of the conidia. In some respects it also resembles *Emp. fresenii* and *Emp. lageniformis*, both aphid parasites. *Ent. fumosa* is regarded as being as effective a control agent as the brown-tail moth fungus *Emp. aulicae.*

The description of the fungus is as follows:—Conidia more or less fusiform, 16 to 28 by 8 to 10 μ, smoke-coloured, tapering rather abruptly towards the base and apex, occasionally elliptical. Apex sharply rounded, base or papilla weak but visible; conidiophores simple, smoke-coloured, slender, arising directly from spherical, yellowish, hyphal bodies. Secondary conidia elliptical, small, 4 by 8 μ, rather thick-walled, without papillae, arising on 1 to 5 slender, capillary-like conidiophores from each primary conidium. Resting spores (? zygospores) apparently arising from conjugation of hyphal bodies, spherical, opaquely black, 15 μ in diameter, provided with a hyaline protuberance or appendage. When crushed the black exospore cracks, revealing the internal, hyaline, spherical, thick-walled spore. Host attached to substratum by insertion of proboscis.

On *Pseudococcus citri* on *Citrus* spp., Florida; on *P. citri* on *Ficus* sp., Louisiana; on *Phenacoccus* sp. on *Hibiscus* sp., Louisiana.

The disease can be recognized at an early stage by the milky white liquid which emerges from the bodies of crushed insects. The so-called 'hyphal bodies' present in the liquid are spherical, thin-walled, and filled with a finely granular protoplasmic content. These bodies represent a vegetative stage of the fungus, and absorb their nourishment primarily from the blood, additional food, however, being furnished by the disintegration of other tissues. Their reproduction is effected by a budding-off process. At first the insect's blood-circulation is slightly impeded and at a later stage entirely inhibited. Finally the muscles and all other soft tissues are destroyed and the interior of the body solidly filled by the fungus.

The development of the conidia and resting spores, which are formed after the death of the insect, is described in detail, the former being the more common type of reproduction in Florida. Germination of the resting spores has not been observed.

The results of investigations carried out in 1921 at Winter Haven, where weekly collections of infested mealy bugs from grapefruit were made between 13th June and 8th August, showed that on the first date only 11 per cent. were destroyed, while in the last collection 94 per cent. succumbed. There was a marked rise in the percentage of mortality between 22nd and 29th June (18 to 64 per cent.).

The artificial control of citrus diseases in Florida by fungicides and the natural control of injurious citrus insects by entomogenous fungi are antagonistic. The results of experiments have shown that, with the possible exception of lime-sulphur, all the fungicides used (Bordeaux mixture, copper soap, barium tetrasulphide, &c.) prevented the development of *Ent. fumosa* and thus facilitated an unrestrained development of the mealy bug.

VOUKASSOVITCH (P.). **Observations sur la Cochylis et l'Eudémis faites à Monlon pendant l'hiver 1921-1922.** [Observations on *Cochylis* and *Eudemis* made at Monlon during the winter 1921-1922.]—*Rev. zool. agric. et app. (Bordeaux)*, xi, 4 and 5, pp. 61–66 and 74–78, 2 figs., 1922. [Abs. in *Rev. Appl. Entom.*, x, Ser. A, 12, p. 620, 1922].

During the observations made near Toulouse in the winter of 1921–1922, about 70 per cent. of the pupae of the vine moths [*Clysia ambiguella* and *Polychrosis botrana*] were found to be destroyed by the fungus *Spicaria farinosa* var. *verticilloides*, the dry weather probably weakening the resistance of the insects. The fungus was readily cultivated on glycerined potatoes in Roux tubes and in nutritive G.S.P. medium (1 per cent. peptone, 5 per cent. saccharose, 3 per cent. glucose, and 2 per cent. agar). At 22° to 24° [C.] the mycelium develops very rapidly, the first fructifications appearing after 72 hours. At lower temperatures development is slower and more irregular, and in such cases potatoes are a better medium.

Reddy (C. S.) & Brentzel (W. E.). **Investigations of heat canker of Flax.**—*U.S. Dept. of Agric. Bull.* 1120, 18 pp., 5 pl., 4 figs., 1922.

The present paper is a report on the results of an investigation started in 1916 by the United States Department of Agriculture, in co-operation with the North Dakota Agricultural Experiment Station, of a very destructive non-parasitic type of canker of flax in the semi-arid regions of western North Dakota and eastern Montana. Of the other known types of flax cankers, anthracnose canker caused by *Colletotrichum lini* Bolley [which the authors consider to be the same as *C. linicolum*, the new name given by Pethybridge and Lafferty because of the inadequate description of the former fungus] was found, during a survey held in 1920, to be widespread in the Michigan flax-growing districts; in a number of cases flax beyond the seedling stage was attacked, and in some instances as many as 60 per cent. of the plants showed girdling connected with anthracnose lesions. The indications are that this condition resulted from a combination of injuries caused by heat and parasitic fungi, and that the area affected is determined more by temperature with its resulting physiological effects on the cells than by moisture, oxygen, or light relations. Anthracnose canker seems to be rather rare in the United States during some years, and, when present, the damage caused by it is confined almost entirely to young seedlings.

The heat canker dealt with in this paper is non-parasitic in origin. It causes severe losses and occurs to about the same extent each year in the northern Great Plains area, in the latter half of June and the first half of July. The chief symptom is the destruction of the cortical tissues at or near the surface of the ground. Plants under three inches in height are usually rapidly killed; if the injury occurs later, when the plants are three to five inches high, the latter fall over but generally continue to live for some time, as their inner vascular system is not injured. Only in rare instances are plants over five inches in height injured in this way; numerous more mature specimens of heat-cankered flax can be found, but in such cases growth continues after the initial injury. Enlargement of the stem on the older plants occurs just above (sometimes also below) the point of injury, at which point most of the cankered stems are sooner or later severed either by the wind or by the action of saprophytes. Otherwise the plant dies when the starving roots can no longer support the needs of the aerial parts.

The evidence gathered from a number of field observations pointed to the possibility of the trouble being caused by excessive heat at soil level during the seedling stage. Field experiments, details of which are given, were therefore carried out in the period 1917–1921 in North Dakota, the results of which may be summarized as follows :—Heat canker developed mainly during or immediately following very hot, sunny days, the temperature on the surface of the soil reaching on some days 48° to 50° C. The young seedlings under four inches in height are the most susceptible, and susceptibility lessens with increasing maturity. Flax plants which have developed under hot, dry conditions are less susceptible than more succulent plants. Seedlings growing in a soil having a shallow surface mulch over a firm seed bed are less liable to be cankered than those in a soil with the surface compacted by rain, as the crust thus formed brings the overheated surface soil in immediate contact with the tender tissues of the succulent young flax stems. The incidence of canker was greatly reduced in plots where partial shading was secured either by sowing a thicker stand of flax or by cereal nurse crops or weeds growing among the seedlings, while no canker at all occurred in plants shaded by vertical strips of canvas ten inches high. A condition very similar to heat canker was artificially produced by chemical agents, such as concentrated sulphuric acid, and by heated wires looped around individual plants. Mention is also made of similar heat injuries to other plants observed and described by various authors.

Promising control measures are thicker and earlier sowing, while it is suggested that drilling the rows north and south instead of east and west may prove helpful in lessening the severity of this type of injury.

Jochems (S. C.) & Maas (J. G. J. A.). **Slijmziekte in de Hibiscus cannabinus op Sumatra's Oostkust.** [Slime disease of *Hibiscus cannabinus* on the east coast of Sumatra.]—*Teysmannia*, xxxii, 12, pp. 542–546, 1 fig., 1 diag., 1922.

Cases of slime disease (*Bacillus solanacearum*) having been reported from the newly established plantations of *Hibiscus cannabinus* on the east coast of Sumatra, a series of investigations on this disease was instituted in August 1922 at the Deli Experiment Station. The *Hibiscus* seedlings were planted on heavily infested soil, formerly occupied by tobacco and other susceptible plants such as *Phaseolus radiatus*, *Ipomoea batatas*, *Crotalaria striata*, and *Impatiens balsamina*. Three rows of healthy *Hibiscus* alternated with one row of healthy tobacco seedlings, the spacing of the plants being closer in the case of the former. Ten days after planting the *Hisbiscus* began to show signs of wilting, and at the end of twenty-five days 68 per cent. of the seedlings were dead. The tobacco plants were attacked by *Sclerotium rolfsii* and ? *Pythium*, as well as by *B. solanacearum*, but the *Hibiscus* did not suffer from any other disease but that caused by the latter.

According to Miss Westerdijk (*Meded. Deli Proefstat.*, x, p. 30, 1918) *H. cannabinus* is liable to be attacked by *S. rolfsii*, but this experiment indicates that it is, at any rate, highly resistant. After forty days, 84·7 per cent. of the *Hibiscus* plants were diseased as compared with 51·2 of the tobacco seedlings. Possibly the much closer planting of the *Hibiscus* may partially account for its greater susceptibility, infection spreading rapidly from the root systems of diseased plants to the adjacent healthy ones.

The first symptom of slime disease of *H. cannabinus* is the assumption of a horizontal position by the petioles, followed by drooping of the leaves. As a rule all the leaves of a plant droop at the same time. A further symptom generally noticeable the same day is the curling of the leaves along the midribs, with the concave sides uppermost. The next day the leaves are tightly furled and hang straight down; soon afterwards they are quite withered. Thus the whole course of the disease is much more rapid in *Hibiscus* than in tobacco.

Microscopic examination revealed no difference between the characters of the attack in *H. cannabinus* and those in other plants affected by slime disease. The causal organism was readily isolated and cultured on bouillon-peptone-agar, typical colonies of *B. solanacearum* being produced. *Hibiscus* and tobacco plants inoculated with two-day-old cultures from tobacco rapidly developed the symptoms of infection, and a few days later the causal organism was re-isolated. The discoloration of the stems was more noticeable in the tobacco plants on account of their greater transparency. All the inoculated plants died in from eight to fifteen days.

NISHIMURA (M.). **Studies in Plasmopara halstedii.**—*Journ. Coll. Agric. Hokkaido Imper. Univ.* (Sapporo, Japan), xi, 3, pp. 185–210, 6 pl. (1 col.), 7 figs., 1922.

In June 1918, the author observed that five sunflower (*Helianthus annuus*) plants in a plot containing about one hundred, at Columbia University in the United States, were infected by *Plasmopara halstedii*, a brief historical account of which is given in this paper. The diseased plants were stunted and showed well-marked light and dark green areas, which gradually spread from the region of the petiole all over the leaf, and were due to the spread of mycelium coming from the stem. Young leaves, when the chlorosis occurred along the main veins, usually became curled. An examination of the diseased plants at various stages of development showed that the fungus often originated in the underground portions and spread into the aerial parts. In *H. divaricatus*, on the other hand, infection takes place through the stomata and travels down the stem to the rhizome, where it apparently becomes perennial.

Seeds from infected sunflower plants gave a low percentage of germination but the seedlings did not show any signs of disease. Seeds sown in soil from diseased plots showed 70 per cent. of infection, the controls in healthy soil remaining unaffected. In another test, sunflower seedlings, planted in moist soil inoculated with the conidia of *P. halstedii*, became infected to the extent of 40 per cent., the control plants remaining healthy. Tests in which the soil was inoculated with zoospores immediately before sowing the seeds gave negative results.

Sunflower plants were naturally infected by *P. halstedii* in the same fields in 1918, 1919, and 1920 successively. In order to ascertain how the fungus overwintered, three lots of soil were inoculated respectively with conidia collected from the leaves, with mycelium which developed in young seedlings, and with oospores collected from the tissue of the host plants. The soil in all three cases was left exposed during the winter 1919–20, and sunflower seeds were sown in it in the following spring. Infection occurred only in the soil inoculated with oospores.

In the course of infection experiments it was observed that when active zoospores were brought into contact with a sunflower root in sterilized water, the zoospores came to rest on the root in one or two hours. Some produced germ-tubes of varying lengths which entered the roots and developed in the intercellular spaces. In some cases the infection occurred where the root hairs had broken off, but entry could also take place through the quite uninjured epidermis.

The mycelium was found in the intercellular spaces of all the tissues and, in young plants, even in the vessels. Diseased plants develop fewer secondary roots. In numerous instances conidia developed in the intercellular spaces of the spongy tissues, and in the substomatal cavities of the leaves; also in the root and stem tissues, especially following injury by insects or other agencies. In fresh material the oogonia and antheridia are found scattered through the root tissue. The former are large, globose bodies, 30 to 48 μ in diameter, the latter somewhat irregular in shape and 12 to 30 μ in diameter. Some of the short branches of the mycelium swell at the end and become filled with a dense mass of protoplasm. Oospores may also develop in the leaves and stem. Sunflower seedlings infected with *P. halstedii* late in April showed a number of oospores four to six weeks later, while in July and August the sexual stage is less common. The oospores are generally formed most readily when the vitality of the host has declined. The mature spores were often found just beneath the epidermis, the inner wall of which was ruptured by them.

The second part of the paper deals with a cytological investigation of the methods of fertilization and oospore formation.

WATERS (R.). **Apple flesh-collapse or brown-heart. Some recent investigational work.**—*New Zealand Journ. of Agric.*, xxv, 6, pp. 334–340, 1922.

Flesh-collapse, now known to be identical with the 'brown-heart' of apples shipped from Australia and Tasmania [see this *Review*, ii, p. 124], has been found to be much more prevalent among mature fruit and may be largely avoided by selecting greener apples for storage. This is, however, by no means the only factor to be considered, since in cases observed by the author 12 per cent. of even the least mature fruit were affected after five months' cool storage.

In 1922 flesh-collapse was first noted about the end of June, rather less than three months after the fruit was placed in cool storage, while in the two preceding years it was not observed until September. The experience of certain growers indicates that fruit held without cooling up to seven weeks after picking has subsequently stood cool storage conditions better than that stored immediately after gathering. The most difficult time to secure control of cool storage conditions is during the first few weeks, when some, at any rate, of the damage to the 1922 consignments occurred.

Natural conditions of temperature and humidity in the Nelson district admit of keeping Sturmer apples in suitable sheds until August or September, after which time the fruit becomes liable to shrivel on account of the lower relative humidity (averaging 82), while in the cool stores the humidity is more often near the saturation point. To be of practical value, cool storage during the period until August or September should more completely arrest the activities of the fruit than can be done in a shed; otherwise shed storage during this period would be just as good. The first essential in accomplishing this is a lower atmospheric temperature range, for the lower the temperature range in the apple-flesh (within limits) the slower is the progress of the metabolic processes in the fruit. It has been shown by statistics that the apple is extremely tolerant of fluctuating temperatures, which are averaged out by the fact that the flesh of the fruit heats and cools more slowly than the surrounding atmosphere. Thus the average of the mean monthly temperatures from May to September (47·8° F. at Nelson in 1920) will correspond closely with that of the apple-flesh temperature in the sheds. At this temperature the apples ripen more rapidly than would permit of long storage and the mean apple-flesh temperature in cool stores must therefore be kept considerably below 47·8° if it is desired to secure successful storage for seven or more months. The relative humidity must be over 82 in order to prevent shrivelling, and a minimum temperature of the atmosphere discharge from the cooling plant of 32° F., the plant being run for twelve hours, is well on the safe side.

Discussing the technical details of cool storage, the author points out that the only way to surmount the various difficulties that may arise in bringing down the temperature of the stored mass of fruit cases sufficiently quickly, removing the excess moisture, securing adequate ventilation, and the like, is to increase the rate of circulation of the air. The greater cooling and drying efficiency of the plant thus secured will reduce the necessary hours of running and leave an interval during which defrosting and ventilation can be safely performed. These measures are particularly necessary in the early part of the season, when flesh-collapse appears to be initiated.

The maintenance of very even temperatures, which is the usual policy in cool stores, appears in some cases to have led to increased humidity and a decreased efficiency of ventilation. In considering this question, attention must be paid to the temperature at three separate positions—in the flesh of the apples, in the atmosphere within the cases, and in the atmosphere of the storage chamber. The longer the working hours the nearer will these three temperatures be to one another, and the slower will be the diffusion between the atmosphere of the case and that of the chamber. A reduction in the number of working hours would result in greater differences between the temperature of the case-atmosphere and the chamber-atmosphere: hence there would be a quicker passage of the gaseous and vaporous apple by-products out into the chamber-atmosphere, where they become dispersed and are later disposed of by ventilation.

WILTSHIRE (S. P.). **Studies on the Apple canker fungus. II. Canker infection of Apple trees through scab wounds.**—*Ann. Appl. Biol.*, ix, 3 and 4, pp. 275–281, 1 pl., 1922.

Infection of the shoots by *Venturia inaequalis* occurs during the autumn and winter following their growth. In the spring most of these scab pustules are surrounded by a cork layer, and are subsequently completely cast off from the tree, leaving only a slight roughness of the bark.

This course of events, however, is sometimes disturbed by the invasion of the scab pustules by the canker fungus (*Nectria galligena* Bres.), which develops so rapidly that an area about 5 mm. in diameter is destroyed before phellogen formation can take place. In the early stages the canker area is usually somewhat sunken, there is no crack in the bark between healthy and diseased tissue, and the scab infection can often be identified in the centre of the scar. Subsequent phases of development are often characterized by the formation of well-defined cracks at the edge of the infected area and a slight swelling of the adjacent tissues. Unless the tree is sufficiently vigorous to form a cork layer round such a scar before the wood becomes infected, the fungus penetrates to the deeper tissues, in which case the scar resembles a normal canker produced by *N. galligena*. The occurrence of this type of infection, though less common than that of the leaf scar type previously described [see this *Review*, i, p. 106], is probably as prevalent as infection through woolly aphis galls.

Early in the autumn, when the scab pustules are still very small, microscopic examination frequently reveals the presence of *N. galligena* established on the stroma of the scab fungus, where it develops its characteristic conidial stage. It is somewhat difficult to distinguish between the mycelia of the two fungi, but, generally speaking, that of *Venturia inaequalis* appears dark and thick-walled, while that of *N. galligena* is hyaline and less robust.

As soon as the canker fungus has gained a firm hold on a scab pustule, the struggle with the tree then begins. The cork layer referred to above is often a sufficient barrier, since the canker fungus is not normally capable of penetrating cork, but it may not be developed quickly enough to confine *N. galligena* to the outside of the barrier. Furthermore, *V. inaequalis* is normally able to penetrate suberized tissue, especially at the edges of an infected region, and when this occurs the *Nectria* appears to follow the scab fungus, and subsequently outgrows the latter. In such cases, the *Nectria* hyphae grow inwards between the cells of the cortical tissue, gradually forming strands of mycelium, which are frequently found radiating from an infected scab pustule, and which are very characteristic of this type of infection. *N. galligena* also appears to secrete some enzymic substance, which is able to attack the cell walls of the cortical tissue in advance of its growth, the walls being partially disorganized. This substance may be a potent factor in overcoming the resistance of the host, for though previous experiments indicated that the enzymes cannot pass through a well-developed cork layer, such as is formed in the summer on growing trees, infection through superficial wounds in the winter months and on cut shoots, where cork formation may be imperfect, sometimes leads to penetration of the cortex.

Once the canker fungus has effected an entrance to the cortex it develops rapidly in all directions, especially along the intercellular spaces. The cells of the cortex in the neighbourhood divide rapidly, and the intercellular spaces become more or less obliterated. This new tissue soon becomes infected unless protected by a cork layer. The host persists in its efforts to form a wound cork layer, especially in the region between the sclerenchymatous bundles of the cortex, the growth stimulus sometimes being so strong that the tissues become ruptured. A strong cork layer is ultimately formed round the infected tissue, and later the concentric cracks in the canker scar which are typical of the disease develop. The stem sometimes becomes completely girdled, the whole of the shoot above being killed.

The usual practice of spraying against scab in the spring does not provide for the control of autumn infection as described above. Possibly winter spraying immediately after defoliation might prove effective.

CUNNINGHAM (G. H.). **Coral-spot, Nectria cinnabarina (Tode) Fries. A wound parasite of fruit-trees.**—*New Zealand Journ. of Agric.*, xxv, 6, pp. 354–359, 7 figs., 1922.

Coral spot (*Nectria cinnabarina*), the symptoms and life history of which are described and figured, caused considerable losses in Central Otago in 1919, when hundreds of fruit trees, especially apricots, were killed outright. In ordinary cases the effects of the fungus in any one orchard are generally slight, but it may cause quite a large reduction in output by destroying the fruiting branches, especially where the trees have previously been injured by frost or insects.

The following preventive measures are recommended: removal of dead wood from the trees, burning of all prunings and other rubbish, and trimming of all rough edges of wounds. Split branches should be bound up or excised, and deep, narrow crevices filled with grafting-wax or other suitable matrix. Gum-pockets should be cut out, and all exposed surfaces coated with coal-tar. All wounds should be painted annually until they are closed by callus.

LINE (J.). **The parasitism of Nectria cinnabarina (coral spot) with special reference to its action on Red Currant.**—*Trans. Brit. Mycol. Soc.*, viii, 1–2, pp. 22–28, 1 pl., 1922.

After a short reference to the previous work on *Nectria cinnabarina*, the 'coral spot' fungus, well known on many broad leaved trees and also on dead branches of red and black currant bushes in

England, the author describes the field observations and experiments made by him in an endeavour to establish (*a*) to what extent the fungus may be regarded as a parasite, particularly on the red currant; (*b*) its normal way of infection and method of growth in the host tissues; and (*c*) whether any differences in power of infection could be detected between different strains of the fungus.

Both direct observations in nature and inoculation experiments indicate that *Nectria cinnabarina* cannot establish itself directly in healthy, uninjured tissues, but that it can do so occasionally when introduced into a wound in certain woody plants, more readily in the case of the lime and horse-chestnut than in the case of the red currant. Its normal method of attacking the red currant is by spread through the wood cells, from a dead portion on which it has gained a footing, into the healthy wood. Infections made on artificially killed side shoots led to the development of stromata on these shoots in six weeks or more, and then—at least six months after inoculation—the fungus worked its way into the main stem and became established as a parasite. The harmful action of the fungus is primarily due to its growth in the xylem elements, which are blocked by the fungal hyphae, thus causing death of the living cells above the infected area on account of water shortage. No ill effects appear to be shown for some time by the leaves and flowers, even when the stem bearing them is almost completely blocked by the mycelium at a lower level; then they suddenly show signs of wilting. It is therefore thought improbable that any toxic substance is secreted by the fungus which can affect living cells in advance of the hyphae.

The red currant (which is much more frequently attacked than either the black currant or the gooseberry) is usually somewhat heavily pruned, and furnishes a number of dead spurs each year. These were observed to be the starting-points of the fungus in the great majority of cases. The time of the actual invasion of the main stem does not appear to be related to the time at which the first infection took place. Older bushes suffer more severely from the fungus than the younger and more vigorous bushes of the same variety, but the indications were that in most cases, the fungus had been growing for several years on the older bushes, before death of branches occurred on a large scale. No differences in power of infection or behaviour in culture were observed between strains of the fungus isolated from different sources. Further work is being done in collecting evidence as to the resistance of different varieties of the red currant to the fungus and as to the effect of soil conditions.

Cunningham (G. H.). **Leaf-rust, Puccinia pruni-spinosae Pers. Its appearance, cause, and control.**—*New Zealand Journ. of Agric.*, xxv, 5, pp. 271–277, 9 figs., 1922.

Leaf rust of stone fruit trees is common in New Zealand on the leaves of nectarines, peaches, and plums, less so on almonds and apricots, and rare on cherries. The aecidial stage of the causal organism, *Puccinia pruni-spinosae*, occurs in New Zealand only on the cultivated anemone.

The infection, which is more severe in wet seasons, first becomes noticeable on the leaves towards the end of December. Small yellow areas, in the centre of which are rusty-brown masses of uredospores, are formed on the under side of the leaf. Partial or total defoliation follows, and when infection persists for several seasons the trees become very susceptible to the attacks of silver blight [*Stereum purpureum*], brown rot [*Sclerotinia cinerea*], and other parasitic diseases. Small, circular, depressed spots are formed on the fruit, uredosori being visible in the reddish borders as maturity approaches. Diseased fruit is frequently so disfigured as to be unsaleable. Leaf rust forms small cankered areas on the shoots of certain peach varieties, the bark splitting longitudinally and the uredosori occupying the crevices.

The life history of *P. pruni-spinosae* is described. Teleutospores are stated to be comparatively rare in New Zealand, except on plums. In view of the limited distribution of anemones in the Dominion, the overwintering of the fungus is thought to be effected mainly by means of the uredospores.

In a note on the control of leaf rust, by J. A. Campbell, the following spraying schedule is recommended: (1) when the buds begin to swell, 5–4–50 Bordeaux or 1–15 lime-sulphur: (2) one month after petal-fall, 1–120 lime-sulphur; (3) when the fruits are half-grown, 1–120 lime-sulphur; (4) shortly before the fruits reach maturity, 1–120 lime-sulphur; (5) shortly after the fruit has been picked, 1–120 lime-sulphur. The final application may require repetition one or more times.

Deep ploughing and careful turning over of the soil to bury infected leaves are essential.

Pope (W. T.). **Avocado die-back.**—*Rept. Hawaii Agric. Exper. Stat., 1921,* p. 12, 1922.

Serious losses have been caused by die-back of avocados, which generally sets in about the time the young trees first come into bearing. The principal symptoms are the wilting, brown discoloration and final dying back of branches, yellowing of the leaves, lifeless appearance of the roots, and the frequent sudden death of trees when laden with fruit. The disease has also been reported to occur on Tahiti and other Pacific Islands.

Mild forms of die-back may be controlled to some extent by pruning out the dead parts of the top and applying plentiful quantities of thoroughly rotted farmyard manure and water to the roots. The disease is believed to be due to a variety of physiological causes, such as defective drainage, an excess of volcanic sand or a layer of rock, or an inadequate water supply. The principal losses occur during the dry summer weather.

Carleton (M. A.). **Note on the Fusarium wilt disease of Bananas.**—*Science,* N.S., lvi, 1,458, pp. 663–664, 1922.

Referring to Gäumann's paper on a vascular disease of the banana in the Dutch East Indies [see this *Review*, i, 7, p. 223], the author states that while working with the United Fruit Company in Panama he conducted an outdoor pot inoculation experiment on the same lines as that made by Brandes with *Fusarium cubense*

(*Phytopath.*, ix, 9, p. 339, 1919), except that the Gros Michel variety was used instead of the Chamalucco.

On 1st November 1921, the soil in fourteen pots was sterilized by means of steaming for two hours at 110° C. Six pots were neither sterilized nor inoculated. All the pots were planted with one 'bit' of a banana having two 'eyes', and seven of those sterilized were inoculated with *F. cubense.* The inoculum, which was a combination of two cultures, one in cornmeal decoction and the other in Uschinsky's solution, was applied in the proportion of about 1 litre per pot. By 1st April 1922 all the inoculated plants were diseased, most of them being severe cases. Up to 12th July following, when the writer left Panama, none of the plants in the uninoculated pots, sterilized or unsterilized, gave any indication of the disease.

This experiment, which has the added interest of being carried out in a different locality from that of Brandes, confirms the latter's conclusions that the destructive wilt or Panama disease is due to *F. cubense.*

Informazione. [Notes.]—*Boll. mensile R. Staz. Pat. veg.*, iii, 7–9, pp. 91–110, 1922.

In the '*Coltivatore*' of 30th August 1922, Ciferri describes a bacteriosis of olive twigs encountered in rather old and not very flourishing trees in the province of Macerata. The disease is marked by the withering and drying up of some of the young branches, in which the cambium is found disorganized and turned brown, the pith being also often partially disorganized. The disease, which is quite distinct from the olive knot [caused by *Bacterium savastanoi*], agrees with one described some ten years ago by Montemartini, who named the organism to which it was due *Bacterium olivae.* According to Ciferri this is a weak parasite, incapable of penetrating unwounded tissues, or rather a saprophyte which becomes parasitic when the host is in particularly unfavourable condition as, for instance, when it suffers from root disease.

Morettini (A.). **Influenza dei trattamenti cuprici sulla produttività del Frumento.** [The influence of the treatment with copper compounds on the productivity of Wheat.]—*Le Staz. Sperim. Agrarie Ital.*, lv, 7–9, pp. 264–277, 1922.

The author's experiments, which are described in detail, indicate that the treatment of seed grain of wheat with dry copper carbonate or dry Caffaro powder results in an increased yield even when no bunt [*Tilletia tritici*] is present. In his tests bunt-free seed was used, and the treatments applied were respectively immersion in water for 17 minutes, immersion in 0·5 per cent. copper sulphate for 15 minutes followed by dipping in a lime bath for two minutes, dusting with dry Caffaro powder used at the rate of 3 parts of the powder to 1,000 parts of grain, and dusting with dry copper carbonate in the same proportions. A fifth lot was sown untreated as a control. All the seed was kept for 12 days before sowing. No bunt appeared and the yield at harvest showed the highest figures for the copper carbonate treatment; Caffaro powder was next, then copper sulphate, water, and control in the order named. These results are explained by the fungicidal action of the copper compounds in preventing injury from the ordinary soil fungi or those carried in on the grain, this beneficial effect being counteracted in the case of the copper sulphate treatment by injury to the embryo of the seed. A contributory cause may be that the copper exercises a stimulatory action on the growth of the plant.

VAN DILLEN (L. R.) & GANDRUP (J.). **Een kleurmiddel voor desinfectantia bij de behandeling van streepjeskanker.** [A colouring matter for disinfectants used in the treatment of stripe canker.]—*Arch. voor Rubbercultuur*, vi, 1922. [Abs. in *Teysmannia*, XXXIII, xi, pp. 526–527, 1922.]

For several years there has been an increasing demand for an economical colouring matter for creoline, carbolineum plantarium, izal, and the other disinfectants used in prophylactic treatment for the control of stripe canker [*Phytophthora*] of *Hevea* rubber. Indigo has been used to some extent, but besides being very expensive it has the drawback of discolouring the manufactured rubber.

In the present paper fuchsine, which colours the painted surface a vivid red, is recommended. It causes no injury either to the appearance or internal qualities of the rubber, and being much more conspicuous than indigo or methylene blue, it affords an easy method of detecting the treated trees. It does not interfere in any way with the technical processes of rubber manufacture.

The writers used a Java preparation of fuchsine costing about 20 florins [about £1. 14*s*.] per kg. For use with izal a concentration of 0·5 per mille sufficed, while double that amount was required to produce a good colour with creoline and treble with carbolineum plantarium. The addition of fuchsine to a 5 per cent. solution of creoline or carbolineum plantarium, the cost of which is about 5 cents [100 cents = 1 florin] per litre, would involve an additional expenditure of 2 and 3 cents respectively.

RUTH (W. A.). **The effect of Bordeaux mixture upon the chlorophyll content of the primordial leaves of the common Bean, Phaseolus vulgaris L.**—*Amer. Journ. of Bot.*, ix, 10, pp. 535–550, 1922.

The fact that a number of plants show a distinctly greener colour after being sprayed with Bordeaux mixture suggests that spraying increases the chlorophyll content of the leaves. The experiments described in this paper were devised for the investigation of this phenomenon.

Bean plants were grown under very carefully controlled conditions in a greenhouse. The results were obtained from primordial leaves only, which were measured and weighed in the fresh condition and immediately dried in a rapid current of air at 45° to 50° C. The leaf areas were estimated by drawing the outline of the leaf on paper and weighing the enclosed portion. As soon as the leaves were crisp each lot was placed in a small tin box until its chlorophyll content was determined. The latter was accomplished by colorimetric comparison of acetone extracts with an extract standardized according to a method essentially the same as that of Willstätter and Stoll (Untersuch. über Chlorophyll, Methoden und Ergebnisse, Berlin, 1913).

Before determining the effect of spraying upon the chlorophyll content, the degree of variation in the chlorophyll content which took place as the plant grew was determined. Primordial leaves at four ages were used for this purpose. During the period before the cotyledons were shed, there was a marked increase in the amount of chlorophyll per sq. cm., and an even more marked increase per gram of fresh weight. From this period onwards, there was a decrease in the amount of chlorophyll to the sq. cm. and per gram of fresh weight, which was associated with an increase in the fresh weight of the leaf per sq. cm. and a lessened rate of increase in area. The necessity was recognized of comparing plants harvested only at the same stage of development.

The correlation between rapid growth and high chlorophyll content was determined also by cutting off the growing buds above the primordial leaves in order to increase the latter's growth. A greater chlorophyll content per sq. cm. was produced by this treatment as compared with controls.

To determine the effect of Bordeaux on growth in length, one half of the seedlings in each of five flats were sprayed as soon as the primordial leaves unfolded. It was found that the relation of the sprayed leaves to the unsprayed, 0, 2, 4, 8, and 14 days after spraying, was 103, 97, 96, 96, and 95 to 100.

The effect of Bordeaux on the development of chlorophyll was investigated by spraying one-half the plants in 3 flats as soon as the primordial leaves had unfolded, and one-half the plants in 3 other flats when the cotyledons were dropping, 4 days later. Three days after the latter spraying all the plants were harvested. The average of the areas of sprayed and unsprayed leaves per flat was 53·3 and 57·9 sq. cm. respectively and the chlorophyll content (mg. per sq. cm.) 0·00390 and 0·00361 respectively. The average chlorophyll content per leaf of the sprayed and the unsprayed leaves was practically the same.

The probable relations between photosynthesis and the increased chlorophyll content are discussed, especially with regard to published work on the subject, but experiments on this problem are reserved for further work.

A bibliography of 42 titles is appended.

Pichler (F.) & Wöber (A.). **Bestrahlungsversuche mit ultraviolettem Licht, Röntgenstrahlen und Radium zur Bekämpfung von Pflanzenkrankheiten.** [Radiation experiments with ultraviolet rays, X rays and radium for the control of plant diseases.]—*Centralbl. für Bakt.*, Abt. ii, lvii, 14–17, pp. 319–327, 1922.

Experiments in the control of bunt of wheat (*Tilletia tritici*), loose and covered smut of barley (*Ustilago nuda* and *U. hordei*), loose smut of oats (*U. avenae*), and maize smut (*U. zeae*), by means of exposure to ultra-violet rays and X rays proved very successful. Exposure of the dry spores to ultra-violet rays inhibited germination more completely than when the spores were placed in tap water, while germination was entirely suppressed when the spores were exposed for 30 minutes to these rays in 0·1 per cent. hydrochloric, sulphuric, or oxalic acid, or in 0·25 per cent. $NaHSO_4$, or 0·1 per cent. $KClO_3$, or in a combination of 0·1 per cent. H_2SO_4 + 0·1 per cent. $KClO_3$. The last mixture gave, on the whole, the best results. Both oxygen and copper salts were activated by ultra-violet rays, and showed enhanced fungicidal efficacy in the presence of the latter. The action of solutions of colouring matters, e.g. methylene blue or iodeosin, was also intensified by ultra-violet rays. In field tests winter wheat seed severely infected by *T. tritici* was exposed to ultra-violet rays in a solution of 0·1 per cent. $KClO_3$ + 0·1 per cent. H_2SO_4 for 20 minutes, with the result that the incidence of infection was reduced to 20 per cent. as against 62 per cent. in the untreated controls.

Excellent results were obtained by the use of X rays, which have the advantage over ultra-violet rays of penetrating the interior of the plant, and are therefore more likely to be of use in such cases as potato wart disease (*Chrysophlyctis endobiotica*) [*Synchytrium endobioticum*]. There was a slight retardation in germination when bean and barley seed was exposed to X rays, but this disappeared later on. As with the ultra-violet rays, treatment in the acid solution H_2SO_4 + $KClO_3$ produced the best results in tests made on bunt of wheat, loose smut of barley, and oat smut. Exposure for one hour caused a slight reduction in germination in the case of oats, but eliminated all the smuts, even that of barley which is ordinarily only controllable by the hot water treatment. Exposure in alkaline solutions was not nearly so successful.

Similar experiments with radium gave negative results.

JEWSON (SIBYL T.) & TATTERSFIELD (F.). **The infestation of fungus cultures by mites (its nature and control together with some remarks on the toxic properties of Pyridine).**—*Ann. of Appl. Biol.*, ix, 3 and 4, pp. 213–240, 3 figs., 1922.

The infestation of fungus cultures by mites, especially by *Aleurobius farinae* and *Tyroglyphus longior*, is a source of considerable annoyance in mycological laboratories. The authors' experiments showed that the mites can be controlled by exposing the cultures to the vapours of pyridine, an exact description of the method employed being given. In laboratory apparatus the pests can be eliminated by the application of strong ammonia. Pyridine is shown to have a slight toxic action on fungi, but in ordinary practice this may be disregarded.

Informazione. [Notes.]—*Boll. mensile R. Staz. Pat. veg.*, iii, 10–12, pp. 125–150, 1922.

Notices of the following papers of interest are contained in this number of the *Bollettino*.

Manzoni has published in the *Coltivatore* additional notes on the leaf curl ('incappucciamento') of *Trifolium pratense* [see this *Review* i, p. 419], in which he states that the bacterium isolated by him is evidently allied to one found in similar conditions by Baccarini and Bargagli-Petrucci in 1914 and described by them in the *Atti della R. Accad. dei Georgofili*. The differences between the two organisms are probably to be traced to the use of different culture media.

Vaglio in the *Italia vinicola ed agraria* discusses the respective merits of dry and wet fungicides for vines. In the author's comparative tests, sprayings with copper solutions have given the best results as regards both *Peronospora* [*Plasmopara viticola*] control and vegetative growth. The fungicidal dusts protected the grape clusters well, but did not act as satisfactorily on the leaves. Sprays are, therefore, recommended, wherever water is available, supplemented by sulphur and copper sulphate dustings for the better protection of the fruit clusters.

The Stazione Chimico-agraria, of Udine, gives in the *Rivista di Ampelografia* an account of experiments designed to control simultaneously the downy and powdery mildews [*Plasmopara viticola* and *Uncinula necator*] of the vine by the employment of fungicidal dusts. 'Cuprosolfol' has given results in this respect which are not inferior to those obtained with sprays, but particulars as to cost are wanting.

Ravaz, in the *Progrès agricole et viticole*, No. 45, recommends the following treatment in cases of partial 'apoplexy' of the vine, [caused by *Fomes igniarius*: see this *Review*, i, p. 417] when, as is not infrequently the case, only a branch is attacked. The latter is removed, and, if possible, all affected wood is cut out, after which a layer of tar is applied, or better still, all old and recent pruning wounds are treated with an arsenical mixture. The following, devised by Gauthier, is recommended: arsenious acid 15 kg., carbonate of soda 15 kg., soap 15 kg., water 65 litres. The carbonate of soda is dissolved in the quantity of water indicated, which is first warmed, and then the arsenic powder is added to the still warm mixture which must be stirred with a wooden implement. Finally, the soap is added. The latter is not strictly necessary, and where arsenious acid is not available this can be replaced by arsenite or arsenate of sodium. The mixture has to be diluted with 10 to 12 times its volume of water before use.

Rayner (M. C.). **Mycorrhiza in Ericaceae.**—*Trans. Brit. Mycol. Soc.*, viii, 1–2, pp. 61–66, 1922.

In the present critical review of H. Christoph's paper on the mycotrophic relations of the Ericales [see this *Review*, i, p. 129], the author deals only with the part of her work concerning seedlings of *Calluna vulgaris*, reserving the part relating to the behaviour of cuttings pending the results of further experiments. She maintains her conclusions that under the experimental conditions described in her earlier paper [*Ann. of Botany*, xxix, pp. 97–133, 1915] the development of *Calluna* seedlings is dependent on infection by the mycorrhizal fungus and that such infection takes place regularly from the testa of the seed at, or subsequent to, germination. With regard to the results obtained by Christoph, where unsterilized seeds sown on sterile peat produced, after six months, seedlings in all cases free from fungous infection, with roots as vigorous as those of infected controls, the author points out that until her claim that seed coat infection occurs has been disproved, all seedlings raised from unsterilized seed should be assumed to be liable to infection at germination. It is not always easy to observe infection in the clean roots of seedlings, and in the absence of opportunity to examine the material it is only possible to suppose that the presence of mycelium in the roots has been overlooked by Christoph. The same criticism applies to his results obtained when sterilized seeds were sown on sterilized soil, since no proof is given that the seeds were really sterile. Similarly in the experiments in which sterilized seeds were sown on unsterilized soil, no controls were sown on sterile media and no proof of any kind is offered that the seeds were adequately sterilized. If the soil used was from a *Calluna* station, infection could obviously take place from such soil.

Further criticisms apply to Christoph's failure to maintain his cultures of sterilized seeds on sterilized soil under aseptic conditions, as shown by a quotation from his paper mentioning the presence in his cultures of mixed infection with species of *Mucor* and *Citromyces*. Neither does the author consider Christoph to have given satisfactory proof of the identity of the fungus isolated by him from *Calluna* roots with the endophyte; so far as it is possible to judge from his description of morphological characters, the right organism was isolated, but the positive proof of identity can only be supplied by inoculating into a pure culture seedling, growing under controlled conditions, and observing the subsequent production of mycorrhiza.

Another explanation of the discordant experimental results recorded by Christoph may be found in the possibility of the presence, in the sterilized peat used in his cultures, of an organic substance capable of replacing the stimulus to development of the seedling normally provided by the endophytic fungus, and this question is now being fully investigated.

PEROTTI (R.) & CORTINI-COMANDUCCI (I.). **Normale presenza di batteri nelle radici di numerose Fanerogame.** [The normal presence of bacteria in roots of numerous Phanerogams.]—*Rend. Acc. Lincei*, xxxi, ser. 5 a, 2 sem., 10, pp. 484–487, 1922.

In the roots of 75 per cent. of the normally developed phanerogamic plants examined by the authors, belonging to various non-leguminous families which have up to now been considered autotrophic, bacteria are found in such numbers that their presence cannot be regarded as accidental. These organisms are distributed throughout the cortex, and in some cases penetrate to the outer zone of the bast, where they are found in the intercellular spaces. At times their presence inside the cells has been detected.

Although it is not contended that these bacteria are necessary for the development of the plant, their presence is not only not harmful, but the state of growth of some specimens examined leads to the belief that it is of advantage to the plant.

The methods of investigation are briefly described, and a list of the plants examined is given. The organisms found in *Diplotaxis erucoides* and *Calendula officinalis* belong to several forms or strains, generally oligonitrophilous, possessing characters which might prove of value to the plants, whether green or not green, with which they live in symbiosis.

SURCOUF (J. M. R.). **Recherches sur la biologie du Phœnix dactylifera. Etude sur la culture, les maladies et les parasites du Palmier Dattier en Algérie (suite).** [Investigations into the biology of *Phoenix dactylifera*. Notes on the cultivation, the diseases and parasites of the Date Palm in Algeria (contd.).]—*Bull. Soc. Hist. Nat. Afrique du Nord*, xiii, 9, pp. 293–312, 1922.

This is an account of the cultivation of date palms in Algeria. In the section devoted to pests and diseases it is stated that 'baïoud' or 'white', a serious disease originating in Tafilalet, has caused some damage in the Figuig district [see this *Review*, i, p. 18]. Palms affected with this trouble die rapidly, and the interior tissues are found in a putrescent condition. According to investigations carried out by the Pasteur Institute at Algiers and by Maire, the disease is spread by the irrigation water.

Another rapidly fatal disease was found to affect trees at Ain-Srouna, in the Oued Rhirh. Nineteen young palms succumbed in the space of a few days; their sap was decomposed and had a strong vinous odour. Numerous saprophagous insects were found inside the palms, but none of them was responsible for the disease, which came on while the trees were in full vigour and while their roots were still actively functioning.

A disease, which affects the fruit only and is called by the natives 'n'faroun', was observed by the author at Tolga and particularly in the Oued Rhirh. It occurs towards September and is characterized by a marked browning of the dates, which become dull and are finally covered with a whitish, pollen-like substance. This modification is brought about by the drying of the epidermis, which is raised in places, and may become flaky. The dates become covered with spores and the ripening process is retarded, the fruit drying up without acquiring the sweet flavour associated with normal dates at maturity. The disease affects frequently a whole garden, or even a palm grove, but the author has only observed it on the 'Deglet Nour' variety, not on 'Ghars', which ripens earlier.

BROWN (W.). **Experiments on the growth of fungi on culture media.**—*Ann. of Botany*, xxxvii, 145, pp. 105–129, 7 figs., 1923.

This paper deals with the so-called 'staling' of fungal cultures. By 'stale culture' is understood one which has ceased, or practically ceased growing; a 'stale medium' is a medium which, through the growth in it of an organism, has been made useless, or nearly so, for further growth of the same or other organism. By 'staling substances or products' are meant those metabolic products of the organism which are responsible for slowing down or stopping its growth.

The general method of experimenting was based on observations of the rate of growth of colonies in Petri dishes, and was in general similar to that more fully described in an earlier paper [see this *Review*, ii, p. 24]. As a rule, the rate of spread of a fungal colony increases to a maximum, then remains steady or slows down. The higher the temperature, the sooner the maximum growth rate is reached, at least in the case of some of the fungi tested. Fungi which show no appreciable decline from the maximum are described as being of the non-staling type, while those in which the rate of growth falls subsequently are described as being of the staling type. Periodical measurement of the diameter of the colony enables these variations to be followed, the results being shown in graphs. The fungi used were mainly *Sphaeropsis malorum* and a species of *Fusarium*, both of which show well-defined staling phenomena.

The amount of staling shown by a particular organism varies with the medium employed (being absent, for instance, when Richards's solution with agar was used) and is dependent upon the amount of the particular medium present. In certain cases it can be modified by slightly altering the conditions under which the experiment is carried out. Thus a greater amount of staling was shown by *S. malorum* when grown on potato agar in closed Petri dishes, than when it was grown on the same medium in open Petri dishes placed in large 5-litre containers, the difference being produced by variations in the conditions of gaseous exchange in the two cases. The same results are obtained with the *Fusarium*, but they are less marked as a rule. The reason of this behaviour was shown to be, not the influence of the oxygen contained in the atmospheric column present in the case of the open dishes, but the action of gaseous or volatile products of the metabolism of the fungus, which in this case were found to be carbon dioxide and ammonia. According to the extent to which these products accumulate or are disposed of, the amount of staling varies. When ammonia is in excess, the result is the accumulation of ammonium carbonate and free ammonia in the medium, and this is a more actively staling combination than the ammonium bicarbonate that forms when carbon dioxide is in excess.

Two main lines of experiment are described. The first consisted of exposing plates of fresh medium to the gases given off by fungal cultures, after which the exposed plates were tested for staleness by inoculating them with various fungi. The other method was to grow fungal colonies in atmospheres which were controlled in respect of their carbon dioxide ammonia content. In the first case a batch of plates containing the same depth of the same medium was inoculated with the fungus to be tested. When these cultures had reached a certain age, a second batch of plates of the same size, but without inoculation, was inverted over each culture of the first batch, the lids being removed. After one or two days' exposure, all the plates of the second batch were removed and inoculated with the same or another fungus and the growth in a given time, usually two days, determined. The results showed that a considerable amount of staling takes place in the medium in exposed plates, but this effect soon disappears if the plates are left for some time with the lids off before inoculation. Deep plates of medium are more slowly staled than shallow plates of the same medium.

In the second series of experiments, the amounts of ammonia generated in *Sphaeropsis* cultures on a number of media were determined, and experiments were carried out to show how far the ammonia given off by a fungus is responsible for slowing down the growth of the fungus itself, and what part the carbon dioxide of respiration takes in the staling process. The results indicate that the growth of *Sphaeropsis* (on a medium from which ammonia is evolved) is improved (*a*) by any treatment which causes dilution of the ammonia or its removal; (*b*) by allowing the accumulation (within limits) of the carbon dioxide of respiration. Over soda, which keeps the carbon dioxide concentration down to practically zero, growth is least: over water, where under the experimental conditions a concentration of about 2 per cent. carbon dioxide may be reached, intermediate growth occurs, while it is best of all in 5 per cent. carbon dioxide. The last statement applies equally well to *Fusarium*, but statement (*a*) to a less degree. The products of fungal growth either diffuse outwards beyond the limits of the growing margin or, as in the case of ammonia, pass into the atmosphere of the culture and from there are re-absorbed by the medium; as a result the portion of the medium on which the growing margin is advancing becomes daily less suitable for fungal growth and staling of the margin begins.

Ammonia is not the only factor, or even the only alkaline factor, responsible for staling. The formation of fixed alkali is more marked in the case of *Fusarium* than of *Sphaeropsis*. With the latter fungus, diminutions of the ammonia factor brought about improved growth to a larger extent than with *Fusarium*, where removal of ammonia had to be accompanied by the raising of the carbon dioxide concentration in the atmosphere of the colony to produce a distinct effect on growth. In *Sphaeropsis* the volatile alkali is the more effective staling substance, whereas in *Fusarium* the converse is the case.

The fact referred to in the earlier paper [see this *Review*, ii, p. 25], that certain organisms show more growth after a time in a moderate concentration of carbon dioxide than in air, is correlated with the production by them of an alkaline staling reaction in the medium. In such cases carbon dioxide, which at the concentrations employed (10 to 20 per cent.) must be regarded as normally a retarder of growth, produces the opposite effect because of its neutralizing action on the staling products.

A correlation between staling and sporulation, and between staling and the conditions governing intermingling of fungal colonies, was obtained. The failure of two expanding colonies to unite, so often observed in plate cultures, is interpreted as being due to a concentration of staling products in the intervening zone of the medium. The relation of staling to sporulation is considered to be probably very complex.

FUNKE (G. L.). **Researches on the formation of diastase by Aspergillus niger van Tieghem.**—*Rec. trav. botan. néerl.*, xix, pp. 219–275, 14 graphs, 1922.

This paper contains details of an elaborate series of investigations on the production of diastase by *Aspergillus niger*, especially on the amount produced at different intervals of time and the influence of the medium on enzyme formation.

In determining these points the importance of ascertaining the optimum hydrogen-ion concentration is emphasized. With *A. niger* the optimum range is wide (about P_H 5·8 to 3·8), and the organism itself produces sufficient acidity in the standard cultures used to ensure the necessary concentration. The origin of the conidia used for making the test cultures is also important, marked differences in the amount of diastase formed, and other characters appearing when conidia from cultures grown on different media were used. The author recommends the use of conidia grown for two generations on a medium of the same composition as the test cultures.

The results of the tests showed that *A. niger* produces large quantities of diastase when cultivated on a standard mineral nutrient solution with the addition of starch, glucose, or maltose, from about two or three days after inoculation, until a certain maximum amount has been produced, after which no more is secreted during the remaining lifetime of the fungus. The amount produced does not vary according as starch or glucose is present in the culture medium, and though the substitution of maltose delayed the production of diastase, the ultimate total produced was probably the same. The concentration of these substances used is also without apparent effect on the total production of amylase, though higher concentrations than 1 per cent. caused temporary disturbances in enzyme formation, due apparently to the production of substances which inhibit the action of the enzyme. These substances, however, disappear during the course of development, and are without influence on the total amylase ultimately produced.

The diastase formed by *A. niger* is secreted into the culture medium as soon as it is produced, and it may be kept for a long period without losing strength.

The substitution of saccharose for the other carbohydrates mentioned above resulted in a great decrease in amylase production, except when very low concentrations (e.g. 1 per cent.) were used. In the latter case the amount was almost as great eventually as with 1 per cent. glucose, but amylase formation did not become considerable until all the saccharose was hydrolysed, and the invert sugar assimilated. Grown on 5 per cent. glycerine, the fungus produced no diastase. On lactose there was no growth, as *A. niger* seems to be unable to form lactase.

PRIESTLEY (J. H.). **The toxic action of traces of coal gas upon plants.**—*Ann. of Appl. Biol.*, ix, 2, pp. 146–155, 1922.

The very deleterious effects upon vegetation produced under certain conditions by small quantities of unburnt coal gas are obviously of considerable economic importance. While in Germany and in the United States these effects have frequently been under investigation, they have received less attention in Britain, possibly owing to the general differences in composition between the illuminating gases employed, but a change in the general methods of coal carbonization could at any time so alter the average composition of British coal gas that the subject might become important to horticulture.

The literature contains clear evidence that the poisoning effect of traces of illuminating gas on plants is due to the presence of gaseous, unsaturated hydrocarbons. It has been found that a concentration of one part of ethylene in ten million of air is toxic to the etiolated epicotyl of a pea, retarding its growth, whilst a concentration of four parts in ten million will produce retardation of growth, increase of girth, and a diageotropic curvature. The effects of gas on superficial corky tissues have been frequently noted, proliferation of lenticel tissue and other abnormalities being produced. The proportion of unsaturated hydrocarbons present in illuminating gas in Germany is very high, and in America, where water gas is the illuminant, it is also usually higher than in Britain, but even with the illuminating gas at Leeds, where the observations were made, which contains a relatively small concentration of ethylene (about 2 per cent.), it is very easy to obtain the full effect on etiolated seedlings grown in a laboratory where gas is frequently used, and experimentally it can be induced without any difficulty.

In many plants grown under etiolation conditions, the stem contains a well-marked functional primary endodermis (composed of an unbroken cylinder of cells in which the Casparian strip forms a continuous network in the substance of both transverse and longitudinal radial walls) from the base of the stem to just behind the growing apex. On the stem of the same plant grown in the light such an endodermis is only present for a very short distance above the ground level. The formation of this structure is prevented, when unsaturated hydrocarbons are present, by the inhibition of the normal accumulations of unsaturated fatty acids in the region of the future Casparian strip. This accounts for the sensitiveness of the etiolated epicotyl and the insensitiveness of the normal stem in the same plant, where no functional endodermis is present. It also explains the poisonous effect of traces of the gas upon roots of higher plants, where a primary endodermis is always present in the growing region. In the case of cork tissues the suggestion is made that the gaseous, unsaturated hydrocarbons arrest the normal deposit of fatty acids in the membrane of the cork cells. The practical significance of these observations lies in the fact that they afford a means of searching for definite diagnostic features when plant injury is suspected to be due to gas poisoning.

Division of Botany, Department of Agriculture [Canada]. Survey of the prevalence of plant diseases in the Dominion of Canada, 1922. Potato disease section.—*Third Ann. Rept.*, pp. 64–183, 1923. [Mimeographed.]

In the arrangement of data collected on the prevalence of potato diseases, each province is separately dealt with, notes of a general nature and a report from the Potato Certification Service being furnished in every case except that of British Columbia, in which the tabulated results are supplied by the Provincial Department of Agriculture.

An examination of the tables shows that in British Columbia the highest percentage of infection was due to blackleg (*Bacillus solanisaprus*) [*B. atrosepticus*], followed by mosaic and leaf roll. In Alberta and Saskatchewan blackleg and mosaic were also very prevalent, wilts (*Fusarium oxysporum* and *Verticillium albo-atrum*) also causing severe losses in the former province. Leaf roll was responsible for the majority of rejected fields in Manitoba, followed by mosaic and blackleg, while in northern Ontario the highest percentage of disease was caused by mosaic, and in southern Ontario by leaf roll. Mosaic was the most prevalent disease in Quebec, New Brunswick, and Prince Edward Island, and leaf roll in Nova Scotia.

Mann (H. H.) & Nagpurkar (S. D.). **Further investigations of the Fusarium blights of Potatoes in Western India.**—*Agric. Journ. India*, xvii, 6, pp. 567–576, 1922.

The investigations reported in this paper extend the results already published [see this *Review*, i, p. 357]. In stored potatoes the *Fusarium* disease, which is one of the most serious potato storage diseases in India, either completely destroys a large proportion of the tubers by a dry rot, or may not be obvious externally during the whole period of storage, and only shows when the potato is cut open, as a brown ring rather like that which is found in the bacterial ring disease of India [*Bacillus solanacearum*]. From the latter it can, however, easily be distinguished by certain characters which are detailed. It is not yet certain that the two forms of *Fusarium* injury described are caused by a single species. Besides the storage rot, a *Fusarium* wilt also occurs in the field, but its etiological relation to the rots is not known.

Contrary to the usual statements regarding this class of disease, the soil was not found to be the chief agent in causing the wilt disease, the use of previously infected seed proving to be the main cause. Infection through the soil is less frequent, probably because, as was found in a series of field experiments, the fungus remains infective in the soil for only between nine and twelve months. Infection by using an infected knife for cutting the setts, or by watering the soil with a suspension of crushed infected tubers, appeared to be much more difficult to secure. Tubers from a crop infected with wilt are very subject to rot on storage. The experiments on the storage rot would seem to indicate that the disease rarely, if ever, passes from one tuber to another, even if they are cut, while a large proportion of tubers attacked by the caterpillar of the potato moth (*Phthorimaea operculella*) became infected when placed in contact with tubers attacked with the dry rot form; this emphasizes the necessity of fumigating all potatoes ntended for seed before they are stored. The opinion held by growers that potatoes affected with *Fusarium* dry rot germinate more quickly than others was confirmed.

The effect of using *Fusarium*-infected seed is not always obvious at the time of harvest, and it is only when the potatoes are stored that the full effect is seen. Early harvesting is advisable in the case of potatoes known to be affected with *Fusarium*, as the loss in storage increases rapidly if the plants are allowed to ripen in the field. A high temperature considerably increases the rapidity of *Fusarium* attack, both on the growing plants in the field, rendering impossible the cultivation of potatoes in the Deccan during the hotter part of the year, and on the stored tubers. Hence if infection is present in the seed, as it almost always is, or in the soil, the choice of a cool season of the year for growing the crop, or a lowering of the temperature in the store, will considerably reduce the damage done by these fungi.

The authors believe that an effective control of the disease can only be attained by the development of pedigree strains of potato free from *Fusarium* infection.

CRÉPIN (C.). **Une maladie grave de la Pomme de terre dans le Forez.** [A serious Potato disease in the Forez district.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 237–243, 2 figs., 1922.

The observations on potato 'dartrose' (*Vermicularia varians*) recorded in this paper have already been fully noticed [see this *Review*, ii, p. 27]. Different stages of the so-called 'flaccid leaf roll', which appears to be one of its most marked symptoms, are figured.

FOËX (E.). **La dartrose de la Pomme de terre en 1922.** [Potato 'dartrose' in 1922.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 244–250, 1922.

The author summarizes the information obtained at the Station de Pathologie Végétale in Paris regarding the outbreak of this disease in France in 1922. The more important points have already been noticed [see this *Review*, ii, p. 173]. None of the specimens examined bore typical fructifications of *Vermicularia varians*, but the author believes that this fungus was the cause of the disease.

TISDALE (W. T.) **Seedling blight and stack-burn of Rice and the hot-water seed treatment.**—*U.S. Dept. of Agric. Bull.* 1116, 11 pp., 6 pl., 2 figs., 1922.

In the southern parts of the United States heavy annual losses in the rice crop are caused by the staining and decay of the grain in the shock and in storage, and by poor germination of the seed. The staining, which is also known as 'stack-burn' and 'flecking', resembles the trouble familiar to the European rice trade as 'yellow grains', the latter, however, being caused by a different fungus (*Protoascus colorans*). During the author's investigations of rice diseases conducted at Crowley, Louisiana, from 1919 to 1921, he found that stack-burn seed injury was associated with a leaf spot and seedling blight of rice. The leaf spot is caused by the small sclerotial fungus mentioned by Godfrey, who found it to be the cause of a seedling blight (*Phytopath.*, vi, p. 97, 1916, & x, p. 242, 1920). The present investigations show that the much more important staining and decay of rice after harvest is due to this fungus and to certain other forms which are mentioned. Amongst the latter are two of the common rice parasites, *Helminthosporium* and *Piricularia*, besides several ordinarily saprophytic species of *Epicoccum*, *Penicillium*, *Aspergillus*, and *Fusarium*.

The development of the disease is favoured by the humid atmosphere and high temperatures of the South, and also by storage of the rice in damp places or transport in warm, damp cars for considerable distances. The spores of the fungi mentioned above probably lodge between the glumes at flowering time and the infection spreads if the rice remains stacked under warm, moist conditions. The sclerotial fungus, which has no spores so far as is known, forms sclerotia in the glumes and on the surface of the kernels, the latter becoming either shrivelled and brittle or, under very humid conditions, much enlarged, irregular in shape, and black in colour. In the presence of the other fungi mentioned, the kernels have brown flecks and the decayed tissue is of a uniform brownish colour. Dark bands of sclerotial tissue may be seen on kernels infected with the sclerotial fungus.

On the whole, the drier and cooler climate of California is not conducive to the development of the injury described above, but a particular type of kernel flecking, apparently due to a species of *Alternaria*, occurs there. An *Alternaria* was also found to be constantly associated with a leaf spot of seedlings in Louisiana, and an *Alternaria* leaf spot of black Italian rice and of C.I. No. 1564 has been found near Los Angeles but the fungus was not definitely identified with the form on the flecked kernels.

Experiments in seed treatment showed that surface sterilization was of no value in checking seed injury. The best method was found to be immersion of the seed in hot water (54° C.) for 15 minutes, preceded by pre-soaking in tepid water for about 16 hours. Honduras rice, a good commercial variety but very susceptible to attack by internal seed fungi, was used in these tests. Seed from California germinated better than that of the Louisiana varieties, the internal fungi prevalent in the latter State being believed to be responsible for the difference. Hot water prevents the further development of the fungi in the seed, provided the latter is sown in clean soil. This form of treatment, however, is thought to be too laborious and expensive for general adoption, and it is hoped that some process may be devised of drying under temperatures that would kill the fungi and not injure the grain. The most promising solution of the difficulty, however, appears to lie in the eventual development of resistant strains and varieties.

STELL (F.). **Some common diseases of kitchen garden crops.**—*Proc. Agric. Soc. Trinidad and Tobago*, xxii, 11, pp. 779–785, 1922.

A brief popular account is given of the causes and symptoms of various diseases of vegetable crops likely to be met with in kitchen gardens, together with elementary directions for their control. The following diseases are discussed:—damping off of seedlings, cabbage yellows caused by *Fusarium* [*conglutinans*], blight of cabbage, beans, tomatoes, &c., caused by species of *Rhizoctonia*, soft rot of cabbage [*Bacillus carotovorus*], downy mildew (*Peronospora* [*parasitica*]) and powdery mildew (*Erysiphe* sp.) of cabbage, black leaf spot of cabbage caused by *Alternaria* [*brassicae*], anthracnose of beans [*Colletotrichum lindemuthianum*], leaf mould disease of tomatoes (*Cladosporium fulvum*), and blossom-end rot of tomatoes.

Polizeiverordnung zur Bekämpfung des Kartoffelkrebses. [Police regulations for combating Potato wart disease.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 12, pp. 102–104, 1922.

This new potato wart disease order, issued by the Minister of Agriculture on 27th September 1922, is an amendment of that dating from 18th February 1918, and applies to the entire State of Prussia.

Potato fields and stored potatoes are liable to inspection, with a view to the control of wart disease [*Synchytrium endobioticum*], by the local police authorities and officials of the plant protection headquarters. The inspectors are authorized to remove suspected tubers, &c., for examination. Owners or occupiers of ground and stores observing symptoms of wart disease (described in an appendix), on growing or stored potatoes are required to notify, within 24 hours, the police or local authorities, who in their turn must immediately inform the plant protection headquarters. The decision of the latter or their representatives is final.

The refuse of plants growing in infested fields must be collected and burnt, or buried at least half a metre deep where burning is impossible. Potatoes harvested from infested fields must neither be used for seed nor removed from their place of growth without permission from the police issued on approval by the plant protection headquarters. They can only be used for fodder when cooked or steamed. The residue from such potatoes must also be burnt. Where factories for the preparation of potato products are near by, it is best to hand over the tubers from contaminated fields to such factories, but any unnecessary movement of the tubers is to be avoided on account of the danger of transmitting infection in particles of soil adhering to them.

Only the potato varieties specially authorized by the local police authorities may be cultivated in infected fields until further notice. The only varieties admissible for this purpose are those listed as immune from wart disease in the annual circular of the Biological Institute. Seed potatoes are to be procured only from fields approved by a Chamber of Agriculture, the Potato Cultivation Society, the German Farmers' Association, or the National Agricultural Federation. Stable manure, etc., must not be sold by, or otherwise distributed from, infected farms. Cellars and other rooms employed for the storage of diseased potatoes must be disinfected with milk of lime after use.

The above regulations do not apply to official Experiment Stations, scientific research purposes, or the removal of samples by the inspection authorities.

In case there is ground for suspicion that the infection has been, or is likely to be, transmitted to other fields, the above regulations may be applied to all the fields within an area to be defined by the police authorities in accordance with the finding of the plant protection headquarters.

If infected potatoes are found elsewhere than on agricultural premises the stock must also be rendered harmless or disposed of for manufacturing purposes under the supervision of the local police authorities.

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SHARPLES (A.). **Preliminary and detailed reports on 'black fruit' disease of Pepper vines in Sarawak.**—*Govt. Print. Office, Kuching, Sarawak*, 15 pp., 1922.

This pamphlet contains a brief preliminary report on a serious disease of *Piper nigrum*, which the writer was invited to investigate by the Rajah of Sarawak, followed by a more detailed account of the state of pepper cultivation in Sarawak and the general characters of the disease. The latter is regarded as being primarily due to the attacks of the alga *Cephaleuros mycoidea*, already known to cause serious diseases of tea and cloves, and less fully studied diseases of several other cultivated plants.

On pepper, the alga is practically confined to the fruit. It is difficult to find any trace of it on young vines up to the time of flowering (1½ to 2 years), and even after the fruit disease is well established the organism is seldom found on the leaves and stems, although in one case the petioles were attacked. After the berries form, those at the free end of the spike turn black, shrivel, and may fall off. At the same time the remaining, practically ripe berries show small, black spots from which arise the fruiting stalks of *Cephaleuros*. In the final stage all the berries are involved; most fall to the ground, but a few remain in a mummified condition attached to the blackened spike. From these mummies a strong growth of the alga can be obtained under suitable conditions. The writer is strongly inclined to the view that *C. mycoidea* is responsible for the whole of the symptoms observed.

The damage caused by this disease is very severe, and it has been one of the main causes of the serious fall in the pepper exports for Sarawak within the past ten or fifteen years. For its control spraying does not seem a promising line of attack on account of local difficulties. Much of the trouble is due to the system of abandoning the pepper gardens after a time and moving to a new area, leaving the abandoned plants a prey to parasites and a menace to other gardens in the vicinity. Measures to check this practice, and also to enforce removal of the old plants when it cannot be prevented, are strongly recommended. The absence of any machinery to ensure that the gardens are properly cared for is emphasized, and the need for some form of agricultural organization in the State pointed out.

FAWCETT (G. L.). **Enfermedades de la Caña de Azúcar en Tucumán.** [Diseases of Sugar-cane in Tucumán.]—*Rev. Indust. y Agric. de Tucumán*, xiii, 1–2, pp. 1–46, 21 figs., 1922.

In this paper the chief diseases affecting sugar-cane in the province of Tucumán, Argentina, are described and an account is given of the author's own researches in regard to them.

Top rot or 'polvillo' affects chiefly plant-cane, the proportion of which to the whole crop is small. Reddish stains appear on the sheaths, and streaks of the same colour on the leaves. Later the two or three most recently formed leaves dry up and the apical shoot can be easily pulled out. The interior leaves and sheaths are rotten and surrounded by a thickish, evil-smelling liquid. At times the pressure of the growing apical shoot ruptures the sheaths where they are weakened by putrefaction, and the shoot may then emerge laterally. This condition, which is known in Java as 'pokkah bong', occurs in cases where the sheaths are attacked while the growing shoot is not yet affected. Usually the latter is ultimately involved in the rot.

The early stages of the disease are marked by the appearance of small translucent spots in the cylinder formed by the sheaths in the apical bud. The spots may be only a few millimetres in diameter and are covered with a watery exudation. Three bacteria were isolated from such spots and named *Bacillus flavidus* n. sp., *Bacillus D*, and *Bacillus F*, respectively. All three are motile, with peritrichous cilia, liquefy gelatine, and form acids on media containing sugar. *Bacillus D* is Gram positive and generates no gas on media containing sugar, while the others are Gram negative and produce gas. Their other characters are tabulated and described. Inoculations proved that all were capable of producing top rot, *B. flavidus* being the most virulent. A high temperature is necessary for successful infection, no success being obtained from inoculations during the cool season (March–April). Rapidly growing cane is usually immune. Infection ordinarily results from bacteria lodged with dust in the apical bud of the cane outside the last three leaves to be formed, where the spaces usually hold water and give organisms every chance to multiply.

Susceptible varieties include plant-cane of 213 POJ, plant-cane and ratoons of 234 POJ, and a few other less important varieties. Kavangire and 36 POJ are considered resistant, though the latter may be attacked during its first year of growth. With regard to the disease known as top rot in Java, the author thinks that several different affections are included. No mention has been made there of a reddish discoloration on the leaves, and the author is of the opinion that the Argentine disease is distinct. *Bacillus vascularum*, to which top rot as well as gummosis has been attributed by some writers, has not been found in Tucumán. Mosaic probably predisposes the plants to 'polvillo' but chlorosis is not a normal symptom of the latter, as stated by Spegazzini. Methods of cultivation and irrigation have no influence on the disease.

Sugar-cane mosaic is common in the province but the affected Javanese canes give good yields. Thick canes seem to suffer more than thin, but the former are believed to be, in any case, unsuited to the Argentine climate which is sub-tropical. The so-called Japanese canes, Kavangire, Zwinga, and Yon Tan San, are immune but give too little sugar to be of value, while of the Java varieties 36 POJ is the most resistant and 213 POJ the least. Of other varieties, D 1135 is almost as resistant as the Java canes. The author reports having received cane affected with mosaic from Brazil, though the disease does not appear to have been recorded in that country as yet. In Tucumán it is impossible to find a cane quite free from mosaic, amongst the commonly cultivated kinds. Indications point to insect transmission of the infection, but the species concerned has not yet been found. Aphids are not believed to be responsible, at least not the species which the author has found on diseased canes and which is believed to be *A. sacchari*. Attempts to secure infection by juice inoculations failed, except when carried out on the young leaves before they had emerged from the bud, in which case 15 out of 21 in three different series were successful.

In experiments on the control of the disease it was found that neither fertilizers nor cultivation had any influence on it. Roguing was also of no value, which is not surprising in view of the universal prevalence of infection. On the other hand, careful selection of seed cane is stated to have given good results.

Rotting of sugar-cane setts after planting is a trouble characteristic of sub-tropical countries, where the low temperatures after planting may delay germination. Partially rotted setts may germinate, but the shoots remain more or less stunted. Varieties differ greatly in their liability to rot; Criolla, for instance, is susceptible, especially the white strain, which usually dies out from this cause in a few years, while the purple strain of this variety is less liable to rot. The common Javanese varieties originally introduced are very resistant, except 100 POJ and 139 POJ; Kavangire and its allies are also resistant, but all the other varieties grown are susceptible. Every year the gaps left by failure to germinate have to be replanted in the case of the susceptible varieties, or the variety would ultimately die out. In damp or badly-drained soils, especially where nitre is present, even the resistant varieties suffer from rot. Mosaic predisposes to this trouble in a marked degree.

Amongst the numerous fungi and bacteria isolated from rotted setts, a list of which is given, the most virulent were found to be *Acrostalagmus glaucus* n. sp., *Cytospora sacchari*, *Melanconium sacchari*, and a species of *Fusarium*. Several others, including *Acrostalagmus sacchari* n. sp. and some bacteria, can cause a certain amount of damage.

Of frequent occurrence in the spring is a disease called 'yellows', in which the young shoots turn yellow or whitish. It is usually the result of the sett rot described above, and is associated with a scanty development of the roots. Similar conditions arise from drought, and the presence of nitre in the soil. Sulphate of ammonia counteracts the latter to a certain extent, but the use of resistant varieties is the best preventive. The practice of 'windrowing' is stated to be productive of sett rot and yellows. Burning the trash on the fields as soon as possible after cutting the cane has been shown by experiment to reduce the damage.

Melanconium sacchari has been said to cause a rind disease of little importance in Tucumán. It is frequently associated in other countries with the much more destructive red rot due to *Colletotrichum falcatum*, and the author thinks that the latter is the usual primary cause of rind disease as described elsewhere, though *M. sacchari* may sometimes directly attack enfeebled canes.

The ring spot due to *Leptosphaeria sacchari* appears to be of recent introduction into Tucumán. Mosaic predisposes to the attacks of this fungus, which does little harm, as it is usually confined to the older leaves of the thick varieties. The species described under the same name by Spegazzini differs from that here referred to in not causing spots and in other characters. A *Phyllosticta* occurs on the same spots as the perithecial fungus, and is believed by the author to be genetically related to the latter [see also this *Review*, i, p. 271].

A linear leaf spot is caused by *Phyllosticta sacchari* Speg., but is not very common. It is restricted to chlorotic leaves and those affected with mosaic, and is found at times on the large white or yellow stripes which are characteristic of the broad leaves of Criolla and other thick canes. These stripes are thought to be identical with those described by Cobb as due to the attacks of *Mycosphaerella striatiformans*, a fungus not known in Tucumán. *P. sacchari* does very little damage, and appears to be found only in the Argentine.

Root disease of the type usually attributed to the attacks of *Marasmius sacchari* is present in Tucumán to a small extent. The disease causes a rot of the young roots, which are at first marked with red spots, then turn black, and later break down and decay. The rot spreads along the roots to the old seed-piece from which they have arisen. Affected clumps are malformed and stunted, and owing to the destruction of a great part of the root system they readily succumb to unfavourable conditions such as drought. The author doubts whether *Marasmius sacchari*, or the species of *Rhizoctonia* and *Pythium* to which the disease has been more recently attributed [see this *Review*, i, pp. 102, 205, 313] are really the primary cause of the rot; he thinks the latter is due more to defective soil conditions such as a bad soil texture or water-logging. He has observed that cane suffers from the disease in some of the badly-drained soils in the south of the province in seasons of excessive rainfall. Elsewhere it is not common. *M. sacchari* has not been found in Tucumán, though two saprophytic fungi rather like it, *Naucoria suborbiculata* and *Omphalia saccharicola*, have been observed on the dead sheaths and bases of the clumps.

Amongst the common diseases of sugar-cane known in other countries but not yet reported in Tucumán may be mentioned pineapple disease (*Thielaviopsis paradoxa*), red-rot (*Colletotrichum falcatum*), and gummosis (*Bacillus vascularum*). These diseases are briefly described, as well as some others of more restricted distribution. Latin diagnoses, with figures, are given of the new species *Acrostalagmus glaucus* and *A. sacchari*, and the *Fusarium* found to be one of the causes of sett rot is briefly described.

GÄUMANN (E.). **Ueber die Gattung Kordyana Rac.** [The genus *Kordyana* Rac.]—*Ann. Mycol.*, xx, 5–6, pp. 257–271, 7 figs., 1922.

Raciborski founded the genus *Kordyana* in 1900 with the following characters. 'Parasitic fungi, related to *Exobasidium* and *Microstroma*, with small, hemispherical hymenia protruding from a small stroma in a stomatal cavity. The non-septate basidia each bear on the apex two sterigmata with oblong elliptical, hyaline, smooth spores'. Of the two original species, the author transfers one (*K. pinangae*) to a new genus, and to the other (*K. tradescantiae*) he adds two new species, *K. celebensis* and *K. polliae.* The host plants of all three are members of the Commelinaceae. As revised the genus consists of parasitic Autobasidiomycetes, which protrude from stomatal cavities, have a limited hymenium, and form more or less hyaline and smooth spores. It resembles *Exobasidium* in its parasitic habit, its white or yellow hymenium, the longitudinal division of its basidial nuclei (stichobasidial type), the variability in number of basidiospores, to some extent in its formation of paraphyses, and in the sporidia germinating sometimes by budding. It differs morphologically in its hypha-shaped basidia (which cannot be recognized as such till the sterigmata and spores appear), their inequality in height, the successive abstriction of spores, and in the fact that the spores do not become uniseptate on germination. It further differs in its restriction to one monocotyledonous family of host plants, its more virulent parasitism, and in the fact that it is dependent on the stomatal cavities of the host for the formation of its fruiting bodies. The author considers that *Kordyana* represents a primitive genus of the family Exobasidiaceae.

The author makes Raciborski's other species the type of his new genus *Brachybasidium*, as *B. pinangae* (Rac.) Gäum. on *Pinanga kuhlii.* This genus is held to differ from *Kordyana* fundamentally in the transverse division of its diploid nuclei (chiastobasidial type), and further in that the basidia are borne on specialized subterminal cells, which the author considers to be homologous with the teleutospores of the Protobasidiomycetes, in which case the apparent hymenium must be considered as a teleutospore sorus. He considers his new genus as the most highly evolved member of Maire's Tulasnellaceae-Vuilleminiaceae group.

The hymenium of *Kordyana celebensis* on *Commelina benghalensis* is often invaded by a fungus belonging to the Mucedineae which is probably parasitic on the *Kordyana.* Its conidia are bicellular and provided at the free end with a single cilium. This fungus is named *Monotrichum commelinae* n. g., n. sp.

BUCHHEIM (A.). **Zur Biologie von Uromyces pisi (Pers.) Winter. Vorläufige Mitteilung.** [On the biology of *Uromyces pisi* (Pers.) Winter. Preliminary note.]—*Centralbl. für Bakt.*, Ab. 2, lv, 21–24, pp. 507–508, 1922.

The author has studied the specialization of *Uromyces pisi* on different hosts in Moscow. Uredospores from *Lathyrus pratensis* infected *Pisum arvense*, *P. sativum*, *Lathyrus nissolia*, and *L. articulatus*, but failed to infect *Vicia sativa* and two other species of *Vicia* tested. The identity of the fungus on *Lathyrus* and *Pisum*, established by Jordi in 1904, was thus confirmed.

Van Luyk (A.). **Ueber einige Sphaeropsideae und Melanconieae auf Nadelhölzern.** [Notes on some Sphaeropsideae and Melanconieae on Conifers.]—*Ann. Mycol.*, xxi, 1–2, pp. 133–142, 1923.

The various species of *Sclerophoma* described on different coniferous trees are discussed, and the conclusion reached that only a single genuine species of this genus has hitherto been recorded on conifers, namely, *S. pityophila* (Cda) v. H. *S. pitya* v. H. and *S. pityella* Died. are merely forms of this fungus found on the larch, and *S. piceae*, a form on the spruce. *S. pini* v. H. is not a *Sclerophoma* but *Rhizosphaera kalkhoffii* Bub. Grove's suggestion that *S. pitya* may be identical with his *Phomopsis abietina* [see this *Review*, i, p. 92] is regarded as requiring further testing by cultural methods.

Notes are given on a number of species of *Phoma* recorded from conifers, and also on several Melanconiaceae. *Gloeosporium pini* Oud. is stated to be identical with *Leptostroma pinastri*, and the latter fungus, together with *L. laricinum*, are regarded as belonging to the Melanconiaceae. *Aposphaeria pinea* Sacc. is said to be based on a misunderstanding of the fructifications, which really belong to *Ceratostomella pini* Münch, while *Sphaeronema pilifera* is also apparently *Ceratostomella*.

Keissler (K.). **Revision einiger von Fautrey aufgestellter Pilze.** [Revision of some of Fautrey's fungi.]—*Ann. Mycol.*, xxi, 1–2, pp. 70–83, 1923.

Under *Ascochyta cucumis* Fautr. & Roum. [pp. 74–75] the author expresses his belief that there can be little doubt that *A. citrullina* C. O. Smith [the imperfect stage of *Mycosphaerella citrullina* (C. O. Sm.) Grossenb.] and *A. melonis* A. Potebn. are identical with Fautrey's fungus, which antedates the others. He suggests also that *Macrophoma decorticans* All. and possibly *M. cucurbitacearum* Trav. & Migl. belong to the same species. It does not appear, however, that authentic specimens of these fungi have been examined by the author.

Cercospora fabae Fautr. on *Vicia faba* is thought to be very near *C. rautensis* Mass. on *Coronilla*. *C. columnaris* Ell. & Ev. is regarded as an *Isariopsis*, and synonymous with *I. griseola* Sacc. *C. phaseolorum* Cke is, however, considered to be a true *Cercospora* and, therefore, not allied to Ellis and Everhart's fungus as the latter thought.

Van der Bijl (P. A.). **A contribution to our knowledge of the Polyporeae of South Africa.**—*South African Journ. of Science*, xviii, 3–4, pp. 246–293, 1922.

This is an account, with technical descriptions in English, of all the species of the sub-family Polyporeae known to occur in South Africa; the sub-families Boleteae and Meruleae are not dealt with. Keys to the genera and species are included, and of the latter nine are new. The author stresses the importance of the study of this group in a country with large forest areas, as its parasitic members reduce the annual rate of wood production, and its saprophytes destroy wood already formed.

TUNSTALL (A. C.). **Notes on some fungus diseases prevalent during season of 1922.**—*Quart. Journ. Sci. Dept. Indian Tea Assoc.*, iii, 115–123, 1922.

Of the fungi causing root disease of tea prevalent in northern India only one, *Hymenochaete noxia* [*Fomes lamaoensis*] produces no spores on this host. This disease is, therefore, always the result of contact infection, usually spreading from root to root below ground but sometimes along trenches in which woody material has been buried. It usually originates in the dead roots of jungle trees and is especially prevalent on sandy soil. No soil treatment, however, appears to be effective. Complete removal of all dead and infected wood (roots, &c.) is the only reliable method of control.

Ustulina zonata not only spreads from root to root but is also transmitted above ground by means of spores, which cause infection of the plants through decaying wounds, such as dead snags or borer holes. The disease occurs principally on acid soils, and may be controlled to some extent by the application of heavy lime dressings to counteract the acidity. All dead snags should be removed and the wounds painted with 5 lb. copper sulphate in 10 galls. of rice water to which sufficient slaked lime has been added to make a paste. *Kretzschmaria micropus* resembles *U. zonata* in symptoms and effects.

On some deteriorated bheels the tea has become infected with the Jew's ear fungus, *Auricularia* [*A. auricula-judae*], which enters the plant through dead snags, penetrates the woody tissue and the growing layers, and finally destroys the bush branch by branch. The treatment recommended for the control of *U. zonata* is also applicable to this disease.

Sphaerostilbe repens spreads similarly to *U. zonata*, but is more readily controlled by heavy liming and improved drainage. The disease is confined to water-logged, acid soils, and even badly infected bushes recover with suitable treatment. Stiff soils, difficult to drain, are generally infected with this fungus.

Rosellinia arcuata is distributed by spores and by spreading along dead organic matter from bush to bush. It generally originates in decaying snags or collections of dead leaves lying in contact with the bushes. It also grows in dead wood buried in trenches. In most cases liming the soil and exposure of the collars of bushes adjacent to the infected plants will check the spread of the disease. In order to avoid the long and tedious work of digging out all the diseased material from infected trenches, the trenching material should be sprinkled with lime before covering, if there there is any reason to suspect the presence of the fungus. The continuity of the trenches should also be broken at intervals.

Thyridaria tarda [*Botryodiplodia theobromae*] is probably the most widely distributed root fungus in the tea districts of north-eastern India but causes serious damage only in exceptional circumstances, as, for instance, after a protracted spell of severe drought, which diminishes the vitality of the plants. In some cases sudden death from the attacks of this fungus occurs after pruning. The fungus is most prevalent on coarse, sandy soils, and infection is most often found when the wood is drying back from the cut ends of branches. The latter should be protected by painting with the mixture recommended under *U. zonata*, while the application to the soil surrounding each bush of 2 to 3 oz. of nitrate of potash has also been found very beneficial in stimulating the development of the plants. All heavy pruning on the soils liable to induce the disease should be done very early, as it has been observed that there are fewer *Botryodiplodia* spores about in September and October. Root attacks are also found, chiefly when the roots have been injured during cultivation. Infected bushes frequently exhibit a moribund condition and are liable to attack by various leaf blights, especially in the case of unpruned or lightly pruned tea. Spraying with lime-sulphur in April is recommended in such cases.

Root diseases spread mainly underground and any dead wood in the soil, is liable to act as a centre of infection. No woody tree appears to be immune from root diseases of one kind or another and it is useless to attempt to compile a list of trees, the stumps of which may serve to start such diseases. The burying of infected material in trenches is also a fruitful source of trouble, unless accompanied by sprinkling with lime. In the case of fungi which are able to spread above ground, decaying snags are the principal points of infection and should be removed. The enormous losses due to root diseases can be greatly minimized by timely precautions, and except *Botryodiplodia* they can usually be controlled by careful removal of the infected bushes immediately the attack becomes visible.

Black rot (*Hypochnus theae*) has recently caused considerable damage in Assam. The fungus attacks the green shoots and leaves, covering them with an exceedingly fine mycelium, the hyphae of which are almost indistinguishable even under a microscope. The first symptom of the disease is a slight discoloration of the leaf which rapidly becomes darker. On drying, the patches resemble those caused by brown blight [*Glomerella cingulata*], which, together with grey blight [*Pestalozzia theae*], is frequently present as a secondary invader and helps to obscure the true nature of the disease. Infected leaves adhere to each other wherever they are brought into contact. In many cases the disease occurs in patches on the bushes, unlike brown blight which is distributed all over the plant. The basidiospores which are produced on the ends of hyphae projecting from the mycelial net, are sprinkled over white patches situated on healthy-looking, green portions of the under sides of the leaves. The disease, however, is disseminated more by contact than by spores, as the spore patches are scanty. During the period of actual production of the spores the spread of the disease is much more rapid than at other times and infected bushes may be found distributed throughout an entire section.

Owing to an incorrect diagnosis of the symptoms, the presence of black rot in one case reported was not detected until very severe and extensive damage had been caused. Suspected areas should be isolated immediately and cultivated by a special gang of coolies who, with their implements, &c., should be sprayed (care being taken to avoid the face) with lime-sulphur on leaving their work. All diseased material should be removed and burnt and the infected plants twice sprayed with lime-sulphur solution at intervals of a week or ten days. Three rows of bushes surrounding those actually diseased should be included in the treatment.

Johnson (J.) & Fracker (S. B.). **Tobacco wildfire in Wisconsin.**—*Wisconsin Univ. Agric. Coll. Bull.* 348, 21 pp., 11 figs., 1922.

The wildfire disease of tobacco (*Bacterium tabacum*) has now spread to Wisconsin, making a total of fourteen States affected in the six years since it was first recorded in America. During that period it has caused losses amounting to millions of dollars. In Wisconsin the damage in 1922 was slight, as weather conditions were on the whole unfavourable to its spread.

As regards the source of infection, the writers confirm the views of previous workers [see this *Review*, ii, p. 37] that the disease is traceable almost exclusively to infected seed-beds. One form of attack, apparently peculiar to Wisconsin, is that of 'bud infection', resulting in a pale yellow discoloration of the bud and the surrounding leaves, with entire cessation of growth. This appears to be due to the passage of toxic products from the infected areas through the plant to the bud, causing a bleaching similar to that ordinarily localized in the diseased spots in older leaves.

The bottom leaves of the plants are the most likely to show infection because they are exposed for the longest time in a position favourable to attack. They also appear to be more susceptible to the disease. In the Wisconsin epidemic of 1922 the worst periods of infection followed two separate storms of wind and some hail early in the growing season. Beating rain especially promotes a high degree of infection.

During the six months of the winter season, when there are no tobacco plants in the fields, the number of wildfire germs is greatly reduced by the absence of suitable material for their sustenance, but a few evidently survive on tobacco refuse, seed-bed covers or frames, cured leaves, and the like. Under certain conditions it seems likely that the bacteria may overwinter on the seed, but from the data collected on the source of seed of infected beds in Wisconsin this is evidently not always the case.

In general the greatest injury in the field crop seems to be caused by an upward spread of infection from the lower leaves of the plants, so that the greater the number of primarily infected plants set out, the greater the damage from the disease. When however, conditions for dissemination are favourable, as during driving rain storms, general spread in the direction of the wind occurs, and relatively few infected plants in the field may cause an epidemic later.

The control measures recommended are concerned chiefly with keeping the seed-beds free from disease, and are on the same lines as those recommended in the earlier paper referred to above. Under Wisconsin conditions the safest plan, in case of widespread infection before 1st July, is to destroy the crop and replant the ground from healthy beds. If only a few plants are affected they may be pulled up, buried or burnt, and replaced by healthy ones. During the first month the tobacco is in the field, an effort should be made to remove all infected leaves, however laborious the process. Ploughing under the suckers after harvesting the crop before they make appreciable growth will effectively prevent their attack by wildfire.

PALM (B. T.) & JOCHEMS (S. C.). **Wilde planten en slijmziekte,** [Wild plants and slime disease.] *Vlugsch. Deli-Proefstat. te Medan* [Sumatra], 20, 3 pp., 1922.

A list is given of thirty-four wild plants, belonging to nineteen different families, which are known to be susceptible to slime disease (*Bacterium solanacearum*) in the tobacco fields of Deli, Sumatra. More than half the names on the list are those of very widely distributed wild plants, the most susceptible of all being *Lantana aculeata*. The cultivation of the latter as a cover crop should therefore be replaced by that of *Mimosa invisa,* which is highly resistant to slime disease [see this *Review*, ii, p. 295].

FROMME (F. D.). **Experiments in spraying and dusting tomatoes.**—*Virginia Agric. Exper. Stat. Bull.* 230, 15 pp., 5 figs., 1922.

Spraying experiments were undertaken in 1918 and 1919 and a dusting experiment in 1922 for the control of tomato diseases in Virginia. The results of the 1918 and 1919 spraying experiments indicate that five applications of Bordeaux mixture with soap (4 lb. $CuSO_4$, 2 lb. resin fish-oil soap, 3 lb. quicklime, and 50 galls. water) provides satisfactory control of leaf blight (*Septoria lycopersici*) and soft rot (probably due to *Bacillus aroideae*). On the basis of these experiments it may be assumed that spraying with soap Bordeaux will result in an average crop increase of 70 per cent. in the middle and western sections of Virginia. Such an increase would approximately cover the cost of spraying and harvesting, when the average price of tomatoes is 30 cents a bushel, while any increase in price above this figure would yield a profit. Standard Bordeaux produced less satisfactory results (36 per cent. of control compared with 68 per cent. with soap Bordeaux).

Seven applications of the Dosch copper lime dust, containing 20 per cent. monohydrated copper sulphate, at the rate of about 42 lb. per acre per application, satisfactorily controlled tomato late blight (*Phytophthora infestans*). Dusting is likely to be preferred to spraying in the higher altitudes to which late blight is chiefly confined, as it is much easier to carry out. The available data indicate that it is probably not equal to soap Bordeaux in the control of the *Septoria* leaf blight, and its value in regions where late blight does not occur remains to be determined.

BEWLEY (W.). **Tomato diseases.**—*Journ. R. Hort. Soc.*, xlvii, 2 & 3, pp. 169–174, 4 pl., 1922.

This paper gives short popular descriptions of the chief tomato diseases in England, some of which are of great commercial importance. Those mentioned include damping off (various fungi, especially *Phytophthora cryptogea* and *P. parasitica*), buck-eye rot or black rot (*Phytophthora parasitica*), stripe disease (*Bacillus lathyri*), sleepy disease (usually either *Verticillium albo-atrum* or, under exceptionally high temperature conditions, *Fusarium lycopersici*, but other fungi may be concerned), 'mildew' (*Cladosporium fulvum*), stem and fruit rots (*Botrytis cinerea*, *Fusarium*, and *Penicillium* spp., *Bacillus carotovorus*, &c.), root rots (*Fusarium* spp. and a new species of *Sclerotium*), a physiological blossom-end rot of tomato fruit, and mosaic. Methods of control are also briefly indicated.

SCOTT (I. T.) **Tomato wilt.**—*Missouri Agric. Exper. Stat. Bull.* 197, p. 49, 1922.

In this Bulletin, which is the report of the Director for the year ending 30th June 1922, is included a note by I. T. Scott, in which it is stated that the growth of the causal organism of tomato wilt (*Fusarium lycopersici*) was found to be markedly influenced by the hydrogen-ion concentration. A maximum in the growth curve was observed at a PH of about 4·0 to 4·5 in all cases, and a minimum at about 5·5. This was succeeded by another less prominent maximum. The results agree in the main with those already reported for *Gibberella saubinetii* [see this *Review*, i, p. 340].

PAINE (S. G.). & LACEY (MARGARET S.). **Studies in bacteriosis, VII. Comparison of the 'stripe disease' with the 'Grand Rapids disease' of Tomato.**—*Ann. of Appl. Biol.*, ix, 3 & 4, pp. 210–212, 1922.

A comparison between *Aplanobacter michiganense* E. F. Smith, the cause of the 'Grand Rapids' disease of tomatoes, and an *Aplanobacter* which is frequently found associated with *Bacillus lathyri* in stripe disease (see *Ann. Appl. Biol.*, vi, p. 183, 1919) showed certain definite differences. The name *Aplanobacter dissimulans* is therefore proposed for the latter species.

Inoculations of three sets of eighteen young tomato plants with the two species *Aplanobacter* and *B. lathyri* gave negative results with *A. dissimulans* in every case. Many successful infections were obtained with *B. lathyri* and *A. michiganense*, the effect upon the pith being identical. Marked differences, however, were observed in the lesions produced by the two organisms on the exterior of the stem. *B. lathyri* caused the formation of dark brown, sunken furrows, normally without any cracking of the epidermis, while *A. michiganense* produced deep fissures with margins resembling callus formations in the outer cortex, but caused no special changes in colouring or effects on the fruit. The two diseases therefore appear to be entirely distinct, and the earlier suggestion that the Grand Rapids disease might be found to be really due to *B. lathyri* is withdrawn.

GARD (M.). **Sur le dépérissement des jeunes Noyers en 1922.** [On the dying off of young Walnut trees in 1922.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 263–266, 1922.

This paper has already been noticed from another source [see this *Review*, ii, p. 187].

MILES (A. C.). **Keithia on Thuya plicata.**—*Gard. Chron.*, lxxii, p. 353, 1922.

In 1918 and 1919 *Keithia thujina* on *Thuja plicata* occurred more or less generally throughout Ireland, being specially severe in seed-beds in Queen's County and Wexford, and on somewhat older plants in other parts of the country. In the autumn of 1920 the disease appeared simultaneously in widely separated parts of the country. A large proportion of the diseased seedlings have since recovered and there was no serious spread of infection on older trees after 1920. Diseased seedlings saved from the 1918–19 epidemic were planted out, after being sprayed with copper sulphate, on low-lying moist ground in Wexford in the spring of 1920. During 1921 and 1922 these trees have gradually regained a healthy appearance, though they are not yet free from traces of the disease.

The origin of the *Keithia* epidemic is somewhat obscure, since it does not appear to be connected with any particular type of soil or climate, and the possibility of transmission by artificial agency is very remote. In view of the considerable economic importance of *Thuja* the disease should be held in check by the regular spraying of seed-beds and young transplants, and by sowing the seed sparsely to prevent overcrowding, which favours the attacks of the fungus.

HEDGCOCK (G. G.) & HUNT (N. R.). **Notes on some species of Coleosporium, II.**—*Mycologia*, xiv, 6, pp. 297–310, 2 pl., 1922.

Coleosporium ipomoeae (Schw.) Burrill is known to occur in its aecidial stage in the area from Pennsylvania to Florida and Texas on six species of pine, of which *Pinus echinata* is the most common and susceptible host. It is now reported for the first time on *Pinus caribaea* from Florida. The uredo- and teleuto-spore stages of this fungus are found on species of *Calonyction*, *Convolvulus*, *Ipomoea*, *Pharbitis*, and *Thyella* over a much wider range, from New Jersey and Kansas in the north, to Florida and Texas in the south. Successful inoculations were made by the authors on species of *Ipomoea*, *Pharbitis*, and *Quamoclit*.

Coleosporium ribicola (Cke. & Ell.) Arthur has been collected in the pycnidial and aecidial stages on *Pinus edulis* in Colorado and New Mexico. Its uredo- and teleuto-spore stages have been recorded on species of *Grossularia* and *Ribes*, from Wisconsin and Montana to Arizona and New Mexico. The fungus has been successfully inoculated on *Pinus edulis*, *P. pinea*, and a number of species of *Grossularia* and *Ribes*. Between 1917 and 1919 the rust suddenly appeared in Minnesota and Wisconsin, although no aecidial host has been found in these two states; no reason is known for this sudden appearance and the apparent disappearance since 1919. *C. ribicola* in its aecidial stage closely resembles *C. ipomoeae*, and since both may occur on the same host in the north central United States, the authors give a short comparative key to the two species. *Coleosporium solidaginis* (Schw.) Thüm. has been reported as occurring naturally in its aecidial stage (*Peridermium acicolum* Underw. & Earle) on 14 species of pine, chiefly in the eastern United States. In the western States it has been recorded only on *Pinus contorta* in Montana and Colorado. The uredo- and teleuto-spores of this fungus, in its form on *Solidago*, have been found occurring naturally on about 60 species of *Solidago* in all regions of the United States except in some of the south-western States. It is now reported for the first time on 29 further species, a list of which is given. The form on *Aster* is known to occur on at least 60 species and has a range similar to that on *Solidago*. The results of numerous inoculations made by the writers indicate that in the eastern United States *Coleosporium solidaginis* is a rust attacking species of *Solidago* but not those of *Aster*. The form on *Aster* is apparently distinct and probably belongs to *Peridermium montanum* Arthur & Kern which, if this is the case, is distinct from *Peridermium acicolum*.

HINTIKKA (T. J.). **Die 'Wisa'-krankheit der Birken in Finnland.** [The 'Wisa' disease of Birches in Finland.]—*Zeitschr. für Pflanzenkrankh.*, xxxii, 5–6, pp. 193–210, 1922.

Birches (*Betula alba*) in certain districts of Finland, especially among boulders on the banks of lakes, are subject to a brown streaking of the wood, which is known commercially as 'lily wood' or 'Finnish (Swedish) grained birch wood' and is in considerable demand for the manufacture of furniture. This peculiarity is locally known as the 'wisa' disease, and is stated by different authorities to occur also in Central Europe and Russia and to be due to parasitic attacks or to the overcrowding of the bud-knots.

The symptoms of 'wisa' disease are very variable. Frequently the affected trees present quite a normal appearance except for a few swellings above and below the junction of the branches with the trunk, or ruptures in the bark. The trunk may be deformed, and is generally sloping instead of upright. The brown streaks may occur either in the centre of the trunk or only in the outer annual rings. The so-called 'coarse wisa wood' is usually found only in the trunk, while the 'fine-grained wisa wood' occurs in all parts of the tree. The latter is very popular in the trade.

A detailed description is given of the microscopic characters of the affected wood. The first stages of the formation of the streaks are found on 4 to 5 year old wood and consist in an enlargement of the medullary rays, with a profuse development of stone cells in the adjacent cortex. The cambium and wood curve inward at the affected parts. There are no pathological alterations in the cells at this stage and the author has failed to find any evidence of parasitic attack. Nutritional or climatic influences are believed to be chiefly responsible for the abnormal development.

Later on the cortex and the wood rupture internally along the streaks and the cell contents and walls of the affected tissues turn brown. Tannin and gum appear in abundance in the cells, while the walls of the parenchyma lose their cellulose character. In this condition the tissues may remain for years without further alteration. The fissures are overgrown by newly-formed wood, but the surface of the wood long remains marked by depressions corresponding to the internal cracks. The process of isolation of the latter is accompanied by the formation of callus and wound wood in a tangential direction on one side only of the wound, leading to the formation of kinks in the wood which may resemble knots.

Other types of internal tissue distortions produced in various ways during the healing process are described.

The author believes that the 'wisa' disease is a non-parasitic form of gummosis, of the type described by Sorauer as latent, and thought by him to precede the stage of visible gum flow. In the 'wisa' disease the latter stage, characterized by gummy degeneration of the cell walls and of the cell contents, is never fully reached. While it is admitted that the symptoms suggest one of the so-called enzymic group of diseases, this view is not supported by the peculiar distribution of the disease, the obvious influence of external factors and especially of climatic conditions on it, the anatomical characters of affected tissues, and the varying susceptibility of individual trees or branches. The whole question of the etiology of the disease is considered to be still obscure.

Glasson (A. K.). **Mortality of Sal in Buxa Division, Bengal.**—*Indian Forester*, xlviii, 1, pp. 22–31, 1922.

An account is given of an inquiry instituted to ascertain the causes of the high rate of mortality of sal [*Shorea robusta*] in the Buxa Division of Bengal. One branch of the work consisted in the investigation of the sal root fungus (*Polyporus shoreae*), ten plots being demarcated in various parts of the Division for purposes of observation. Two of these have now been under observation for 6 years and the others (each of 4 acres) for 4½ to 5½ years.

It was found to be very difficult to arrive at any accurate conclusion as to the rate of spread of the disease, the fungus frequently being well established in a tree before any external signs of attack become apparent. As regards the lapse of time between the first perceptible sign of attack and the death of a tree, the results of the observations were also conflicting. Some trees which had sporophores on them six years ago are still alive and healthy, while others died almost immediately after showing symptoms of infection. Up to May 1921 the average mortality associated with the sal root fungus was 1·25 per cent. per annum, the average total mortality being estimated at 1·6 per cent. These figures are probably above the general average over the whole forest. An increased number of infected trees became noticeable at the end of the observation period. As mentioned above, however, it is possible for the disease to exist in a tree for years before producing any external symptoms, so that it would be unsafe to make any deductions from the present data as to the rate at which the infection spreads.

A further analysis of the deaths showed that the mortality associated with the fungus was about equal for all girth classes. Deaths due to the fungus appear to occur in groups, thus causing the formation of gaps in the stand. This point is of some importance in growing pure plantations of sal.

The observation plots are being maintained and in time should give further information regarding the incidence of mortality and rate of spread of the disease.

De Wildeman (E.). **Les maladies de l'Arachide.** [The diseases of Groundnut.]—*Rev. de Bot. appliquée*, ii, 15, pp. 631–633, 1922.

The author supports a recent recommendation by Chevalier in the same *Revue* that uncontrolled importation of American groundnuts [*Arachis hypogaea*] into Africa should be prohibited, in view of the danger of introducing *Puccinia arachidis*. He considers that all imports of groundnuts should be controlled, since other, not less important diseases occur elsewhere. Of these, two are particularly mentioned, due respectively to *Septogloeum arachidis* [*Cercospora personata*] and *Bacillus solanacearum*, and are stated to cause great damage in the Dutch East Indies. The latter is not mentioned on this crop in Africa but the former is already known there.

GLEISBERG (W.). **Das Rätsel der Hernieverbreitung.** [The mystery of the dissemination of club-root]. *Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 11, pp. 89–90, 1922.

Club-root of cabbage [*Plasmodiophora brassicae*] is widespread throughout Silesia, occurring with particular frequence and virulence in small holdings and allotments. In the Zoological Experiment Station at Proskau a series of laboratory experiments was instituted to ascertain the influence of the earthworm on the spread of the disease. Three to ten earthworms of various sizes, after being kept for a month in flower pots in infected soil, were placed in fresh pots, the soil of which was free from infection. Cabbage seed was sown in the latter series of pots, and also in a corresponding number without earthworms in infected and non-infected soil. At the end of two months the infected soil without earthworms had 100 per cent. of the plants attacked, the healthy soil without earthworms had 0 per cent. and the healthy soil with earthworms had 60 per cent. The dissemination of club-root in the soil through the agency of earthworms is thus possible. For practical purposes it is immaterial whether the infection is carried in the mucilage of the skin or in the intestinal contents, but the results of further experiments indicated that *Plasmodiophora brassicae* is present in an extremely virulent form in the excreta of worms.

The results of these tests emphasize the danger of leaving decaying cabbage stalks in the field, as worms frequently penetrate the tissues in large numbers in the spring. The prevalence of the disease in small gardens and other confined areas is explained by the shorter distances which the worms must traverse between the cabbage plots. In the control of the disease the disinfection of the soil is only likely to be of value if simultaneously carried out on all plots within the range of the worms. Deep ploughing is a purely temporary palliative, since the worms rapidly bring infective material again to the surface.

THATCHER (R. W.). **Forty-first Annual Report New York Agricultural Experiment Station (Geneva) for 1922**, 51 pp., 1923.

Some items of phytopathological interest are contained in the report of the Division of Botany [pp. 29–34].

Raspberry disease investigations were instituted in 1922 in the Hudson River Valley, where the future of the crop is threatened by several diseases. A survey of the plantations showed that the mosaic or yellows disease is universally present. For the last ten years in this area the red variety Perfection has been cultivated almost exclusively, and mosaic apparently became prevalent in the early plantings from which all the present stands have descended. A small quantity of healthy stock was obtained for experimental purposes, and tests will be carried out to determine the most practical methods of selecting and growing disease-free plants. Mosaic is the most important disease of red and purple raspberries in New York, black raspberries, blackberries, and dewberries being also affected by a similar and probably identical disease. Studies have been made of the varying symptoms of mosaic, especially the first stages, in the Division of Horticulture, and investigations are in progress on the rate of spread of the disease from infected to healthy plants, and the natural factors involved in its transmission.

Western blue-stem disease has ruined the black raspberry industry in Dutchess county of recent years. The disease is not completely understood, and no control measures are known.

Rosette or eastern blue-stem [see this *Review*, ii, p. 128], which in some respects resembles mosaic, primarily attacks black and purple raspberries. A preliminary study of its importance in New York is in progress.

Carrots on Long Island are liable to a destructive leaf blight caused by *Macrosporium carotae*, while a root rot of unknown origin is also of some importance. The leaf blight disease is seed borne, and seed disinfection experiments will therefore be carried out. Trials will also be made with Bordeaux mixture, which appears to be a promising method of treatment.

DOIDGE (ETHEL M.). **[Report of the Division of] Botany and Plant Pathology [for the year ending 30th June 1922.]**—*Journ. Dept. of Agric. S. Africa*, v, 6, pp. 546–549, 1922.

Citrus canker [*Pseudomonas citri*] eradication continues to make satisfactory progress, only four trees being found infected during the year, all on one farm in the Rustenburg district. An extensive field experiment is being carried out to ascertain whether citrus trees may safely be replanted after three to five years in orchards where trees infected with canker have been removed. Citrus scaly bark has only been known in South Africa for the last two years, but appears to be spreading very rapidly in certain areas.

The outbreak of potato wart disease (*Synchytrium endobioticum*) in Natal [see this *Review*, ii, p. 10] seems to be confined to two adjoining farms in the Impendhle Division, and it is hoped that the disease has not become more widely distributed. No cases of infection have occurred in the Boston area, near Impendhle, where potatoes are grown in considerable quantities. Two obscure diseases of groundnut were observed; in one case the plants turn yellow and die without apparent cause, and in another seemingly healthy plants produced a large crop of kernel-less nuts. Amongst the plant diseases mentioned as being under observation in the western Cape districts are silver leaf disease of fruit trees [*Stereum purpureum*] and apple mildew. Other aspects of the mycological work referred to in the Report have been, for the most part, separately noticed in this *Review*.

In the National Herbarium at Pretoria, an up-to-date reference index was compiled of the 1,000 odd genera of fungi represented, with special reference to their systematic position.

Departmental Activities: Botany.—*Journ. Dept. of Agric. S. Africa*, vi, 2, pp. 114–115, 1923.

Climatic conditions in the Transvaal are stated to have been particularly favourable for the development of anthracnose (*Gloeosporium ampelophagum*) in grape vines in the past season, and considerable damage to both shoots and fruit has resulted. Winter treatment is recommended, which consists of pruning out and burning all affected wood and then spraying the dormant vines with a solution of lime-sulphur (1 : 12), or swabbing them with a mixture of iron sulphate (25 lb.), sulphuric acid (1 pint), and water (50 galls.). If after this treatment young shoots are found to be affected, spraying with Bordeaux mixture should be carried out (*a*) when shoots are eight to twelve inches in length, (*b*) just before the flower-buds open, (*c*) just after the blossoms fall, and, if necessary, once or twice again later.

Chlorosis in fruit trees is becoming more and more widespread in South Africa, and while in some cases purely cultural remedies have been effective, in others no treatment tried has had successful results. The trouble has been reported from several districts in Cape Colony, while in the Transvaal many apricots, plums, pears, and apples have been affected, the latter trees in a characteristic, variegated manner.

Report of the Minister of Agriculture, South Australia, for the year ended 30th June, 1921, 79 pp., 1922.

The Report contains various scattered references of phytopathological interest included in the annual survey of the work of experimental farms and orchards. At Berri, River Murray, *Oidium* and anthracnose [*Gloeosporium ampelophagum*] of the vine occurred, the former being controlled by dusting the vines with flowers of sulphur. A late infection by downy mildew [*Plasmopara viticola*] was also reported, but no appreciable loss was caused. In the Mount Lofty Ranges black knot of cherry, probably caused by a fungus, occurred on old trees in several orchards. Root gall was prevalent on the sandy soils of the Mypolonga Irrigation Area, where it caused severe losses. Root rot (*Armillaria mellea*) of apple trees was reported from several localities. Anthracnose of the vine was prevalent, and anthracnose of the gooseberry [*Pseudopeziza ribis*] appeared in several gardens, chiefly on the Ostrich variety.

Darnell-Smith (G. P.). **Biological Branch.**—*Ann. Rept. Dept. of Agric. New South Wales 1920–21*, p. 27, 1922.

The number of specimens examined on behalf of the general public in connexion with fungous diseases of plants was the highest on record. In conjunction with the Fruit Branch and orchard inspectors, field experiments have been carried out for the control of sour sap of apple, collar rot of citrus, citrus exanthema, brown rot of stone fruits [*Sclerotinia fructigena*], black spot of Williams pears and apples [*Venturia pirina* and *V. inaequalis*], downy mildew of the vine [*Plasmopara viticola*], the black spot disease of orange due to *Phoma* [*citricarpa*], and *Armillaria mellea* on citrus.

Considerable attention was given to the bunchy top disease of bananas [see this *Review*, i, p. 108, and ii, pp. 131, 372], resulting in the isolation of a number of organisms from infected corms. Owing to the unsatisfactory conditions under which the inoculation experiments were conducted no definite conclusions as to the nature of the disease could be drawn.

The following diseases were also under investigation: take-all of wheat [*Ophiobolus cariceti*], gummosis of sugar-cane [*Bacillus vascularum*], blue mould of tobacco [*Peronospora hyoscyami*], and the treatment of seed potatoes for scab [*Actinomyces scabies*]. The officers of the branch also submitted reports, some of which have been prepared for publication in a scientific series, on the following diseases: *Helminthosporium* of wheat [see this *Review*, i, p. 340], various diseases of sorghum, aster wilt, spotted wilt of tomato, tomato seedling diseases, Fiji disease and bunchy top of sugar-cane, woodiness of the passion vine, brown rot of pomegranates, *Alternaria* spot of orange, *Sclerotium rolfsii* and its hosts, cross-inoculation with *Gloeosporium* sp. from the stem of rose to apples, blotch condition of apples, a disease of *Pinus insignis* [see this *Review*, ii, p. 299], and palm and pepper seedling diseases.

During the year, imported plants, consisting chiefly of fruit stocks and seeds, were examined with a view to preventing the entrance of any serious disease into the State. *Cylindrosporium padi* was found for the first time on some cherry stocks imported prior to the fireblight proclamation by the Federal Government. Powdery scab (*Spongospora subterranea*) was detected in Tasmanian potatoes.

Downy mildew of the grape, spotted wilt of tomato, brown rot of stone fruits, and brown spot of the mandarin [*Colletotrichum gloeosporioides*] were all serious. The last-named appears to be extending into new areas. A *Dematium*-like fungus resembling *Aureobasidium* was isolated from grapes and vine leaves in Cumberland county.

Report on the Department of Science and Agriculture, British Guiana, for the year 1920, 92 pp., 1922.

The Economic Biologist, Mr. G. E. Bodkin, reports that a great reduction has taken place in the area in the Colony devoted to Para rubber cultivation owing to the South American leaf disease (*Melanopsammopsis ulei*). The Departmental Station at Christianburg had to be abandoned as 95 per cent. of the trees were affected by the disease, which subsequently became very prevalent at Issorora, the yield of dry rubber from tapped trees having sunk from 4·97 lb. in 1919 to 2·4 lb. in 1920. Trees which have been at all seriously attacked by the disease never recover their original vigour. The fungus is indigenous on the native rubbers, *Hevea confusa* and *H. guyanensis*, neither of which, however, suffers to the same extent as *H. brasiliensis*. The virulence of the disease depends greatly on meteorological conditions, its ravages being particularly severe during protracted periods of heavy rainfall. At such times the young leaflets shrivel up a few days or even hours after the buds burst. This virulent form of the disease is largely in abeyance during relatively dry periods, the leaves remaining green though riddled with small holes. Even slightly affected trees show a falling off in yield and fail to make a satisfactory increase in girth. In every plantation a few trees appear to be immune from the disease, but the reason of their resistance is not known.

Bud rot of coco-nuts was prevalent, especially among trees growing on 'pegassy' soil in the north-western district. The most severe attacks occurred on trees which had reached the bearing stage (ten to twelve years old). Defective drainage and cultivation were found to encourage the spread of the disease. Red ring disease of coco-nut palms [caused by the nematode *Aphelenchus cocophilus*] was also recorded.

'Ripe rot' of mangoes and breadfruit was observed, but was readily controlled by the application of Bordeaux mixture.

Witches' broom disease [*Marasmius perniciosus*] of cacao was in evidence on some estates where the proper cultural measures were neglected.

WELSFORD (E. J.).—**Yearly Report—April to December 1921.**—*Rept. Agric. Dept., Zanzibar Protectorate, for 1921*, p. 136, 1922.

Owing to the lack of apparatus for detailed work the greater part of the year was spent in the examination of clove [*Eugenia caryophyllata*] 'shambas' [gardens]. Inspection of the roots and of soil around dead and dying trees indicated conclusively that the sudden death of certain trees was not due to the physical constitution of the soil or to senility. Two parasites were found on the clove, which are believed to be respectively responsible for two distinct diseases, die-back and 'sudden death'. Experiments have been undertaken to test the effect of a dressing of lime on the acid soil of the shambas. So far the results have been beneficial.

Much of the 'mhogo' [= cassava, *Manihot utilissima*] crop in Pemba is severely infected by a fungous disease which greatly reduces the yield.

An experimental garden has been started at Weti for plant disease work and improving existing varieties of the more useful crops. The sweet potato, yam, mhogo, and pigeon pea are under cultivation.

BROWN (NELLIE A.). **Experiments with Paris Daisy and Rose to produce resistance to crown gall.**—*Phytopath.*, xiii, 2, pp. 87–99, 2 pl., 4 figs., 1923.

In trying to obtain a strain of the Paris daisy [*Chrysanthemum frutescens*] resistant to crown gall, the author took perfectly healthy plants, inoculated them with *Bacterium tumefaciens* and when the galls had developed, took cuttings again, the process being repeated several times in the hope that resistance would eventually develop.

Two series of experiments were made. In the first an apparent resistance developed up to the fifth set of cuttings, but with a strain of the bacterium isolated from slowly developed galls on this set, the resistance gave way and the plants two generations later were killed. In the second series this virulent strain of *B. tumefaciens* was used, and the plants died out in the sixth set of cuttings. The results of both series are interpreted as indicating that the vitality of the plants was considerably reduced by repeated infection with the organism.

When the fifth set of cuttings in the first series were showing apparent resistance to grown gall, juice from the diseased plants was expressed and added to beef agar, and juice from healthy plants treated likewise. Colonies of *B. tumefaciens* were slower in appearing on the former medium than on the latter.

Plants inoculated with dead cultures and then in the same spot with living ones also showed a marked decrease of successful infections.

Breeding experiments with rose seedlings on similar lines as with the Paris daisy, except that the plants were propagated by seed instead of cuttings, produced a seedling which appeared quite resistant, but in two years this resistance had appreciably lessened.

WEBER (G. F.). **Septoria diseases of cereals. III. Septoria disease of Rye, Barley, and certain grasses.**—*Phytopath.*, xiii, 1, pp. 1–23, 9 figs., 1923.

This paper, the last of a series of three, deals with five distinct diseases.

The *Septoria* leaf blotch of rye caused by *S. secalis* Prill. & Del. is described first. The disease produces small, almost circular spots confined to the leaves or larger areas involving sometimes the whole leaf area. The causal organism, described in 1889 from France, grows readily in culture, producing white colonies which do not bear conidia but only pycnidia containing 3-septate pycnospores, 2 to 3·5 by 25 to 49 μ. Inoculations with the latter on eight kinds of cereals showed that only rye was susceptible. The disease has appeared more or less sparingly in the United States, but is not of economic importance.

Septoria leaf blotch of barley, caused by *S. passerini* Sacc., is characterized by lesions of a very indefinite outline, the yellow diseased area gradually blending to the normal, and has pycnidia which appear as black specks, not confined to the yellow areas, containing 3-septate pycnospores measuring 1·7 to 3 by 23 to 46 μ. The organism grows well on potato dextrose agar, forming flesh-coloured colonies of conidia (which are exactly like the pycnospores) becoming black with age. The disease, previously reported from Italy, is confined to barley, and it is not important economically.

Septoria leaf blotch of quack grass (*Agropyron repens*), caused by *S. agropyri* Ell. & Ev. has only been reported from the United States, and so far as is known *A. repens* is the only host attacked. The fungus was readily obtained in pure culture and on potato-dextrose agar developed circular, raised, smooth, conidial colonies, first pinkish-rose in colour and later turning black. The pycnospores and conidia are 3-septate and the former measure 1·5 to 2·5 by 24 to 45 μ.

The *Septoria* leaf blotch of brome grass (*Bromus inermis*), caused by *S. bromi* Sacc. and previously reported from Italy, is now recorded for the first time from the United States. It does not attack the common cereals and is of negligible economic importance.

The spots resemble those caused by other species of *Septoria* on the Gramineae, and the pycnidia bear spores 1·5 to 2·5 by 31 to 50 μ. The fungus grows well in artificial culture producing a white mycelium, which later turns olivaceous. Conidia are not mentioned.

A leaf blotch of Kentucky blue grass (*Poa pratensis*) is reported as being caused by a species of *Septoria* which resembles *S. graminum*, but differs from the latter in the lesions not being delimited by veins, in the pycnidia being much less closely seriately arranged, and in the measurements of the pycnidia, 50 to 120 μ in diameter, and of the pycnospores, 1 to 1·5 by 29 to 57 μ. The fungus grew readily in culture, the colonies consisting first of conidial masses with scant mycelium, but later producing olivaceous hyphae, and resembling greatly those of *S. tritici*, *S. passerini*, and *S. agropyri*. Inoculations on 40 graminaceous plants gave successful results only on *Poa pratensis*.

Reddy (C. S.) & Godkin (J.). **A bacterial disease of Brome-grass.** —*Phytopath.*, xiii, 2, pp. 75–86, 2 pl., 1923.

The authors describe in this paper a new disease of brome grass (*Bromus inermis*) caused by a bacterial organism.

The disease first appears on the leaves as light olive green, circular to elliptical, water-soaked areas, with light brown centres. Later the spots become dark brown, almost black, and a characteristic halo, visible in the early stages, becomes more prominent. In severely attacked plants, the panicles wither and die, producing symptoms similar to frost injury.

Each year from 1917 to 1921 the disease occurred on *Bromus inermis* in North Dakota, and it has also been noted in Wisconsin on the same host.

Isolations were made readily and successful infections obtained without difficulty, the ends of the first leaves turning black and withering in two to four days, and the more typical lesions developing in three to nine days. Twenty-three species of *Bromus* were found to be susceptible, although in five cases the centres of infection did not become black, but were small, sunken, and light grey, thus resembling to a marked degree the halo blight of oats caused by *Bacterium coronafaciens*. Inoculations with the latter organism, however, gave negative results with all species of *Bromus* tried except *B. carinatus*. Four cereals and six other grasses yielded negative results with the brome grass organism, whilst *Agropyron repens* and oats were slightly susceptible.

The organism resembles *B. coronafaciens*, but on account of the differences in infectivity between the two organisms, the authors regard it as a new variety, and have named it *B. coronafaciens* var. *atropurpurem*. A long series of physiological tests was applied to both organisms, but no striking differences could be discovered. The brome grass organism has the group number 211.2323023 and the same number is suggested as correct for *B. coronafaciens*.

Newton (Margaret). **Studies in Wheat stem rust (Puccinia graminis tritici).**—*Trans. R. Soc. Canada*, 3rd series, Section V, xvi, pp. 153–210, 6 pl., 3 figs., 1922.

After a brief reference to the economic importance of wheat stem rust (*Puccinia graminis tritici*) in Canada, and to the history of the discovery of biologic forms of the parasite, the author gives details of her investigations, started in 1918, to determine what strains occur in Western Canada. In her experiments she adopted Stakman and Levine's differential key to the biologic forms, as well as their symbols for recording the type and degree of infection [see this *Review*, ii, p. 158]. Tables and diagrams are also given, illustrating the results of collections and of inoculation experiments on eleven varieties of wheat belonging to the same groups as used by Stakman and Levine, together with a report on preliminary infection experiments with twenty-nine species of grasses.

The investigation demonstrated the presence in Canada of fourteen biologic forms of *Puccinia graminis tritici* identical with fourteen of the forms isolated by Stakman and Levine in collections from widely separated points in both the northern and southern United States. This fact, the more interesting as it was previously thought that the rust in the protected foot-hills of the Rocky Mountains and in north-western Alberta, might be different from that found in the open plains of the Red River Valley of Canada and the United States, suggests that climate is not a controlling factor in the distribution of these forms.

In consideration of the generally accepted hypothesis that rust moves during the season in waves from south to north across the continent, collections were made in the field from the time the first pustules appeared in early summer until late in September. It was thought that if this hypothesis were correct, and if the biologic forms varied in point of origin, they would appear at successive dates during the summer, varying with the remoteness of the point of origin. Although in the three years under review no definite succession of biologic forms was found, it was noted that the same form, XVII, appeared first each year, having been collected as early as 5th July, while the form IX, which attacks emmer heavily, was always one of the last, seldom appearing before September, thus suggesting that the former may be more local in origin, and the latter carried by winds from farther south. Usually more than one form was found on the same wheat variety, sometimes even on the same plant: thus, forms III, IX, and XVII were found on a single plant in Saskatchewan.

A striking fact emerging from these investigations is the constancy of behaviour of the biologic forms. Association of the same form with a great variety of hosts, in widely separated localities, was without apparent effect on its biologic characters. Inoculations on the test wheats invariably gave the same results, whether the inoculum was obtained from the same varieties, or from very different hosts even when the fungus had been cultured on the latter for several generations, thus supporting the conclusions of Stakman, Piemeisel, and Levine. The frequently expressed idea that a permanently rust-resistant variety cannot be bred owing to the plasticity of the rust is erroneous, and rests on the misleading interpretation, either of the results obtained by a person unfamiliar with the exacting technique required in the study of biologic forms, or of the morphological variations in the uredospores; the latter may vary in size under the influence of the resistance of the host and other cultural factors, but such variations within a given form should not be confused with true morphological distinctions.

The geographical distribution of the biologic forms is still imperfectly known. However, tentative maps have been prepared showing the areas in which the six more frequently occurring forms have been collected, but further exploration will, no doubt, extend the limits so far found.

Referring to Stakman's statement that 'Methods of breeding for rust resistance must now be changed fundamentally. The breeder must know and work with those forms of rust which occur in the region for which his new variety is intended', the author states that the six forms I, IX, XVII, XXI, XXIX, and XXX, all of which give the same reactions on the bread wheats, and constitute together 70 per cent. of all the collections, deserve the first attention of Canadian wheat breeders, since there is ground to hope that when a hard spring wheat is evolved which is resistant to any one of these six forms, it will likewise prove resistant to the others; this would effect a very considerable reduction in the annual losses from wheat rust. Genetic material bearing the necessary factors for rust resistance for eleven out of the fourteen Canadian forms hitherto isolated, is available in the common and durum wheats. Kanred, for instance, is immune from all of the six biologic forms predominating in the principal wheat-growing areas of Canada and from two others, though it is susceptible to the remaining six forms.

The second part of the paper deals with the author's researches on the development of the parasite within the tissues of resistant and susceptible hosts. The experiments, technical details of which are given, showed that up to its entry through the stomata, the development of the fungus follows the same course on either a resistant or susceptible host. In the latter the parasite may then continue its growth and complete its cycle with the formation of a new uredosorus, the host apparently adjusting itself readily to the presence of the fungus. In a resistant host, the tissues appear to be intolerant of the parasite. The progress of the hyphae sent out from the sub-stomatal vesicle is rapidly checked. The failure of infection in this case appears to be due to the starvation of the parasite by the local killing of the intolerant host tissue, as the author has found in most cases some indication of disintegration in the host cells before a similar breakdown could be observed in the hyphae. Miss Allen's suggestion [see this *Review*, i, p. 377] that the resistance of Kanred wheat may be due to the narrow stomatal openings of this variety is not supported, since some of the forms to which this wheat is highly susceptible have germ-tubes not appreciably narrower than those of forms from which it is immune, and even in the latter penetration of the stomata is not rare.

A bibliography of 67 titles is appended.

WESTON (W. H.) **Production and dispersal of conidia in the Philippine Sclerosporas of Maize.**—*Journ. Agric. Res.*, xxiii, 4, pp. 239–277, 10 pl., 2 figs., 1923.

This paper deals chiefly with the production and dispersal of the conidia of two Philippine species of *Sclerospora* parasitic on maize, namely, *S. philippinensis* and *S. spontanea*. The production of conidia on infected plants is preceded by the formation on leaves and sheaths of characteristically discoloured, yellowish-white areas, which are defined in the very young leaves and show no tendency to subsequent spread. Production takes place in the greatest relative quantity on the largest of these areas, some of the smaller stripes and spots remaining barren, and it always occurs during the night, generally in cool, moist weather. The conidiophores develop during the night exclusively from the stomata, when the surface of the plant is covered with dew or rain. From the mycelium in the underlying tissue, branches protrude through the stomatal pores, forming crowded groups of lobed and knob-shaped outgrowths which are not completely developed until some two to four hours after the surface of the plant has been covered with moisture. They later elongate, developing successively into mature conidiophores in about another three hours. Several conidiophores are formed at each stoma during the night. The conidia, which mature in greatest numbers about 2.30 a.m., are apparently set free by active ejection from the sterigmata, rather than by passive disjunction, as previously assumed. The nocturnal development of conidiophores follows a relatively regular cycle under normal meteorological conditions.

Conidia are produced in enormous numbers, even a small plant liberating sufficient to infect the neighbourhood. Estimates of the total number of conidia produced on a single plant of Native Yellow maize during one night ranged from 758,033,400 to nearly 6,000,000,000. This process continues night after night for months, finally resulting in an almost inconceivable figure.

The dispersal of conidia necessarily takes place at night and is accomplished chiefly by wind. Slight air-currents and strong breezes are both important, since they occur very frequently at the time of maximum conidiophore production. Violent gales do not promote the copious production of conidia, but are important in so far as they sweep the available conidia over greater distances. Dispersal is also effected by splashing drops of rain or dew, laden with conidia, either falling from infected leaves directly on to healthy ones or being transported thence by the wind. Agents of minor importance in the transmission of conidia are surface water, insects, and moist infected soil.

The genus *Sclerospora* may be disseminated in three stages of development—mycelium, oospores, and conidia. The first two stages are comparatively unimportant in the Philippines, the destructive spread of the downy mildews being almost entirely accomplished by conidia. The spread of these diseases to the United States could not, however, be effected by conidia unless the latter developed on imported live plants. Oospores have not been found on maize in the Philippines, and it is not yet known whether any of the oospore-forming *Sclerospora* spp. on other Gramineae are identical with the maize parasites. As mycelium, long-distance transport might occur in sugar-cane (which is also attacked by *S. spontanea*) or possibly in cuttings of other grasses.

HURD (ANNIE M.). **Hydrogen-ion concentration and varietal resistance of Wheat to stem rot and other diseases.**—*Journ. Agric. Res.*, xxiii, 5, pp. 373–384, 1923.

The present investigation was undertaken with a view to furnishing additional data on the hydrogen-ion concentration of the expressed juice of a number of wheat varieties, some resistant and others susceptible to stem rust (*Puccinia graminis*). Most of the plants used in the experiments were grown in the greenhouse, but germinator seedlings were also studied. The hydrogen-ion concentrations were determined electrometrically, and most of the measurements were made at a temperature of 25° C. Throughout the series the procedure was to make at least three determinations of each sample, the average of which was taken to represent the reaction of the juice.

The most striking result revealed by the data was the absence of any significant difference in the P_H values of the juice of resistant and susceptible varieties of wheat. The variations in the reaction of the juice of the plant at different stages of development were also very slight, only a small increase in acidity being observed in seedlings two to four weeks old over those of one week.

A table of the reactions of different well-known wheat varieties to other common diseases besides stem rust (bunt, mildew, scab, &c.), compiled from the observations of several investigators, indicates very inconsistent behaviour. The only examples of uniform resistance and susceptibility are Khapli and Little Club respectively.

It may be concluded from the above data that there is no correlation between the hydrogen-ion concentration of the expressed juice and varietal resistance or susceptibility to disease.

Much greater differences in the hydrogen-ion concentration of the expressed juice were produced by environmental than by varietal factors. Thus the P_H value of the juice of greenhouse wheat seedlings cut at 1 p.m. averages 0·1 higher than that of those cut at 9 a.m. Wheat plants grown in limed soil have a lower hydrogen-ion concentration than those from unlimed ground. General debility, as well as severe infection by *Erysiphe graminis*, results in an abnormally high acid content. No appreciable differences in the hydrogen-ion concentration were observed in wheat plants grown from seed originating in widely separated localities. The concentration of hydrogen-ions in expressed wheat juice increases on standing. The addition of two volumes of water to one of expressed juice increased the P_H value by 0·10 to 0·15. Young germinator seedlings are more highly buffered against dilution than older greenhouse plants.

BEAUVERIE (J.). **Sur les rapports existant entre le développement des rouilles du Blé et le climat.** [On the relation existing between the occurrence of Wheat rusts and climate.]—*Comptes Rendus Acad. des Sciences*, clxxvi, 8, pp. 529–531, 1923.

Comparative field observations on the occurrence in 1921 and 1922 of three rusts (*Puccinia graminis, P. glumarum, P. triticina*) on some fifty varieties of wheat, in Auvergne (France), gave some interesting indications in view of the extremely divergent weather conditions of the two years. In 1921, during the critical period in May and the beginning of June (which the author in previous work has given reasons for regarding as the period during which, under local conditions, the weather exercises the maximum influence on the wheat crop), the rainfall in the neighbourhood of Clermont-Ferrand [for periods of ten days each] amounted to 22·9 mm., 65·6 mm., and 12·6 mm., and was followed by a period of absolute drought up to the harvest. In 1922 the total rainfall was considerably smaller during the earlier period, but rainy weather followed until the end of the season. In the former year *P. glumarum* was very prevalent at the beginning of active growth and during the wet period mentioned; as dryness set in, *P. triticina* appeared and was present with an average intensity until the harvest, while *P. graminis* was totally absent. In 1922 *P. glumarum* was present to a slighter extent during the first vegetative phase, but maintained itself on the young shoots; *P. triticina* appeared a little later and developed feebly; *P. graminis* was the last to appear but gained in intensity up to harvest time.

From the above observations, which, however, the author remarks were not controlled by experiment, and which should be continued for several years to become of practical significance, he draws the conclusions that the wheat rusts occur in the following sequence: (1) *P. glumarum*, (2) *P. triticina*, (3) *P. graminis*. The first is a rust of the first vegetative phase and of the tillers, the second is the chief rust in dry years, and the third is especially prevalent during wet years. This is said to agree with the observations in other countries. Thus, in the dry regions of the United States the prevalent rust is *P. triticina*, *P. graminis* being seldom found; but the latter can cause heavy damage in periods of high humidity.

Some notes are also given on the relative susceptibility of the varieties cultivated by the author in the two years under review, special mention being made of Kanred CI 5146, which was highly resistant and showed no trace of rust in 1922.

Blaringhem (L.). **Sur la résistance aux parasites cryptogamiques d'un hybride d'Epeautre et de Seigle.** [On the resistance to cryptogamic parasites of a hybrid from Spelt and Rye.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 267–276, 2 figs., 1922.

The author describes the behaviour of a hybrid from *Triticum spelta* var. *T.* (female) and *Secale cereale* (male) in regard to rusts and ergot. A noteworthy feature of this hybrid is its great vegetative vigour, which results in the production of a dry weight at least eight times that of the parents in the same growth period. This is accompanied by feeble and delayed lignification of the tissues, the transpiration and assimilation are prolonged after the ears dry up, and the latter are completely sterile.

Of the parents, both the autumn and the spring sown rye were heavily attacked by *Puccinia graminis*. On harvesting in the first days of August, fully developed sori of *P. dispersa* were also found at the base of the leaf sheaths underneath the uncracked epidermis. The spelt wheat suffered considerably less from *P. graminis*, though a late attack developed between the 25th July and 4th August, the date of harvest. The plot sown on 4th March was much more affected than that sown on 20th March.

The hybrid was much more resistant to rust attacks during its growing period than either of the parents. Teleutospores of *P. graminis* showing a number of morphological divergences from the normal appeared only on the shoots which developed after cutting in August. The sori were larger and more confluent than those on the wheat, and the teleutospores were much more variable and frequently apiculate instead of rounded or flattened at the free end. These peculiarities are thought to be the result of the softer tissues of the hybrid and the deeper position of the sori, many of the spores of which do not come in contact with the epidermis at their tips.

The slow unfolding of the spikelets, which in the hybrid have exceptionally elongated axes, seems to have been more favourable to infection by the spores of *Claviceps purpurea* than was the case with the parent rye. The ergot on the hybrid was shaped more like a grain of wheat than of rye, a fact in harmony with the production in other fertile wheat × rye hybrids, of grain resembling wheat rather than rye.

O'Byrne (F. M.). **Bordeaux-oil emulsion. Its preparation and use.**—*Quarterly Bull. State Plant Board of Florida*, vi, 2, pp. 46–58, 1922.

Bordeaux-oil emulsion, the principal use of which is for the control of citrus scab and melanose [*Phomopsis citri*], should be prepared as follows:—(*a*) Dissolve copper sulphate in a barrel at the rate of 1 lb. per gallon of water; (*b*) slake rock lime in water and then add water until the number of gallons is equal to the number of pounds of lime used (if hydrated lime is used double the amount will be required). To mix 50 gallons of Bordeaux of the 3–3–50 formula, 22 gallons of water should be put into the sprayer, and 3 gallons of solution (*b*) added. Then put 22 gallons of water into a barrel and add 3 gallons of solution (*a*). The barrelful of diluted copper sulphate should then be poured slowly into the diluted lime solution in the sprayer, stirring the whole time. The resulting solution is first-class Bordeaux mixture which will stay in suspension for a long time and adhere to the plants. While stirring rapidly, add very slowly indeed 3 quarts of oil emulsion.

The following is the formula for oil emulsion used: 2 galls. paraffin oil, 1 gall. water, 2 lb. caustic potash fish oil soap, 1 lb. ground glue, and 2 to 4 oz. 50 per cent. carbolic acid or liquor cresolis composition.

It must be remembered that infection by the scab organism occurs some time before the disease becomes perceptible on the surface, and the spraying should therefore be started in the early spring. To control scab on the fruit the spray should be applied directly to the blossom. This can be done without risk of injury. The time to spray for melanose is from ten to twenty days after the petals have dropped. Excellent results have been obtained for the past three years in an experimental nursery at Gainesville by the use of 3–3–50 Bordeaux mixture, with or without the addition of oil emulsion, the control of scab being absolute. The operations were carried out at fortnightly intervals from March to November, and were not followed by any injurious results. Both ammoniacal solution of copper carbonate and lime-sulphur considerably reduced the amount of infection, but neither was equal to Bordeaux in efficiency.

BURGER (O. F.), DE BUSK (E. F.), & BRIGGS (W. R.). **Preliminary report on controlling melanose and preparing Bordeaux-oil.**—*Florida Agric. Exper. Stat. Bull.*, 167, pp. 132–140, 6 figs., 1923.

Melanose and stem-end rot, both caused by *Phomopsis citri*, are the most serious diseases of citrus in Florida. The former is responsible for a larger percentage of low-grade and unsightly fruit than any other disease, and the latter causes more losses through premature dropping and decay than all other agencies combined. Melanose is distributed throughout Florida, but appears to be more prevalent on the west coast and in the central districts than on the east coast. Grapefruit and seedling oranges appear to be more susceptible to melanose than any other variety of citrus.

The symptoms and the life-history of the fungus are described. The latter lives in the dead twigs and branches of citrus and the spores produced in this situation are the source of the infection of living tissues. The results of inoculation experiments showed that only young and growing tissues are susceptible to the attacks of the fungus, leaves from four to six weeks old being immune. The fruit becomes immune about the end of May or beginning of June.

The results of a series of experiments conducted in 1921 and 1922 showed that spraying with Bordeaux mixture 3–3–50, plus 1 per cent. oil emulsion, gave very satisfactory control of the disease and noticeably improved the appearance of the crop. As the oil emulsion recommended contains 66 per cent. oil it requires $1\frac{1}{2}$ galls. per 100 galls. Bordeaux to make 1 per cent. oil emulsion. [Apparently the object of this addition is to control scale insects and white fly.]

Directions are given for the manufacture of Bordeaux-oil emulsion [see preceding abstract]. All dead wood should be pruned away as far as possible, but it is difficult to secure complete control by this means without spraying, since it is almost impossible to remove all the wood likely to harbour the fungus.

WINSTON (J. R.). **Citrus scab: its cause and control.**—*U.S. Dept. of Agric. Bull.* 118, 35 pp., 16 pl., 6 figs., 1923.

Citrus scab, a parasitic fungous disease second in importance only to the melanose and stem-rot disease caused by *Phomopsis citri*, attacks many species of citrus in India, South China, Japan, Hawaii, Paraguay, Brazil, Central America, Yucatan, the southern United States, Cuba, Porto Rico, and the lesser West Indian islands. It is also reported from the Canary Islands and South Africa. The damage to leaves on bearing trees is slight, but a large percentage of the early dropping of the green fruit is due to fruit scab. Later attacks cause serious blemishes on the fruits and reduce their market value.

In the nurseries the disease is severe, producing a marked stunting effect upon seedling stocks for budding and often reducing growth by 40 or 50 per cent. The average annual loss from scab to Florida growers is about 1,000,000 boxes, and the cost of production is greatly increased by the necessity of spraying to control the disease. Under Florida conditions the following species are highly susceptible: sour orange (*Citrus aurantium*), lemon (*C. limonia*), calamondin (*C. mitis*), and tangelo (a tangerine-grapefruit hybrid.) The grapefruit and shaddock (*C. grandis*), the King, tangerine, mandarin, and Satsuma oranges, the kid-glove group (*C. nobilis*), and the citrange (a hybrid of *Poncirus trifoliata* and the tangerine) are also susceptible, while sweet oranges (*C. sinensis*) and kumquats (*Fortunella* spp.) are rarely attacked, and the Mexican or Key lime (*C. aurantifolia*) and the Royal and Triumph grapefruits appear to be immune. The Duncan, Walters, Pernambuco, Leonardi, and Foster varieties of grapefruit are all about equally susceptible, Hall (Silver Cluster) being much more so, and Marsh comparatively resistant.

Scab appears on the leaves in the form of minute, circular, raised protuberances, usually on the under surface of the leaf. After a few days the apices of the lesions turn cream-coloured or yellow, and with the expansion of the leaf the lesions become more conspicuous, some forming hollow, conical outgrowths, and others coalescing into flattened scabs. At a later stage the lesions resemble warts and assume a pinkish and finally olivaceous tinge. The functions of moderately infected leaves do not seem to be seriously impaired. On the fruit the outgrowths of the lesions are solid. The protuberances turn from pale yellow to a dusty grey, and on the grapefruit they eventually flatten out, so that the fruit regains its normal shape. On the sour orange and lemon the lesions develop into corky, raised warts. Abnormally early dropping of the fruit or severe blemishes are frequently caused by scab, and even slight blemishes considerably lower the commercial value of the crop. Generally speaking, only the twigs of very susceptible varieties are attacked, infection occurring in the form of cream-coloured (afterwards pinkish and finally grey) warts on the succulent growth of vigorous nursery stock.

The cause of citrus scab was first referred to a fungus of the genus *Cladosporium* by Scribner in 1887. Massee named this fungus '*C. citri* pro tem.' in 1899, and the latter name has come into general use since. The earlier work, however, was erroneous, the fungus observed being a saprophyte unconnected with the disease, though common on the old seeds. The true cause of the latter was isolated by Fawcett in 1906 and erroneously named *Cladosporium citri* Massee, with which, however, it has little in common. What its systematic position really is has not yet been determined, but it has none of the characteristics of *Cladosporium*. The fungus develops well on glycerine agar, colonies being produced on this and on other media in five to eight days at room temperature. The cultures, which form very characteristic, raised, convoluted colonies of a tawny or purplish colour and limited growth, are figured. True conidia are borne very sparingly in culture. In older cultures the convoluted mycelium becomes thick-walled and develops tangled chains of constricted hyphae, which are easily broken apart into chlamydospores. The latter are capable of germination, and probably are the chief source of infection. The optimum temperature for the growth of the fungus was found to be about 68° F., which may explain the relatively high proportion of infection which occurs during the cool weather of spring. The results of numerous isolation tests showed that when once the scab fungus enters a leaf it can persist there throughout the winter. From cultural data and field observations alike it appears that the disease is seldom or never carried over winter on fruit set in the spring or summer. Examination of the leaf lesions showed that the fungus forms a compact stroma of thick-walled, hyaline hyphae from which numerous sporophore-like stalks arise, but no spores have been found on the latter. The host tissues are penetrated to the depth of a few cell layers, and the affected cells become brown and distorted. Hyperplasia often occurs beneath the invaded area.

The spread of citrus scab is very erratic, the disease sometimes being confined for years to a small group of trees and then suddenly becoming pandemic over large areas. Probably the chlamydospores are responsible for the majority of the primary infections occurring in the early spring, repeated examinations of the lesions having failed to reveal the presence of conidia. In addition to old lesions supplied with a hold-over stroma, many scars occur in which the stromatic mass has weathered away. During the early spring there is a marked flaking off of host and mycelial fragments which may also contribute to the spread of the disease. The relative scarcity of scab in the drier sections of Florida and its absence in California indicate that the fungus is largely dependent on abundant moisture during the period when the leaves are expanding and the fruit is setting. According to Fawcett (*Journ. Agric. Res.*, xxi, 4, p. 243, 1921), natural infection depends also on a temperature range of 61° to 73° F., but the author's investigations indicate that the degree of humidity during the growing season is the more important determining factor. The widespread impression that grapefruit scions on rough-lemon stocks are particularly susceptible to scab is probably due to the fact that such trees produce a much greater vegetative growth during the first few years than is the case with other root systems. There appears to be no scientific foundation for the belief in the immunizing or sensitizing influence of the stock on the scion. There is also no reason to suppose that the virulence of the fungus is on the increase, or that the orange is gradually losing its resistance. The results of an extensive series of inoculation experiments (particulars of which are given) showed that the susceptibility of the grapefruit to scab is greater immediately after the falling of the petals, with a progressive decrease until the fruit reaches a diameter of about three-quarters of an inch. The leaves of all the citrus species tested were most susceptible on emerging from the bud, reaching a stage of immunity when they have developed to half an inch in width. All strains used in the tests appeared to be equally virulent. The fungus remains pathogenic after growing on artificial media for four years. Inoculation experiments on the fruit and leaves of the grapefruit and Satsuma orange with *Cladosporium citri* from old scab scars resulted in a very slight degree of infection.

The results of a series of spraying experiments indicated that Bordeaux mixture, Bordeaux mixture with oil emulsion, and copper soap gave absolute control of the disease. Burgundy mixture caused a slight russeting of the foliage and lime-sulphur produced serious defoliation. The following spray schedules are recommended for Florida:—I. In orchards where scab is always serious. (1) Just before growth sets in: Bordeaux mixture 3–3–50 plus 1 per cent. oil emulsion. (2) In height of bloom: Bordeaux mixture 3–3–50 plus 0·5 per cent. oil emulsion. (3) A fortnight later: same as (2). (4) A fortnight after (3): same as (1). II. In orchards where scab varies from moderate to serious. As in the foregoing schedule, except that lime-sulphur solution 1 in 40 may be substituted for Bordeaux mixture in the second and third applications. III. In orchards where scab is of minor importance. Three applications of lime-sulphur solution (1 in 30 for the first and 1 in 40 for the subsequent applications). Nurseries can be kept commercially free from scab by occasional applications of Bordeaux mixture plus oil emulsion, and the treatment seems to stimulate the growth of the seedlings. The oil emulsion recommended in this paper is the 'Government formula', namely: 2 galls. paraffin oil, 2 lb. fish oil soap, and 1 gall. water, boiled together.

Ballard (E.) & Norris (Dorothy). **Bacterial infection of Cotton bolls.**—*Agric. Journ. India*, xviii, 1, pp. 40–49, 1923.

A large proportion of the premature shedding of young bolls of Cambodia cotton (*Gossypium hirsutum*) in South India appears, in the light of preliminary investigations made in 1922, to be due to a bacterial infection which is not *Bacterium malvacearum*; angular spot was not found in the area under observation, though present elsewhere in the Madras Presidency. No fungus was found associated with the early stages of the disease, which always appeared first on the developing seeds, turning them brown and subsequently discolouring the lint and producing a slimy rot within the boll. The exterior of the latter was marked by black, shining spots, and a puncture-like injury could in some cases be noticed right through the boll wall. The organism isolated from affected bolls and considered responsible for the disease is a stout, rod-shaped bacillus, feebly motile, Gram-positive, and non-acid fast; it grows readily on various culture media and produces moist, whitish, translucent colonies on cotton boll extract agar. Preliminary inoculations from cultures gave inconclusive results.

Insect agency appears to play an important part in the dissemination of the disease, although it still remains to be proved whether it is absolutely necessary. So far as any case has been made out, two capsids, *Ragmus morosus* n. sp. and *R. flavomaculatus* n. sp., would appear to be the most likely agents of infection. This point of view is supported by various observations. Boll shedding declined with the partial disappearance of these insects from the field, in spite of the fact that this coincided with a period of strong winds, which are known to be important factors in the distribution of bacterial diseases. The season was very dry, and rain, another possible method of dissemination of the bacteria, could scarcely have played much part. Furthermore, where cotton stainers were not found in the area under observation, only very small bolls were shed with the symptoms described, whereas in another district where cotton stainers were prevalent the diseased shed bolls were much larger; this difference may well be due to the fact that the capsids are unable to puncture large bolls.

The authors suggest that the disease might possibly be controlled by the use of insecticides, and point out that it may be necessary to find whether the insects suspected of carrying the disease have other plant hosts.

FRIEDERICHS (K.) & BALLY (W.). **Over de parasitische schimmels, die den Koffiebessenboeboek dooden.** [Parasitic fungi which destroy the Coffee berry borer.]—*Meded. Koffiebessenboeboek-fonds* 6, 147 pp., 5 pl., 2 figs., 1923. (English summary.)

In this paper an account is given of two parasitic fungi capable of destroying the coffee berry borer (*Stephanoderes hampei* Ferr. = *S. coffeae* Haged.). The first has been known for some years in the Dutch East Indies, but without identification. It is always found where the beetle occurs, and is now named *Botrytis stephanoderis* Bally n. sp. The diagnosis of the fungus, pure cultures of which were readily obtained on potato agar and other media, is as follows: mycelium white, clearly septate within the body of the insect, internal hyphae up to 4 μ in diameter, and external ones up to 2 μ. Conidiophores verticillate on branches which are sometimes thickened; conidia 2 to 3 μ in diameter, globose, arising terminally or laterally from small sterigmata. The lateral branches may form secondary or tertiary branches and large heads of conidia are thus developed (as many as 1,000 in one head). In potato cultures stout coremia, simple or branched, and 1 to 2 cm. in height, are formed. *B. stephanoderis* greatly resembles *B. bassiana* in many respects, but differs from the cultures of the latter from the Centraalbureau voor Schimmelcultures examined by the authors in the much larger number of conidia in one head, the presence of coremia, the longer adhesion of the spores, and the yellowish tinge assumed by the cultures in from eight to ten days. In old cultures the conidia remain viable for at least two and a half years.

The second fungus, *Spicaria javanica* Bally n. sp., is much rarer than *B. stephanoderis*, but is equally virulent. It has hitherto been found only on dead beetles in black berries, not in the red or green stages. The diagnosis is as follows: hyphae septate, white, conidiophores profusely branched, length very variable, 1 to 2 μ in width, numerous verticillate branches at the apices. Conidia elliptical, 2 by 1 to 1·5 μ, white, afterwards purple, formed in long chains on secondary branches produced by the primary branches. Smooth antler-shaped coremia, yellow at the base, white at the apex, 1 to 3 cm. in height, developed in potato cultures after three to four weeks. The colour of the fungus on dead beetles is purplish-grey.

Insects destroyed by *B. stephanoderis* obstruct the bore holes with the back part of their bodies, which are covered with the mycelium of the fungus. Days or even weeks may elapse before the dead insects are detected, the mycelium becoming apparent only during rainy weather. The fungus is found chiefly on shaded branches of the bushes. Natural epidemics of sufficient virulence to eradicate the borer do not occur, presumably on account of the rapid propagation of the insect. It is estimated, however, that the normal number of offspring is diminished by 50 per cent. as a result of the attacks of the fungus.

Inoculation experiments, which are described in detail, with spores from cultures were invariably successful both in the laboratory and in an experimental garden at Malang. Larvae, young and old borers, and other insects, e. g. caterpillars of *Cricula trifenestrata*, were easily infected. A considerable period often elapses before the mycelium develops from the dead insects.

By dusting and spraying spores of *B. stephanoderis* on to coffee berries, and by liberating infected beetles still able to move freely about the plantations, the fungus was introduced into some estates where it had not previously been found. It did not, however, spread any further, probably on account of unfavourable weather.

UPHOF (J. C. T.). **Ueber die Verwendung von Krankheitserregern zur Bekämpfung schädlicher tropischer Insekten.** [The application of pathogenic agents in the control of injurious tropical insects.]—*Tropenpflanzer*, xxvi, 1, pp. 4–7, 1 fig., 1923.

The author, writing from Florida, states that arrangements have been made by the Florida State Plant Board for the cultivation, on a large scale, of entomogenous fungi to check the ravages of scale insects in the citrus plantations. The following fungi are said to be useful against the insects named: *Sphaerostilbe coccophila* for the control of *Lepidosaphes beckii* and *L. gloveri* on citrus fruits, the San José scale (*Aspidiotus perniciosus*) on peaches, plums, and pears, *A. hederae* on *Melia azedarach*, and *Parlatoria pergandei* on citrus. *Microcera fugikuroi* controls *Chrysomphalus aonidum*, *C. aurantii*, and *Lepidosaphes beckii* on citrus. *Ophionectria coccicola* absolutely destroys *L. gloveri*, *L. beckii*, and *Parlatoria pergandei* on citrus. *Aschersonia cubensis* is an extremely useful parasite of various insects occurring on camphor, cinnamon, guava, bananas, mango, &c., including *Toumeyella liriodendri*, *Pulvinaria pyriformis*, and *Eucalymnatus tessellatus*. Pure cultures of *A. cubensis* and other entomogenous fungi will be grown on a commercial scale by the State Plant Board and will be available for distribution at 75 cents each. *A. turbinata* is parasitic on the 'Florida wax scale' (*Ceroplastes floridensis*), *A. aleurodes*, and *Aegerita webberi* on *Dialeurodes citri*, and *Aschersonia flavocitrina* on *D. citri* and *D. citrifolii*.

The importance of entomogenous fungi can easily be demonstrated by spraying citrus trees with Bordeaux mixture, which kills the useful parasites together with other fungi. In a short time scale and other insects, especially the white fly (*Dialeurodes citri*), appear in great numbers.

The fungi flourish during the summer rains or earlier under suitable conditions. *Aegerita webberi* thrives until late in the autumn. Young or neglected orange plantations are not adapted to the cultivation of useful fungi owing to the scarcity of foliage.

During the summer rains the trees should be sprayed with the pure cultures with an ordinary apparatus, the spores of the fungi being diluted with water and put through a coarse sieve before use. The apparatus must be quite free from copper, to which the fungi are very susceptible.

BRYCE (G.). **Experiments with the green muscardine fungus on rhinoceros beetle larvae.**—*Ceylon Dept. of Agric. Bull.* 65, 7 pp., 1923.

The results of inoculation experiments with two strains of the green muscardine fungus (*Metarrhizium anisopliae*) from the Philippine Islands and Malaya on the larvae of the rhinocerous beetle (*Oryctes rhinoceros*) showed that the fungus was not markedly pathogenic to the insect. This corresponds with Speare's observations on the effect of *M. anisopliae* on the sugar-cane borer beetle (*Exper. Stat. Hawaiian Sugar Plant. Assoc., Path. and Phys. Ser., Bull.* 12, 1912). The incubation period varied from thirty-nine to eighty-one days. Of the two strains, the Philippine made the better growth. The evidence from each experiment indicated that the larvae were only attacked after a considerable period of captivity had diminished their vitality and power of resistance. Apparently healthy larvae, under normal conditions, are not particularly susceptible to the disease, and it is very questionable whether natural infection, to which the beetles are probably subject in Ceylon, since the fungus is known to be indigenous there, could be appreciably increased by artificial means. The method cannot, therefore, be recommended for the control of the rhinoceros beetle on coco-nuts.

BALLINGS (MADELEINE). **Le Vermicularia herbarum parasite des Œillets.** [*Vermicularia herbarum*, parasitic on Carnations.] —*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 288–289, 5 figs., 1922.

A disease observed in the autumn of 1922 at Gagny (Seine-et-Oise) on small-flowered carnations (? *Dianthus caryophyllus*) is stated to be due to *Vermicularia herbarum* (Westend.) Kicks (= *V. dianthi* Westend.).

The plants were not usually killed but were partially defoliated at the base, where the fungus occurred on both stems and leaves. In the middle part of the plant, the leaves only bore small, black dots, formed of sterile fungous tissue, while the top leaves were quite clean. Mature fructifications of the typical *Vermicularia* form were only found at the base of the stem or on old, severely attacked leaves. They bore few conidia. True sclerotia were not seen, but small, compact masses of brown cells are sometimes formed, and possibly play a part in the overwintering of the fungus.

BROWN (NELLIE A.). **Bacterial leaf spot of Geranium in the eastern United States.**—*Journ. Agric. Res.*, xxiii, 5, pp. 361–372, 3 pl., 1923.

A bacterial leaf spot disease of the cultivated geranium (*Pelargonium* spp.) occurs very widely in eastern United States, mostly on greenhouse plants, but occasionally out of doors also. The causal organism, the morphological and cultural characters of which are fully described, was isolated from diseased plants, and inoculation experiments on healthy geraniums resulted in the typical symptoms of the disease. The organism is regarded as distinct from *Bacterium erodii*, already known to cause a disease of pelargonium leaves, and is named *Bacterium pelargonii* n. sp. Suggestions for control of the disease are given, the chief being the proper regulation of greenhouse conditions and proper spacing of the plants out of doors. Infected leaves should be removed, and very sensitive varieties discarded.

DUCOMET (V.). **Observations sur le développement du Rhizoctone de la Lucerne.** [Notes on the development of the Rhizoctonia disease of Lucerne.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 312–316, 1922.

The author gives an account of his observations on the violet root rot of Lucerne [*Rhizoctonia violacea*] during many years in south-west France, especially in the Lot-et-Garonne Department.

He states that the disease is favoured by dry conditions, and also by a shallow soil, which permits only a surface root system to develop. The latter factor was responsible for the varying severity of the disease in different parts of an experimental field that has been under observation since 1919. In this field a flat portion consisted of shallow soil overlying fissured calcareous rock, while the adjoining slopes were formed of a deep clay subsoil. The disease was practically confined to the former area, where, however, it was absent from spots in which the soil occupied deeper 'pockets' in the rock. The real cause of the damage in the shallower soils is considered to be insufficient water supply to the roots.

The deaths from the disease are stated to occur chiefly at the beginning of summer and early in autumn. The former period coincides with the onset of dry weather, but the latter is usually wet. It is believed that actual infection of the root by the parasite occurs chiefly during wet periods, and the deaths observed in any one year are probably each the result of an infection contracted during the preceding autumn. If this has made much progress death will result during the dry season at the commencement of the following summer, otherwise the plant survives until a further extension occurs during wet weather later in the year.

If any advantage is to be expected from soil disinfection, as often recommended, the treatment must be given in the autumn, but the author is not hopeful, pending further experiments, of much success in this direction. No evidence has as yet been obtained that it will be possible to select resistant strains of lucerne. Attempts to inoculate strong and well-developed plants have failed, and the parasite, like *Armillaria mellea* and *Ophiobolus cariceti*, is regarded as definitely harmful only to weakly plants.

BENNETT (C. W.). **Apple scab and its control.**—*Quarterly Bull. Michigan Agric. Exper. Stat.*, v, 3, pp. 130–134, 2 figs., 1923.

The season of 1922 was very favourable for the early development and spread of apple scab [*Venturia inaequalis*], a brief popular account of the symptoms and life-history of which is given. A study of the rate of development and discharge of the winter spores under Michigan conditions showed that by 17th April the great majority of the ascospores which developed in the perithecia on fallen leaves, were ripe and ready for emission during the first rain, which occurred a week later. The spots produced by the first infection were far enough advanced in the next three weeks to form conidia. The danger of early infection is so great in Michigan that the application of a pre-pink spray [see this *Review*, ii, p. 71] cannot be dispensed with.

'Bunchy top' and 'choke throat' in Bananas.—*Queensland Agric. Journ.*, xviii, 5, pp. 368-369, 1922.

In order to check the spread of 'bunchy top' of bananas [see this *Review*, ii, p. 354], the New South Wales agricultural authorities have prohibited the removal of suckers from certain of the Northern River areas. They have also instituted manurial investigations and experiments in dipping. The affected region reaches down towards Byron Bay, and the Brunswick River area is now involved. Plants may not be taken south of a line drawn from east to west south of the Brunswick, and may only be imported from Queensland with the sanction of the Government banana expert. 'Bunchy top' must not be confused with 'choke throat', a contraction of the 'throat' of the banana which prevents the bunch from emerging. This condition is brought about by a protracted spell of drought.

Banana bunchy top disease.—*Queensland Agric. Journ.*, xix, 1, pp. 32-33, 1923.

The results of the investigations on bunchy top of bananas conducted by Darnell-Smith and Tryon in New South Wales have been embodied in a report to the Ministry of Agriculture. The disease has extended from New South Wales into the south-eastern corner of Queensland, where it is causing much loss to growers. The recent research work and field experiments have considerably narrowed the problem by showing that certain theories formerly advanced to explain the disease must be dismissed as untenable.

Field experiments have proved that the use of complete fertilizers of varying constitution, as well as those providing mainly a single essential plant food, do not prevent the occurrence of the disease either in relatively rich or relatively poor soils. The loss of vigour in banana plants by the continuous use of strains of a single origin was also proved not to be an operative factor in bunchy top, which occurred with equal prevalence on plants imported into the affected area from remote districts. Negative results also followed the application of lime or basic phosphates to the soil in order to counteract soil acidity; while the disinfection with various fungicidal preparations of suckers and the soil in which they were planted was equally ineffective in checking the disease.

Investigations have hitherto failed to reveal the presence of fungi capable of originating bunchy top under experimental conditions, though certain organisms, amongst which are some belonging to groups known to contain parasitic forms, have been observed. Further research on these lines is in progress. A nematode has commonly been found in the roots of plants affected with bunchy top, but its presence is not invariable and it cannot, therefore, be the sole cause of the disease. It has been suggested that the banana aphis (*Pentalonia nervosa*) transmits the disease from one plant to another, or is even possibly the primary cause of bunchy top, but general observations do not support this theory, though field tests based on it are being carried out.

Meteorological factors do not appear to play any considerable part in bunchy top, although a further study of climatic and soil conditions in relation to the disease is necessary before a definite statement to this effect can be made.

Cunningham (G. H.). **Leaf-curl, bladder-plum, and cherry-curl. Their appearance, cause, and control.**—*New Zealand Journ. of Agric.*, xxvi, 2, pp. 85–97, 7 figs., 1923.

Leaf curl, bladder plum, and cherry curl in New Zealand are caused by *Taphrina* [*Exoascus*] *deformans*, *T.* [*E.*] *pruni*, and *T.* [*E.*] *minor* respectively. The symptoms of these diseases and the life-history of the fungi concerned are described and figured. *E. deformans* attacks peaches, nectarines, almonds, and apricots in New Zealand, being especially severe in seasons of alternating cold and warm weather. Paragon and many other varieties of peach are susceptible, as well as all nectarines. Under New Zealand (Hawke's Bay) conditions Hobbs's Royal, Charlotte, Hales's Early, and Saunders are resistant, but varietal susceptibility differs widely with the locality. Seedling peaches are generally susceptible.

Bladder plum is confined in New Zealand to the plum, the so-called Japanese plums being the most susceptible, though English varieties are occasionally infected. The results of infection include blistered leaves, distorted shoots, dropping of buds, and swollen and hollow fruits.

Cherry curl appears so far to be restricted to isolated orchards in Hawke's Bay and Central Otago, occurring on the Black Tartarian, Early Purple Guigne, and an unknown variety. In Germany the fungus is stated to attack the ground cherry (*Prunus chamaecerasus*) as well as *P. cerasus*, but the latter is the only host known in New Zealand. There seems to be little danger of widespread infection. The symptoms resemble those of leaf curl, but the following points of difference should serve to distinguish the two diseases. Cherry curl attacks only one or two leaves on a branch, and is confined to a limited area covering about one half of the leaf. The leaf tissues and petioles are often curved so that apex and base point in the same direction.

Leaf curl and, to a less extent, bladder plum can be controlled by an application of 5–4–50 Bordeaux mixture or 1 in 15 lime-sulphur when the buds begin to swell. Where leaf curl infection continues to appear throughout the season, spraying should be supplemented by the excision of infected shoots. In bladder plum, and especially in cherry curl, it is always necessary to cut out infected shoots or branches, and this should be done in cherries shortly after growth begins in the spring. Each wounded surface should be at once painted with coal-tar. Bladder plum is only partly controlled by spraying and cherry curl not at all, infection in each case coming from a perennial mycelium in the shoots. Shoots and branches need not be cut back to a greater distance than 2 in. below the point of visible infection, as the mycelia do not readily grow downwards into larger shoots.

WELDON (G. P.). **Spring spraying of Peaches with lime-sulphur.**—*Monthly Bull. Dept. Agric. California*, xii, 1–2, pp. 44–47, 1923.

Experiments in the combined control of leaf curl (*Exoascus deformans*) and the twig borer (*Anarsia lineatella*) of the peach, carried out in California in the spring of 1922 with commercial dry and liquid lime-sulphur, gave excellent results. The experiments are described in detail. A single spraying was given, different plots being treated at different dates. The dry lime-sulphur was stated by the manufacturers to be of such a strength that 2 lb. equalled 1 gall. of the liquid preparation, and was recommended for use dissolved at the rate of 2 lb. to 10 galls. water. The liquid lime-sulphur tested 33° Baumé, and was used at a strength of 1 gall. to 10 galls. water. Both gave practically complete control, and early applications in February were as effective as the later ones in March.

The treatment should be given before the trees bloom, but even when lime-sulphur is applied to peach trees in full flower there is very little risk of injury.

VILLEDIEU (G.) & VILLEDIEU. **Action des oxydes insolubles sur le mildiou de la Pomme de terre (Phytophthora infestans).** [Action of insoluble oxides on the potato mildew (*Phytophthora infestans*).]—*Comptes Rendus Acad. des Sciences*, clxxvi, 8, pp. 534–536, 1923.

In a series of experiments, in which they used conidia of *Phytophthora infestans* and various insoluble metallic oxides (of cadmium, nickel, cobalt, zinc, black oxide of copper, red oxide of mercury, calcined and hydrated magnesium), the authors claim to have established that the latter are toxic to the fungus to the extent that they inhibit the germination of the spores. The insoluble or slightly soluble oxides were placed in twice distilled water for at least 24 hours, with frequent stirring, and the water filtered off in one series, while in another the oxide was left suspended in a finely powdered form in the water. In the former the spores germinated normally, and gave active zoospores. In the latter the few zoospores that escaped were immediately killed. Further experiments showed that killing only took place in the immediate vicinity of the solid particles. This toxicity is considered to be connected, in part at least, with the basic function of the oxides used, since a number of others tested had no such action, and besides, by reducing the oxides to salts by the addition of mineral or organic acids, their toxicity was very considerably diminished.

BRYCE (G.). **The toxicity of lime to Fomes lignosus Klotzsch.**—*Ceylon Dept. of Agric. Bull.* 64, 17 pp., 1923.

The application of quicklime to infected soil for the control of *Fomes lignosus*, which causes considerable damage to the roots of *Hevea brasiliensis* in Ceylon and elsewhere, is fairly general. After the removal of the diseased trees the quicklime is forked into the soil or scattered over the surface at the rate of about 60 lb. per tree. The effect of the lime on the fungus may be two-fold: (1) scorching caused by direct contact; (2) toxicity produced by the slaked lime in solution or by the alkalinity induced in the soil.

Quicklime having occasionally proved ineffective in the field, cultural experiments were carried out in order to obtain information as to the growth of the fungus under acid and alkaline conditions, and to investigate the action of quicklime on its development.

Pure cultures were obtained from a young fructification and subcultured on a neutralized medium, as required, during the remainder of the experiment. The fungus grew best on French bean agar, forming a thick, felted mycelium interspersed with strands; on maize and potato the growth was somewhat thinner. Particulars are given of the titration of the media and the preparation of the acid, alkaline, and control series of cultures. The following substances, namely, hydrochloric acid, sulphuric acid, citric acid, caustic soda, and caustic potash, were added to the media in the toxicity series, in different concentrations, obtained by adding varying quantities, by volume, of normal solution to 12 cc. of medium. Lime was added as slaked lime in weighed quantities and as concentrated lime water solution.

The results of the experiments, which are described in detail, showed that the fungus is capable of growth on media up to -66 Fuller's scale, while it develops with difficulty at $+8$, and is totally inhibited at $+16$ of the same scale. At -8 Fuller's scale growth was generally equal to that on the neutral control dishes. The fungus, therefore, is capable of growth under a wider range of alkaline than of acid conditions. With slaked lime total inhibition of growth occurred at a concentration of about 0·15 gm. per 11·25 gm. of medium, or 1·33 per cent. of slaked lime. Taking the top 8 in. of soil as weighing 2,000,000 lb. per acre, and the area occupied by one tree as 480 sq. ft., the weight of the top 8 inches of soil round one tree is 22,000 lb. To obtain a concentration of 1·3 per cent. of slaked lime in this quantity of soil the amount required for each tree would be 292 lb., or roughly five times the quantity usually applied.

The fungicidal effect of burnt lime on *Fomes lignosus* mycelium depends on the caustic action of caustic lime in direct contact with the mycelium, and on the degree of alkalinity subsequently produced in the soil. The proportion of caustic lime in Ceylon burnt coral lime is only 25 per cent., as against 80 to 90 per cent. in good European burnt lime. Hence the corresponding lower fungicidal value of the Ceylon product. Carbonate of lime has no deterrent effect on the growth of the fungus. Recent soil studies demonstrate that, under Ceylon conditions, the quicklime applied to the soil is rapidly converted into carbonate. Its effects on the mycelium of *F. lignosus,* therefore, are purely ephemeral, and its application, pending further investigations, cannot be recommended.

Parker (T.) & Long (A. W.). **Spray spreading agents.**—*Bull. Bureau Bio-Technology* (Murphy & Son, Ltd., Sheen Lane, London), 8, pp. 252–258, 10 figs., 1923.

In this paper various experiments are described the aim of which was to determine the value of calcium caseinate as a spray spreader.

In the first experiment, two clean sheets of glass were sprayed, one with lime-sulphur 1 in 20 and the other with a similar solution to which 0·2 per cent. of calcium caseinate had been added. The plates were allowed to drain and photographs of them show the deposit from the former solution in patches, whereas that from the latter is evenly distributed.

Similar experiments with ammonium polysulphide 1 in 100, arsenate of lead 4 lb. to 100 galls., and liver of sulphur and nicotine petroleum emulsion gave similar results.

Dried films from lime-sulphur, ammonium polysulphide, liver of sulphur, and lead arsenate solutions with and without the addition of 0·2 per cent. calcium caseinate were examined microscopically, and it was observed that the particles deposited from solutions with the spreader were much closer together than those from solutions without. The former therefore would probably have a greater fungicidal efficiency.

An experiment was carried out to ascertain the effect of calcium caseinate over the rate of settling of a suspension of lead arsenate. The latter (4 lb. to 100 galls.) was placed in one cylinder, and a similar suspension, with calcium caseinate added, in another, the cylinders being shaken simultaneously for one minute before being allowed to settle. Photographs taken at intervals show in the former case evidence of sedimentation in five minutes, whilst after fifteen minutes settling was nearly finished, and in an hour it was complete; in the latter case the arsenate still showed excellent suspension six hours later. The addition of calcium caseinate to lead arsenate therefore obviates the necessity for very elaborate stirring gear in the spraying machine.

A number of experiments were carried out to test the spreading power on plants of solutions with and without the addition of calcium caseinate. Foliage having a polished and smooth surface (e. g. ivy, apple) yielded results similar to those on plate glass, whilst on leaves with spines (e. g. hop, marrow) the fluid either with or without the spreader appeared to collect in globules on the apex of the spines, and on leaves with a waxy bloom (e. g. carnation, savoy, cabbage) the spreader had little effect in increasing the spreading.

Further experimental work is stated to have shown that apple scab [*Venturia inaequalis*] and American gooseberry mildew [*Sphaerotheca mors-uvae*] can be controlled with lime-sulphur, 1 in 160, used in conjunction with calcium caseinate, without defoliation or russeting.

ADAMS (J. F.). **Improving our orchard sprays with a fixative.**— Reprinted from *Trans. Peninsular Hort. Soc., 1923,* pp. 1–8, 1923.

In a somewhat detailed historical summary of the development of the use of spreaders from 1885 onwards, the author, following Moore, first points out that 'spreading' refers to the formation, or maintenance after being formed, of a continuous film over the surface of the leaf, whilst 'adherence' applies to the resistance of the dried spray deposit to weathering. 'Wetting' is the slight chemical or physical affinity between the liquid and solid, and is one of the factors producing a continuous film.

Of recent years much attention has been given to the possibility of using casein as a spreader. This substance is colloidal in character, and combines with certain other substances to form agglutinant compounds which are very stable and extremely resistant to moisture and atmospheric changes.

In order to obtain a preparation in liquid form and one thereby easier to use, experiments were made to bring the casein into solution. Casein is soluble in an alkaline solution, but the process is slow when lime is used, and the proportion of lime necessary increases the volume of the resultant mixture. Sal soda was found to be the most economical of the efficient substances tried and a stock solution of the following composition was adopted. Casein 5 lb., sal soda 1 lb., water 10 galls. [American]. The sal soda is added to the water, which is then gradually heated and the casein added slowly during heating. The latter should become dissolved in about 10 minutes, boiling being unnecessary. This stock solution should be of a slimy, sticky consistency, and should be used at the rate of 2 qts. per 200 galls. of diluted spray solution, producing a foam on the surface of the latter after thorough mixing. The casein solution imparts to the spray both spreading and adhesive properties, and the author therefore applies the term 'fixative' to it.

A series of experiments was made to determine the quantity of arsenic in the deposit of an arsenic spray with and without the casein 'fixative'. The increase of arsenic adhering to the leaves when the latter was used amounted to 20 per cent. over the control.

Trials with the fixative on a commercial scale with B.T.S., atomic sulphur, lime-sulphur, and Bordeaux mixture were carried out with very satisfactory results.

COOK (M. T.). **The origin and structure of plant galls.**—*Science*, N.S., lvii, 1462, pp. 6–14, 1923.

The author considers that the study of the pathological histology of plants has been greatly neglected, especially in America. Workers on the various groups of galls caused respectively by insects, fungi, nematodes, and bacteria, have generally known little of the studies pursued by investigators in the other groups. The results of these studies require to be correlated in order to serve as a basis for future research in this important branch of botany.

One of the earliest problems which arose in connexion with plant galls was the nature of the irritant, and this has not yet been fully solved. In the case of both insect and nematode galls it is uncertain whether the stimulus which induced their formation is mechanical or chemical, and the same seems to be true of galls caused by fungi. The slime mould *Plasmodiophora brassicae* penetrates the cells, causing enlargement and division not only of the cells with which it comes into direct contact, but also of those in the vicinity. The latter are apparently stimulated by the passage of some substance from the diseased cells. Oedemas are well known to result from chemical irritation, while calluses and the like are frequently due to mechanical causes. Many insect galls are now believed to be the result of purely mechanical stimuli.

Galls caused by bacteria may be divided into three groups: (*a*) the olive knot group [*Pseudomonas savastanoi*], in which the bacteria occupy small pockets and stimulate the surrounding cells; (*b*) the legume nodule group, in which the bacteria are within the cells; (*c*) the crown gall group, where the position of the bacteria does not seem to be well understood.

There are three well defined stages in the formation of plant galls: (1) cell enlargement or cell division or both; (2) the failure of the affected part to differentiate into the characteristic tissues of the normal plant organ on which the gall is formed; (3) the differentiation into the characteristic tissues of the gall. Küster has classified galls into two comprehensive groups: (1) kataplasmas or those in which the structure is undifferentiated parenchyma and (2) prosoplasmas in which there is a differentiation into other tissues. The galls of *P. brassicae* on the Cruciferae are true kataplasmas, intumescences are very simple kataplasmas, and bacterial and fungous galls include kataplasmas and simple prosoplasmas.

Insect galls all originate from the meristematic cells and are at first true kataplasmas, but many of them pass into the prosoplasma stage in which fibrous and sclerenchymatous tissues are more or less prominent. The writer's researches have consistently indicated that insect galls always originate during early periods of very active development in the life of the plant. In nematode galls the point of excitation is less definite than in the insect galls, and the form and character of the abnormality vary according to the age of the root and the number of individuals attacking it.

Some of the fungous galls are kataplasmas, while others are prosoplasmas of varying degrees of complexity. In all cases the direct modifications are mainly in the parenchyma tissues. Study of the galls caused by the cedar and apple rust fungi have led to very divergent conclusions. Stewart believes that galls of *Gymnosporangium juniperi-virginianae* arise from axillary buds, and that each gall contains two fibro-vascular systems, one derived from the incipient stem and the other from the leaves; the parenchyma tissues predominate, and the fibro-vascular structures are dwarfed and modified. He finds practically the same condition in the galls of *G. globosum.* Reed and Crabill believe that the galls arise from the leaf, and their descriptions indicate that in origin and structure these galls are similar to those caused by the Cynipidae on oaks and roses. The author has studied a number of other plant galls due to fungi and found them to conform quite well in origin, structure, and development to insect galls in general.

The galls caused by *P. brassicae* have been closely studied of recent years by Lutman, Chupp, and Kunkel. They are true kataplasmas, and it is evident that the cortex of the host reacts to the organism, that the cambium is specially susceptible, and that the cells of the medullary rays also respond to the stimulus. The distortions of the xylem appear to be due to the force exerted by the infected rays and other parts. The action of the organism on the cambium tends to prevent the formation of vascular elements.

Bacterial galls must be classed as kataplasmas, or in some instances as very low forms of prosoplasmas. The legume nodules due to *Bacterium radicicola* and the olive knot also appear to originate in the cambium, and are true kataplasmas. Recent studies on crown gall indicate that all meristematic cells react to *B. tumefaciens*, but the character of the galls depends largely on the activity of the cells at the time of infection. The author believes that the xylem seldom, if ever, reacts to stimulation by *B. tumefaciens*, though the sheath cells may do so. The most complex and definite galls in this case arise from the cambium, the simpler ones from other meristematic tissues. The development of rather weak fibrous tissues in the galls indicates that the crown gall is a low type of prosoplasma. It agrees very generally in origin, development, and mature structure with other plant galls regardless of the causal organism. There are, however, three marked differences between some of the bacterial and the other galls, namely, (1) the presence of the tumour strands in crown gall; (2) the more prolonged or more variable stimuli of bacterial galls; (3) the formation of embryomas or tumours containing leaf shoots or roots attributed to crown gall. The first appears to be a well defined feature of crown gall, but not of other types of bacterial galls; the second and third are still open to question.

In answer to the author's queries, Dr. E. F. Smith defined embryomas as 'crown galls containing aborted shoots, often in great numbers', and differing from the aerial tubers on potatoes caused by *Rhizoctonia solani* in their adventitious character. He also stated that the shoots resulting from inoculation with *B. tumefaciens* do not differ from shoots arising as a result of other injuries, except that the tumour tissues mingle with them, causing injury and abortion. Levine, working with crown gall on *Bryophyllum calycinum*, states, however, that *B. tumefaciens* does not cause the formation of the leafy shoots, but inhibits and retards normal development; the formation of the leafy shoots is mechanical and secondary to that of the gall. The production of buds where they do not normally occur has been reported by Woronin, Favorsi, and Kunkel in *Plasmodiophora brassicae* infections.

The fungous, slime mould, and bacterial galls differ from the more highly developed insect galls in the absence of any well defined cessation of cell activity such as results in the latter case when the larva reaches maturity.

The researches of Wells confirm the author's view that all galls originate with the excessive development of parenchyma tissue. Accepting Küster's groupings into kataplasmas and prosoplasmas, Wells points out that the latter have arisen by evolutionary processes. Kataplasmic evolution is the result of progressive inhibition of differentiation ending with tissue homogeneity. Prosoplasmic evolution begins when homogeneity has been attained and is the development of new tissue characters.

The author concludes that all galls originate in practically the same manner whatever the stimulus which excites their growth may be. The latter must be applied to meristematic tissues, but in all cases it appears that it may extend beyond the point occupied by the causal organism. In most cases the stimulus is probably due to an excretion by the organism and the reaction of cells to the stimulus is remarkably similar whatever the nature of the latter.

Butler (E. J.). **Some characteristics of the virus diseases of plants.**—*Science Progress*, xvii, 67, pp. 416–431, 1923.

In this paper the information at present available on the virus diseases of plants is summarized and discussed. Four main groups are distinguished : mosaic, infectious chlorosis, phloem necrosis, and the peach yellows type, the last two being regarded as allied. The work of various investigators is outlined and the symptoms of the diseases described. An account is given of the different methods of transmission, the passage of the virus within the plant, and the properties of the virus. The influence of environmental factors, including temperature, soil, fertilizers, and light, is briefly discussed, and the paper concludes with some general observations on the nature of the diseases, their economic importance, and the analogy between them and certain diseases of animals and man.

COLEMAN (L. C.). **The transmission of Sandal spike.**—*Indian Forester*, xlix, 1, pp. 6–9, 3 pl., 1923.

The author has shown in a previous paper (*Dept. Agric. Mysore, Mycol. Ser., Bull.* 3, 1917) that sandal spike can be transmitted by means of grafting, this being the only method of transmission hitherto established. It is obvious, however, that in nature the disease must be transmitted in some other way, either through the roots or through the aerial portions of the tree. The fact that sandal trees readily form haustorial connexions with the roots of sandal as well as of other trees suggested the probability of root transmission, and an experiment was therefore carried out to settle the question.

During 1916 a number of seedling sandal trees were transplanted in groups of two or three in common pits in the laboratory compound and left to grow till June 1921 to ensure the development of a good root system and the formation of haustorial connexions. On 11th June 1921, one of the seedlings in several of these groups was grafted with bits of branches from a diseased tree. In the case reported in detail the scion grew, producing the typically spiked leaves of the stage shown by the tree from which it was taken. On 1st July 1922, the disease was first observed breaking out simultaneously on all parts of the adjacent tree in the pit. This phenomenon differed completely from that produced by grafting, when the disease spreads gradually from branch to branch. Two months later the roots of the two trees were examined and three haustorial connexions were established, two belonging to the ungrafted and one to the grafted tree. The haustoria were alive and apparently functioning. Many other haustoria were unearthed, some forming connexions between two roots of the same tree, and others being attached to the roots of an adjacent cork tree (*Millingtonia hortensis*).

It is important to note that two of the above-described haustorial connexions were of the ungrafted tree on the grafted one. The infective virus or ultramicroscopic organism could readily be taken up by these haustoria and carried into the previously healthy tree along with the sap stream. Probably, however, any organic connexion from grafted to ungrafted or vice versa would lead to infection.

The result of this experiment, which is supported by two other similar cases in which the roots have not yet been exposed, proves conclusively that spike disease is transmissible through the haustoria, and at the same time disposes of the theory of an external cause of infection. In the area in which the experiment was conducted there were at least one hundred sandal trees, and not a single case of spike has occurred except those brought about artificially by grafting or haustorial infection as described above.

It is highly improbable that the natural transmission of spike disease occurs only through the haustoria. New diseases of the same general type have recently been discovered in large numbers and in many cases insects have been definitely proved to be responsible for their transmission from infected to healthy plants. Experiments will be undertaken to ascertain whether insects are concerned in the transmission of spike disease.

BRANDES (E. W.). **Mechanics of inoculation with Sugar-cane mosaic by insect vectors.**—*Journ. Agric. Res.*, xxiii, 4, pp. 279–283, 2 pl., 1923.

A study of the results of experiments conducted in the United States, Java, Cuba, Hawaii, and Porto Rico, affords conclusive proof that *Aphis maidis* is capable of transmitting mosaic disease of sugar-cane. Evidence has further been adduced which indicates that *Peregrinus maidis* and possibly *Carolinaia* sp. may also act as agents of transmission.

The results of recent experiments carried out by the author demonstrated that with *A. maidis* the beak is usually placed on the thinnest point of the cuticle covering a stomatal guard cell, and the setae are then thrust into the cuticle by pressure. A copious secretion is poured out at the end of the setae from the salivary glands, and continues to exude from the tips of the setae as they pass into the deeper tissues, forming the sheath described by Büsgen in his work on aphids and honey dew in 1891. The setae of *A. maidis* pass through the sub-stomatal cavity, then either inter- or intracellularly through the mesophyll cells, continuing between two cells of the starch sheath and finally into the phloem of the vascular bundle. During the entire process, the copious secretion from the insect pours into the rapidly-growing tissues of the leaf, which remain practically intact. The fact that the setae reach to the phloem cells, rich in substances of nutritive value for micro-organisms, seems specially significant. In the writer's opinion, the secretion above mentioned is unquestionably the medium whereby the infective principle of mosaic is carried into the plant. A more perfect mechanism for inoculation could scarcely be devised. There is no apparent wound reaction on the part of the plant; at any rate, none could be seen in the phloem.

Sections of the leafhoppers, *Peregrinus maidis* and *Draeculacephala mollipes*, point to the tracheae rather than the phloem as the object of attack with these forms. It would appear possible for the latter insect to penetrate to the vascular bundles by mechanical pressure alone, instead of by the digesting action of saliva, which appears to be necessary for the process in the case of *A. maidis*.

SALMON (E. S.). **'Mosaic' disease of Hops.**—*Journ. Min. Agric.*, xxix, 10, pp. 927–934, 3 figs., 1922.

An obscure disease of hops, somewhat resembling, but distinct from the 'nettlehead' or 'eelworm' disease is stated to belong to the mosaic or 'virus' group of plant diseases, and it is suspected that the 'nettlehead' disease also belongs to this group and is not caused by eelworms.

In the mosaic disease described in the present paper, the plant is usually infected for some time before the symptoms become noticeable. The stems ('bines') have shortened joints, are unable to climb, and grow to a height of only four to six feet from the ground. The leaves are somewhat curled with recurved margins (not incurved, as in nettlehead), more or less mottled green and yellow, and, together with the upper part of the stem, markedly brittle. All such affected bines remain sterile. The diseased shoots may remain green throughout the season or die off during the summer; the roots on examination are found to be partly dead. Less frequently—possibly in cases of recent infection—the bine attains a normal height and produces a varying amount of hops, but symptoms of disease are apparent in the curling and mottling of the leaves, especially of the lateral branches, and in certain characteristic malformations of the hop-cones. In the commercial hop-gardens this relatively mild form of the disease is probably overlooked, with the result that the disease is spread by cuttings taken from such hills. In rare instances the tips of the bines and lateral branches die back for a certain distance.

The disease has been under observation for some years past both at Wye and at the East Malling Research Station, and all the available evidence shows that the infection is frequently spread by means of cuttings taken from affected plants at a time when the latter were apparently healthy. Details of several cases are given in which the disease, in a latent form, was carried in cuttings taken from apparently normal plants.

Attempts to control the disease by the early pulling of shoots from affected hills, in the hope that the shoots arising later would be healthy, gave negative results except in a very few instances. The full control of the disease cannot be achieved until its exact cause and the manner of infection are known, but in the meantime the following measures may be recommended. (1) Immediate grubbing up of affected hills. (It is believed that green-flies (aphids) and possibly other insects transmit the disease from infected to healthy plants). (2) The careful inspection of adjoining hills for the detection of the first signs of the disease. During June and immediately before picking a systematic examination of the gardens should be made. (3) Cuttings should, if possible, not be taken at all from any garden affected with mosaic disease; if this course is impracticable they must not, on any account, be taken from the hills contiguous to one which has been grubbed up.

Lundegårdh (H.). **Die Bedeutung des Kohlensäuregehalts und der Wasserstoffionkonzentration des Bodens für die Entstehung der Fusariosen.** [The importance of the carbonic acid content and hydrogen-ion concentration of the soil in the origination of *Fusarium* diseases.]—*Bot. Notiser*, 1923, 1, pp. 25–52, 4 figs., 1923.

The results of a series of experiments carried out in 1922 showed that a concentration of carbonic acid exceeding 1 per cent. in the soil delayed the germination and development of wheat seedlings. The addition of 3 to 5 per cent. of CO_2 resulted in a reduction of germination exceeding 50 per cent. There was no trace of the alleged stimulating effect of carbonic acid observed by previous investigators. Corresponding tests with three species of *Fusarium* (*F. avenaceum*, *F. culmorum*, *F. herbarum*) and *Gibberella saubinetii* indicated that high concentrations of CO_2 (3 to 7 per cent.) not only exerted no retarding influence on mycelial growth, but actually stimulated it in two cases (*G. saubinetii* and *F. culmorum*). Thus it is evident that the fungi in question can thrive in conditions which adversely affect the development of seedlings. This fact may give a useful clue to the cause of the prevalence of fungous attacks in impermeable soils.

The infection of growing seedlings by the fungi in question was favoured by the presence of 2 to 8 per cent. of carbonic acid in the air. In every case the seedlings were reduced to an enfeebled condition by the carbonic acid. Under natural conditions the seedlings are exposed to the soil atmosphere during the first few days, and if this is rich in CO_2 a somewhat similar effect would be produced. The attacks of *G. saubinetii* and *F. avenaceum* were very virulent under such conditions, the affected plants showing the typical symptoms of wilting, namely, a brown discoloration of the base of the stem and a stoppage in the flow of water through the vessels. The disease was progressive, more plants showing evident symptoms of attack after 30 than after 9 to 12 days. The CO_2 treatment ceased after 9 to 12 days, so that the later development of the disease indicated that once infection has been promoted the subsequent growth of the parasite within the host tissues is not dependent on CO_2 to the same degree. In certain cases, however, the infected plants outgrew the infection and developed normally, another typical feature of foot rot of wheat under natural conditions.

The injurious influence of impermeability of the soil may be due not only to excess of carbonic acid but also to a deficiency of oxygen. The latter must be very pronounced, however, to produce any noteworthy effect, as cereals and other economic plants germinate normally at one-fifth to one-tenth of the normal oxygen pressure. The likelihood of such a shortage of oxygen in ordinary cultivated soils is negligible, and the arrested development of the seedlings used in the experiments may safely be attributed to the high proportion of carbonic acid.

Experiments were also carried out with hydrogen-ion concentrations ranging from 2·7 to 8·4, within which limits the four species referred to above were capable of growth. The germination of wheat was lessened at P_H 5·5 to 5·9, on each side of which the germination curve rose to about P_H 5 and P_H 7 respectively. At P_H 2·7 to 3·0 development of the fungi proceeded very slowly. Morphological differences were also noticeable in the fungus cultures; at high concentrations several distinct colonies were formed, while an alkaline reaction produced only a single, thin, hyphal membrane. The results of the author's tests with *G. saubinetii* confirmed those obtained by Hopkins [see this *Review*, i, p. 340], the growth curve showing a minimum at about P_H 5·6, on each side of which it rose in approximately the same manner as in the wheat germination curve. All the species showed a definite tendency to develop a slightly alkaline reaction in the culture medium. *G. saubinetii* and *F. avenaceum* exhibited this character most strongly, which may account for their capacity to flourish in almost all soils and to withstand the acidity in the sap of their host plants.

It has frequently been observed that plentiful fertilization with organic manure, especially in a fresh condition or too late in the season, favours the development and spread of infectious diseases. On the results of these researches the author attributes this to the fact that, even in moderate quantities, such manure increases the CO_2 content of the soil, with the consequences described above.

Priestley (J. H.) & Woffenden (Lettice M.). **The healing of wounds in Potato tubers and their propagation by cut sets.**— *Ann. of Appl. Biol.*, x, 1, pp. 96–115, 3 figs., 1923.

When the cut surface of a potato tuber is exposed to air, the sequence of events during the healing process is as follows, the colour changes, which are of no direct significance, being omitted. The first step is the deposit of a fatty 'suberin' layer, formed by the oxidation and condensation of the fatty substances from the sap, along every wall of every cell at a certain depth below the cut surface. Oxygen seems to be essential to the formation of this layer, which develops within twenty-four to forty-eight hours and is continuous if the cut surface is exposed in a moist atmosphere, but is broken when the air is dry, and particularly when the cut surface is exposed to sunlight. When cut tubers are lost owing to fungous attacks the loss can often be traced to exposure to dry air or the sun after cutting, with consequent inefficiency of the protective suberin layer.

A few days later cork is formed below the suberin deposit, as the result of cell divisions in an active cork phellogen. This activity appears to be promoted by the accumulation behind the surface blocked by the suberin layer of sap-containing substances diffusing from the vascular bundles, and by the production of an acid reaction just below the blocked surface through the anaerobic conversion of sugars into fatty acids. The activity of the cork phellogen, which is roughly estimated by the number of cork layers produced, differs with the variety of potato, and tests have shown that Majestic, King Edward VII, and Bishop are particularly lacking in this respect. The results of the authors' tests bring out the undesirability of cutting potato setts in sunlight or exposing them to an exceedingly dry atmosphere before planting, and the advantage of an interval of one or two days between cutting and planting. The practice of treating cut setts either with slaked or caustic lime does not appear to serve any useful purpose, at least so far as it influences the healing of the wound.

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Cotton (A. D.). **Potato pink rot: a disease new to England.**—*Journ. Min. Agric.*, xxviii, 12, pp. 1126–1130, 1922.

During the summer of 1921 cases of potato pink rot (*Phytophthora erythroseptica*) were discovered in Shropshire and Hertfordshire. This is the first record of the disease in England, and although it is not necessarily true that it is new to the country, it is certainly as yet not present to any serious extent. As its symptoms in the growing plant are those of a wilt, while the denuded stems somewhat resemble those which have been severely attacked by *Phytophthora infestans*, it has possibly been mistaken for these diseases. In Shropshire pink rot was found in six localities near together, the variety attacked in all cases being Great Scot, grown from Scotch seed; this fact would point to the introduction of the disease with the seed from Scotland, where it is known to occur. In Hertfordshire the outbreak occurred in only one isolated field which had not been under potatoes for five years. The seed was home-saved, and the crop during 1920 showed no signs of pink rot. The indications are that the disease in this case was introduced with 'London manure' with which the field had been heavily dressed, and which contained a large amount of vegetable débris, including market refuse. A brief description is given of the disease, which owes its popular name to the fact that cut surfaces of infected tubers rapidly turn pink when exposed to the air. In some of the western districts of Ireland it has caused considerable losses, exceeding at times those due to *P. infestans*. It has been known there for years, but apparently has not spread to any extent. With proper rotation of crops, care in the use of healthy seed tubers, and precautions in regard to town manure highly contaminated with vegetable refuse, there is no reason to fear further serious outbreaks in England. Where pink rot has occurred, diseased haulms and tubers should on no account be left lying about and especially not allowed to reach the manure heap. Spraying is useless against this disease.

Doidge (Ethel M.). **Potato diseases.**—*Journ. Dept. Agric. S. Africa*, vi, 1, pp. 71–78, 1923.

In this paper an illustrated list of South African potato diseases is given, with brief popular descriptions and recommendations as to suitable methods of control.

Whetzel (H. H.). **The Alternaria blight of Potatoes in Bermuda.**—*Phytopath.*, xiii, 2, pp. 100–103, 1 fig., 1923.

The author describes an epidemic of early blight (*Alternaria solani*) of potatoes which occurred in Bermuda in the early winter of 1921. The disease appeared about mid-November on a luxuriant crop, and by the end of the month one-third of the potato fields were severely affected; the best yields from blighted fields were six barrels to one of seed planted. Features peculiarly striking in this outbreak were (*a*) its suddenness, (*b*) its severity, (*c*) the size of the leaf lesions and their similarity to those of late blight (*Phytophthora infestans*), and (*d*) the development of large water-soaked lesions on the stalks.

Bisby (G. R.), Higham (J. F.), & Groh (H.). **Potato seed treatment in Manitoba.**—*Scient. Agric.*, iii, 6, pp. 219–221, 1923.

Soil infestation with the fungus that causes black scurf of potatoes (*Rhizoctonia solani*) in Manitoba is such as to render the tubers extremely liable to attack, and the results of three years' experiments have shown that the disease cannot be controlled by the ordinary methods of seed treatment (corrosive sublimate, formaldehyde, and copper sulphate), found efficacious in other areas, where infection appears to result more commonly from the fungus on the surface of the seed.

During 1922, tests were made of the effect of planting and harvesting tubers at different dates, on the incidence of black scurf. Potatoes dug on 1st September showed an average of 39 per cent. affected by the disease; those dug on 10th September, 43·3 per cent.; on 4th October, 71·4 per cent.; and on 13th October, 82·8 per cent. Thus the longer the tubers were left in the ground, the higher was the percentage of infection. The average percentage of black scurf on potatoes planted on 5th May and dug at different dates was 73; those planted on 15th May gave 80; 22nd to 26th May, 76; 29th May to 1st June, 81; 10th June, 61·2; 20th June, 39·2; and 1st July, 42·5. Late planting within the time limits that are practicable in Manitoba, was therefore not effective in the prevention of the disease.

Goss (R. W.). **Potato diseases in Nebraska.**—*Nebraska Agric. Exper. Stat. Bull.* 186, 32 pp., 12 figs., 1923.

The following potato diseases occur in Nebraska: *Rhizoctonia* (*Corticium vagum*), *Fusarium* wilt and stem-end rot (*F. oxysporum* and *F. eumartii*), blackleg (*Bacillus phytophthorus*) [*B. atrosepticus*], scab (*Actinomyces scabies*), dry rot (*Fusarium tricothecioides*), early blight (*Alternaria solani*), mosaic and curly dwarf, leaf roll, net necrosis, hopperburn, tipburn, black heart, hollow heart, internal brown spot, and frost necrosis. In addition to a short account of each disease there is a table showing the symptoms, methods of transmission, and control measures.

Diseases carried on the surface of the tuber, such as scab and *Rhizoctonia*, may be controlled by seed treatment with corrosive sublimate (4 oz. to 30 galls. water). Owing to the absence of late blight [*Phytophthora infestans*] in Nebraska it is doubtful whether any advantage is to be derived from spraying.

TRINCHIERI (G.). **Su la pretesa presenza, in Italia, della 'rogna nera' della Patata.** [On the alleged occurrence of the black wart disease of Potato in Italy.]—*Riv. di Biol.*, v, 1, pp. 139–140, 1923.

Commenting on Dickson's paper 'Diseases of the Potato' [see this *Review*, ii, p. 26], the author refutes the statement that wart disease of potato [*Synchytrium endobioticum*] occurs in Italy, basing himself on the results of inquiries made up to date by the Italian Phytopathological Service. Furthermore, an order issued by the Ministry of Agriculture in 1921, and still in force, prohibits the importation into Italy of potatoes and of fruits and plants of all other Solanaceae from abroad with a view to protecting the potato crops against the introduction of the disease.

SCHULTZ (E. S.) & FOLSOM (D.). **A 'spindling-tuber disease' of Irish Potatoes.**—*Science*, N.S., lvii, p. 149, 1923.

Recent investigations by the authors have shown that a potato malady commonly known as 'running long' is an infectious disease, transmissible from affected to healthy plants by means of tuber and haulm grafts, leaf-mutilation inoculation, and plant lice. The disease is perpetuated from year to year by the tubers, and in the absence of control measures the incidence of infection in a given stock increases annually.

Plants infected late in the season may show no symptoms of the disease, while those infected early have erect, spindling stalks, smaller, more upright, and darker leaves than the normal foliage, and more cylindrical, spindling, and spindle-shaped tubers than healthy or apparently healthy plants. The eyes of the tubers are numerous and more conspicuous than usual. The yield is somewhat reduced in the first year, and there is a progressive decrease in later years in production from plants grown from spindling tubers. The term 'spindling-tuber disease' is proposed as appropriate to the symptoms described.

Further data on this and other so-called 'degeneration' diseases of the potato will be published in a later paper.

EDSON (H. A.) & SHAPOVALOV (M.). **Parasitism of Sclerotium rolfsii on Irish Potatoes.**—*Journ. Agric. Res.*, xxiii, 1, pp. 41–46, 3 pl., 1923.

Both the haulm and tuber of the Irish potato may be attacked by *Sclerotium rolfsii*, the symptoms of the disease varying with the age and environmental conditions of the plant. Very young plants growing in extremely damp soil are most likely to show signs of damping-off, while older plants may suffer from a rot of the roots or stems, or both, with subsequent wilting of the leaves and stems, the latter eventually lying prostrate on the ground.

Natural infection in the field was observed in an advanced stage in several southern States, the symptoms produced generally resembling those of wilt or stem blight. The stems were decayed at or near the surface of the soil, and in some cases the rotting of the underground tissues was so severe that only a few strands of vascular fibre remained attached if the tops were lifted. Wefts of mycelium or the sclerotia of the fungus would be seen clinging to the stem or extending radially from the plant in and on the surface of the soil.

Inoculation experiments carried out in 1919 at Arlington, Virginia, on forty tubers of the Irish Cobbler and Bliss Triumph varieties, with two different isolations of the fungus (*Sclerotium* nos. 126 and 127), resulted in severe infection. In 1920 the tests were repeated on the Irish Cobbler variety only, with two sets of plantings. In both tests the successive development of the various symptoms of the disease was essentially the same. There were first some missing hills where the seed pieces were destroyed in the ground, then some of the young plants that had come up showed symptoms of damping-off, and finally wilt, stem rot, and blight followed in the older plants. In 1919 no tubers were found in any of the thirty-five hills destroyed by the fungus, while the remaining five hills produced very small ones. The yield of the control plants was satisfactory. The severity of the attack of the two isolations differed somewhat, *Sclerotium* no. 126 (from North Carolina) destroying all the inoculated plants, while *S.* no. 127 (from Arkansas) appeared to be less virulent, five of the inoculated plants, though undersized, remaining otherwise unaffected by the disease. There was no perceptible difference in the response of the two varieties used.

In 1920 the most serious infection with *S.* no. 126 took place in the later of the two plantings or late in the earlier planting, while with *S.* no. 127 the position was reversed. These results indicate that the Arkansas isolation was more adapted to cooler, and the North Carolina to warmer, temperatures. In this experiment the total number of infected hills with *S.* no. 126 was nineteen, and with *S.* no. 127 only eight, out of twenty-four inoculated in each case. The apparently weaker pathogenicity of the latter accords well with the results of the 1919 tests.

The markedly different parasitic action of the two *Sclerotium* isolations and their different behaviour in the field suggest the existence of distinct morphological strains in *S. rolfsii*. Taubenhaus's assertion that the fungus comprised neither varietal nor physiological strains (*Journ. Agric. Res.*, xviii, 3, pp. 127–138, 1919) can be accepted only in respect of the particular strains included in his studies, and not of the species as a whole. The sclerotia of strain no. 126, considered relatively, were always larger than those of no. 127, and also showed a tendency to mass in clusters.

Potato tubers naturally or artificially infected with *S. rolfsii* are subject to a rapid progressive decay, the affected tissues being practically odourless and colourless in the earlier stages, but assuming a yellowish tinge in the older portions; they are also usually more or less porous. Strain no. 126 was isolated from this type of 'white rot', which may, under favourable conditions of humidity and temperature, develop into the so-called 'melter' type, in which the affected portions become very soft and watery. Both relatively young sclerotia and young mycelium of the fungus were used with equal success in the inoculation experiments, the inoculated tubers being placed in glass moist chambers or stone jars at a temperature of 20° to 22° C. for a fortnight.

The destructive effect of the fungus on tuber tissue was clearly seen on sterile raw potato blocks inoculated in Erlenmeyer flasks. The blocks were rapidly enveloped by a dense growth of pseudoparenchymatous mycelium, followed by abundant sclerotial formation in large, compact aggregates which were often an inch or more in diameter. At the maximum of mycelial development an increasing accumulation of light amber liquid appeared in the bottom of the flasks. This liquid obviously resulted from the action of the fungus on the potato. The mycelium did not penetrate the blocks, and it is therefore logical to infer that digestive enzymes are secreted which dissolve the host tissue, the latter being rendered available to the fungus by means of diffusion and osmosis. The middle lamellae are first softened, then the cell contents and cellulose walls, the starch being evidently the last of the solids to disappear. Partial autolysis of the mycelium and sclerotia occurred when the cultures were left undisturbed for a sufficient period.

Disks of raw potato in water treated with enzyme preparations of the hyphae softened to a curd-like consistency. Disintegration took place through the softening of the middle lamellae and consequent liberation of the individual cells, the process corresponding exactly with that described above as the initial stage of decomposition by the fungus itself.

SHAPOVALOV (M.). **Relation of Potato skinspot to powdery scab.**—*Journ. Agric. Res.*, xxiii, 4, pp. 285–294, 4 pl., 1 fig., 1923.

The skin spot disease of the potato tuber has been attributed to various organisms, and recently by Miss Owen to *Oospora pustulans*, but the author regards all these alleged causes as unconvincing, and believes skin spot to be primarily a young stage of powdery scab (*Spongospora subterranea*), although various saprophytic fungi are frequently found in the diseased spots. He states that the geographical distribution of skin spot is markedly similar to that of *S. subterranea*, and that it has not yet been reported from those regions where the latter is unknown. *O. pustulans* is either rare or entirely absent in the skin spot material of the United States, and in spite of the continuous influx of skin spot infected tubers into that country fails to establish itself, this behaviour being exactly similar to that of powdery scab.

In arrangement and appearance there is a great similarity of skin spot pustules to the closed sorus condition of powdery scab. On some tubers all stages of *S. subterranea* can be seen, and it is difficult to determine whether the infections should be classed as skin spot or powdery scab.

The writer was not able to detect plasmodia of *Spongospora* in the skin spot pustules, and suggests that this may be due to its disappearance at certain stages of development from spaces it formerly occupied. On the other hand, hyphae are entirely absent from a certain number of the pustules.

The formation of new cork below a skin spot, signifying the cessation of activity by the parasite, is inconsistent with the view that the damage is caused by *Oospora pustulans*, which is said to be invisible at lifting time, but to develop considerably in the stored potatoes as spring approaches. On the other hand, it is quite in harmony with the progress of powdery scab, which is active during the growing period of the tuber, but usually is more or less checked during storage.

Undoubted skin spot material was obtained from various parts of the world and yielded *O. pustulans* in 36·1 per cent. of cases. A number of plantings were sterile, and various other fungi were also obtained. *S. subterranea*, only once cultured by Kunkel, naturally did not occur. Inoculations of healthy tubers with *O. pustulans*, like those of Miss Owen, gave negative results, and the view is held that all the fungi isolated are mainly secondary invaders, developing during the storage period, whose presence is altogether unnecessary to give the appearance of skin spot. The principal invader in Pennsylvania is *Colletotrichum atramentarium*, in Germany a *Phoma*, in England *Oospora pustulans*.

If skin spot is merely an immature condition of powdery scab, then the abundance of the immature stage of the latter disease in certain years becomes an interesting phenomenon which may be due to various causes, e.g. an early check in the development of the disease, a late infection, drought, or varietal response.

Chardon (C. E.) & Veve (R. A.). **The transmission of Sugar-cane mosaic by Aphis maidis under field conditions in Porto Rico.** —*Phytopath.*, xiii, 1, pp. 24–29, 1 fig., 1923.

The authors have conducted a number of experiments in Fajardo, Porto Rico, the results of which tend to establish that the disease is transmitted by *Aphis maidis*. The discovery by Wolcott, at Santa Rita, of a quantity of *A. maidis* in the central whorl of leaves of young plants, correlated with a marked increase of mosaic disease, formed the starting-point of the investigations. In each of two large insect-proof cages, 24 by 15 by 5 feet, forty-eight setts of the susceptible DIIII cane variety were planted at ordinary field distances. In one case half the setts used were diseased, and the other half healthy. A large quantity of the common grass 'malojillo' (*Eriochloa subglabra*), a favourite host of *A. maidis*, was planted in cage A (which was not weeded), and a number of the insects introduced into it. Cage B was kept free from weeds and insects, and served as a control. One month after planting, when the cane plants were six to eight inches in height, the weeds in cage A, which included, besides *E. subglabra*, *Cyperus rotundus*, *Echinochloa colona*, *Eleusine indica*, *Syntherisma sanguinalis*, *Portulacca oleracea*, *Chamaesyce hypericifolia*, *Commelina* sp., *Amarantus spinosus*, and *Ipomoea tiliacea*, were systematically removed. Early the next day (the weeding having taken place at 5 p.m.) the aphids were seen feeding on the central whorl of the young cane plants, where they stayed until their favourite hosts grew again. Of these

Eriochloa subglabra decidedly ranked in the first order of preference, followed by *Echinochloa*, *Eleusine*, and *Syntherisma*. Secondary infection of the sugar-cane appeared quickly after this, the first case in two weeks, and fifteen out of the twenty-four healthy plants (62·5 per cent.) were infected by the end of two months. The plants in the control cage remained quite healthy throughout. Three of the grasses in cage A, *Syntherisma sanguinalis*, *Eleusine indica*, and *Echinochloa colona*, exhibited true symptoms of mosaic, from which, however, the favourite aphid host, *Eriochloa subglabra*, appears to be immune.

The locality in which the experiments were carried out is remote from any possible source of infection, so that the new cases of mosaic in cage A must have come from the diseased plants in the cage, and it is suggested that the infection must have been transmitted by *A. maidis*, the only insect present.

WAKEFIELD (F. W.). **A biometric study of the conidia of Macrosporium and Alternaria.**—*Papers and Proc. Roy. Soc. Tasmania, 1922*, pp. 27–31, 1 graph, 1923.

The dimensions of fungus spores are subject to considerable variation, and a marked lack of uniformity frequently characterizes the descriptions of an identical fungus by different authorities. Previous investigations by the author having shown a considerable range of variation in the dimensions of the conidia produced by *Cladosporium graminum* Cda. (*Scolecotrichum graminum* Fckl) and other species, a critical examination of two common species, *Macrosporium cladosporioides* Desm. and *Alternaria brassicae* var. *citri* Penz., was undertaken. These fungi have morphologically similar spores though they are borne in a different manner on the conidiophores. Cultures of the former were prepared on onion leaves, and were eight days old when the measurements were made. The *Alternaria* conidia were derived from a mandarin orange which was under observation on a culture dish. All the conidia measured in the latter series were taken from the same culture and the same centre of infection at approximately the same time.

The total number of measurements taken was 861, viz. 540 of *Macrosporium* and 321 of *Alternaria* conidia. The conidia of *M. cladosporioides* were found to vary in length from 17 to 51 μ, while the limit of variation observed in *A. brassicae* var. *citri* was 9 to 44 μ. In the former case the number of each length closely approximated to the curve of normal frequency, whereas in the latter the curve was considerably more complex, and probably represented a composite curve, consisting of a series of smaller, overlapping and intersecting curves. Each of the latter may possibly correspond to a conidium of fixed position with reference to the conidiophore, and in relation to the other conidia associated with it in the chain. A study of curves of the length-variation of detached free conidia would therefore indicate their solitary or concatenate origin, thus facilitating the correct classification of the morphologically identical conidia of *Macrosporium* and *Alternaria*.

GROVE (W. B.). **The British species of Cytospora.**—*Kew Bull. Misc. Inform.*, 1, pp. 1–29, 1923.

The author describes the characters of the genus *Cytospora* in detail, and mentions those features which distinguish it from *Naemospora* and *Libertella*, two other tendril-forming genera with which it is apt to be confounded. There are notes on the best method of examining the fungus, the appearance of the spores as seen from different angles, the change of colour sometimes seen in the spore tendrils, and the type of evidence which field mycology can produce concerning related ascigerous stages. Sixty-two species are admitted for Great Britain, of which half have been referred to ascigerous forms, but the authorities for such relationships are not specifically stated. In a few cases notes of phytopathological interest are added. Localities in Great Britain and the world distribution are given, together with references to the systematic literature. The work closes with a host index of all the British species considered valid.

Report of the College of Agriculture and the Agricultural Experiment Station of the University of California, 1st July 1921 to 30th June 1922, 249 pp., 61 figs., 1922 [1923].

This report contains a brief record of the phytopathological work in progress at Berkeley, at the University Farm, Davis, and at Riverside. The following notes deal chiefly with some of the work not already noticed elsewhere.

Tests of cereal varieties, hybrids, and selections resistant to various diseases were continued by Mackie and his collaborators. Selections from Galgalos, Emmer × Defiance, and Algernon wheats have been obtained which have remained entirely free from bunt [*Tilletia tritici* and *T. levis*] for three successive years, though the seed grain was heavily inoculated with bunt spores each season. Of 998 varieties of wheat tested for resistance to *Puccinia graminis* and *P. triticina* under artificial epidemic conditions, forty-three were entirely free from the former and four from the latter, while others were very mildly attacked. *P. glumarum* was found to be able to infect a number of grasses belonging chiefly to the genera *Agropyron*, *Bromus*, *Elymus*, and *Sitanion*. Strains of barley resistant to scald (*Rhynchosporium secalis*) have maintained this character, the best yield combined with high resistance being given by Mariout C. 2775. Tests of the effect of sowing at different dates on this disease indicate that the attack on Coast or common barley is negligible for sowings after 20th January, and on common Mariout after 1st March.

Further work by Fawcett and Camp confirmed the identity of *Bacterium citrarefaciens* Lee, the cause of citrus blast, with the previously described *Bact. citriputeale* Smith, which causes black pit. The difference in the symptoms described in the two cases is due to differences in climatic conditions in the north of the State, where blast was found, and in the south, where black pit is prevalent. In the latter region symptoms resembling blast have now been found at high elevations and in moist, cloudy weather. Injury to the wing of the petiole is responsible for much of the infection. The organism can also attack *Quercus wislezenii*. Bartholomew has found that the black discoloration and ultimate breakdown of lemons, especially those suffering from internal decline [see below, p. 406], in storage or transit, is not caused by the spread of internal decline through the tissues, but is due to infection by a species of *Alternaria*. Considerable losses have occurred in certain sections from this trouble, and control measures are under investigation. Shell bark of lemon trees has been investigated by Fawcett, whose cultural and inoculation experiments indicate that a fungus may be involved in the development of this disease.

Investigations of a disease occurring on the black walnut (*Juglans californica*) in two walnut-growing sections, have been conducted by Barrett and Batchelor. Both crown and roots may be attacked, and it is believed that a specific organism is concerned in the injury. Excessive moisture is probably a predisposing factor in the occurrence of the disease.

The results of further experiments by Fawcett on the prevention of brown rot due to *Pythiacystis citrophthora* showed that this decay was prevented on heavily infected fruit by washing with water at 115° F. for one minute or longer, and at 120° or 125° F. for half a minute or more. The development of brown rot on heavily infected fruit stored at 60° F. was prevented by treating with water at 115° F. for two minutes at any time within eight hours from the time of infection, and at 120° for two minutes at any time within thirty hours. The standard copper sulphate treatment of 1 in 1,000 was of little value after the lapse of four hours, and of none after eight hours.

The results of preliminary tests by E. H. Smith indicate that gradual infection by strains of *Pythiacystis* may take place at the crown of the roots of stone fruit trees seven or eight years old, provided the fungus comes into contact with a cut or bruise on the bark, even under normal soil and moisture conditions. The most vigorous tree inoculated showed the most infection, viz. an advance of $\frac{1}{2}$ to $\frac{3}{4}$ inch from the inoculation between January and May.

The same worker reported a disease similar to the eastern rough bark of apples, caused by *Phomopsis mali*, on slow-growing, mature pear trees near the coast. The *Phomopsis* isolated from the cankers strongly resembles the eastern organism, and appears to be identical with that previously reported as causing a die-back of young pomaceous trees in the same districts.

During the spring of 1922, bacterial gummosis of stone fruits, caused by *Bacterium cerasi* Griffin, occurred with unprecedented severity, climatic conditions having been exceptionally favourable for infection. According to Barrett, Bordeaux mixture gave promising results in the control of the disease in the Hemet district. The results of scarification experiments carried out by Tufts and Day, in March and April, with a view to arresting the cankers formed by this organism, were very satisfactory, the development of all the cankers being checked. This procedure consists of cutting off a thin slice of the outer bark and applying a disinfectant to destroy the bacteria in the affected area thus exposed. Several disinfectants were tried and the concentrations determined which would not destroy the cambium below the scarified bark. One part formalin solution (37·3 per cent.) to five parts 50 per cent. wood alcohol controlled the disease on apricots and almonds, but this concentration killed the cambium of cherry and plum trees. One part of formalin to ten of water would probably be safe for the latter species. The work has not progressed far enough to prove that the bacteria were totally destroyed, but it is highly probably that the scarified cankers are cured. Similar tests with the fireblight (*Bacillus amylovorus*) canker on pears gave promising results. Observations extending from 1919 to 1922 on some forty varieties of apricots have shown that the Russian varieties, Black and Catherine, are entirely free from attack by *B. cerasi*, while the following are resistant: Large Early Montgamet, Early May, Rualt, Apricot Hybrid, Nicholas, and Alexander.

C. O. Smith continued his studies on the resistance to crown gall [*Bacterium tumefaciens*] of various species of *Prunus*. A high degree of resistance has been exhibited by the Japanese apricot, *P. mume*, which withstood a number of artificial inoculation tests. Six species of pear stocks (*Pyrus calleryana*, *P. betulaefolia*, *P.* 'ba Li', *P. serrulata*, *P. serotina*, and *P. ussuriensis*) planted in close proximity to stumps of trees killed by *Armillaria mellea* were found to be in a healthy condition after two years.

FREEMAN (W. G.). **Administration Report of the Director of Agriculture for the year 1921.**—*Dept. of Agric. Trinidad and Tobago*, 12 pp., 1922.

The following references to the diseases of economic crops are of interest. A special campaign was waged against the mosaic disease of sugar-cane, over 2,000 acres in the northern district of Trinidad being regularly inspected. The average infection at the beginning of the inspection course was 106 stools per acre, while at the close of the season it had been reduced to less than two. These encouraging results justify the hope that, with the continued co-operation of the planters, the disease may shortly be entirely eradicated.

Anthracnose (withertip or blossom blight) of limes [*Colletotrichum gloeosporioides*], first reported in 1918, is extremely widespread in Trinidad, occurring even on an isolated old tree at an elevation of over 800 ft. on the island of Chacachacare. In Tobago it appears to be present only on one estate where the limes were destroyed. By Regulations of 27th October [1921] the removal of lime plants, or parts thereof, from the infected area was prohibited. The Rangpur lime, stated to be resistant to anthracnose, has been introduced into Tobago.

Bud rot of coco-nuts was also prevalent.

BEVAN (W.). **Annual Report of the Director of Agriculture, Cyprus, for the year 1921**, 11 pp., 1922.

The only references of phytopathological interest in this Report are to the damage caused by *Peronospora* [*Plasmopara*] *viticola* in the Paphos and Limassol vineyards and the losses from *Oidium tuckeri* [*Uncinula necator*] consequent upon neglect of spraying. Active measures for the control of *P. viticola* were undertaken by the Department of Agriculture under an Order in Council, but weather conditions interfered with the operations at a critical period and it was also difficult to ensure the co-operation of the vine growers. The matter is receiving attention and further measures will be taken to control the disease.

Eastham (J. W.). **Report of Provincial Plant Pathologist, Vancouver.**—*Sixteenth Ann. Rept. Dept. of Agric. British Columbia for the year 1921*, pp. 64–69, 1922.

Amongst the new diseases noted during 1921, the wilt or *Sclerotinia* disease of clover (*S. trifoliorum*) caused severe injury to red clover in the Kootenay District. There is no evidence as to how the fungus was introduced, but its presence in British Columbia is decidedly serious, as it can attack a number of leguminous forage plants, including lucerne. Sweet clover [*Melilotus*], which is resistant to, if not immune from wilt, should be substituted for the susceptible varieties whenever possible.

Buck-eye rot of tomatoes (*Phytophthora terrestris*) caused some damage to the lower fruits in a Victoria greenhouse. In picking it is almost impossible to detect the early stages of infection, with the result that affected tomatoes decay in transit.

White pine blister rust (*Cronartium ribicola*) [see this *Review*, ii, p. 253], first detected at North Vancouver on 10th September 1921, was subsequently found to be widely distributed in the coastal section of the province. A quarantine was immediately put into effect to prevent the movement of *Ribes* and five-leaved pines from the infected area into the eastern part of the province, which is presumably free from the disease. Most of the Dry Belt is included in the protected area.

Late blight of potatoes [*Phytophthora infestans*] was severe in eastern areas. The disease provisionally termed 'skin spot' in a previous report has now been identified as a form of powdery scab [*Spongospora subterranea*; see also this *Review*, ii, p. 389].

Fireblight [*Bacillus amylovorus*] was present in a severe form in parts of the Okanagan Valley, and heavy infection was also found near Cranbrook. The recent embargo placed by the Commonwealth of Australia on all trees or fruits of host plants of *B. amylovorus* from countries in which fireblight is known to occur is considered to be unnecessarily sweeping. Considerable fruit areas in British Columbia have never been invaded by fireblight, and it is believed that shipments of fruit from such districts might reasonably be admitted into Australia under guarantee.

Prowse (V. McN.). **Report of the Acting Economic Botanist and Plant Pathologist.**—*Ann. Rept. Dept. of Agric. Western Australia for the year ended 30th June* 1922, p. 31, 1922.

The most important feature of phytopathological interest during the year was the appearance of a new citrus disease at Kalamunda, Western Australia. The trouble was at first believed to be due to the fungus *Phoma omnivora*, the cause of withertip, but the subsequent examination of a further consignment of material showed that another fungus accompanied the withertip organism, and produced somewhat different symptoms. The name 'twig scorch' is suggested for the new disease on account of the withered or scorched appearance of scattered twigs on the tree, which give the impression of being charred by fire. The spores of the fungus are larger than those of the withertip organism and were referred to the genus *Macrophoma*, the name *M. destruens* being provisionally proposed, but without diagnosis.

The excision of diseased branches one foot below the grey, dead section and the application of Bordeaux mixture are recommended.

EATON (B. J.). **Report of the Director of Agriculture, Federated Malay States and Straits Settlements, for the year 1921,** 14 pp., 1922.

The report contains the following references to subjects of phytopathological interest. The two principal diseases of rubber under investigation during the year were pink disease (*Corticium salmonicolor*) and mouldy rot (*Sphaeronema fimbriatum*), the latter being closely correlated with heavy rainfall and damp conditions. Systematic treatment with disinfectants for the control of mouldy rot is being carried out, but owing to the neglect of small holdings consequent upon the low price of rubber the disease has become very widespread. Patch canker (*Phytophthora* sp.), thread blight, brown root disease [see this *Review*, ii, p. 291], and *Sphaerostilbe repens* were also observed. *Fomes lignosus* was prevalent on certain Chinese estates, especially where tapioca or gambier was interplanted with the rubber. Dry rot (*Ustulina zonata*) was of fairly frequent occurrence and wet rot (*Fomes pseudoferreus*) caused a good deal of damage on two estates in Negri Sembilan.

Black stripe (*Phytophthora faberi*) occurred near Katjang and in the Temerloh and Jelebu districts, but the treatment of this disease has now become a matter of routine. In Pahang the infected areas have been greatly reduced owing to the cessation of tapping. Brown bast has also been kept in check by the adoption of more conservative methods of tapping. Experiments in heavy tapping conducted on the Castleton Estate have shown a correlation between such tapping and the incidence of the disease [see this *Review*, ii, p. 178] and have also indicated that certain trees, for some unknown reason, remain immune in spite of these methods of latex extraction.

A new species of *Helminthosporium* attacking branches of badly grown rubber trees has been observed and also a branch canker not yet investigated. Several fungi, including a species of *Mucor*, *Pestalozzia palmarum*, and *Diplodia* were isolated from leaves arising from buds on three year old bud-grafted stock. The use of stocks which have attained this age appears to result in a weakness of the bud which predisposes it to disease.

Investigations on the bud rot disease of coco-nuts were continued. The disease is not epidemic in Malaya and may be due to several causes, including previous attacks of beetles. A bleeding disease, apparently different from that occurring in Ceylon, was fairly prevalent. Several fungi were isolated and are under study. Premature nut-fall was also studied.

Young African oil palms suffered from an affection of the heart leaves which could not be assigned to any definite agency and its relation to the coco-nut bud rot is being investigated.

LEVINE (M.). **Studies on plant cancers. V. Leafy crown galls on Tobacco plants resulting from Bacterium tumefaciens inoculations.**—*Phytopath.*, xiii, 3, pp. 107–116, 2 pl., 1923.

The author distinguishes two types of leafy crown galls on the tobacco plant produced by *Bacterium tumefaciens*. The first type results from the inoculation of the midrib of the leaf and of the internodes of the stem. The growth of the gall is at first normal, but after two to three weeks diminutive leafy shoots develop, the leaf structures first appearing as small, greenish-white protuberances. The leafy crown gall appears to arise by a secondary process of differentiation; just as the small embryonic cells of the normal crown gall later become differentiated into various mature tissues, so those of the leafy crown gall become leaves and often modified stems and roots. The leafy crown galls on the stems become much larger than those on the midribs and the embryonic leaves which appear on them more numerous and larger; otherwise they are much the same.

The second type of crown gall is caused by the inoculation of stems at the axillary buds and is termed axillary leafy crown gall. It may be distinguished as a comparatively elongated, branch-like, axillary growth, which is undoubtedly the result of an abnormal development of the axillary bud. These structures are never so well developed as in the axillary shoot arising from a decapitated stem but are dwarfed, fasciated, and abnormal in appearance. Sometimes, however, inoculations of the axillary buds do not produce leafy shoots but large globular galls and the development of the dormant buds may be partially inhibited.

Inoculations at axillary buds of decapitated plants result in malformed, branch-like growths, generally stunted and with small, pale green leaves. The added stimulus of the decapitation, therefore, does not increase the size of the axillary leafy crown gall.

Johnston (T. H.). **Biological control of the Prickly Pear pest.**—*Scient. Australian*, xxviii, 2, pp. 24–26, 1923.

The governments of Australia, Queensland, and New South Wales have co-operated financially in a scheme of investigations for the control of the prickly pear [*Opuntia*] by means of its natural enemies, including insects, fungi, and bacteria. Eight distinct kinds of fungi known to cause disease in prickly pears either in North or South America were obtained by the chief laboratory of the Prickly Pear Board, near Brisbane, only one of which (*Gloeosporium lunatum*) has hitherto proved to be of any value. Under certain conditions, namely, combined heat and moisture such as a Queensland summer furnishes, this fungus may set up a serious decay in *Opuntia* joints. So far it has not attacked any of the other plants tested.

While in Florida, the writer discovered a bacterial disease, the causal organism of which has been isolated and proved capable of causing a very virulent disease among all the species of prickly pear naturalized in Queensland and New South Wales. Attempts are in progress to secure the transmission of the bacterial disease from joint to joint (an essential to effective control) by the agency of moth borers (*Melitara* sp.) and the *Mimorista* moth.

Judging from the laboratory results, it appears that a complex of organisms has now been established in Australia which may ultimately secure the complete control of the prickly pear menace.

NOBLE (R. J.). **Studies on Urocystis tritici Koern., the organism causing flag smut of Wheat.**—*Phytopath.*, xiii, 3, pp. 127–139, 1 pl., 2 figs., 1923.

Studies on smuts have often been hampered by the difficulty of securing a vigorous germination of the spores and the present investigations with *Urocystis tritici* were directed to determining the conditions necessary for this to take place.

After many fruitless trials, it was found that spores which had been presoaked in water for several days would germinate profusely after the addition of small quantities of the tissue of wheat seedlings.

The stimulation by the latter is greater when the spores have been presoaked for 3 or more days than when it is added simultaneously with them. Dry spores sown on wheat plant infusions failed to germinate. A table is given showing the germination after various periods of presoaking before the addition of wheat tissues, a period of 4 days giving 90 per cent. germination whilst 28 days gave only 2 per cent. All portions of young wheat seedlings or even the whole uninjured wheat seedling were equally powerful as stimulants. There was no difference between tissues from einkorn, emmer, and spelt types nor from wheat susceptible or resistant to flag smut, and whilst wheat plant tissue was the most effective, tissues of rye, barley, oats, flax, and various grasses also stimulated germination to some extent. Autoclaved infusions and the distillates from water extractions of wheat seedling tissue also gave satisfactory results, showing that the stimulatory substances are volatile. The temperature relationships of *U. tritici* were found to be largely influenced by the presoak treatment the spores had received. For instance, a presoak period of 5 days at 20° C. gave good germination, but an additional presoaking for 30 hours at 27·5° C. reduced the germination to a trace. In distilled water spores incubated at temperatures varying from 7° to 27° C. for 3 days germinated in the following order on the addition of wheat tissue:—first at 18° C., then at 20°, 12°, and 7°, none occurring at 27° C., but spores presoaked at 20° C. for 6 to 8 days even germinated at 29° C. (and in one case at 32° C.) In another test, spores presoaked 6 days at 20° C. germinated well at 5° (and in one case at 0°) and growth was greatest at 24° C. although there was little difference in percentage germination between 18° to 27° C. Spores which have not been presoaked germinate most quickly about 18° C. When kept above 24° C. for some time, they respond less readily.

With regard to oxygen, spores of *U. tritici* germinated almost as readily and practically to the same extent when totally submerged as when sown on the surface, on receiving a suitable stimulus after presoaking. The promycelia of the former tended to become abnormally elongated before producing sporidia.

In germinating, the promycelium normally reaches 20 to 30 by 5 μ before the protuberances (usually 2 to 4 in number) which finally develop into sporidia are formed at the tip. The sporidia are cylindrical in shape and about 30 by 5 μ in size. Various irregular germinations were observed consisting chiefly of fusions or elongations of the sporidia or promycelium into long, thin germ-tubes.

In discussing the results obtained, the author points out that soil may be heavily infected with spores of *U. tritici* and a clean crop sometimes grown, while under other conditions a relatively small amount of inoculum may cause a serious outbreak. This apparent capriciousness would appear to be due to the operation of various factors,—soil moisture, soil temperature, soil aeration, and the presence of a stimulatory substance—and probably these factors must operate in proper sequence to cause the development of flag smut epidemics.

THOMPSON (N. F.). **Kill the common Barberry with chemicals.**—*U.S. Dept. Agric. Circ.* 268, 4 pp., 3 figs., 1923.

Of the several chemicals tested for the eradication of barberry, the best results were obtained by the use of salt and of a solution of arsenite. The former, either crushed rock salt or ordinary ground salt, should be piled in a dry state on the soil at the centre of the barberry bush, where it usually remains for several months, slowly dissolving. Ten pounds of salt are generally sufficient to kill an average bush, i.e., with a crown not over 12 inches in diameter. Smaller bushes may not need so much, but no bush should receive less than five pounds. The dose should be proportionally increased for larger bushes. The bush may be treated at any time of the year and may either be cut down or left standing.

The commercial sodium arsenite solution tested contained the equivalent of 8 lbs. of white arsenic (As_2O_3) per gallon [American]. For use it was diluted with 40 to 50 volumes of water, two gallons of the dilute solution poured into the centre of the plant so as to wet the base of each stem usually killed an average bush as defined above, but less than $1\frac{1}{2}$ gallons should not be used even for small bushes. The best time for applying sodium arsenite is between the 1st May and the 30th September and the bush should be left standing. The soil immediately round the bush becomes sterilized as a result of both treatments, but this effect is of shorter duration with sodium arsenite than with salt.

Womit soll man beizen? [Which are the best seed disinfectants?]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 3, p. 17, 1923.

For the control of bunt of wheat (*Tilletia levis*) [and *T. tritici*] the following fungicides are recommended by the German plant protection service. Weizenfusariol, obtainable from W. C. Fikentscher, Marktredwitz, Bavaria; germisan (Saccharinfabrik, Magdeburg); formaldehyde and fungolit (Holzverkohlungsindustrie A. G., Constance, Baden); uspulun (F. Bayer & Co., Leverkusen); kalimat (L. Meyer, Mainz); and Präparat 23—Halle (Phytopathological Experiment Station, Halle-an-der-Saale). Fungolit and the two last-named preparations have been tested during 1922 only.

Stripe disease of barley [*Helminthosporium gramineum*] can be controlled by germisan and uspulun, and loose smut of oats [*Ustilago avenae*] by formaldehyde, germisan, sublimoform (Fikentscher, Marktredwitz), fungolit, and kalimat.

Loose smut of wheat and barley [*Ustilago tritici* and *U. nuda*] can only be controlled by immersion of the seed for ten minutes in hot water (50° to 52° C.). Immediately after steeping, the seed must be rinsed in cold water or spread out to cool. The quantities required for steeping 10 cwt. of seed wheat are 200 litres, barley 300 l., and oats 400 l. The seed should not only be sprinkled with the liquid but immersed in it. Wheat must be thoroughly stirred so that the uninjured bunt balls may rise to the surface and be removed by scooping off. Granary floors and grain sacks should also be disinfected to prevent subsequent infection of the seed.

HECKE (L.). **Neue Erfahrungen über Mutterkornkultur.** [New experiments in the cultivation of ergot.]—*Wiener landw. Zeit.*, lxxiii, 1–2, p. 3, 1923.

The author continued during 1922 his experiments on the cultivation of ergot for medicinal purposes [see this *Review*, ii, p. 114]. The work of infection was simplified by the use of a Perolin spray, and the total yield of ergot in 1922 was 527 kg. from one hect. of summer rye, or almost twice as much as in 1921. The average number of sclerotia per ear was 4·5, as against 3 in 1921. The sclerotia were normally developed, smaller and more symmetrical than those previously obtained from the winter rye. The yield of ergot from crosses between *Secale montanum* and rye was 370 kg. per hect., without any artificial stimulus to blossoming or artificial infection.

On the whole, the cultivation of ergot, which is at present fetching increasingly high prices, appears to be well worth while.

SAMPSON (KATHLEEN). **Seed treatment for smut in cereals.**—*Bull. Welsh Plant Breeding Stat. Aberystwyth*, Ser. C., 3, pp. 46–54, 1923.

The author discusses briefly the well-known disadvantage of seed grain disinfection with copper sulphate and formalin, a treatment which often results in a serious reduction of germination when the treated seed is sown in dry soil or stored for some time before sowing. Recently Harrington [*Journ. Agric. Res.*, xxiii, 2, p. 79, 1923] has shown that the practice of presoaking with a view to lessening formalin injury may itself cause a reduction of germination under certain conditions. It is, therefore, evident that a dry method of seed disinfection would be of value, and experiments are described giving the results of trials with dry copper carbonate against bunt of wheat [*Tilletia tritici*] and covered smut of barley [*Ustilago hordei*).

The grain was mixed with smut spores, and treated with ½ oz. powdered copper carbonate per ¼ bushel of grain, then stored for three weeks before sowing. There was no injury to germination or yield and very satisfactory control of the two smuts was obtained. The cost was, however, considerable (sixpence per bushel against one halfpenny and one penny for formalin and copper sulphate respectively).

Comparative tests with copper sulphate (2½ lb. to 10 galls. water) and formalin (1 in 320) for the control of the above diseases as well as loose smut of oats [*Ustilago avenae*] showed a reduction in germination and yield when the seed was kept for three weeks before sowing. Copper sulphate followed by dusting with finely powdered slaked lime was better than the others, but still reduced the yield by 9 per cent. with wheat and 3 per cent. with barley, as compared with no reduction after copper carbonate and 27 and 10 per cent. respectively after formalin. Oat smut was completely controlled by formalin, but the yield was reduced by 3 to 10 per cent.

Sampson (Kathleen) & Davies (D. W.). **Incidence of fungus diseases on Oat varieties in the seasons 1921–22.**—*Bull. Welsh Plant Breeding Stat. Aberystwyth*, Ser. C., 3, pp. 55–57, 1923.

The incidence of fungous diseases on different varieties of oats during the seasons of 1921 and 1922 is recorded. Crown rust (*Puccinia lolii*) was practically absent in the former year when the harvest was unusually early. In 1922 the varieties most severely attacked were Orkney *strigosa*, Potato, Victory, and Yielder, Black Tartar, and American Sixty Day being relatively free from the disease.

Black rust (*Puccinia graminis*) has not been recorded on oats in the Aberystwyth experimental plots since 1920.

Mildew (*Erysiphe graminis*) was abundant in July 1921 and 1922, no variety showing any marked degree of resistance.

Loose smut (*Ustilago avenae*) occurred on 31 different varieties during the period 1920–22. Among those most severely affected were Radnorshire Sprig, Ceirch du Bach, and Potato.

Covered smut (*U. levis*) was recorded in the trial grounds only on *Avena nuda* var. *chinensis*, *A. strigosa* subsp. *glabrescens*, and *A. strigosa* subsp. *orcadensis*. A preliminary inoculation experiment with *U. levis* on a number of varieties susceptible to *U. avenae* gave negative results. The range of varieties susceptible to *U. levis* in Britain is believed to be limited.

Stripe (*Helminthosporium avenae*) occurred on 41 varieties of spring sown oats in 1921, Record, Yellow Naesgaards, Leader, and Goldfinder being the most severely affected, while Algerian *sterilis* was immune. In 1922 the disease was unimportant.

Halo blight (believed to be identical with the American disease caused by *Bacterium coronafaciens*) was especially severe in 1921 on Fulghum, an autumn sown variety, a few well-known spring oats, however, also being affected. In 1922 the autumn varieties escaped, but the disease was very severe on Odal, Black Tartar, Orion, and other spring varieties.

Allen (Ruth F.). **A cytological study of infection of Baart and Kanred Wheats by Puccinia graminis tritici.**—*Journ. Agric. Res.*, xxiii, 3, pp. 131–151, 6 pl., 1923.

An investigation of the process of infection of Baart (susceptible), Kanred (very resistant), and Mindum (semi-resistant) wheat seedlings by three strains of stem rust (*Puccinia graminis tritici*) has been conducted at Berkeley, California.

From inoculations with uredospores on Baart, and to a limited extent on Mindum seedlings, it was found that the germ-tubes take the nearest route to the stomata ; the protoplasm is massed toward the growing tips leaving the older parts almost empty. On reaching a stoma the end of the germ-tube swells out to form an appressorium in the stoma aperture, a cross wall cutting off the now empty germ-tube which soon disappears. Within 24 hours of inoculating, many appressoria may be produced.

From the appressorium a blade-like wedge is forced through the stomatal slit, and this swells up inside to form the substomatal vesicle into which the cell contents pass leaving the collapsed appressorium outside. One or more hyphae are given off from the vesicle, and when the tip of one of those meets a host cell, and growth is forcibly checked, a haustorium is usually initiated. The hypha swells up, its contents become concentrated near the tip, which becomes closely applied to the wall of the host cell, and soon after a septum cuts off the haustorium mother cell whose contents are very dense. When the fungus is ready to enter, a minute pore is formed which allows the osmotic membranes of host and parasite to come into contact. The osmotic pressure in the latter is probably higher than in the former, and the substance of the haustorium mother cell pushes through into the host cell whose protoplast is forced inwards. The young haustorium consists of a dense ball of deep staining, fungous cytoplasm and a narrow neck joining this ball to the parent cell. Later the haustorium expands. Frequently the cell below the haustorium mother cell gives off one or more side branches which continue growth.

On Kanred seedlings, the process is similar, but very few (about 10 per cent.) of the appressoria grow through the stomatal slit to form mycelium in the host, the stoma being slender and the aperture small. Another strain of rust (*P. graminis tritici* iii) to which Kanred is less resistant, gave on the whole a larger number of successful entries (about 20 per cent.). When entry has been observed, the fungus passes in at one end of the stomatal slit and swells up inside. Haustorium formation commences in normal fashion, but with the entrance of the fungus into the host cell abnormal changes begin. The haustorium mother cell may collapse and shrink away from the host and a small, red-staining spot on the host cell wall mark the attempted point of entry. The appearance of sections suggest that some substances diffuse out from the host cell, disorganizing the haustorium-producing cell, and sometimes plasmolysing the cell below it also. Changes in the host cell are equally marked, an increase of turgor being rapidly succeeded by collapse and death. Walls of host cells adjacent to this dead cell become markedly thickened and thereby probably prevent the diffusion of substances to and from the diseased cell. A fungus which has been checked in this way once may still retain enough vigour to grow and may make a number of attempts (up to 6) to produce a haustorium. In some cases the reaction between host and parasite is more sluggish than has been described and the fungus may succeed in producing a haustorium thereby gaining food to grow on to the next cell before the first invaded cell dies. This process may be repeated a number of times, resulting in a succession of dead host cells (up to 24) and an ever weakening advance of the fungus. When a haustorium is formed, at first it usually possesses the normal cytoplasmic envelope formed from the host cytoplasm, but in the older haustoria this is usually lacking, possibly because some substance diffuses from the haustorium which either destroys or repels the cytoplasm of the host cell. In old material all traces of the mycelium disappear, except the initial hypha at the stoma, but just how this happens is not clear.

In discussing her results, the author points out that Kanred possesses three means of defence against rust: (1) stomata which exclude all but a few germ-tubes [see this *Review*, ii, p. 359], (2) heavy contact walls adjoining pathological cells, and (3) a true immunity. She finds little support for the 'starvation' theory of immunity, as although the fungus exhausts itself in unsuccessful attempts to enter into food relations with the host, yet the failure is due not so much to lack of food as to a specific reaction set up in the host which destroys the fungus. As long as no haustorium is initiated, host and parasite remain unharmed, but when they come into contact each appears to give out substances harmful to the other. These observations are in line with the view that immunity is due to the formation of specific toxins and antitoxins as in the case of animal diseases.

A bibliography of 30 titles is given.

Hiltner (E.). **Havrens gråflecksjuka och dess botande med mangan.** [The grey speck disease of Oats and its control with manganese.]—*Landtmannen*, vii, 9, pp. 133–135, 2 figs., 1923.

The results of laboratory experiments with various mineral nutrient solutions have shown that the grey speck disease of oats [see this *Review*, i, p. 417] is promoted by the presence of potassium chloride, potassium nitrate, and calcium nitrate (singly or in combination). The injurious effects of these minerals in water cultures are counteracted by the addition to the solution of magnesium phosphate or potassium phosphate (or both). When KH_2PO_4 and $Ca(NO_3)_2$ are both present in the solution, grey speck does not occur but the plants suffer severely from chlorosis. A series of field tests indicated that oats are particularly liable to attack on heavily limed peat soils and on calcareous soils with an abundance of humus. Grey speck does not occur on sandy or clay soils even after the application of lime. The influence of light and shade on the development of the disease was also studied. Plants growing in the shade were found to be much more severely attacked than those in sunny situations.

It was shown by further tests that the disease could be completely controlled by the application of manganese salts together with potassium nitrate. This combination also ensures a higher yield. By expediting maturity and thus curtailing the period of growth (the critical stage in grey speck disease) manganese salts reduce the chances of attack to a minimum.

Savastano (L.). **Lavoro della Stazione durante il periodo 1915–20.** [Work of the Station during the period 1915–20.]—*Ann. R. Staz. Sper. di Agrumic. e Fruttic. in Acireale*, vi, pp. 125–138, 1922.

Amongst the plant diseases studied at this Experiment Station in Italy a root rot of sour fruit trees, which brings about their rapid decay, constitutes a serious menace to the Sicilian citrus industry. Locally known as 'cagna', the disease is due partly to pathogenic agents—not all of which are as yet fully determined—and may occur either sporadically or in an intensely epidemic form, varying from year to year in accordance with weather conditions. The following factors tend to aggravate the trouble: (1) defective aeration due to compact and water logged soils; (2) reduced powers of resistance of the bitter orange brought about by attempts to accelerate and improve its yield by forced cultural methods; (3) close planting, which prevents solar action on the soil and helps to maintain excessive humidity, thus favouring parasitic growth and upsetting the trees' economic balance; (4) excessive manuring at long intervals which has the same effect and lowers vitality; (5) excessive and badly regulated irrigation; (6) the practice of 'verdello' ['verdelli' are lemons forced to maturity before the ordinary crop by special methods of irrigation] carried to excess in the lemon groves.

While these causes can undoubtedly be successfully met by appropriate cultivation, the question arises whether, and to what extent, the bitter orange could be replaced with advantage by some other stock more resistant to root rot. As under favourable soil conditions the bitter orange has so far proved sufficiently resistant, and its cultivation has been profitable, the Station has in these cases been content for the present to recommend cultural remedies, which experience has shown to be effective in keeping the disease within very narrow bounds. Experiments with stocks other than bitter orange are being carried out, exotics, however, being excluded for fear of introducing diseases, such as citrus canker, still unknown in Italy.

SAVASTANO (L.). **Contributo allo studio del male dello scopaccio negli Agrumi.** [Contribution to the study of 'witches' broom' on Citrus trees.]—*Ann. R. Staz. Sper. di Agrumic. e Fruttic. in Acireale*, vi, pp. 119–124, 6 pl., 1922.

Witches' broom disease of citrus was observed by the author for the first time in 1914 on a few isolated trees in Palermo. Although its occurrence in this district can be traced back for at least fifty years, the trouble is so rarely met with that no serious attention has been paid to it. A similar deformation has been observed on forest and ornamental trees, amongst the latter being cypress and *Broussonetia papyrifera*. Whereas witches' brooms are comparatively frequent on forest trees, and develop at times with great intensity, cultivated fruit trees are rarely attacked, and it is thought that this immunity may be due to pruning. On the other hand, in forest trees the trouble appears to be confined to one branch only, while in citrus trees the whole tree becomes invaded. The species most subject to the disease is the lemon, but the comparative immunity of the orange may be simply the result of its less intense cultivation in Sicily.

Normally, the disease affects trees of a somewhat advanced age, the youngest recorded case being a tree that had been grafted six years before. It develops slowly, but the rate of progress is faster in some years than in others. Once established in a branch it proceeds to invade others until after some years the whole tree is affected.

At the beginning, the foliage shows the symptoms of chlorosis, and the individual leaves sometimes tend to become elongated. The cortex dries up and is detached with difficulty, and at this stage some degree of sterility may result. On the branches the beginnings of the disease are marked by the formation of hypertrophied tubercles in many of the buds, which if able to produce shoots at all, give only very small ones. The apical portion of the affected branch is also atrophied. During the second stage the hypertrophy becomes intensified and many of the buds are killed by constriction, while the apex and lateral shoots produced by an affected branch are normally atrophied but may be hypertrophied. On the hypertrophied twigs, the leaves are generally small and malformed and any lateral branches borne are weak and stunted. The third phase is the formation of the 'broom' by the production of single twigs from one or more of the swollen buds and the development of secondary lateral branches, more or less crowded together, on these. This period of vigour is followed by the gradual decay of the twigs forming the 'broom', which wilt and become atrophied. Lastly, twisted branches with large sterile tubercles are left, which give the tree an enfeebled appearance.

Lemons on diseased trees develop in a characteristic manner; the navel becomes somewhat elongated and the fruit itself, from being ovoid or subrotund assumes an elongated oval form, while the smooth rind becomes roughened. There is no great difference in the acid and sugar content of lemons from healthy and diseased trees, but an increase in acid and a decrease in sugar become more noticeable as the disease progresses, as is usual in troubles affecting citrus trees.

The cause of this malformation is unknown, and the only proved remedy is the cutting away of affected branches as soon as they are noticed.

JANINI JANINI (R.). **The chief diseases and pests of the Orange and Lemon groves in Spain.**—*Intern. Rev. of the Sci. and Pract. of Agric.*, N.S., i, 1, pp. 61–73, 2 pl., 1923.

The chief fungous diseases of citrus trees and fruit in Spain are said to be those caused by the following fungi:—*Agaricus citri* Inz. ('mal de caña'), *Polyporus obliquus* Fr., *Meliola citri* Br. ('mal de ceniza'), *Meliola penzigi* Sacc. (*Fumago vagans* Pers.), *Cladosporium fumago* Link, *Dematium monophyllum* Ris., *Capnodium citri* Mont., *Morphea citri* Catt. ('negrilla' &c.), *Physalospora citricola* Penz., *Sphaerella gibelliana* Pass., *Melanomma medium* Sacc., *Pleosphaeria hesperidum* (fruit spot), *Sphaerium wolffensteiniani* Kühn ('mal de goma' &c.), *Aposphaeria sepulta* Penz., *Colletotrichum gloeosporioides* Penz., *Oospora hyalinula* Sacc., *Penicillium glaucum* Link., *P. digitatum* Sacc., *Botrytis vulgaris* Fr., *Echinobotryum citri* Gar., *Cladosporium herbarum* Link., *Fusarium limonis* Br. and *Rhizoctonia violacea* Tul.

Of these the most dreaded are 'negrilla' and 'mal de goma' (gummosis). The latter is usually controlled by cutting the main root of the tree and uncovering the large roots to a distance of 25 cm. from the trunk. A circular trench is dug round the tree to prevent the irrigation water reaching the trunk. Another method is to apply powdered iron sulphate every three, four, or five years. The chemical is spread on the soil at the rate of 600 to 1,200 kg. per hectare and dug in like other fertilizers.

The chief insect pests are described in some detail and a bibliography of Spanish references is appended.

Bartholomew (E. T.), Barrett (J. T.), & Fawcett (H. S.). **Internal decline of Lemons. I. Distribution and characteristics.**—*Amer. Journ. of Botany*, x, 2, pp. 67–70, 1 pl., 1923.

The term 'internal decline', as used in the present article, includes 'blossom end decay', 'tip deterioration', 'yellow tip', 'dry tip', and other local names applied to the same trouble. The indications are that the disease, which is particularly prevalent in the hot inland valleys of southern California, is increasing in severity. All varieties of lemon appear to be more or less susceptible, and trees of any age from three to fifty years may be attacked. The highest percentage of infection is usually found in the so-called 'tree-ripe' fruit, i.e., the lemons which remain on the tree until they have attained their mature yellow colour, but in severe cases the green fruit may also be seriously damaged. The disease may be found at almost any time of year from June onwards.

The external symptoms of the disease are by no means infallible, but in most cases the development of an intensive orange-yellow colour at the stylar end of the fruit denotes the initial stages of an abnormal breakdown of the internal tissues, and at a later stage, in ripe fruit, a depression often appears in the rind at the stylar end. The internal symptoms, which vary considerably in green, silver, and ripe fruit, consist of the collapse of the parenchymatous cells at the stylar end, the clogging of the vessels in the peel at this end with a pinkish to rust-brown deposit of gum, and a loss of water from the neighbouring tissues, including the cells of the fruit pulp below the apex. This loss extends gradually deeper in towards the centre of the fruit and may ultimately result in the drying out and collapse of the pulp involving a third or half the fruit at the distal end.

Bartholomew (E. T.). **Internal decline of Lemons. II. Growth rate, water content, and acidity of lemons at different stages of maturity.**—*Amer. Journ. of Botany*, x, 3, pp. 117–126, 1923.

A series of experiments was conducted at Corona, Upland, and Riverside (California), on Eureka lemon trees of varying ages, to determine the possible bearing on the etiology of internal decline [see last abstract], of (*a*) the rate of increase in size, as influenced by climatic and seasonal changes and the time of year at which the fruit is set, and of (*b*) the increase in acidity and water content of the fruits at different stages of development. The results of the tests, details of which are given, showed that, while the Eureka lemon tree tends to a continuous production of new fruit, the age of the tree and climatic and soil conditions render such production more or less seasonal, especially in the inland regions.

Climatic and seasonal factors determine the growth rate of the fruits some of which mature in seven or eight months, while others on the same tree require fourteen months. The time of the year when the fruit sets and the position on the tree also affect the growth rate. Lemons may actually decrease in size while still attached to the tree in consequence of the withdrawal of water by the leaves, and this may result in the collapse of a portion of the tissue in the stylar end of the fruit. The lemon fruit in fact acts as a water reservoir for the leaves. The wilting coefficient of the soil as indicated by the leaves is not a reliable criterion as to the adequacy of the water supply to the fruit. The water contents of the two ends of the normal lemon are practically identical. The water content increases rapidly until the lemon has attained a diameter of about 3·8 cm., and then more slowly until the fruit reaches maturity. The size of the lemon is not necessarily proportional to the percentage of water it contains. In the young fruit the percentage of water depends to a considerable extent on the available supply of water to the roots. The variation in the water content of the mature lemons under observation in the experiments ranged from 88·20 to 92·14 per cent.

The total acid content of the lemon increases rapidly with increasing size, but there is a very slight increase in the true acidity of the juice after a diameter of 3·8 cm. has been attained. The examination of a large number of normal lemons showed that in spite of some wide variations, the average degree of acidity was substantially the same in the stylar and stem ends. Ripe lemons of approximately the same age and size exhibited a comparatively wide range of acidity, the average for all tested being P_H 2·31.

Winston (J. R.) & Bowman (J. J.). **Commercial control of Citrus melanose.**—*U.S. Dept. of Agric. Circ.* 259, 8 pp., 1923.

As a result of numerous spraying experiments and of field observations by commercial growers, the authors state that, under Florida conditions, melanose of citrus fruits (*Phomopsis citri*) is readily controlled by one or two applications of standard 3–3–50 Bordeaux mixture plus one per cent. oil in the form of emulsion; in an average season the treatment should be completed by 5th May. Comparative tests with other preparations showed that weaker Bordeaux mixture and other weak copper sprays are not as effective as the one recommended. The formula and instructions for the preparation of the mixture are essentially the same as previously described [see this *Review*, ii, pp. 363 and 364] except that the oil emulsion recommended is made by boiling 2 gall. paraffin oil, 1 gall. water, and 2 lb. fish oil soap together and pumping the hot liquid into another vessel and back again. Sulphur sprays as a class and copper or sulphur dusts have not thus far proved satisfactory for the control of melanose. Thorough pruning of the dead wood (which has been recommmended for a number of years as a means of controlling melanose in a normal mature grove) has not been found commercially practicable in view of the high cost and slowness of the work, and careful experimental trials made in 1921 and 1922 did not give satisfactory results as little or no control of the disease was effected. Prunings on the ground and fallen fruit did not appear to be a source of melanose infection. When melanose is controlled, stem end rot of the fruit is reduced. Treatment against melanose should be followed by spraying against insect pests and other fungous diseases.

Small (W.). **The diseases of Coffea arabica in Uganda.**—*Uganda Dept. Agric. Circ.* 9, 22 pp., 1923.

This account of the principal fungous diseases of coffee in Uganda has been prepared mainly for the use of planters and agricultural officers. Technical details have been omitted as far as possible, the symptoms of the diseases and the life-histories of the causal organisms being briefly described in popular language. The amelioration and prevention of the local diseases of coffee are much more feasible than their cure. The suggested control measures are therefore based mainly on an improvement in the environment of the trees, the general condition of which is too frequently below par in Uganda.

Coffee leaf disease (*Hemileia vastatrix*) is common on *Coffea arabica*, especially in the absence of shade. Direct control of the disease by spraying is, in the writer's opinion, impracticable in Uganda. The cost is prohibitive and the results uncertain. Indirect control measures include the planting of the trees in small blocks isolated by wind-breaks, arranged in such a way that the prevailing winds sweep them crosswise rather than lengthways; wide planting; the burying of fallen diseased leaves; the selection of dry sites for nurseries, and the provision of suitable shade. Overbearing should be prevented by stripping. Some system of pruning to lighten overburdened trees is necessary, and it is hoped that the multi-stem experiments now in progress will be continued.

The leaf spot and berry blotch due to *Cercospora coffeicola* also occurs principally in the open and may be largely controlled by the provision of shade trees. The destruction of infected leaves and berries and a series of spray applications with Bordeaux mixture while the berries are ripening are also recommended.

Brown blight of leaves and berries (*Colletotrichum coffeanum* = *Glomerella cingulata*) may be adequately controlled by due attention to shade and other cultural methods.

Sooty mould (*Capnodium brasiliense*) is in itself more unsightly than harmful and is important chiefly as indicating the presence of the scale insects with which it is associated. The fungus is dependent on the honey dew secreted by these insects and disappears when they are destroyed. Attacks of sooty mould have been infrequent of recent years.

Defective beans, usually termed 'lights' or 'floaters', may be due to any one of the following causes, or to a combination of several: *Hemileia* leaf disease, prevalence of die-back, *Colletotrichum* blight, *Cercospora* blotch, variegated bug, or unfavourable weather conditions during ripening. The variegated bug has been proved to be implicated in the introduction of a species of *Phoma* into the tender tissues of the young beans by means of spores carried in or on the beak with which it punctures the 'cherries'. The fructifications of the *Phoma* can afterwards be found on the cured beans, where their presence and development add considerably to the direct harm caused by the insect. The provision of shade and attention to other cultural measures will greatly reduce the proportion of defective beans.

Anthracnose of branches may be due to a variety of causes besides the direct attack of the fungus *Colletotrichum coffeanum*, which was conclusively proved in 1919 to be mainly saprophytic. *Hemileia* leaf disease frequently leads to the dying back of branches, while insect attacks and sun scorch are also often responsible. The use of the terms 'large scale die-back' and 'small scale die-back' has given rise to some confusion, which will in future be avoided by referring to the former as die-back proper and to the latter as anthracnose.

Die-back proper is the result of a disturbance in the normal physiological balance of the plant and is confined to the older trees. Its prevalence in Uganda is believed to be largely due to the errors of cultivators which accompanied the commercial rise of coffee-growing from 1910 onwards. The choice of unsuitable sites, and the neglect of pruning and other cultural operations resulted in serious losses. To-day the disease is less in evidence on account of the gradual spread of scientific knowledge, and it should be possible to reduce it to a minimum by proper care. The selection of healthy seed, thorough weeding, mulching and fertilizing, and the provision of shade are among the most important preventive measures. *Hemileia* is an important factor in the production of die-back, and the measures recommended for the control of the former will contribute to the prevention of the latter.

Witches' brooms, the cause of which is unknown and may possibly be an insect or a parasitic fungus, are uncommon on coffee in Uganda. Affected branches should be burnt.

Brown root disease (*Fomes lamaoensis*) [see this *Review*, ii, p. 291] is somewhat rare, being generally restricted to isolated young trees. The degeneration which it causes is sometimes so gradual as to be imperceptible until the collapse of the affected trees in a storm reveals the decay of the lateral roots. The following preventive measures are recommended: (1) isolation of the infected area by a trench one to three feet in depth; (2) removal of the diseased trees and all broken fragments of roots; (3) disinfection of the soil by exposure to sun and air and the working in of lime or a soil fungicide.

Root rot (*Armillaria mellea*) produces symptoms similar to those of brown root disease and may be controlled in the same manner. The scarcity of both these diseases on Uganda coffee is largely attributable to the fact that elephant grass land rather than forest was used for planting.

Mealy bug root disease (*Pseudococcus citri* and *Polyporus coffeae*) is very prevalent in old native gardens, the mealy bug (which the author regards as the dominant and earlier partner in the association) occurring on a number of indigenous crops. *Polyporus coffeae* has not yet been found as an independent parasite of coffee, and is not known to occur on any other plant or in any country except Uganda. Apart from the insect, therefore, the fungus appears to be only very weakly, if at all, parasitic. Further investigations, however, are necessary to determine the exact nature of the relations between the two.

SCHIKORA (F.). **Ueber die Krebspest und ihren Erreger, Aphanomyces magnusi Schikora.** [On the Crayfish plague and its cause, *Aphanomyces magnusi* Schikora.]—*Verhandl. Bot. Vereins Prov. Brandenburg*, lxiii, pp. 87–88, 1922.

This paper, read before the Botanical Society of the Province of Brandenburg in September 1920, deals with the results of an investigation lasting many years into a disease affecting crayfish. The crayfish fisheries of Germany are of considerable importance, the yearly value of the catch in German waters amounting to 100,000,000 marks [then worth about £800,000]. The disease itself, the cause of which has been the subject of much controversy, is stated now to have almost disappeared. Hofer's hypothesis that the *Bacterium* which he named *Bact. pestis astaci* must be held responsible has not been borne out by tests undertaken by both the German Ministry of Health and the Hygienic Institute, while his opinion that the organism in question acquired its first virulence in factory waste waters in Belgium is also controverted by the present author. It is stated that attempts to demonstrate the action of an ultra-microscopic virus failed.

The author is of opinion that the original focus of infection was at Gambara, in Italy, whence the disease spread through western and north-western France, northern Germany and Russia to Siberia. Another path can be traced along the Danube depression to the Black Sea. The dissemination of the disease appears to have taken place within a period of forty years, and indications—stated to have been neglected by other investigators—pointed to the pathogenicity of a species of the Saprolegniaceae which the author found in 1902, and named *Aphanomyces magnusi*. This fungus is said to be absent in healthy animals, and to be able to produce the typical symptoms of the disease on inoculation. The failure of other workers to recognize its causal relations to the disease is considered to be due to the extraordinary complexity of the symptoms which it can produce. American Cambaridae are stated to be immune.

GREENBAUM (S. S.). **On the biologic properties of pathogenic molds.**—*Journ. Infect. Diseases*, xxxi, pp. 26–31, 1922.

The work recorded in the present paper was undertaken with the following objects: a study of the proteolytic and amylolytic ferments of 26 pathogenic fungi; their action on various sugars and on litmus; a study of indol production; and a study of the toxins of several species.

The results of experiments conducted under uniform conditions to ascertain the comparative proteolytic properties of the fungi in 10 cc. of 10 per cent. gelatine showed that complete liquefaction was obtained in 24 hours with two species of *Trichophyton* [which are named], with *Microsporon pubescens*, and *Achorion quinckeanum*; moderate liquefaction in the same period with three species of *Trichophyton* and *Sporotrichum beurmanni*; and slight liquefaction with eight species of *Trichophyton* and *Microsporon lanosum*. No liquefaction was obtained with *Trichophyton rosaceum*, *Microsporon audouini*, *M. fulvum*, *Sporotrichum gougeroti*, *Actinomyces bovis*, *Achorion schoenleinii*, and *A. gallinae*. The ring-worm fungi in this group, however, caused liquefaction at a later stage.

Both Truffi and Roberts showed that liquefied gelatine was able to hold and transmit the proteolytic body, but this was not always true for the organisms in the present study. In several cases when the filtered liquefied gelatine was placed in contact with fresh gelatine no liquefaction of the latter was caused. When the liquefied gelatine possessed a definite enzymic power, this was found to vary in activity according to the organism which had produced it. Whereas in some cases the fresh gelatine was liquefied in 24 hours with a given quantity of the liquefied material, others required 48 hours to complete the process. The variation in the activity of the gelatinase with the organism was due less to the rapidity with which the latter grew than to the quantity or quality, or both, of the gelatinase.

The author was unable to detect sugar with Benedict's solution at any time during the two months of the growth of the fungi in a starch-water medium. They grew well in 3 and 5 per cent. starch solutions, indicating their capacity to assimilate the larger starch molecule without previous hydrolytic changes.

For the study of sugar fermentation and litmus reaction a Russell's modified double sugar medium prepared with lactose and glucose was used, together with a series of tubes each prepared with one only of the following: lactose, glucose, maltose, saccharose, dextrine, or levulose. The fungi grew well on these media, but lacked the characteristics given by Sabouraud's concentrated and proof media. None of 15 species of *Trichophyton*, 4 of *Microsporon*, and 4 of *Achorion* tested altered litmus or caused fermentations of any of the sugars. The same organisms grown on identical media without peptone also failed to ferment any of the sugars used.

Böhme's technique (*Journ. Amer. Med. Assoc.*, lxxvii, p. 959, 1921) was used for indol production, the organisms being planted in sheep serum broth. Indol could not be detected in any of the implants, some of which, however, failed to grow.

Toxin production was studied in *Trichophyton acuminatum*, *T. gypseum asteroides*, *Microsporon audouini*, *Sporotrichum beurmanni*, and *Achorion schoenleinii*, cultivated in a proof medium with bouillon as a base and sealed to prevent evaporation. The *Trichophyton* spp. and *Sporotrichum* were grown for eight weeks, the others for fourteen, and the cultures were then filtered through sterile filter paper and a sterile Kitasato candle. A control flask of the medium was filtered in the same way. Intraperitoneal injections into eight guinea-pigs with 4 cc. of each medium proved fatal with the *Trichophyton* spp. and *Achorion*, but gave negative results with the others. Death supervened in 24 hours after injection, with *T. acuminatum*, in 10 days with *T. gypseum asteroides*, and in 12 days with *Achorion schoenleinii*. A post-mortem examination revealed a marked suprarenal vascular disturbance resembling that produced by the intraperitoneal injection of diphtheria toxin. Cultures made from the peritoneal fluid remained sterile.

Departmental Activities: The Schools of Agriculture and Experiment Stations.—*Journ. Dept. Agric. S. Africa*, vi, 3, p. 205, 1923.

Grasshoppers of several species in the vicinity of Cedara were decimated in December 1922 and January 1923 by a severe epizootic of a fungous disease caused by *Empusa grylli* Fresenius. The diseased individuals exhibited the characteristic habit of crawling to the top of the grass to die. This circumstance facilitates the dissemination of the conidia, which are produced in abundance on the surface of the insect a few hours after death and thrown off on to the surrounding foliage, thus infecting other grasshoppers. In some areas nearly every blade of grass bore a victim. Prolonged periods of low evaporation being necessary for the best development of the fungus, its scarcity in the preceding season may be explained by the drier weather in December 1921 [see also this *Review*, i, p. 391].

Weather conditions were also responsible for the relatively mild attack of *Entomophthora megasperma* Cohn on the two worst South African species of cut-worm in 1922, as compared with its virulence in the preceding year, the early rainfall of 1921, in the wet season, when cut-worms are most numerous, being absent in 1922.

LE MOULT (L.). **La destruction des insectes nuisibles par les parasites végétaux.** [The destruction of injurious insects by vegetable parasites.]—*Rev. de Bot. appliquée*, iii, 18, pp. 84–102, 1923.

The author gives an account of his earlier work in connexion with the formation in various parts of France of syndicates for the destruction of cockchafers [see this *Review*, i, p. 355]. The work was accomplished by the ordinary methods known at that period (1889), namely, the capture of the insects when stupefied by dew and the collecting of larvae after ploughing.

Altogether, over 5,000,000 kg. of cockchafers were destroyed during the seven years over which the work extended. It was obvious, however, that such primitive methods had serious drawbacks. They could not, for instance, be employed in seasons when ploughing was delayed, since the insects burrow into the soil at the first sign of cold weather; they were also useless in fields bearing perennial crops, such as lucerne.

In 1890 the author became acquainted with the work of the Russian professor, Krassilstschik, a pupil of Metchnikoff, who, in 1884, had constructed a small experimental factory at Smela (Kiev) for the artificial production of the fungus *Metarrhizium anisopliae*, parasitic on *Cleonus punctiventris*, a serious pest of sugar beets. In four months 55 kg. of pure spores of the fungus were produced on maize beerwort at a temperature of 25° [C.], 1 sq. m. of the liquid yielding 189 to 200 gm. of spores at each collection, which took place fortnightly. By this method sufficient spores were obtained to cause epidemics which destroyed from 55 to 80 per cent. of the insects in small areas in 10 to 15 days.

In 1890, on an estate in the Orne Department, the author found numerous mummified larvae of cockchafers, some of which were covered with a pink growth of *Beauveria densa* (*Isaria densa* Giard). In 1891 and 1892 he used cultures of this fungus on infested soil with great success; one field was estimated to contain over 20,000 mummified larvae after treatment. The cultures take some time to produce the necessary effects (from the autumn to the spring in certain cases), but their influence is of long duration. The fields treated in 1890 are still exempt from the insects. The average quantity of spores required per hect. is 5 kg., which is mixed with 1 hectol. of soil and scattered broadcast immediately before ploughing. The rest of the work is accomplished by natural means. In meadows and plantations it is necessary to raise the grass or dig holes for the insertion of the cultures.

The author is convinced that *Isaria farinosa* (the conidial stage of *Cordyceps militaris*) can be substituted for *Spicaria verticilloides*, which is considered by some to be only a variety of the former [and is sometimes known as *Spicaria farinosa* var. *verticilloides*], in the control of the *Cochylis* and *Eudemis* of the vine. *Beauveria globulifera* (*Sporotrichum globuliferum*), which is employed in the United States against *Blissus leucopterus*, is probably adapted also to the control of the vine *Phylloxera*.

From Holland cultures have been received of *Cladosporium aphidis* which will probably be efficacious in the control of plant lice, and will be tested against *Phylloxera*. *Schizoneura lanigera* and other insects with subterranean colonies can in all probability be controlled by inoculation of the soil with *B. globulifera*, which, in 1916, completely destroyed these insect pests on the author's apple trees. This method is more permanent than merely spraying the trunk and branches with a suspension of the spores. In 1892 larvae of what appeared to be *Elater segetis* infested by *B. globulifera* were received from Nantes. In general the author believes that all soil-dwelling pests are likely to yield to treatment with a suitable fungus. His laboratory now contains cultures of thirteen entomogenous fungi, further experiments with which on various insects are in progress.

The cultures for field use are made chiefly on potato and carrot, and should be broken up and mixed with sand or mould before spreading on the soil prior to ploughing in. Care must be taken to keep free from contamination the cultures used for inoculating the flasks in which the fungus is multiplied on a large scale; impurities in the latter, unless such as are obviously visible, are of less importance, since no further cultures are made from them. The essential point is to use really large quantities of the fungus, small doses being too uncertain in their effects, and this can only be done by adequate organization.

Nakada (N.) & Takimoto (K.). **Bacterial blight of Hibiscus.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 13–19, 1 fig., 1923. [In Japanese, with English summary.]

An undescribed bacterial leaf spot of *Hibiscus* has been under observation in Korea since 1913. The disease, which affects the cotyledons of young plants when two to three leaves are expanded, first appears in the form of minute, circular, black spots which gradually increase in size, the margins finally becoming angular. The edges of the spots assume a whitish-yellow tinge or water-soaked appearance, and when the leaves are severely attacked the whole plant becomes blackened and withered. The causal organism (*Bacterium hibisci* n. sp.) has been isolated and its pathogenicity proved by inoculation experiments. It is a cylindrical rod with rounded ends, occurring singly, in pairs, or concatenate, 1·2 to 2 by

0·6 to 0·7 μ, motile by means of one or two polar flagella, forming no spores Gram negative, staining readily in carbol fuchsin, aniline water, gentian violet, and aqueous methylene blue; surface colonies on agar smooth and circular, slightly elevated in the centre and finely granular under magnification, shiny and cement-coloured by reflected light: bouillon culture clouded after 20 hours at 25° to 27° C.; gelatine slightly liquefied, milk slowly peptonized, no gas produced, nitrate slightly reduced, no reaction of indol, thermal death point 42° C., aerobic.

The results of an experiment in seed disinfection carried out in April 1921 showed that the plants grown from seed treated with mercuric chloride 1 in 1,000 or hot water (55° C.) for ten minutes remained healthy, while those in the untreated control plots developed 50 per cent. of disease. The organism is thus proved to be capable of overwintering on the seed. The application of a 5–5–50 spray of Bordeaux mixture was found greatly to reduce the incidence of infection.

TELLEZ (O.). **Una plaga en el estado de Jalisco: La 'pinta' o 'clavo' de la naranja y de la guayaba.** [A pest in the State of Jalisco: The 'spot' or 'knob' disease of the Orange and the Guava.]—*Rev. Agric. (Mexico)*, vi, 11, pp. 651–652, 2 figs., 1922.

This disease, caused by *Gloeosporium psidii*, is very common in the State of Jalisco, Mexico. The brown, coriaceous, circular spots, from 1 to 4 mm. in diameter, form crusts on the rind of the fruits and penetrate to a depth of 7 or 8 mm. In the case of the guava, they are so numerous that they may cover the whole of the skin, but they are more scattered on the orange.

In the control of the disease the following measures are stated to give good results:—Spraying with Bordeaux mixture (2·76 kg.–2·76 kg.–200 litres) every fortnight, beginning just before the fall of the petals and ending when the fruits are nearly ripe. All fallen leaves must be burnt and the ground under the trees kept clean. Each tree requires from 4 to 5 litres of the spray mixture, one man being able to treat 100 trees per day. After picking it is well to wash the fruits in a 9 per cent. solution of vinegar, and then they must be rinsed in fresh water and placed to dry on reed mats.

HOPKINS (E. F.). **The Sphaerulina leaf-spot of Clover.**—*Phytopath.*, xiii, 3, pp. 117–126, 2 pl., 3 figs., 1923.

A disease of white clover (*Trifolium repens*), new to America, was observed by the author at Missouri in 1920 and subsequently identified as *Sphaerulina trifolii* E. Rostr. The loss caused by it is probably not great, although it may cause some defoliation.

The first symptom is the appearance of minute, black lesions on the leaves, petioles, and stipules. Later these spots enlarge and have a light brown to grey centre, surrounded by a dark reddish-brown margin; they bear perithecia, especially under moist conditions, the infected tissue becoming water-soaked.

The morphology of the fungus is described, the ascospore measurements being 30·4 to 39·5 by 12·2 to 15·1 μ.

Numerous isolations of the fungus were made. On potato agar the colonies were white at first and then gradually became black, except for a white border. The black structures failed to show any asci or pycnospores. When growing actively the cultures have a pleasant fruit-like odour.

Inoculation experiments with pure cultures were not very successful, but in one case strong infection was obtained on mammoth clover (*T. pratense perenne*), medium infection on white clover, and slight infection on red clover (*T. pratense*). Re-isolations were successfully made. By suspending leaves bearing perithecia over healthy plants under a bell jar, infections were obtained without difficulty. A table is given showing the relative susceptibility of eight different clovers, of which mammoth clover appears to be the most susceptible.

The first case of infection in 1922 was observed on 17th March after heavy rain. The germ-tubes from the ascospores penetrate the epidermis directly, sometimes after growing some distance. No appressoria were observed, but the empty walls of the ascospore persist for some time after infection has taken place.

Bonanni (A.). **La tubercolosi o rogna dell' Olivo.** [Tuberculosis or scab of the Olive tree.]—*Le Staz. Sper. Agr. Ital.*, lvi, 1–3, pp. 124–144, 2 pl., 1922.

In this paper the results are given of a detailed study of the olive knot disease caused by *Bacterium savastanoi* E. F. Smith, with which the author has frequently found various other bacteria as well as budding and filamentous fungi, all of which are regarded as incidental invaders of the tumours. Inoculation experiments were carried out which prove the pathogenicity of *Bact. savastanoi* and the inability of the other organisms mentioned to cause infection. The morphological and cultural characters of the pathogen are described. It was found to have peritrichous flagella instead of the one to four polar flagella described by E. F. Smith, but the author does not attach much importance to this discrepancy, which he thinks may be due to the staining technique employed.

In agreement with Schiff-Georgini, the author distinguishes between the primary tubercles resulting directly from the entrance of the causative agent through lesions, and the secondary tubercles produced by metastasis in which vessels are the path through which the infection is transmitted, while the tegumentary tissues remain perfectly sound. The first type occurs always on young twigs, where the younger tissues favour bacterial development. In this case the bacterial cavity is situated in the cortical tissues and there is a hyperplasy of the bark. From the cortex the infection spreads to the central cylinder and through the woody layers to the pith. On reaching the vessels more extensive diffusion of the organism commences and the second form, the metastatic tubercle, is produced. In this type infection starts from the vessels and proceeds tangentially and radially from the infection centre. The bacterial cavities are found only in the wood and the cell prolification causes the rupture of the cambium and bark layers as the tubercle increases in size.

The conditions which predispose to the disease are stated to be sometimes connected with the soil, sometimes climatic, and sometimes to depend on the constitution of the plant. Insects may be carriers of the organism and wounds allow infection to take place.

Miyake (C.). **On a brown shot hole disease of Cherry leaves caused by Mycosphaerella cerasella Aderh.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 31–42, 1 pl., 1923. [In Japanese, with English summary.]

Investigations on *Mycosphaerella cerasella* Aderh., which causes the brown shot-hole disease of the cherry (*Prunus cerasus*) and also of *P. yamasakura* var. *typica*, *P. yamasakura* var. *spontanea* subvar. *hortensis*, *P. itokasura*, and *P. itokasura* var. *subhirtella*, in the west of Japan, were carried out at the Ohara Institute, Okayama. The genetic relation between *Cercosporella cerasella* Sacc. and the *Mycosphaerella* was demonstrated by comparative cultural studies of the isolations secured from both the ascigerous and conidial stages, the morphology of which are described in Japanese and illustrated by excellent figures. The parasitic nature of *M. cerasella* was determined by successful inoculations carried out on the above mentioned varieties of cherry.

Müller (H. C.), Molz (E.), & Müller (K.). **Einige Ergebnisse unserer Beizversuche 1921–22.** [Some results of our disinfection experiments 1921–22.]—*Deutsche landw. Presse*, l, 6, pp. 48–49, 3 figs., 1923.

The authors have carried out extensive experiments with the following preparations, the value of which they consider may now be regarded as definitely established.

Against bunt of wheat caused by *Tilletia* [*tritici*] formaldehyde (40 per cent., immersion for 15 minutes in a 1 in 400 solution) gave, on the whole, very good control, but its injurious effects on germination and subsequent vigour of the plants were undeniable. The treated plants also suffered considerably from frost. Germisan (immersion in 0·25 per cent. for 15 or 30 minutes; or sprinkling, 0·5 and 0·75 per cent., 15 litres of solution per 100 kg. of wheat, covered for 8 hours) gave very good protection. The stand was normal and some of the plots considerably above the average. Weizenfusariol (applied according to directions) controlled the disease very well both with immersion and sprinkling. In the latter method the seed should be washed before sprinkling to ensure good results. Uspulun (0·5 per cent. immersion for one hour) was very satisfactory, but the 0·25 per cent. solution proved inadequate. The results of sprinkling were conflicting, but in one case, when the seed had been previously washed, they were very good. The growth of the plants was excellent. Kalimat, the active principle of which is an unstable compound of phenol and formaldehyde, has all the advantages of the latter without its drawbacks. Good results were obtained both by immersion (0·25 per cent. for 30 minutes) and sprinkling (0·33 per cent.)

Against the stripe disease of barley due to *Helminthosporium* [*gramineum*], germisan (immersion in 0·25 per cent. for one hour or sprinkling with 15 litres of the solution at a strength of 0·75 per cent., 8 hours covered) gave the best results. In some cases it was necessary to immerse in a 0·5 per cent. solution and even then the disease was not absolutely controlled. The growth of the treated plants was extremely satisfactory. Uspulun (0·5 per cent., immersion for two hours) also gave good results, but failed to control the disease entirely.

Against the snow *Fusarium* [*F. nivale*] of rye, germisan (0·25 per cent., immersion for one hour) gave almost complete control of the disease, the number of ears in the treated plants being nearly double that of the untreated. Sprinkling at the same strength also gave good results. Roggenfusariol (used according to directions) was equal to germisan. Uspulun (immersion for one hour in 0·25 per cent.) gave satisfactory results. In the sprinkling method (50 gm. per 15 litres of water) the effect was slightly weaker but still adequate. 778 (immersion for 15 minutes in 0·75 per cent.) gave very satisfactory control.

Against the flag smut of rye due to *Urocystis* [*occulta*], the results obtained have already been published [see this *Review*, ii, p. 170]. In addition to the preparations therein mentioned, 778 (0·5 per cent. immersion for 15 minutes) gave very good control.

Against the loose smut of oats, caused by *Ustilago* [*avenae*], formaldehyde (40 per cent., immersion for 15 minutes in 1 in 400 solution, or sprinkling with 20 l. of 1 in 200 solution per 100 kg. of oat seed, covered for 2 hours) gave excellent control of the disease. In most cases the stand of the crop was satisfactory. Germisan (immersion for 30 minutes in 0·25 per cent. solution or sprinkling with 30 l. of 0·75 per cent. solution per 100 kg. of oat seed) gave excellent control and vigorous growth. Sublimoform (used according to directions) effectively controlled the disease, but somewhat impaired germination and energy. Kalimat (immersion for one hour in 0·25 per cent. or sprinkling with 20 litres of 0·3 per cent. solution per 100 kg. of seed) gave absolute control of the disease and improved the appearance of the stand.

It is pointed out that, owing to the depreciation of the German currency, the cost of germisan and other mercurial preparations will soon become prohibitive, while kalimat, being manufactured from home-produced raw materials, is readily obtainable at a reasonable price. It is a first class fungicide, especially for the control of bunt of wheat, loose smut of oats, and flag smut of rye, and causes no injury to germination.

Morstatt (H.). **Bibliographie der Pflanzenschutzliteratur: das Jahr 1922.** [Bibliography of plant protection literature published in 1922.]—*Biol. Reichsanst. Land.- und Forstwirtsch., Berlin-Dahlem*, 162 pp., 1923.

This comprehensive bibliography of the literature published during 1922 relating to the various aspects of plant protection is divided into the following four sections, each of which is further sub-divided into appropriate groups: general; diseases and causes; host plants; plant protection measures (comprising legislation, administration, statistical information, and preventive and curative methods).

Rao (K. A.). **A preliminary account of symbiotic nitrogen fixation in non-leguminous plants, with special reference to Chomelia asiatica.**—*Agric. Journ. India*, xviii, 2, pp. 132–143, 2 figs., 1923.

The author in this preliminary paper adds another plant, *Chomelia asiatica*, to the list of species which bear nitrogen-fixing bacteria in nodules on their leaves. Von Faber (*Jahrb. Wiss. Bot.*, 51, p. 285, and 54, p. 243) investigated the symbiotic relationships of the bacteria in the leaf nodules of five species of Rubiaceae, and showed that they had the remarkable property of fixing nitrogen from the air. Miehe (*Ber. d. Bot. Ges.* 34, p. 576), working on the Myosinaceae, came to similar conclusions.

Chomelia asiatica, a Rubiaceous shrub, bears ten to twelve generally round and rarely irregular bacterial nodules on each leaf, situated at the junction of the veins with the midrib. *Pavetta indica*—previously described by von Faber—was studied for purposes of comparison. Stomata serve as points of entry, from which the bacteria pass into the intercellular spaces, and penetrate therefrom between the cells, causing the latter to divide vigorously. A special nodule tissue is thus formed, with the result that the leaf swells on the affected side. In older stages liquefaction of the nodule tissue was noticed, possibly owing to digestion of the bacteria by the host.

The organism was isolated by inoculating nitrogen-free mannite solution [see Ashby, *Journ. Agric. Science*, ii, p. 38] with an emulsion of teased nodules. The liquid medium recommended by von Faber was also used. After subculturing five times on the liquid medium the organism was plated on the gum arabic agar medium of von Faber. The colonies develop slowly on this solid medium, and are extremely small, milky white, opalescent, thin, round, and of a gummy consistency. The bacteria stain well with ordinary stains. They prefer an alkaline reaction and plenty of air. Their nitrogen-fixing capacity was tested from cultures in Ashby's medium.

The bacteria are most active at growing points in the leaf primordia of unopened buds, but they can be found between the embryo and the endosperm of the seed, and apparently also in the vegetative apex of the embryo. Successful cultures were obtained from seeds, leaf buds, and ovaries. During germination the bacteria can be found in the growing points. The infection is thus evidently hereditary. Pot culture experiments are in progress to ascertain whether the bacteria are necessary for plants of *Chomelia asiatica* to thrive, as is said to be the case with *Pavetta indica*.

The nitrogen content of the leaves of these plants must be large, and the author suggests their application in large quantities as a manure, a practice which appears to be in vogue already among the Tamil cultivators of Ceylon.

Weimer (J. L.) & Harter (L. L.). **Pectinase in the spores of Rhizopus.**—*Amer. Journ. of Bot.*, x, 4, pp. 167–169, 1923.

The results of experiments with the ungerminated spores of *Rhizopus tritici* and *R. nigricans* showed that both species contain an enzyme, pectinase, which is capable of dissolving the middle lamellae of sweet potatoes. The rate of action of the enzyme was tested by immersing raw sweet potato disks in a suspension of spores treated so as to prevent germination. That of the spores of *R. tritici* was comparatively rapid, the raw sweet potato disks being completely macerated in twenty-four to forty-eight hours. *R. nigricans*, on the other hand, acted very slowly, taking seventy-two hours or longer to accomplish maceration. This is in harmony with the authors' previous results regarding the activity of the enzymes of these two fungi [see this *Review*, i, p. 273].

It is probable that pectinase plays an important part in the early nutrition of the fungus, while it may also be a factor in the initial infection of some of its hosts.

HARTER (L. L.) & WEIMER (J. L.). **Amylase in the spores of Rhizopus tritici and Rhizopus nigricans.**—*Amer. Journ. of Bot.*, x, 2, pp. 89–92, 1923.

The results of experiments in the growth of *Rhizopus tritici* and *R. nigricans* at various temperatures showed that the former produced spores in profusion at 20° to 38° C., and the latter at 16° to 30° C. Amylase was found to be contained in the spores at any temperature at which they were produced. The same held good with respect to the mycelium, which, as Harter has already shown (*Journ. Agric. Res.*, xx, p. 781, 1921), produced amylase when grown at temperatures ranging from 9° to 40° C., the enzyme being most active when the fungus was grown at 9°, and least at 40°. The available data are not sufficient to justify the conclusion that the amount of amylase contained in the spores is correlated in any way with the temperature at which the organism was grown.

Comparative tests of the hydrolysing power of the spores and mycelium grown at the same temperature have shown that the enzyme of the latter is more active than that of the former when compared on the basis of unit weight.

MATSUMOTO (T.). **Further studies on physiology of Rhizoctonia solani Kuhn.**—*Bull. Imp. Coll. Agric. and Forestry* (Morioka, Japan), v, 63 pp., 1 pl., 8 figs., 1923.

The results of inoculation experiments with various strains of *Rhizoctonia solani* on the leaves of Azuki and broad beans, *Cameria*, sliced potato disks, and cucumber stems have shown that mechanical pressure exerted by the hyphae is an important factor in the penetration of the cuticular layer and cell wall. The latter process, however, appears to be assisted also by the action of enzymes or allied substances liberated by the invading hyphae.

The effect of H-ion concentration varies according to the nature of the media used, and it is, therefore, almost impossible to name a definite optimum P_H value for the growth of the fungus. In no case was mycelial growth secured on any medium having a P_H value of 2·5. As regards the limit of alkalinity the results of the tests were less consistent. Thus on Czapek's solution mycelial growth was fairly luxuriant at P_H 9·8, while in turnip or potato decoction it was scanty even at P_H 8·5. The change of the P_H value due to the growth of the fungus in the culture media is not constant but appears to fluctuate with the different solutions used.

Further experiments were conducted to ascertain the effect of the H-ion concentrations on the activity of the enzymes secreted by the fungus. The amylase of the strain Pl (isolated from an infected potato stem in California, 1917) is active within a range of P_H 3·4 to 9·4, the optimum being about 6·2 or less. A marked acceleration of invertase activity occurs on the acid side, the optimum after twelve hours being observed at the exponent P_H 2·8, and after two days at P_H 3·2. On the alkaline side invertase activity is markedly retarded, the limit appearing to be P_H 9·1. The optimum H-ion concentrations for maltase and emulsin seem to be approximately P_H 6·0 and P_H 5·2 respectively. Gelatine is liquefied by the mycelial extraction when NaOH is added, but not when HCl is used. Liquefaction, however, may take place in the latter case also if the enzymes secreted by the living hyphae are substituted for the mycelial extractions.

When grown on potato the fungus secretes intracellular and extracellular pectinase by means of which it dissolves the middle lamellae of the host plant tissue. The diastatic activity, both intra- and extracellular, of the various strains of *Rhizoctonia* studied, increases in proportion to the mycelial growth, the maximum activity occurring immediately before sclerotial formation. Diastase and invertase are always found in appreciable quantities when the fungus is grown on any of the media studied, the amounts not necessarily being increased when the carbohydrate supplied was starch or sucrose respectively. The fungus secretes maltase in any medium, but the enzyme is produced in large quantities when maltose is present. Maltase is more active in the extracellular than in the intracellular enzymes.

Glycerine can be utilized to a great extent in the presence of peptone, but not in that of ammonium nitrate or sodium nitrate. *Rhizoctonia* thrives on carbohydrate media containing peptone as a source of nitrogen, the rate of its development being proportionate to the amount of peptone used, at least up to 4 per cent.

In glucose media containing 0·1 per cent. NH_4NO_3 the hyphal growth increases in proportion to the degree of the concentration of glucose, provided that the latter does not exceed $\frac{3}{8}$ *M*. [*M*. = 1 molecular weight in grammes in 1 litre of water], while in solutions containing 0·2 per cent. NH_4NO_3 the best growth is observed on media with a higher concentration of glucose up to $\frac{3}{4}$ *M*. In general, sclerotial formation was more or less checked as the concentration of glucose increased within the limits tested. The hyphal growth of the fungus appears to be somewhat retarded by the addition of even low concentrations of tannin, though a very low concentration stimulated mycelial growth on sucrose-containing media. Tannic acid inhibits the diastatic action of the fungus even at the lowest concentration used. At 0·083 per cent. no hydrolysis of starch was observed. Tannic acid does not appear, however, to affect the action of invertase.

'Staling' phenomena were observed in the cultures of this fungus. The deleterious action of the toxic substances in staled solutions was more marked in some of the author's experiments when the cultures contained the filtrate of the media formerly occupied by a different strain of the fungus. These toxic substances may be deactivated by heating, and the growth of the fungus is promoted by eliminating them even if no more nutrient is added.

The fusion of hyphae occurs more readily between those of strains isolated from the same species of host than between isolations from different hosts.

In general it can be said that the physiological characteristics of *Rhizoctonia solani* may be more or less modified by environmental conditions, and may also vary with the different hosts on which it occurs.

Garner (W. W.), McMurtrey (J. E.), Bacon (C. W.), & Moss (E. G.). **Sand drown, a chlorosis of Tobacco due to magnesium deficiency, and the relation of sulphates and chlorides of potassium to the disease.**—*Journ. Agric. Res.*, xxii, 1, pp. 27–40, 7 pl. (1 col.), 1923.

The principal results of the authors' investigations on sand drown of tobacco have already been noticed [see this *Review*, ii, p. 80]. In the present paper the experimental work on which the conclusions already reported are based is described in considerable detail, especially with regard to the methods of pot culture, which involve certain important modifications of those ordinarily used in the study of fertilizer problems.

Gram (E.). **On Kartoffelbrok og Foranstaltninger mod denne i vore Nabolande.** [Wart disease of Potatoes and the legislation against it in force in neighbouring countries.]—*Ugeskrift for Landmaend*, lxviii, 3, pp. 32–33, 1923.

Considering the position with regard to wart disease of potatoes (*Chrysophlyctis endobiotica*) [*Synchytrium endobioticum*] in countries adjacent to Denmark, the author thinks that the Danish quarantine legislation [see this *Review*, i, p. 125] was promulgated only just in time. Should the disease once gain a foothold in Denmark, the quarantine regulations of other countries would very considerably reduce the Danish potato exports.

In Germany the disease is greatly on the increase, especially in industrial districts. In the Rhine Provinces there are at least 200 hect. of infected ground, and in Westphalia 250 hect. The disease occurs also in various parts of Saxony, Silesia, Hanover, and Brandenburg. From the Danish point of view, however, the greatest importance attaches to the spread of the disease in Mecklenburg, Hamburg, Lübeck, and Schleswig-Holstein, whence it may very easily be introduced into Denmark by means of small frontier transactions, or by fishermen landing at the ports.

In Holland there are 75 hect. of infected ground, all in the possession of smallholders and the peasantry. Since 1920 the cultivation of resistant varieties on infected soil has been permitted, subject to annual inspection. Potatoes may be imported from Great Britain when accompanied by a certificate of freedom from wart disease, but not from Germany.

In Norway, where the disease is very prevalent in the vicinity of Christianssand, the cultivation of the resistant British varieties, King George, Great Scot, Lochar, and Templar, has been proceeding on a large scale since 1920.

The disease has not been observed in Sweden since 1913, when the only case of infection was promptly suppressed by means of crop rotation and soil disinfection with 1 per cent. formalin. It is possible that the subsequent absence of infection may also be due to the inability of the fungus to withstand the severe northern winters.

Claus (E.), Köck (G.), & Janchen (E.). **Neuere Erfahrungen über den Einfluss von Uspulun und Uspulunbolus auf die Kartoffelerträge.** [Recent experiments on the influence of uspulun and uspulunbolus on Potato production.]—*Oesterr. Zeitschr. für Kartoffelbau*, ii, 8, pp. 29–30, 1923.

The results of previous experiments (*Oesterr. Zeitschr. für Kartoffelbau*, i, 11, pp. 41–42, 1921) showed that the yield from potatoes treated with uspulunbolus before planting considerably exceeded that of the untreated controls. A further series of tests carried out in 1922 both with uspulun and uspulunbolus gave conflicting results, the yield in certain plots being higher, and in others lower, than in the untreated controls. On the whole, the favourable effects predominated, the average increase in the yield being estimated at 25 to 45 per cent. Uspulunbolus not only acts as a stimulant to production but also as a preventive of decay in storage. Further investigations are necessary to determine the correct degree of maturity of the potato at the time of treatment and the meteorological conditions in which the best results may be expected.

Zum Auftreten des Kartoffelkrebses in Böhmen. [The occurrence of wart disease of Potatoes in Bohemia.]—*Wiener landwirtsch. Zeit.*, lxxiii, 1–2, p. 3, 1923.

Wart disease of potatoes [*Synchytrium endobioticum*], which in 1921 was reported from only one locality in the north of Czecho-Slovakia, has been steadily spreading to other districts, and the situation is now regarded as very serious. According to a member of the National Agricultural Council, the entire potato cultivation of Czecho-Slovakia is imperilled unless absolutely immune varieties can be secured for planting. The export of potatoes from the infested districts has been prohibited.

Paravicini (E.). **Die Kartoffelkrankheiten in Niederländisch-Ost-Indien.** [Potato diseases in the Dutch East Indies.]—*Centralbl. für Bakt.*, Ab. 2, lviii, 9–12, pp. 212–220, 1923.

Mosaic disease is responsible for very severe damage to the Dutch East Indian potato crops, especially in Western Java and the Tengger mountains, where the amount of infection at a recent inspection was estimated in certain fields at 75 per cent. The average yield per plant was only 65 gm. as compared with 151 gm. from healthy plants.

Leaf roll also causes considerable losses in the Tengger mountains and the Preanger Regency. It does not occur in Central Java or Sumatra.

Early blight (*Alternaria solani*) attacks not only potatoes but various other Solanaceae, e.g. tomato, eggplant, *Solanum wendlandii*, *Cyphomandra betacea*, and *Datura* sp.

Late blight (*Phytophthora infestans*) and bacterial ring disease

(*Bacillus solanacearum*) are of minor importance in the Dutch East Indies. Blackleg [*Bacillus atrosepticus*] and *Rhizoctonia* diseases occur only in isolated cases, and the attacks are negligible in severity and extent. Various species of *Fusarium*, *Verticillium*, and a species of *Rosellinia* frequently destroy the roots of potatoes grown on freshly reclaimed forest land.

Sprain ('Rostfleckenkrankheit') is a tuber disease which cannot be detected externally. Sections of affected tubers, however, reveal irregular, brown spots, very variable in size, number, and position. The spots are never situated in the region of the vascular bundles, nor do they extend to the surface of the tubers. The brown discoloration is due to cork layers surrounding single cells or groups of cells. The starch content undergoes no change, but there are other indications of abnormal chemical processes. Sprain does not occur on tubers under 20 gm. in weight, and sometimes affects only a few tubers on a plant.

Attempts to isolate a causal organism from affected tubers gave negative results, and the disease is believed to be due to chemical disturbances consequent on a deficiency of lime in the soil. Experiments in the control of the disease by liming the soil gave conflicting results. The cultivation of infected potatoes on comparatively healthy soils, however, gave a sound crop in the third generation.

Sprain neither reduces the yield of the crop nor spoils the flavour of the potatoes. Their appearance, however, is much impaired, and they fetch a lower price than healthy ones. The expensive white varieties are more severely attacked than the ordinary yellow ones cultivated in the Dutch East Indies. Certain 'indigenous' varieties, e.g. Kentang Djawa, Colonjo, and Radja Singa, are almost immune from sprain. The last-named variety is quite free from sprain in Central Java, but on being transferred to the Karo Plateau, where the disease is very severe, 2·4 per cent. of the tubers became infected. Besides the Karo Plateau, where potato cultivation has been almost brought to a standstill owing to the ravages of sprain, the disease is also very severe in the Tengger mountains and Poetjon (Eastern Java). In the Preanger Regency it has been declining in severity for some years. It occurs more extensively in comparatively low-lying situations than at high altitudes.

Actinomyces scab (*A. scabies*) is of widespread occurrence, and is steadily increasing on the yellow varieties. Its economic importance, however, like that of the dry rot caused by different species of *Fusarium*, is negligible in the Dutch East Indies.

Lasiodiplodia [*Diplodia*] *tubericola* has been found on potatoes exported from Java to America, and the mycelium of *Phytophthora erythroseptica* on potatoes which had rotted in transit from Java to Holland. Neither fungus has previously been known to occur in Java.

BISBY (G. R.). **Manitoba Potato diseases and their control.**—*Manitoba Farmers' Library Extension Bull.* 66, 19 pp., 10 figs, 1923.

A brief account in popular language is given of the causes, symptoms, and effects of the principal fungous and physiological diseases of potatoes in Manitoba, together with appropriate measures for their control. Leaf roll and mosaic are stated to be the most serious diseases occurring at present in the province. Dry stem rot and black scurf (*Rhizoctonia solani*), blackleg (*Bacillus atrosepticus*), wilt (*Fusarium oxysporum*), and dry rot (*F. discolor sulphureum* and other species of *Fusarium*) also cause severe losses. Late blight (*Phytophthora infestans*), powdery scab (*Spongospora subterranea*), and wart disease (*Synchytrium endobioticum*) are not known to occur in Manitoba.

There is at present no potato variety on the market which is resistant to the above diseases occurring in Manitoba, but growers are advised to cultivate exclusively healthy seed of the following standard varieties: Early Ohio, Beauty of Hebron, Irish Cobbler, and Green Mountain.

Franchini (G.). **Essais d'inoculation de latex parasitisé aux souris blanches. Abcès du foie expérimentaux déterminés par les amibes des latex.** [Inoculation experiments with parasitized latex on white mice. Abscesses of the liver produced experimentally by latex amoebae.]—*Bull. Soc. Path. exot.*, xvi, 3, pp. 162–166, 1 fig., 1923.

It was shown in a previous paper [see this *Review*, ii, 5, p. 229] that the inoculation of white mice with the parasitized latex of various species of *Euphorbia* resulted in slight infection. The present paper describes in detail the technique and results of a further series of experiments on nine white mice. In two cases (one of peritoneal inoculation and the other of ingestion of a culture from the spleen of a mouse inoculated with latex from *E. antiquorum*), a post-mortem examination revealed hypertrophy and abscess of the liver. In both cases amoebae were found in abundance, especially near the edges of the abscess and in the digestive tract, and phagocytosis of the red corpuscles took place on a large scale. Cultures of the amoebae on Nöller's medium resulted in the production of the forms previously described.

In the seven remaining mice of the series the effects of inoculation with, or ingestion of, the latex of various species of *Euphorbia* and *Urtica* were less pronounced, while a post-mortem examination of six others similarly treated gave negative results.

Franchini (G.). **Action du latex d'Euphorbes sur différents trypanosomes. Culture de flagellés dans des latex divers.** [The action of the latex of *Euphorbiae* on various trypanosomes.]—*Bull. Soc. Path. exot.*, xvi, 1, pp. 41–50, 1923.

Experiments are described in some detail which show that various species of *Trypanosoma* (*T. lewisi*, *T. gambiense*, *T. brucei*, &c.), as well as the organism of oriental sore [*Leishmania tropica*] and some species of *Herpetomonas* from animals, can live for a considerable time in latex, and in some cases multiplied freely in latex cultures.

SHARPLES (A.) & LAMBOURNE (L.). **Preliminary report on brown bast experiments in Malaya.**—*Malayan Agric. Journ.*, xi, 2, pp. 30–35, 1923.

The results of the first series of field experiments on the production of brown bast in Malaya indicated that the systems of tapping rubber trees in common use were not sufficiently drastic for the purposes of comparative tests, a single daily cut on a quarter or half the tree not producing enough brown bast to lead to any definite conclusions. Experiments with spiral cuts were accordingly undertaken. After seven months the incidence of brown bast in the plots tapped on the full spiral system every third day was only 5 per cent. as compared with 10 per cent. in the plots tapped on alternate days, and 20 per cent. in those tapped daily. An extension of the interval between successive tappings is therefore clearly shown to be advisable [see this *Review*, ii, pp. 232 and 396].

The total yield from trees tapped on a half spiral every third day during seven months was higher than would be expected on a proportional basis when compared with the yields from those tapped daily or every other day. This point is of considerable importance in relation to the brown bast problem, many investigators being agreed that the disease is a wound response due to overtapping. The results of these experiments indicate the possibility of yields being limited by the development of a high percentage of brown bast. In the writer's opinion the yield is sharply limited according to the type of soil and general growth conditions. Below this limit the amount of brown bast developed is of little practical importance, but above it there is so great an increase in the disease as to counteract the augmented yield. This point must be considered in the general question of obtaining high-yielding strains of *Hevea brasiliensis* by bud-grafting and selection.

It was found during the course of the experiments that in order to obtain a guiding line as to the behaviour of different plots with reference to brown bast development, at least three months previous heavy tapping was necessary. A second series of experiments confirmed the previous observation of a sudden rise in the incidence of brown bast during certain months, followed by a long period of quiescence. In 1919, and again in 1921, March to August was a quiescent period; in 1922, however, May, June, and July were heavy brown bast months. Hence there is some difficulty in correlating the incidence of brown bast with meteorological conditions or other external factors. Another interesting feature in this series of experiments was the cessation of the extension of brown bast at definite points marked by the different ages of the tapped bark. Out of 410 trees tapped in virgin bark above the 36 inch level, 133 developed the disease. In 40 of these no extension took place after tapping was stopped; in another 20 the brown bast was checked at the 36 inches mark, which indicated the junction between the virgin and the youngest renewed bark of previous cuts; in 47 trees the brown bast extended to the 24 inches mark, which indicated the junction between the old and young renewed bark, and in 19 the affection extended to the base of the tree.

In one plot of 44 trees tapped on a seven-eighths spiral the response to tapping was obviously abnormal. From November

1920 to August 1921 only two cases of brown bast were reported, followed in September 1921 by a sudden increase of six diseased trees. From that time until December 1922 the plot developed the normal heavy incidence of the disease found on severely tapped trees, and this was correlated with a sudden increase in the average tree yield. The conclusion must be drawn that brown bast is closely associated with high yields, and that it will act as a limiting factor in high production.

In numerous cases the appearance of the brown bast symptoms is so sudden that it may be classed with the phenomena dependent on 'trigger action', i. e., a sudden release followed by immediate effects. The typical symptoms of brown bast frequently appear in twenty-four hours on trees which seemed perfectly normal the day before. It appears highly probable that brown bast is due to a process of exhaustion.

The recently described breaking-down of the sieve-tubes which has been regarded as an incipient stage of brown bast [see this *Review*, i, p. 144], and included under the term phloem-necrosis, is characterized in other cases of phloem-necrosis by lignification of the cellulose walls of the sieve-tubes. The latter phenomenon, however, frequently accompanies tapping, even in trees which cannot be suspected of brown bast. Pending further inquiry, therefore, the relation of this condition to the disease cannot be regarded as established.

Attention is drawn to the risks attendant on the system of bud-grafting from high-yielding trees which is now widely practised in Malaya. High yielders are known to succumb to exhaustion earlier than trees with an average production, and one of the results of bud-grafting already observed is an insufficient development of leaf cuticle, which facilitates attack by various species of fungi, which are normally saprophytic. At present there is a very dangerous alga, *Cephaleuros mycoidea*, epiphytic on rubber leaves, which causes serious damage to tea, cloves, and pepper [see this *Review*, ii, p. 337], and would certainly injure *Hevea* if it succeeded in penetrating the thin cuticle of the bud-grafts. The authors think that the bud-grafting results are not sufficiently encouraging to form the basis of a definite policy, especially in view of the great risks attaching to the system.

SHARPLES (A.). **Final report on treatment of mouldy rot disease with agrisol.**—*Malayan Agric. Journ.*, xi, 2, pp. 36–37, 1923.

For eighteen months the rubber trees on an estate infested by mouldy rot (*Sphaeronema fimbriatum*) have been treated with agrisol [see this *Review*, i, p. 329]. While total eradication of the disease appears to be impossible, very effective control has been secured at the remarkably low cost of 10½ cents [about threepence] per acre per month. The macrospores of *S. fimbriatum*, unlike the spores of the *Phytophthora* of black stripe canker, are resistant to desiccation, and a recurrence of the attack under suitable conditions is therefore probable after dry weather has caused its temporary disappearance. The number of affected individuals, however, may be reduced to a minimum by the routine application of agrisol on the lines previously recommended.

Edwardes (J.). **Mould prevention tests with sodium silico-fluoride.**—*Bull. Rubber Growers' Assoc.*, v, 1, pp. 21–24, 1923.

The promising results previously obtained by Dr. Stevens in the prevention of mould on sheet rubber with sodium silico-fluoride have already been described [see this *Review*, i, p. 263, and ii, p. 139]. Further tests showed that the solution was effective as a fungicide at a concentration of 0·25 per cent., the minimum quantity necessary for coagulation being 1·5 gm. to 3,000 cc. standard latex. Two series of samples were therefore tested to determine the effect of soaking sheet rubber in solutions of the chemical of different strengths: (*a*) S. S. F. sheet soaked for two hours after smoking in sodium silico-fluoride solution; and (*b*) S. S. F. sheet soaked for thirty minutes before smoking in sodium silico-fluoride solution. The advantage of soaking the sheet before smoking was most marked, producing resistance to mould under very favourable conditions for twenty-two days in the case of the saturated solution. The rubber treated with the higher percentage solutions did not absorb moisture as readily as the controls which quickly developed an opaque strip in the interior, causing the effect usually termed by the brokers 'undercured'.

Further tests in which both acetic acid sheet and sheet coagulated with sodium silico-fluoride were exposed to heavy rains for periods of two hours and an entire night respectively, showed that resistance to mould was greatly increased by the use of sodium silico-fluoride. The extreme liability of acetic acid sheet to mould was strikingly illustrated in these tests.

Mizusawa (Y.). **A bacterial rot disease of Saffrons.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 1–12, 1923.

Bacterial rot of the saffron crocus [*Crocus sativus*] was first observed in Japan in 1909, but attracted no special attention till 1917, since when its severity and distribution have considerably increased.

The first symptoms of the disease become noticeable in December, when the leaves lose vigour, wither, and gradually turn yellow. The roots and corms are found to be dark brown. This is the common form of the disease which results from successive culture in infected fields. In the rare cases when diseased corms are planted in healthy fields infection occurs at some point of the sheath, followed immediately by yellowing of the leaves.

The causal organism, a peritrichiate bacterium, to which the name *Bacillus croci* n. sp. is given, was repeatedly isolated from decayed corms and sheaths. It resembles, but is not identical with, *Bacillus carotovorus*, *B. omnivorus*, *B. oleraceae*, and *B. aroideae*. It is a medium sized rod, with rounded ends, 1·2 to 3·2 by 0·6 to 1·1 μ, usually single but occasionally in pairs or short chains. Endospores and capsules not seen. Flagella two to four. Gram negative. It grows readily on various media, especially with the addition of sugar, producing white, round colonies. On carbohydrate media the organism produces acid but no gas. The optimum temperature for development is 25° to 28° C., the maximum 40° C., the minimum below 10° C., and the thermal death point 55° C. The results of experiments showed that the organism can tolerate a high degree of acidity. It retains its virulence for a period of ten to twelve months. The morphological and physiological characters are fully described. Healthy corms inoculated with pure cultures of the organism rapidly exhibited the typical symptoms of the disease. *Bacillus croci* remains on the decayed part of the plant and in the infected soil. The disease is disseminated mainly by transplanting infected corms. The group number is 221.2233032.

The selection of healthy corms and disinfection of seed corms in saturated lime water for half an hour are recommended.

Disease defeated by drainage.—*South African Sugar Journ.*, vii, 2, p. 179, 1923.

Prof. Cobb, entomologist to the Cairns (Queensland) Sugar Bureau, in the course of a report on gummosis (*Bacillus vascularum*) of the H. Q. 426 variety of sugar-cane, states that the chief factors responsible for the disease are: (1) poor drainage; (2) an impervious subsoil within two or three feet from the surface; (3) defective cultural methods; and (4) abundant rainfall. Rotation of crops is recommended on land which has long been under susceptible varieties of cane.

An example of the benefit derived from proper drainage was brought to Prof. Cobb's notice at Halifax [Queensland], where a sixty-acre plantation on the river bank is intersected by a road. On the side adjoining the river good crops of sugar-cane have always been obtained, while the cane grown on the other portion, which is bounded on the far side by a swamp, has invariably been a failure. By cutting a few deep main drains through the block emptying on to the swampy land, and running cross drains into them, the present owner has succeeded in raising a fine crop of cane.

Clayton (E. E.). **The relation of temperature to the Fusarium wilt of the Tomato.**—*Amer. Journ. of Bot.*, x, 2, pp. 71–87, 4 pl., 1 fig., 1923.

There are three different tomato diseases in the United States, supposed to be caused by three distinct species of *Fusarium*. They are the 'summer blight' of California, the 'yellow blight' of the Pacific North-west, and '*Fusarium* wilt', the last-named being one of the most serious tomato diseases in the southern States. For this disease, which is due to *F. lycopersici*, the author has determined definite temperature limits under greenhouse conditions in Wisconsin soil-temperature tanks. The behaviour of the fungus was tested by incubating pure cultures of a strain of the fungus from Indiana at each of twelve graduated temperatures ranging from 4° to 38° C. It was found that the minimum for growth was 9° to 10° C., the optimum about 28° C., and the maximum 37° C. Under greenhouse conditions the soil temperature range most favourable to the development of the susceptible commercial tomato varieties, Mangus and Chalk's Early Jewel, was 24° to 31° C., a range which, therefore, includes the optimum temperature for the development of *F. lycopersici*. Growth was still vigorous at 33°, but was checked at 35°, while it decreased gradually from 24° to below 19° C.

The symptoms of the disease vary in relation to the soil temperature in which the host plant is grown. There is an optimum soil temperature for the disease between 25° and 31° C., characterized by a sudden wilting, usually without yellowing, first of the lower leaves and then of those higher up. At temperatures immediately above or below the optimum, namely 33° C., or 20° to 24° C., wilting is accompanied, and often preceded, by yellowing of the leaves. The appearance of the plants suggests a slow blight rather than wilt, and they are often stunted. At temperatures above 34° or below 20° C. there is no external evidence of the disease. Under certain temperature conditions the fungus may penetrate only into the bundles in the lower portion of the stem; this is often the result of a brief exposure to temperatures favouring the disease, followed by a fall in temperature sufficient to check the further development of the fungus.

It is reasonable to expect that changes in temperature would not equally increase or decrease both the attacking power of the fungus and the resistance of the host. The correlation between the temperature ranges of the host, the parasite, and the disease, considered separately, is closer in this case than usual in similar diseases. It is especially marked at the optimum points, which are approximately equal for both host and fungus, as well as for the disease caused by the interaction of the two. On the other hand, the disease develops more rapidly at 31° than at 25°, though the fungus grows at least equally well at the latter as at the former temperature. So also the growth of the fungus at 33° to 34° C., the upper limit for the disease, was much less vigorous than at 19° to 21° C., the lowest temperature at which the disease occurs. Both host and parasite can develop at a wider range of temperature than the disease, the latter being absent above 34° or below 20°, though both are within the growth range of the tomato and of the *Fusarium*.

In two of the experiments both air and soil temperatures were controlled. The air in three greenhouse compartments was maintained at temperatures of 17°, 27°, and 33° C. respectively. Three different soil temperatures were maintained in each of these compartments, namely, 17°, 27°, and 35° C. Air temperature was found to be as effective as that of the soil in controlling the appearance of the disease, which developed fatally in only two of the nine combinations of air and soil temperatures, namely, warm air (27° C.) and warm soil (27° C.), and hot air (33° C.) and warm soil (27° C.). At a cool air temperature (17° C.) and optimum soil temperature for the disease (27° C.), heavy infection occurred in the root and extended up into the basal portion of the stem, but there were no external symptoms of the disease. The temperature conditions of soil and air most favourable to the disease are 27° C. and 28° C. respectively, with short interludes of sudden rises in air temperature to 33° or 34° C.

The evidence accumulated during the course of these experiments indicates that the wilting and death of plants attacked by *F. lycopersici* is due to toxic action rather than to a mechanical plugging of the xylem bundles.

Taylor (W. H.). **Tomato diseases. Black-stripe and its control.** —*New Zealand Journ. of Agric.*, xxvi, 2, pp. 101–103, 1923.

A serious outbreak of blackstripe disease of tomatoes (? *Bacillus lathyri*) was recently investigated in the Hutt Valley, Wellington, New Zealand. A comparison of the diseased plots with adjacent healthy fields indicated that the epidemic was promoted by the application of excessive quantities of stable manure, and that the injurious effects of the latter can be counteracted by an additional dressing of blood-and-bone and sulphate of potash, this being attributed to the action of potash, which stiffens the tissues of the plant and also improves the quality of the fruit. The results of recent experiments in Canada are stated to show that the disease can not only be prevented, but actually cured by fertilizing the plants with acid phosphate or bone-flour (3 oz. per plant) and potassium sulphate (¼ oz. per plant) either before transplanting or just as the blooms appear; while in England watering with sulphate of potash solution or dressing with the solid compound is reported to enable the infected plants to grow away clean when attacked by *B. lathyri*.

De Koning (M.). **Een nieuw bestrijdingsmiddel tegen de wortelzwam.** [A new measure for the control of the root fungus.]—*Tijdschr. over Plantenziekten*, xxix, 1, pp. 1–4, 1923.

All attempts to eradicate the 'root fungus' (*Trametes radiciperda*) [*Fomes annosus*] from Dutch pinewoods have failed, including the method of separating the diseased from the healthy trees by means of trenches.

In September 1922, the Dutch Heathland Association made an excursion to Bremen, where a system of so-called 'forest rejuvenation', which the author thinks would be of service in Holland in connexion with this disease, was seen. As soon as the trees show signs of deterioration, felling is carried out on a large scale, all the less valuable timber being cut down to provide light and air for new seedlings. Then the 'humus layer' of moss and needles is removed as far as the soil in strips about 2 m. broad, and placed on the intervening strips, which are about 1 m. broad. The bare patches are then sown with a mixture of beech, silver fir, larch, birch, oak, *Sorbus*, and *Prunus*. This procedure serves the double purpose of providing a good humus layer and of keeping the root fungus in check, the latter rarely occurring in mixed plantations.

Richardson (A. D.). **Witches' Broom on Silver Fir.**—*Gard. Chron.*, lxxiii, p. 11, 1 fig., 1923.

'Witches' brooms', the popular name for the globose swellings caused by *Peridermium elatinum*, are very common on silver firs (*Abies pectinata*) in Ireland and the western parts of Great Britain, where these trees are more extensively grown than in the east of the country. The stems of affected trees are considerably weakened, and liable to break under wind pressure, and the value of the timber is much depreciated.

The first symptom of infection is a small swelling, which keeps pace with the growth of the affected branch or stem. Erect shoots are often produced from such swellings, giving the characteristic 'broom' appearance. The leaves arising from affected shoots are short, pale, and of annual duration only, defoliation occurring in the autumn. The aecidia are produced on the under side of the leaves. The bark is ruptured and cast off at the cankered swellings.

P. elatinum is the aecidial stage of the heteroecious fungus *Melampsorella caryophyllacearum*, the uredo and teleuto stages being produced on the stems and leaves of *Stellaria*, *Arenaria*, *Cerastium*, and other Caryophyllaceae.

The disease is prevalent on the Continent, and has also been found on *Abies nordmanniana*, *A. cephalonica*, *A. pinsapo*, *A. balsamea*, and *A. sibirica*.

VALCKENIER-SURINGAR (J.). **Eine Ulmenkrankheit in Holland.** [An Elm disease in Holland.]—*Mitt. deutsch. dendrol. Gesellsch.*, xxxii, pp. 145–147, 1 fig., 1922.

After a brief recapitulation of the symptoms of the obscure disease of elms occurring in Holland and the north of France [see this *Review*, i, pp. 277, 334, and ii, pp. 1, 92], the author questions the accuracy of the conclusions reached by Miss Schwarz as to the identity of the causal agent. The fact that the *Graphium* isolated from diseased elms produced a brown discoloration (but not the other typical symptoms of infection) when inoculated into healthy trees is not a convincing proof of pathogenicity. Several fungi are known to produce similar discolorations on elms and other trees, and in the absence of further proof of its causal relationship to the disease the author is unable to accept Miss Schwarz's conclusions. He also regards her description of the fungus as a new species of *Graphium ulmi* as requiring further confirmation.

DUFRÉNOY (J.). **Biologie de l'Armillaria mellea.** [Biology of *Armillaria mellea*.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 277–281, 2 figs., 1922.

In the Pyrenees, and particularly above Barèges, *Armillaria mellea* is responsible for the destruction of the birch, and in the Landes region it is, in common with *Trametes pini*, and to some extent *Rhizina undulata*, amongst the principal cryptogamic enemies of *Pinus maritima*. On the outskirts of the latter region, cork oaks whose roots are attacked by *Heterodera radicicola* are reported to be killed by the same fungus. Other workers have recorded it seriously injuring fruit trees in Lot-et-Garonne and elsewhere. Although possibly able to attack vigorous trees, the fungus appears to act usually as a secondary parasite under circumstances which are still not clearly defined. Chestnuts suffering from ink disease may be attacked by *A. mellea*, while young chestnuts planted too deeply are very liable to be killed by this form of root rot, as the mycelium first attacks the asphyxiated roots, then the underground region of the collar, and may finally ascend in the cambium of the trunk to a distance of several metres above soil level.

The extended use of resistant varieties, which may be employed as stocks in certain cases as, for instance, in growing walnuts, is recommended.

GREENWOOD (F. W.). **Collar-rot in Pea crops on the Wairau plain.** —*New Zealand Journ. of Agric.*, xxvi, 1, pp. 35–37, 1 fig., 1923.

Serious damage to pea crops in the Wairau Plain, Marlborough, New Zealand, is reported. The disease, which is caused by a species of *Fusarium*, first appears in the stem just above the collar, subsequently spreading to the roots, which are reduced to a putrid mass. Extension upward along the stem also occurs. Infection is carried on the seed and straw, rarely through the soil.

The worst attacks occurred on badly drained and sour soils, and also on very sandy soils in which nitrogen was deficient. The application of lime is recommended.

NEWHALL (A. G.). **Seed transmission of Lettuce mosaic.**—*Phytopath.*, xiii, 2, pp. 104–106, 1923.

Lettuce mosaic is usually present to the extent of 3 to 6 per cent. in western New York, but was very prevalent in 1921, its spread being correlated with a general infestation of aphids. Milkweed (*Asclepias syriaca*) and water dock (*Rumex britannica*) were tried as overwintering hosts, but inoculations were negative. In order to test the possibility of seed transmission, seed was harvested from twelve diseased plants and sown. The seed from three of these plants yielded twenty-seven mosaic seedlings out of 563 grown, whilst that from the remaining nine, grown in sterilized soil under very carefully controlled conditions, gave fifty-one mosaic plants out of 1,465. These results were supported by field observations, and both seem to prove that mosaic of lettuce is frequently transmitted through the seed.

GLEISBERG (W.). **Plasmodiophora brassicae Woron.: Zur Auswertung von Kruziferen-Infektionsreihen.** [*Plasmodiophora brassicae* Woron: On the evaluation of infection tests with Cruciferae.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 2, pp. 10–12, 1922.

In order to test the susceptibility of a number of Cruciferae to club-root (*Plasmodiophora brassicae*), ninety-three plants belonging to the sub-families Siliquosae, Siliculosae, and Nucamentaceae were sown in heavily infested plots in 1922. Only fifty-two of the species germinated, among which the incidence of infection is given in detail. There was complete absence, or barely a trace, of infection in the Arabideae (except *Cheiranthus allionii*, 20 per cent.), several of the Sisymbriae, Alysseae, Lepidieae, *Brassica napus* and *B. rapa*; 70 to 100 per cent. of infection in *B. cernua*, *B. juncea*, *Sinapis alba*, and various Alysseae, Camelineae, and Thlapseae. The remainder were intermediate. An adjacent plot of white cabbage showed 100 per cent. of infection, while the wild form of *B. oleracea* had only 16·6 per cent. The immunity of *B. rapa* and *B. napus* conflicts with Sorauer's statement that all cultivated forms belonging to these two species are susceptible to the disease.

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Beach (W. S.). **A crown rot of Rhubarb caused by Phytophthora cactorum.**—*Pennsylvania Agric. Exper. Stat. Bull.* 174, 28 pp., 5 pl., 1922.

In a short introduction the author states that the *Phytophthora* crown rot of rhubarb in Pennsylvania, to which he called attention in a previous report [see this *Review*, i, p. 102] is caused by *Phytophthora cactorum* (Leb. & Cohn) Schroet., heretofore known in America mainly as causing a disease of ginseng and a rot of apples and pears. As some experimental results indicate that the fungus from ginseng or apple may pass over to rhubarb, the crown rot of the latter will probably be found to have as wide a range of distribution as the other two diseases. Near Philadelphia, where rhubarb is fairly extensively grown, a number of fields have had to be abandoned owing to the disease. The heaviest losses usually occur in new plantings, the general practice of dividing old crowns for setting new hills apparently facilitating the entry of the parasite through the wound surfaces, the principal source of infection appearing to be the diseased plants in the original field. In a typical case cited by the author, a field was set in the spring with setts taken from a place where there was a mild degree of infection. By the end of September only 46·1 per cent. of the hills had healthy and vigorous plants, while 34·2 per cent. had been completely destroyed; 9 per cent. were still alive but showed typical symptoms of attack, and 10·7 per cent. were weakly and probably diseased. Plants attacked late in the season may recover sufficiently to become more or less productive the next year, but it is probable that they are the leading source of future infection. In older fields the plants are killed comparatively slowly; those that survive the setting-out season in a vigorous condition appear better able to withstand further attacks.

The first outward symptom of the disease, which usually appears during July, is the wilting of one or of a few leaf blades, followed by a loss of turgidity in the leaf stalk, so that the whole leaf structure falls prone on the soil. In warm, muggy weather the symptoms, which may appear in leaves of any age, are rapid in development and spread to other leaves, the whole plant being killed in a few days. In some cases, however, only a section of the crown is killed, the rest of the plant appearing healthy until another rainy period revives the activity of the fungus. In plants in an advanced stage of wilt, an extensive brownish-black discoloration marks the area occupied by the mycelium, while brown, depressed lesions develop on the surface of the portions of the leaf stalks enveloped in the crown. All the rotted tissues contain the mycelium, at first intercellular but later penetrating the cells. The fungus usually does not advance far into the petioles; a prolonged rainy period occasionally renders possible the infection of young leaf blades or the upper parts of the petioles, but ordinarily the aerial parts wilt and collapse as a consequence of the destruction of the crown and roots. The tissues invaded by the *Phytophthora* are at first not much softer in texture than healthy ones, but secondary saprophytes soon bring about the complete disintegration of the affected parts.

It seems probable that a sufficiently prolonged drought may preclude the development of the crown rot in any season, yet the disease has been evident to some degree in the vicinity of Philadelphia each year from 1918 to 1921; the damage was greatest in 1920 and least in 1918, the former summer being very wet and the latter very dry during the critical time for the development of the disease. No difficulty was met in securing infection in April both on roots and petioles of rhubarb in frames. It is probable that the fungus becomes established much earlier than indicated by the first outward symptoms. According to field observations, the disease is able to assume severe proportions on well drained soil, although heavier losses occur on low, wet areas. The physical character of the soil seems to have no influence, except as it tends to increase the water-holding capacity. A rich, fertile soil appears, however, to increase the resistance of the host to the fungus.

Inoculation experiments with *Phytophthora cactorum* from rhubarb gave positive and usually fatal results in practically all instances in which the cultures were inserted in wounds. A small proportion of inoculations without wounding succeeded, but only under very favourable conditions of temperature and moisture. Infection failed in an experiment in which macerated cultures were worked into the soil around the roots of twenty seedlings in pots, care being taken not to wound the roots. Taking into consideration the apparent relation of wounding to the severity of crown rot in the field, it would appear that the fungus is but little able to infect through perfectly sound roots; but though both observations in nature and the general results of the infection experiments indicate that wounding is a very important factor in the spread of the disease, some experiments have shown that infection can take place through the uninjured epidermis under favourable conditions. In culture the maximum temperature for growth was 33° C., the optimum near 25° C., and growth was still possible from 7° to 9° C.

Oospore production was heavier below 20° C. than above, the reverse being the case as regards conidia.

It seems probable that, as in the case of the ginseng disease, the conidia are distributed by wind and by rain. There are also indications that oospores lying in decaying tissues are carried along the rows by cultivation. The writer records cases where the disease was introduced into new fields through oospores and possibly latent mycelium present in the roots.

Oospores were only twice found by the author upon rhubarb material, but were freely produced in culture. Conidia are always produced during damp weather on the petiole lesions above the soil. Comparative tables of measurements of the spores from different hosts are given in support of the conclusion that the fungus described is *Phytophthora cactorum*. This morphological agreement is confirmed by the fact that the form from apple is capable of infecting rhubarb and causes crown rot, although it is somewhat less virulent than the rhubarb isolations. *P. fagi*, as known in Europe, is thought to be at least biologically distinct.

For the control of the disease, the planting of setts from infected stock should be avoided, and new plantings with stock started from seed under disease-free conditions or from a healthy field should be made on soil on which rhubarb has not been grown for a considerable number of years. The destruction of infected plants early in the season and the disinfection of dormant roots before planting are strongly recommended. Bordeaux mixture sprayed into the crowns and over the petioles promises to be effective in preventing the spread of the disease in summer, but will not prevent the decay of plants already attacked.

Mention is made of two other *Phytophthora* diseases of rhubarb in the United States, the outward symptoms of which are similar to those described above. One of these, caused by *P. parasitica* var. *rhei*, is being described by Godfrey under the name 'foot rot' [see following abstract]. In this case, besides morphological differences from *P. cactorum*, the causal fungus appears to be adapted to higher temperatures, but although the disease caused by it progresses somewhat more rapidly during hot weather, there appears to be little difference in the ultimate damage done by the two parasites. The other, also a serious foot rot, occurs in southern Illinois, and is recorded in this paper for the first time. It is caused by a third species of *Phytophthora*, the identity of which has not yet been established.

GODFREY (G. H.). **A Phytophthora foot rot of Rhubarb.**—*Journ. Agric. Res.*, xxiii, 1, 26 pp., 12 pl., 3 figs., 1923.

The present paper is the first record of a serious foot and root rot of rhubarb caused by *Phytophthora parasitica* var. *rhei*. It has been found in Maryland, the District of Columbia and Virginia, but is probably much more widely distributed. In outward symptoms, final damage done, and weather relations, the disease closely resembles the crown rot in Pennsylvania described by Beach [see above abstract].

The fungus was isolated and grown on various culture media, the morphological and cultural characters being briefly described. It readily infects rhubarb plants, with or without wounding, causing the typical symptoms of the disease and usually killing the plants.

Inoculations on other hosts showed that the fungus was able to rot apples, and readily attacked parsnips and carrots, causing a soft wet rot which, in the latter case, spread to the growing leaves. Turnips were slowly decayed without softening, and in sweet potatoes the rot caused was also firm and dry. On ordinary potatoes the symptoms resembled those caused by *P. erythroseptica*. Green and ripe tomatoes were rapidly attacked, but inoculations on young tomato plants failed. *Colocasia* was immune, and onion practically so. On *Ricinus communis* the young inflorescences and leaves were successfully infected, but the attack was confined to small spots and did not spread.

There is a full discussion of the taxonomy of the fungus, which is regarded as being morphologically similar to *P. parasitica*, except in the size of the oospores, which average about 25 μ in the rhubarb fungus as against 18·6 μ in *P. parasitica*. Other differences from this species are the divergent results obtained on inoculating various other hosts such as tomatoes, and some variations in ability to grow on certain media. These differences are not regarded at present as of more than varietal significance. and the new variety *rhei* of *P. parasitica* Dastur is proposed. *P. melongenae* Sawada and *P. terrestris* Sherb. are also regarded as belonging to the same series and not as distinct species. A detailed English diagnosis of the variety *rhei* is given.

Preliminary experiments indicate that spraying with Bordeaux mixture, during the usually brief period when infection is likely to occur, gives promise of successful control. The other measures recommended are essentially the same as for the disease caused by *P. cactorum* described above.

HOWITT (J. E.). **Two diseases new to Ontario.**—*Scient. Agric.*, iii, 5, p. 189, 1923.

During the summer of 1922 the author's attention was drawn to two diseases, apparently new to Ontario, of considerable economic importance, namely pink root of onions, caused by *Fusarium malli* [see this *Review*, i, p. 405], and white rot of grapes due to *Coniothyrium diplodiella* [see this *Review*, ii, p. 45].

Diseased onions from a marsh bordering on Pelee Point were found to be attacked by *F. malli*, which is prevalent in the onion-growing marshes south-east of Leamington, Ontario. In 1922 at least fifty acres were affected. Outside the Bermuda onion-growing regions of Southern Texas, the economic importance of this disease has not yet been generally recognized, and it requires immediate attention.

White rot of grapes was first observed by the writer in a vineyard near Winona, Ontario. Observations in the Niagara district in 1922 indicated that the disease may cause serious damage to certain commercial varieties, especially Agawam (Roggers No. 15). Over 80 per cent. of the bunches in unsprayed rows of this variety were unmarketable. The disease, which must not be confused with the somewhat similar black rot caused by *Guignardia bidwellii*, may be controlled by spraying with Bordeaux mixture.

Moreau (L.) & Vinet (E.). **Contribution à l'étude de l'apoplexie de la Vigne et de son traitement.** [Contribution to the study of apoplexy of the Vine and its treatment.]—*Comptes Rendus Acad. Agric. de France*, ix, 1, pp. 32–36, 1923.

For the last three years the authors have set aside for the investigation of apoplexy 1·5 hect. of their experimental vineyard containing 6,750 vines at Belle-Beille [Angers, Maine-et-Loire]. It was found that the disease, hitherto believed to be peculiar to the south, was equally virulent in the west of France. In 1920 the number of vines killed per 1,000 was 35, in 1921, 10, and in 1922, 65. Examination of dead vines in the vineyard showed that in 1920, 90 per cent. and in 1922, 80 per cent. were attacked by the parasite responsible for the 'esca' disease [*Fomes igniarius*: see this *Review*, i, p. 416].

The development of the disease is very gradual, the final phase often setting in quite unexpectedly when the internal damage reaches a point at which the tissues are no longer able to convey enough water to meet losses through transpiration. Sometimes, however, a progressive withering of the leaves and tendrils may indicate the approaching death of a branch. In some cases partially defoliated branches form new shoots in July or August, the reduction of evaporation consequent on the loss of leaves being sufficient to preserve the vitality of the buds and enable them to sprout.

The symptoms of the disease may be traced from year to year in a gradual chlorosis, in the failure of the wood to mature properly, and in the withering of individual branches. An examination of the interior of the diseased vines almost always reveals the presence of the tinder-like decay characteristic of the 'esca' disease. Death most often occurs towards the end of the season, the majority of the fatal cases observed being between 15th September and 26th October.

Experiments in the control of the disease by the application to the vines, a few days after pruning, of a solution of arsenite of soda containing 1,350 gm. of arsenious acid per hectol. of water gave excellent results, the number of branches affected during the following season being greatly reduced. By the 26th October the treated plots had an average of 4 dead and 3 partially dead plants, while the controls had 65 dead and 71 partially dead.

The tests will be continued to ascertain whether it is sufficient to treat the vines two consecutive years out of every four, the practice followed in the south.

Brereton (W. Le G.) & Hamblin (C. O.). **Black spot of the Vine (Gloeosporium ampelophagum): Experiments with controls 1920–21.**—*Agric. Gaz. New South Wales*, xxxiii, 6, pp. 432–436, 3 figs., 1922.

Experiments were carried out at Hawkesbury Agricultural College and at Yanco Experiment Farm in New South Wales in treating vine anthracnose (*Gloeosporium ampelophagum*) to determine the best winter swabs and sprays, to test summer control sprays, and to test late season sprays for ripening fruit. The first series was inconclusive, as very little disease appeared during the year, but it was found that the application of a swab consisting of 5 lb. sulphate of iron, one gallon of water, and half a pint of sulphuric acid, delayed the bursting of the young buds about ten days. At Yanco a similar delay in the bursting of the buds was caused by the application of sulphuric acid (1 : 10) swabs. When applied to vines with the buds already burst, the swabbing caused the foliage to be burnt off. Spraying experiments in the winter with Bordeaux mixture (6–4–22), Burgundy mixture (4–6–22), and lime-sulphur (winter strength) had no retarding effect. Owing to the late appearance of the disease, neither swabbing nor winter spraying had any controlling effect.

The following treatment for vine anthracnose is recommended. (1) After pruning, all cuttings should be collected and burnt. (2) If time and labour permit, the loose old bark may be removed, and it must then be burnt. (3) While dormant, the following swabs or sprays should be applied once or twice : (*a*) one gallon of water, 5 lb. sulphate of iron, half a pint of commercial concentrated sulphuric acid (dissolve the sulphate of iron by suspending it overnight in a piece of sacking in the water contained in a wooden or earthenware vessel, in the morning add the acid slowly to prevent spurting) ; (*b*) ten gallons of water, one gallon of sulphuric acid. This is effective both for spraying and swabbing. The brush or mop must contain no metal, and the sprayer should be lined with lead. If the disease has been virulent the preceding season, two applications are desirable, one five weeks before the bud-bursting period and another just prior to this event. Where only one application is decided upon, it should be made as near as possible to the bursting of the buds, but care must be taken not to leave it too late, as unexpected sprouting might prevent the work from being carried out at all. (4) In the spring, when the buds are bursting, spraying with Bordeaux mixture (6–4–40) must be undertaken, and another application with the mixture at summer strength (6–4–50), when the later buds are sprouting. Further spraying must depend on weather conditions. Spraying during the blossoming period should be avoided as a rule, but if, through any cause, the application just before blossoming has been delayed and weather conditions are favourable to the disease, the sprayings should be continued rather than risk the spoiling of the entire crop. The sprayings are also valuable in regard to downy mildew, which appears later in the season.

Bioletti (F. T.). **Black measles, water berries, and related Vine troubles.**—*California Agric. Exper. Stat. Bull.* 358, pp. 509–524, 3 figs., 3 diag., 1923.

There are several obscure diseases of the vine in California, indiscriminately referred to as black measles. Spanish measles, black mildew, blight, Anaheim disease, California disease, Santa Clara disease, and top disease, which appear to be closely allied to the European 'brunissure' and to two other Californian vine diseases, namely, 'water berries' and 'grape shrivel'.

The chief symptoms of the diseases are various spots, patches, and dead areas on the leaves ; spotting, softening, and premature drying of the fruit, with absence of sugar, acidity, colour, and flavour ;

dying back of the tips of the shoots, uneven or imperfect ripening of the canes, with a deficiency of starch ; dark spots and streaks in the wood; short growth and death of arms, branches, or even entire vines. Various combinations of these symptoms may appear in individual cases. In black measles, Spanish measles, black mildew, California, Anaheim, and Santa Clara diseases (which are distinguishable from one another only by their distribution, the first three being sporadic and the last three epidemic), any or all of the symptoms may occur. These diseases appear to represent a chronic state of the same conditions that produce water berries and grape shrivel, namely, overbearing and malnutrition.

A study of these diseases of the vine in California affords strong evidence that the epidemic form of the trouble is due to excessively heavy crops following good growing conditions and abundant rains, succeeded by deficient or irregular rainfall. The obvious remedy for the disease, besides the application of suitable fertilizers and other cultural measures, is a diminution of the load by short pruning—down to the base-buds in severe cases. The various types of the disease merely represent different stages or degrees of the same trouble. It is very probable that the severity of the final stages of the disease may be due to some undetected infective micro-organism or facultative parasite to which the vine is susceptible only after being weakened by malnutrition.

SWINGLE (D. B.). **How the Department of Botany and Bacteriology has been meeting obligations.**—*Rept. Montana Agric. Exper. Stat. for the year ending 30th June, 1921*, pp. 39–44, 3 figs., 1922.

During the period under review an outbreak of fireblight [*Bacillus amylovorus*] threatened the destruction of the apple industry in Montana but satisfactory control was effected. An investigation of the disease brought to light new facts in connexion with varietal resistance.

Apple scab [*Venturia inaequalis*] was reported in Montana for the first time, and information has been obtained concerning varietal resistance and rapidity of spread. Lime-sulphur was more satisfactory than Bordeaux mixture as a protective spray owing to the serious injury to the fruit caused by the latter.

The results of investigations on brown bark spot of fruit trees, a destructive disease due to malnutrition, have been separately published [see this *Review* ii, p. 221].

A form of plum pockets [*Exoascus pruni*], quite different from the eastern type, destroyed 50 to 90 per cent. of the ordinarily hardy American plums in the Yellowstone Valley. Satisfactory control measures, however, were organized.

Stem rust of wheat [*Puccinia graminis*] has been considerably checked by the vigorous campaign of barberry eradication, in which Montana is one of the leading States. As a result of the serious epidemic in 1916, when the loss to the wheat crop was estimated at three million bushels, there has been no lack of co-operation on the part of the farmers.

A serious wilt disease of sunflowers, caused by a fungus probably identical with *Sclerotinia libertiana*, was widely distributed over the State. The first symptoms are usually noticed when the plants are four to six feet in height, the affected bases of the stems at first turning black, then brown, and finally yellow. The fungus appears to spread rapidly through the ground, and diseased crowns and roots are generally covered with the dense, white mycelium of the fungus, which afterwards forms large, black sclerotia, especially in the pith. Young seedlings in the field do not appear to be very susceptible to the disease, but the losses among older plants range from 10 to 60 per cent. Inoculation experiments on young sunflower and lettuce seedlings resulted in the production of the typical symptoms of the disease.

Osmun (A. V.). **The crop disease situation in 1921.**—*Thirty-fourth Ann. Rept. Massachusetts Agric. Exper. Stat.*, pp. 62 a–75 a, 1922. [Rec'd 1923.]

About the usual number of plant diseases was reported from Massachusetts during 1921. On the whole the season was free from serious epidemics, which occurred in three instances only.

An unusually warm and wet spring provided ideal conditions for the discharge and germination of the spores of the apple scab fungus (*Venturia inaequalis*) and resulted in a very severe outbreak of the disease. The McIntosh variety was the most susceptible, showing 90 to 100 per cent. infection in many orchards. A second period of heavy rainfall in July was accompanied by considerable secondary scab infection.

Tobacco wildfire (*Bacterium tabacum*) was extremely prevalent in the seed-beds of the Connecticut Valley, probably owing to the abnormally wet weather during April and May [see this *Review*, ii, p. 37].

The third disease to occur in epidemic form was the downy mildew of cucumber and melon caused by *Pseudoperonospora cubensis*, which resulted in very severe damage except in places where it was held in check by the application of Bordeaux mixture. In no case was the fungicide applied until after the mildew appeared on the vines, and, judging by the successful results, preventive sprays can apparently be dispensed with.

The season was remarkable for the almost complete absence of late blight of potatoes (*Phytophthora infestans*) which was doubtless due to the unusually dry conditions prevailing from August to October.

A complete list of the 166 diseases diagnosed from over 600 cases during the year, together with the localities in which they occurred, is appended.

Annual Report of the Director Arkansas Agricultural Experiment Station, 1921–1922, 103 pp., 35 figs., 1922. [Rec'd 1923.]

The following references to subjects of phytopathological interest occur in the section of the report devoted to plant diseases (pp. 88–94). Apple scab [*Venturia inaequalis*], which was particularly severe during the period under review, was effectively controlled by spraying. Tomato wilt (*Fusarium lycopersici*) is greatly on the increase, and the frequent occurrence of the disease in crops grown from seed on virgin soil, led to experiments by Elliott and Crawford which have demonstrated that the fungus is carried on seed from infected plants [see this *Review*, ii, p. 92]. Mosaic of sweet potatoes is widespread, and there has been a serious outbreak of mosaic on clovers and cowpeas, the latter sometimes being severely injured and the yield much reduced. On sweet clover [*Melilotus*] the disease is perennial and easily spreads from one plant to another. In the case of the cowpea the disease does not appear to be carried in the seed, but mosaic was found to be transmitted in seed from infected horsebeans and bur clover. A serious epidemic of anthracnose of alfalfa [*Colletotrichum trifolii*] occurred in the Mississippi Valley.

Other important diseases mentioned are cotton blight (*Ascochyta gossypii*), cotton wilt [*Fusarium vasinfectum*], and a bacterial root rot of maize, but the work on these diseases has already been noticed in this *Review* [see ii, pp. 215, 66, and 158 respectively].

RATCLIFFE (G. T.). **The work of the San Antonio Experiment Farm in 1919 and 1920.**—*U. S. Dept. of Agric. Circ.* 209, 38 pp., 4 figs., 1922. [Rec'd 1923.]

The results of experiments on cotton root rot [*Ozonium omnivorum*] extending over the period 1916 to 1919 showed that neither acid phosphate nor calcium acid sulphate fertilizers controlled the disease under San Antonio conditions. Mulching was without effect on the incidence of the disease, and further investigations on the advantages of aeration in infected fields, indicated that any benefit derived from the process was of very brief duration. Root rot was found to occur at a depth of at least four feet.

NEAL (D. C.). **Report of the Plant Pathologist.**—*Ann. Rept. Mississippi Agric. Exper. Stat.*, xxxv, pp. 25–28, 1922. [Rec'd 1923.]

During 1921 about thirty selections of tomatoes were made at the Central Station, Mississippi, from the Norton, Marvel, Norduke, Greater Baltimore, Glove, and Stone varieties, with a view to developing strains resistant to wilt [*Fusarium lycopersici*]. These selections have been re-propagated in wilt-infected land for observation during the coming season. The same procedure is being adopted at the Poplarville Branch Station. So far the yield records have been somewhat unsatisfactory owing to the drought, but there is reason to believe that the wilt-resistant strains will yield better under Mississippi conditions than the ordinary commercial varieties. Attempts at crossing wilt-resistant strains with early commercial varieties are in progress.

A comparative study of resistance and susceptibility of three leading sweet potato varieties (Nancy Hall, Triumph, and Porto Rico) to black rot (*Sphaeronema fimbriatum*) gave inconsistent results, probably owing to the drought, and the work will be repeated. Studies on the surface rot (*Fusarium oxysporum*) of sweet potatoes are also in progress.

Spraying experiments for the control of pecan scab [*Fusicladium effusum*] are being continued at Ocean Springs and Pascagoula with susceptible varieties, such as Pabst, Success, and Delmas. The plots are being sprayed with 4–4–50 Bordeaux mixture and

Bordeaux oil-emulsion at intervals of three to four weeks according to weather conditions.

Forty-first Annual Report Ohio Agricultural Experiment Station for 1921–22.—*Ohio Agric. Exper. Stat. Bull.* 362, 59 pp., 1922.

The following references to plant diseases are included in the report. At Clermont one-tenth and one-twentieth acre plots were planted alternately with diseased and healthy maize seed in order to determine (1) the reduction in yield of grain and stover [the stalks from which the ears have been husked] due to root rot, caused by *Diplodia zeae*, which is very prevalent in the west and south-west of the State, and (2) whether the loss could be eliminated by testing the germination of the seed before sowing. The seed was carefully selected in the autumn of 1921, using the modified rag doll method of germination to determine the relative presence or absence of the disease. In all plots where diseased seed was used there was a marked reduction in the yield both of grain and stover. Production was also much higher on drained than on undrained land. The total yield of grain from healthy seed plots on drained land was 782 lb. and that of stover 550 lb., the corresponding figures for the diseased seed being 486 and 319 lb. respectively. On undrained land the total yield from the healthy seed was 321 lb. of grain and 221 lb. of stover, and from diseased seed 249 lb. of grain and 150 lb. of stover.

It is evident from the above results that the expert use of the rag doll germinator greatly increases the maize yield, but the difficulties connected with the method debar the average grower from taking full advantage of it.

In southern Ohio apple scab [*Venturia inaequalis*] and blotch [*Phyllosticta solitaria*] cause a considerable amount of damage, and spraying experiments on their control were conducted in 1922. The best results were obtained by the use of lime-sulphur 1 in 40 applied (1) when the trees were dormant, (2) when the blossoms showed pink, (3) at petal-fall, (4) a fortnight later, and (5) two months after 4. Bordeaux mixture 3–9–50 and 2–6–50 gave fairly good control but caused considerable russeting of the fruit and defoliation during the latter part of the season. The omission in certain plots of the spray given a fortnight after petal-fall resulted in severe secondary infection by Brooks's spot (*Phoma pomi*) and scab.

Two years of research (for the biennium ending June 30, 1921).—*Pennsylvania Agric. Exper. Stat. Bull.* 170, 31 pp., 1922. [Rec'd 1923.]

The following references in the section of the report devoted to botany and plant pathology (pp. 15–20) are of interest.

Root and ear rots of maize [*Diplodia zeae, Gibberella saubinetii* and *Fusarium moniliforme*] cause a considerable reduction in the annual yields of the Pennsylvania crops. The possibility of detecting diseased ears by very carefully controlled germination tests has been demonstrated. The results of field experiments in various parts of the State showed an increase of about six bushels per acre from healthy ears planted side by side with diseased ones (as determined by the germinator). Such an increase, however, is not regarded as sufficient to warrant the adoption of the germinator test as a part of the general farm routine [see also above abstract].

Co-operative investigations with the United States Department of Agriculture, Bureau of Plant Industry, and Federal Horticultural Board on the morphology and cytology of the causal organism of potato wart disease (*Chrysophlyctis endobiotica*) [*Synchytrium endobioticum*] are being continued. Studies are also in progress on the physiological and anatomical relations of various hosts to the parasite; methods of control by the use of soil sterilization and immune varieties; and the genetical behaviour of immunity and susceptibility of potato varieties to this disease. Infection has not been observed to occur in controlled soil temperature tanks above 22° C., indicating a relatively low temperature requirement. Thirty-four American varieties, including Green Mountain, McCormick, Cobbler, Spaulding Rose, and Burbank, were found to be immune, and 63 out of 149 seedlings. Several varieties of tomatoes have proved to be susceptible. Long-continued steaming of the soil has been found to destroy the sporangia of the fungus, but this method is impracticable for use on a commercial scale. Certain chemicals are effective as regards complete penetration of the soil, but the necessity of giving very heavy applications renders the cost prohibitive.

The results of extensive observations on the incidence of wilt and tuber rots of the potato in the warmer soils of Pennsylvania indicate that at least three fungi, *Fusarium oxysporum*, *F. eumartii*, and *Verticillium* sp. are involved in the causation of these diseases. The results of preliminary trials suggest that a large percentage of infection in the field comes from the soil. Some difference in the varietal resistance of plants inoculated in the field was shown.

Field work on leaf roll of potatoes, begun in 1919, has shown that the percentage of leaf roll in a field may increase in two years from 2·5 to as much as 100 per cent. By the practice of roguing early in the season the percentage of leaf roll plants can be reduced but in none of the trial plots was the disease entirely eliminated by this method. Generally speaking, it does not pay to rogue fields containing over 10 to 15 per cent. of leaf roll. Disease-free seed should be secured whenever possible.

Winter blight of tomatoes, known in Australia as 'spotted wilt' and in Great Britain as 'stripe', is primarily due to a bacterial organism [*Bacillus lathyri*] but unbalanced nutrition of the host and a high degree of humidity were found to be predisposing factors. Greenhouse tomatoes are principally attacked, though outdoor ones may also suffer severely under certain conditions. Conclusive proof of seed dissemination was secured.

The results of four years' work on *Septoria* leaf spot [*S. lycopersici*] of tomatoes show that spraying with standard Bordeaux or other copper compounds increases the total yield of fruits. Under Erie County conditions it is not usually advantageous to spray tomatoes for the canning market.

Three bacterial diseases of tomatoes appeared in Erie County;

the first, apparently a seed-borne disease, resembles the 'Grand Rapids disease', but the causal organism differs somewhat from *Aplanobacter michiganense* [see this *Review*, ii, p. 347]. The second was identical with the canker reported from Michigan and Indiana and recently attributed to *Bacterium exitiosum* Gard, while the third was a wilt apparently caused by *Bacillus solanacearum*.

In 1915 a number of plots on a piece of ground thoroughly infested with club-root of cabbage [*Plasmodiophora brassicae*] were treated respectively with Bordeaux mixture, ammoniacal copper carbonate, formalin, flowers of sulphur, and lump lime. Cabbage was planted on these plots for six years in succession without the treatment being repeated. The residual effect of the treatment was most pronounced in the case of the Bordeaux mixture and lump lime. By the end of the sixth season all the plots were again infested and were treated with copper sulphate, Bordeaux mixture, lump lime, milk of lime, ground limestone, lime-sulphur, and nicotine sulphate. One year's results indicate that Bordeaux mixture (8–8–50), applied in amounts approximately equal to 3,200 lb. calcium oxide per acre, is by far the most satisfactory. Lime-sulphur proved extremely injurious.

Four years' observations on *Sclerotinia libertiana*, the cause of a 'drop' of lettuce and a storage rot of carrots and celery, show that, if non-susceptible crops are grown for two years, the disease will virtually disappear. The sterilization of the soil of frames and seed-beds with formalin (1 in 100 at the rate of 1 gall. per sq. ft.) is recommended. In 1918 two sprayings of lime-sulphur, Bordeaux mixture, or Pyrox, gave satisfactory control of apple rust [*Gymnosporangium juniperi-virginianae*], the first-named being the most effective. In 1919, however, Bordeaux was best, whilst sulphocide and sulphur dust (in 1920) were not satisfactory. Black rot or frog-eye of apples [*Physalospora cydoniae*] can be effectually controlled by the timely application of liquid sprays, dusts being less satisfactory. Most of the infection usually occurs from the time the leaves appear until three or four weeks after the fall of the petals. All attempts to reproduce the disease by artificial inoculation have failed. Apple blotch [*Phyllosticta solitaria*] was well controlled by three applications of lime-sulphur, the first being given 3½ weeks after the fall of the petals. The results of preliminary trials indicate that no infection takes place before 23rd May.

WELLES (C. G.). **Identification of bacteria pathogenic to plants previously reported from the Philippine Islands.**—*Philipp. Journ. of Science*, xx, 3, pp. 279–285, 1922.

The present paper, the first of a series in which all known bacterial organisms pathogenic to Philippine plants will be briefly described, deals with *Bacterium solanacearum*, *Pseudomonas phaseoli*, *Bact. malvacearum*, and *Bacillus nelliae* sp. nov. After a brief review of the records of these diseases in the Philippines, the author describes in detail the cultural and morphological characters of the organisms concerned. The media used were based on the American descriptive chart and in each case inoculations were carried out to prove the pathogenicity of the organisms.

Bacterium (Bacillus) solanacearum was isolated from wilted tobacco, eggplant, and tomato plants. The cells of the organism measured 0·8 to 1·2 μ in length, Smith's figures being 0·6 to 1·0 μ, and agreed in most cultural respects with the particulars previously published (*U. S. Dept. Agric. Div. Veg. Physiol. & Path. Bull.* xii, p. 1, 1896). *Pseudomonas phaseoli* was isolated from diseased bean leaves, and the organism appears to be identical with that described by Smith in 1901, both from the symptoms and the tests, so far as they were comparable. *Bact. malvacearum*, isolated from young, watery lesions on cotton leaves, agreed with the description of the organism by Rolfs (*South Carolina Agric. Exper. Stat. Bull.* 184, p. 1, 1915), except that no difference in degree of growth was observed on the various sugar media. The bright yellow, non-pathogenic organism mentioned by Rolfs was also encountered by the author in making the inoculations. The bacterial wilt of parsley was for several seasons believed to be caused by *Bacterium solanacearum*, the behaviour of the attacked plants corresponding in all respects with that of those infected by this organism. The result of physiological studies showed, however, that the organism was an entirely new species, which was named *Bacillus nelliae*. The organisms are short rods with rounded ends, 0·83 to 2·27 by 0·37 to 0·50 μ, staining readily with all common aniline dyes. The thermal death point lies between 53° and 54° C. Three to seven peritrichous flagella were demonstrated. Cultural characters are fully described.

THOMAS (R. C.). **A bacterial rosette disease of Lettuce.**—*Ohio Agric. Exper. Stat. Bull.* 359, pp. 197–214, 8 figs., 1922.

Since the autumn of 1919 a bacterial rosette disease of Grand Rapids lettuce has been observed in a number of Ohio greenhouses. The losses caused by the disease, which in many respects resembles that caused by *Rhizoctonia*, vary from a trace to 60 per cent. of the crop.

Affected plants develop unevenly and show a tendency to rosette, accompanied by a yellowing or flaccidity of the outer leaves, especially at high temperatures. Examination of the roots showed them to be seriously affected, the small fibrous roots rapidly ceased to function, and the larger roots were readily detachable when a plant was pulled up. The general cultural conditions prevailing in the greenhouses were excellent.

A microscopic examination of the stems and roots revealed a brownish substance, soluble in alcohol and acetic acid, in the xylem and other portions of the vascular system, and in some cases bacteria extended upwards from half an inch to an inch above ground level. Isolation experiments readily yielded a single species of bacterium, from dead rootlets and soil adhering to diseased plants. Healthy lettuce plants inoculated with pure cultures of the organism developed the typical symptoms of the disease. An inoculation of the soil in which the plants were grown resulted in much slighter infection but the organism was re-isolated from the diseased rootlets and stems in the majority of cases.

The bacterium has never been observed to cause a rot or spots on the leaves or stems of lettuce plants, and negative results were obtained in every case when a suspension of the bacteria was sprayed on the leaves of healthy plants. The chief action of the organism appears to be to gain admission to the vascular system of the plant and interfere with the free passage of food material.

The morphological and cultural characters of the organism are described at length. The bacterium is non-motile, occurring singly or concatenately, 1·4 to 1·9 by ·5 to ·85 μ or ·9 to 1·5 by ·4 to ·8 μ according to the medium, greenish-yellow, later olive-buff and finally red in colour, strictly aerobic, optimum temperature for growth 25° to 27° C., maximum below 38° C., minimum below 0° C., thermal death point 51° to 52° C., remaining viable in artificial media and soil cultures for one year. The organism produced ammonia and some indol, but no acid or gas. There is a marked reduction of nitrates, in which the organism differs from *Bact. vitians* Brown, the cause of a similar lettuce disease in South Carolina. The bacterium is Gram negative, non-acid-fast, withstands desiccation for four days, and will grow in media made alkaline with sodium hydroxide to 20 degrees Fuller's scale, and in various acid-containing media. The group number of the organism, for which the name *Aplanobacter rhizoctonia* n. sp. is proposed, is 211·3333523.

Good results in the control of the disease were obtained by the saturation of the soil, previous to planting, with formalin (3 to 3½ pints to 50 galls. of water), applied at the rate of one or more gallons of liquid per sq. ft. of surface area. The soil was allowed to dry for a week or ten days before the lettuces were planted.

Nobécourt (P.). **Inoculations d'une bactérie phytopathogène à des grenouilles.** [Inoculations with a phytopathogenic bacterium on frogs.]—*Comptes Rendus Soc. de Biol.*, lxxxviii, 13, pp. 1041–1042, 1923.

Inoculation experiments with pure cultures of *Bacillus carotovorus* Jones, isolated from a lettuce in July 1922, were recently carried out on five frogs, all of which died after periods ranging from six to fifty-one days. The animal which survived longest was inoculated with a culture previously heated in order to kill the bacillus. Pure cultures on bouillon of the organism isolated from the dead frogs behaved in all respects like the original cultures and produced the symptoms of rapid decay in carrots. Thus the phytopathogenic properties of the bacillus were in no way impaired by its passage through the animals. The fact that *Bacillus carotovorus* has been proved to be zoopathogenic as well as phytopathogenic is regarded as important from the standpoint of comparative pathology.

Allyn (O. M.). **Reducing Corn root-rot by careful hand selection of seed.**—*Journ. Amer. Soc. Agron.*, xv, 2, pp. 73–76, 1923.

In Illinois during the spring of 1922 a number of apparently healthy ears were found in a stock of 400 bushels of Western Ploughman seed maize, a smooth variety with blocky kernels, and it was decided to test by germination experiments in the laboratory and by planting in the field [see above p. 442] the relative merits of the ears showing no disease, of those going into the general run of seed, and of those badly diseased, the ears being grouped into these three grades before shelling.

Composite samples for germination tests were taken from the bags after shelling, both the plate and blotter, and rag doll methods being used. In each test 200 kernels were placed in a germinating cabinet at a temperature of 80° F. and dissected and examined after seven days. The results of all the tests may be summarized as follows: selected seed gave 91·1 per cent. healthy and ·96 per cent. dead, 'general run' seed 69·7 per cent. healthy and 3·7 per cent. dead, and diseased seed 52·3 per cent. healthy and 12·5 per cent. dead.

When samples of the above seed were planted on a comparatively new piece of ground, the following yields were obtained: selected seed, 73·7 bushels shelled maize per acre; 'general run' seed, 65·8 bushels; diseased seed, 64·2 bushels. The largest number of disease-free ears (67·6 per cent.) came from the selected plot: 31·2 per cent. from the 'general run', and 13·8 per cent. from the diseased plot. These results show that careful hand selection materially reduces root rot [*Diplodia zeae*] even in the first year.

ROSEN (H. R.). **A bacterial disease of Foxtail (Chaetochloa lutescens).**—*Ann. Missouri Bot. Gard.*, ix, 4, pp. 333–385, 7 pl. (2 col.) 1 graph, 1922. [Rec'd 1923.]

A bacterial disease of foxtail, first recorded by the author in Arkansas in 1919, has since been studied in more detail especially with regard to its symptoms and etiology. No systematic attempt has been made to discover the disease on other grasses, but the results of artificial inoculation experiments show that the pathogen can infect wheat, oats, rye, barley, maize, Sudan grass (*Holcus sorghum sudanensis*), millet, and perennial foxtail. On oat and barley seedlings the disease may cause serious damage.

The lesions on foxtail appear as light or dark brown spots of no definite size or shape; they are most frequently found on the blades and sheaths. On other hosts the symptoms vary from light yellow, indefinite areas (often with a reddish tinge in the case of oats) to greyish-green, withered spots. The invaded tissues swarm with bacteria which cause discoloration, disintegration, and finally death. The organism was not difficult to isolate and artificial inoculations were readily successful when the bell jars used were properly aerated. Temperature plays an important rôle in infection, which does not occur on plants incubated below approximately 21° C., whilst above 24° C. infections are effected, and about 32° C. the symptoms appear in 24 to 48 hours. Admission is gained by means of stomata and water pores.

The disease appears to be different from any other known bacterial affection of grasses. The causal organism, *Pseudomonas alboprecipitans* n. sp., is described as follows: narrow rods with rounded ends, solitary or in pairs, averaging 0·6 by 1·8 μ, motile by a single polar flagellum; no spores, zoogloea, or irregular forms; capsules present: strictly aerobic: surface colonies on nutrient agar white, round, raised, smooth, amorphous, sticky, margins entire, surrounded by colourless areas followed by a white precipitate on media testing acid as P_H 6·6; nitrates reduced to nitrites; ammonia produced, but no indol, hydrogen sulphide, acid, or gas; diastatic action strong; fair growth in Uschinsky's and Fermi's solutions; minimum temperature for growth 0° C., optimum 30° to 35° C., maximum about 40° C., thermal death point 41° to 43° C.; not sensitive to drying or freezing and only slightly so to sunlight; Gram negative, non-acid-fast. The group number is 5322–31220–1333.

The meaning of hydrogen-ion concentration, its relation to titratable acidity, the methods of measuring it, and the necessity of utilizing it in the study of bacterial pathogens are discussed. Comparisons are given between Fuller's scale and P_H values. Numerous cultural reactions are presented, and the relationship of various organic anions to growth and several questions of technique are discussed.

Beef extract was found to be the probable source of the white precipitate (a phosphate) in media containing the extract.

A bibliography comprising nearly a hundred titles is appended.

MUNRO (D. G.) & SUNDARARAMAN (S.). **Coffee-spraying experiments.**—*Planters' Chron.*, xviii, 14, pp. 193–196, 1923.

A series of experiments was undertaken at the Purchikadu (Sidapur) estate [India] to ascertain (*a*) to what extent leaf diseases of coffee, such as red rust (*Hemileia vastatrix*) and black rot [*Corticium koleroga*] could be checked by spraying; (*b*) the optimum strength of solution for efficacy and economy; (*c*) the efficacy of different kinds of adhesives when added to Bordeaux mixture; and (*d*) whether the improvement in the health of the plant and the gain in yield compensated for the cost of the work. The spraying was carried out in May to June 1922 under adverse weather conditions, the experimental area being divided into plots of about one acre in extent. The results may be summarized as follows. Two per cent. Bordeaux mixture 10–10–50 with resin adhered well to the leaves and caused no injury to the foliage, whilst almost equally good results were obtained by the use of half strength Bordeaux (5–5–50) plus resin or casein, and even quarter strength Bordeaux ($2\frac{1}{2}$–$2\frac{1}{2}$–50) with resin or casein, was also very satisfactory. Casein is recommended as cheaper and easier to manipulate than resin soda. Fish oil soap was found not to be a good adhesive. Lime-sulphur $7\frac{1}{2}$–$7\frac{1}{2}$–50 was washed off the leaves by the heavy rains of the monsoon.

The value of the treatment may be gauged by the fact that the leaves produced in the April to May (1922) flush remained on the sprayed trees till February 1923, by which time the trees in the unsprayed controls had lost nearly all the leaves of the September flush. Die-back was much less prevalent in the sprayed than in the untreated plots.

Spraying is both difficult and expensive especially where water is scarce. Large sprayers are unsuitable, and the frequent filling of small ones, together with the preparation of the mixture, entails considerable time and care. The time for spraying is limited by climatic conditions to about four weeks from 1st May to 1st June.

Efforts are being made to obviate the various difficulties in connexion with the treatment by devising a dry fungicide which can be dusted on the plants either in a heavy dew or light shower of rain.

BRITON-JONES (H. R.). **A wound parasite of Cotton bolls.**—*Min. Agric. Egypt Tech. and Sci. Serv.* (*Bot. Sect.*) *Bull.* 19, 8 pp., 2 pl. (1 col.), 1923.

Black mould (*Rhizopus nigricans*) causes a severe rotting of the bolls of Indian, American, and native varieties of cotton in Upper and Lower Egypt.

The fungus, a common facultative parasite, gains admission to the plants through the wounds made in the bolls by the attacks of the pink boll worm (*Gelechia gossypiella*) and the boll worm (*Earias insulana*). Two days after infection the boll becomes soft and turns reddish-brown or greenish-black. At this stage a slight touch will cause the boll to break off at the junction between the base of its stalk and the main axis. Two or three days later the boll hardens and dries up, thereby causing a premature splitting along the sutures. The stem immediately under the affected boll also turns reddish-brown, becomes shrunken and hard, and is not readily detached by contact or by the wind. The boll does not open out completely and the production of numerous sporangia by the fungus imparts an olive-green or dirty appearance to the fibre. The bolls thus affected have been described by Willcocks as 'Mabroom' bolls (*Sultanic Agric. Soc.*, 'The insect and related pests of Egypt,' i, 1916).

The disease is most prevalent from the latter part of June onwards and reaches its climax during the late summer, which is the period of the maximum activity of the boll worms. The atmospheric humidity caused by the advance of the Nile flood at this season also contributes to the rapid growth of the fungus.

In 1920 out of 10,537 bolls examined at the Gîza Experiment Station, 795 were attacked by *R. nigricans* and in 735 of these the fungus was associated with the boll worm. By inducing premature opening of the bolls the fungus facilitates the entry of the cotton seed bug. Infected bolls cannot be saved and the disease can only be controlled by preventing the attacks of the boll worm.

An important question which arises in connexion with the attack of *R. nigricans* is the relation between the fungus and the boll worm, but at present this relationship is merely a matter of conjecture.

PAPE (H.). **Ein neuer, auf Schneeglöckchen (Galanthus nivalis L.) schmarotzender Brandpilz (Urocystis galanthi n. sp.).** [A new smut (*Urocystis galanthi* n. sp.) parasitic on the snowdrop (*Galanthus nivalis* L.).]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 4, pp. 331–336, 7 figs., 1923.

In January 1921 the leaves, leaf-sheaths, and spathes of snowdrops collected from a garden near Berlin for experimental purposes were found to be partially or totally covered with lead-coloured, callus areas, measuring 5 to 50 by 3 to 5 mm. Closer examination revealed the presence of the mycelium of a species of

Urocystis, dark brown spore masses being formed in the parenchymatous tissues of the leaves. The spore balls consisted of one, two, or occasionally three or four primary spores in the centre, and numerous secondary spores situated at the periphery. They were globular to ellipsoid and measured 23 to 51 μ across, whilst the primary spores averaged 14 by 21 μ. When fully developed the secondary spores formed a firm, single, compact layer of smooth, light-brown spores, 7 to 14 μ in diameter and globular to irregular in shape.

The hyphae, which were about 4 μ in breadth, hyaline, and intercellular, were detected only in the tissues surrounding the spore balls. Here and there, ramified or lobed haustoria were produced. The intercellular spaces were much enlarged by the formation of the spore masses.

Attempts to germinate the spores were unsuccessful, probably because the resting period allowed was not long enough. Natural infection of the snowdrop appears to take place in the very early spring, the fungus probably remaining quiescent during the following summer, autumn, and winter. The presence of the fungus in the first shoots of the plant indicates that it overwinters in the bulb.

The snowdrop smut is in all probability closely related to *Urocystis leucoji* Bubak, which attacks *Leucojum vernum*, another member of the Amaryllidaceae, and to *U. colchici*, which is found on numerous Liliaceae. The snowdrop parasite, however, differs in various morphological particulars from the published descriptions of *U. leucoji* and *U. colchici* (a comparative table of which is given), and the creation of a new species, *U. galanthi*, is believed to be justified.

Ware (W. A.). **Violet felt rot (Rhizoctonia) of Clover.**—*Journ. Min. Agric.*, xxx, 1, pp. 48–52, 6 figs., 1923.

So far as the author is aware, this is the first record of the occurrence of *Rhizoctonia violacea* on red clover in England, although it has already been described as attacking this host on the continent. The fungus is well known as causing injury to many other cultivated plants, such as seakale, carrots, potatoes, lucerne, &c., but it has yet to be proved whether it can pass from other host species to clover, or whether specialized races or forms of the fungus exist.

The disease was first noticed at the end of November 1922 in a field of red clover attacked by stem rot (*Sclerotinia trifoliorum*), but it was quite evident that *Rhizoctonia* was present as a parasite on the clover, and was not merely saprophytic on plants or parts of plants previously killed. Whether primary infection was aided by the mild conditions prevailing in the early winter of 1922 is not known; it is possible that the occasional frosts were responsible for stirring into activity the dormant sclerotia of the *Rhizoctonia* which may have been present in the soil. The *Rhizoctonia* was first recognized on the stubble of the previous oat crop, the violet-brown mycelium being fringed with white at its growing extremity. Affected clover plants were dwarfed and stunted and frequently showed the leaves in a dying condition. On digging up and carefully washing attacked plants the violet-brown mycelium could be seen just at and below the soil level.

The fungus attacks the main root and its branches, covering them with minute, twisted, brown strands, and penetrating the outer cork layers of the root at various points, forming sclerotial bodies [corps miliaires, infection cushions] which may possibly function also as suckers. The layers in contact with these sclerotia are apparently killed and the rot proceeds until the whole of the main root system is involved.

The plants, in the majority of cases, make an effort to recover by developing adventitious roots from the base of the crown, and under favourable conditions the effort may be successful, the new root system not being observed to be attacked. In addition to the killing of a certain number of plants, however, patches of the clover may be retarded, dwarfed, weakened, and somewhat thinned.

Besides red clover, the *Rhizoctonia* was found attacking living plants of corn mint (*Mentha arvensis*), meadow grass (*Poa*), speedwell (*Veronica agrestis*), and a dead plant of knotgrass (*Polygonum aviculare*), but in none of these cases were sclerotia found.

No experiments in the control of the disease on clover have yet been made. Having regard, however, to the probability of the sclerotia set free in the soil remaining dormant for some years, it is suggested that infected soil should be given as long a rest from clover as possible, an interval of over eight years being advisable.

PUTTERILL (V. A.). **Silver leaf disease of fruit trees and its occurrence in South Africa.**—*Dept. of Agric. S. Africa, Bull.* 27, 19 pp., 10 figs., 1923.

Silver leaf in South Africa is making headway, chiefly owing to the indifference shown to the disease by growers. The two types, 'false' silver leaf, due to physiological causes and often of a non-permanent character, and true silver leaf due to the parasitic fungus *Stereum purpureum*, are mentioned and a description of the symptoms and effects of the latter is given.

The disease has been reported from different parts of the Union, but as silvering of the foliage was the only diagnostic character available, many of the cases must be referred to false silver leaf. A fungus found on peach trees near Pretoria and on an unknown host at Maritzburg, Natal, could not be referred to *S. purpureum* with absolute certainty. In the Western Cape Province true silver leaf disease has occurred at Stellenbosch, Wynberg, and Paarl, on plums, apricots, peaches, and sometimes on apples.

The fruiting bodies of the fungus occur more rarely in South Africa than in England, probably owing to the climatic conditions and also perhaps to different methods of planting and culture, which in South Africa are not favourable to fungal development. On the other hand, the virulence of *S. purpureum* may increase with time, as has been the case with *Schizophyllum commune*. Fruiting bodies of *S. purpureum* have been found on *Populus alba* near Capetown, and observation has shown that fruit trees in close proximity to poplars constantly develop silver leaf. As the latter trees are generally grown in damp situations, the ready fruiting of the fungus on them is only to be expected. The identity of the

South African fungus was confirmed by British workers as *S. purpureum*, although some of the specimens sent bore hairs on the hymenium, a characteristic of *S. rugosiusculum*, which species, however, is now held to be not specifically distinct.

In South Africa very little is known about the relative susceptibility of the different varieties. Of plums, Kelsey seems particularly susceptible. Generally speaking, plums and peaches appear to suffer more than other fruit trees, but inoculation experiments on apricots, apples, and pears were also successful, while the results on loquat were doubtful.

The control measures recommended consist of the cutting out and burning of all discoloured wood including the branches which show silvering, the pruning tools being dipped in a 10 per cent. solution of formalin after use. Large pruning wounds should be pared and treated with Stockholm tar or some good paint. As the disease is supposed to make more rapid headway in heavy soils and in damp situations, liming must not be neglected.

There are no legislative regulations in South Africa similar to those in force in England regarding this disease, but it is in the growers' own interests to take energetic measures to control it.

Plant diseases in the Western Cape Province VII. Silver leaf disease of fruit trees.—*Journ. Dept. Agric. S. Africa*, vi, 3, pp. 233–236, 4 figs., 1923.

This is a more popular account of the disease discussed in the preceding paper.

Borg (J.). **Cultivation and diseases of fruit trees in the Maltese Islands.**—*Govt. Printing Office, Malta*, 622 pp., 1922.

This valuable compilation deals with the cultivation and diseases (due to fungi, insects, and physiological causes) of the following Maltese fruit and nut trees: citrus (eight varieties), olive, carob (*Ceratonia siliqua*), fig, black and white mulberry, pomegranate, pear, apple, medlar, Azarola thorn (*Crataegus azarolus*), almond, peach and nectarine, plum, apricot, cherry, walnut, pistachio (*Pistacia vera*), stone or edible pine (*Pinus pinea*), kaki or Chinese date plum (*Diospyros kaki*), banana, prickly pear (*Opuntia ficus-indica*), date palm, vine, gooseberry, currant, raspberry, and strawberry. Various other trees are mentioned but the diseases attacking them are not of sufficient importance to justify enumeration. The cultivation and diseases of the vine are discussed at considerable length, and throughout the book there are many useful suggestions on control measures and the application of appropriate cultural methods.

Gossard (H. A.) & Walton (R. C.). **Dissemination of fireblight.**—*Ohio Agric. Exper. Stat. Bull.* 357, 126 pp., 14 fig., 1 diag., 1922.

These investigations, commenced in 1915, were carried out to elucidate the spread of the fireblight organism (*Bacillus amylovorus*). It was first found that this organism was capable of living in honey for 72 hours or more. Apple twigs inoculated with honey drawn from three different hives developed fireblight and from two of the twigs the fireblight organism was recovered. Tender twigs, inoculated with apple pollen removed from the baskets of bees caught as they were entering the hive, died in several cases, presumably from fireblight, though the organism was not isolated. Mouthparts of bees, caught during the blossoming period and inserted into tender twigs, resulted in the death of the latter, almost certainly from fireblight, though again the organism was not recovered. The results of further tests showed that the organism was capable of living in aphid honey dew for seven days, and in peach, plum, and cherry nectar for five days or longer. The records showed an average of 64·5 per cent. infection of the nectar from peach blossoms, 74 per cent. from plum, and 94 per cent. from cherry.

Rain was proved to be a most important agent for the spread of infection over trees where centres were already established, especially if these were near the top. It was estimated that 50 to 90 per cent. of all blossom infection is accomplished by rain water.

Susceptibility to fireblight was shown to be greatly reduced in blossoms pollinated 72 hours previously, while blossoms 144 hours after pollination were immune from the disease. From this it may be inferred that the presence of bees in an orchard is desirable, since they hasten the flowers past the period of susceptibility to fireblight, and it is advisable therefore to encourage pollination before the blight wave sets in. In one case the initial infection of a young pear orchard was found to have originated through blossom blight.

Several sucking and boring insects were observed to be carriers of fireblight, and in general it may safely be stated that any contaminated insect, either of the biting or sucking class, is a potential insect of transmission. Attempts to prove that ants were responsible for spring infection on a large scale met with negative results, as also did the attempted isolation of the blight organism from the bodies of aphids, aphid wax, and syrphid larvae taken from living blight cankers. The possibility of the organism surviving in the intestinal tract of bees appears so remote as to be negligible.

The application of the ultra-violet rays to leaves and twigs to test their destructive action on the fireblight organism gave negative results.

The writers believe there is ample ground for suspecting that fireblight travels northward with the zone of blossoming more extensively than is generally accepted.

Directions for spraying fruits in Illinois.—*Illinois Agric. Exper. Stat. Circ.* 266, 15 pp., 2 figs., 1923.

The standard sprays used in the control of fungous diseases of Illinois fruit are described in the present paper, which is particularly designed to meet the requirements of smallholders.

Apples. (1) Dormant spray of lime-sulphur or oil emulsion primarily for the control of San José scale; (2) cluster-bud spray of lime-sulphur ($1\frac{1}{4}$, or 4 lb. dry, in 50) and lead arsenate (2 lb. paste or 1 lb. powdered), chiefly for the control of scab [*Venturia inaequalis*]; (3) calyx spray, similar to 2 and applied for the same purpose; (4) one week after petal fall as in 2 and 3; (5) a fortnight after fall of petals; same formula as 2, 3, and 4 for the control of blotch [*Phyllosticta solitaria*], scab, codling moth, curculio, and leaf spot [*Physalospora cydoniae*]; (6) three weeks after fall of petals: same formula and objects as 5; (7) four weeks after fall of petals (for blotch only): same formula as above, minus the lead arsenate; (8) five weeks after fall of petals: as in 7. Wherever attacks of bitter rot [*Glomerella cingulata*] are anticipated, four applications of Bordeaux mixture should be given at intervals of ten days from the first week in July.

CHERRIES. (1) Lime-sulphur (1, or $2\frac{1}{2}$ lb. dry, in 50) and lead arsenate (3 lb. paste or $1\frac{1}{2}$ powdered) for the prevention of brown rot [*Sclerotinia cinerea*], leaf spot [*Coccomyces hiemalis*], and curculio, to be applied just before the opening of the buds; (2) similar to 1 and for same reasons, to be given immediately after fall of blossoms; (3) as preceding, to be applied as above, ten days after 2 in case of damp, close weather only.

PEACHES. (1) Dormant lime-sulphur spray ($5\frac{1}{2}$, or 15 lb. dry, in 50), for the control of San José scale and leaf curl [*Exoascus deformans*], to be applied in late autumn or early spring; (2) four weeks after fall of petals, self-boiled lime-sulphur (8–8–50) and lead arsenate (3 lb. paste or $1\frac{1}{2}$ powdered) for the control of scab [*Cladosporium carpophilum*], brown rot [*Sclerotinia cinerea*], and curculio; (3) for midseason and late varieties, another application, as in 2, should be given against brown rot from four to five weeks before the fruit ripens; (4) in the event of damp, close weather, an additional lime-sulphur (8–8–50) spray should be applied a fortnight before picking.

PEARS. (1) Dormant spray as for apples; (2) cluster-bud spray as for apples for the control of scab [*Venturia pirina*] and curculio; (3) calyx spray as for apples for control of scab, codling moth, and curculio; (4) three weeks after fall of petals for the control of smudge and insects: as in cluster-bud spray for apples.

PLUMS. (1) Dormant spray as for apples; (2) as in first summer spray of cherries for the control of leaf diseases, brown rot [*Sclerotinia cinerea*], and curculio; (3) and (4) same as 2, to be applied immediately after blossoms fall and ten days later respectively; (5) additional applications of lime-sulphur lead arsenate should be given at fortnightly intervals until a month before picking in wet seasons.

BRAMBLES. Anthracnose of black raspberry [*Gloeosporium venetum*] may be controlled as follows: (1) lime-sulphur (1 in 20) applied before growth starts in spring; (2) lime-sulphur (1 in 40) when new shoots are 6 to 8 inches high; (3) lime-sulphur (1 in 40) just before blossoming.

CURRANTS and GOOSEBERRIES. Spraying for leaf spot [*Mycosphaerella grossulariae*] should begin when the leaves are unfolding and be repeated at fortnightly intervals until five applications have been made, Bordeaux mixture being used. Gooseberry mildew [*Sphaerotheca mors-uvae*] may be controlled by six applications of liquid lime-sulphur (1 in 40) given at ten-day intervals from the opening of the buds.

GRAPES. Most diseases can be combated by a combination spray of Bordeaux mixture and lead arsenate applied at the following times: (1) as the leaf buds are opening; (2) immediately after fall of bloom; (3) ten days after fall of bloom; (4) twenty days after fall of bloom. The last two applications should be of double strength lead arsenate.

Strawberries. Leaf spot [*Mycosphaerella fragariae*] may be controlled by spraying with Bordeaux mixture (1) as the plants begin growth; (2) just before blossoming; and (3) just after blossoming.

Full directions are given for making and mixing the standard sprays.

Gardner (M. W.). **Apple blotch control.**—*Trans. Indiana Hort. Soc. 1921*, pp. 184–185, 1922. [Rec'd 1923.]

Apple blotch [*Phyllosticta solitaria*] is gradually spreading northwards in Indiana. The most reliable fungicide for its control is Bordeaux mixture 4–4–50 or 4–6–50, but lime-sulphur may be substituted in cases of varieties liable to russeting, such as Ben Davis. Sulphur and Bordeaux dusts reduce infection to some extent but are not so efficient as liquid Bordeaux. The best results are secured by the 2–4–6–10 week schedule. In planting new orchards the use of susceptible varieties, such as Northwestern Greening, should be avoided.

Fisher (D. F.). **Spoilage of Apples after harvest.**—*Rept. Proc. Thirty-second Ann. Convention Brit. Columbia Fruit-Growers' Assoc. held at Victoria, B. C. 18th to 20th Jan. 1922*, 68 pp., 1922.

Storage diseases greatly reduce the harvested crop of apples and at the same time increase the cost and risk of market operations. It is almost impossible to form any conception of the importance of these diseases unless the fruit can actually be traced to the ultimate consumer, but certain useful data may be collected from the records of the United States Bureau of Markets. The terminal markets' inspection reports indicate that in 1919, out of 2,973 cars examined 23·7 per cent. were infected with blue mould (*Penicillium expansum*), representing the parasitic group of storage diseases, and 1·6 per cent. with scald, one of the principal physiological affections of stored apples. In 1920, of 3,462 cars examined 60·6 per cent. were infected with blue mould and 13·3 per cent. with scald.

P. expansum is normally incapable of penetrating the unbroken skin of the fruit and does little harm to the crop on the trees, although it has been observed to do so following injury by codling moth. In commercial storage and in transit it probably causes 80 to 95 per cent. of the total rots, while in the local markets and home storage the losses are estimated to exceed 10 per cent.

The fungus most frequently enters through stem punctures, but sometimes through finger-nail scratches by pickers, insect injuries, scab spots, bruises and all kinds of wounds. The disease may spread from one apple to another by the dissemination of the spores or by actual contact. Low temperatures greatly delay the development of the mould, more particularly at the inception of decay than during its later development, rots starting while the apples were warm, developing rapidly even at 32° F. The losses from the disease may be greatly minimized by careful handling, early cooling of the apples to 32° F., and securing sanitary conditions in the packing houses.

Apple scald causes more losses than all the other [physiological] storage diseases combined, being particularly severe on York Imperial, Grimes, Black Twig, Arkansas Black, Rome, and Stayman. It can be distinguished from all other apple diseases by its preference for the greener side of the fruit, the flesh of which is sometimes decayed to a depth of half an inch.

The influence of temperature on the production of scald has been demonstrated experimentally. In general, apples held at 60° to 70° F. scald three to four weeks earlier than those held at 50°; those at 50° about four weeks earlier than those at 40°; and those at 40° about three weeks earlier than those at 32°. The higher temperatures are frequently encountered in cases of delayed storage. The time immediately following picking is a critical period during which refrigeration is urgently required. There are, however, other factors besides temperature to be considered. The green portion of the skin is most susceptible to scald, and measures to secure proper colouring of the fruit are desirable.

Investigations have also been carried out which indicate that humidity has no effect upon the development of the disease except where actual drops of moisture form on the apple, when probably the harmful effects are primarily due to the partial exclusion of the air or the retention of oxidation products by the apple. The experiments demonstrated that accumulations of carbon dioxide (1 to 6 per cent.) tend to prevent, rather than promote the development of the disease, and apples susceptible to scald were rendered immune by storage for a few days in an atmosphere of pure carbon dioxide.

The conclusion was also reached that abnormal respiratory conditions consequent upon poor aeration are largely responsible for scald. It was shown that a constant air movement of from one eighth to one quarter of a mile per hour either entirely prevented scald or reduced it to a minimum. The intensity of the air movement was apparently more important than its continuity, and the circulation of the air more important than its renewal. Thorough aeration during the first eight weeks of storage was of much more value than later.

These results show that scald is due to some product which can be carried away by air or possibly taken up by absorbents. Further tests in which apples were enveloped in paper impregnated with various gas-absorbing substances (paraffin, vaseline, and olive oil), or surrounded by sawdust, animal charcoal, or corn starch, gave convincing evidence that scald can be prevented by the absorption of the gases (other than carbon dioxide) given off by the apples themselves. The odorous constituents of the apple were suspected and experiments showed that typical scald effects could be produced by exposing the fruit to the esters of amyl acetate and amyl formate.

On the whole the treated wrap method, which provides each apple with its own preservative, appears to be the best and most reliable preventive of scald. Further experiments are in progress to ascertain the relative efficiency of the various mineral oils and the exact quantities required.

LUDWIGS (K.). **Bericht über das Auftreten der Spitzendürre (Monilia) bei Kirschen in der Provinz Brandenburg im Jahre 1922.** [Report on the occurrence of withertip (*Monilia*) of Cherries in the Province of Brandenburg in 1922.]—*Deutsche Obst- und Gemüsebauzeit.*, lxix, 12, pp. 91–92, 1923.

The replies to a circular letter of inquiry issued by the Brandenburg Chamber of Agriculture in co-operation with the Plant Protection Head-quarters at Dahlem, Berlin, indicate that, in general, the *Monilia* disease of cherries was much less severe in Brandenburg in 1922 than for some years previously. It is believed that the drought of 1921, which allowed of a complete ripening of the wood of young shoots, was largely responsible for the comparative absence of the disease. The brief duration of the blossoming period in 1922 was also unfavourable to the fungus.

The following varieties were generally resistant: Früheste der Mark, Hedelfinger Riesenkirsche, Grosse Prinzess, Königsknupper, Gassin's Herz, Saure Natte, Ostheimer Weichsel, Königin Hortense, Guben's Ehre, and Podbielski; whilst susceptible varieties were Shade Morello, Doppelte Natte, Grosse Gobet, Rote Glaskirsche, Ochsenherzkirsche, and Diemitz (slightly). Treatment with lime-sulphur mixture or solbar was reported to be more efficacious than the application of Bordeaux mixture or carbolineum.

HÖSTERMANN (G.) & NOACK (M.) **Das Rutensterben der Himbeeren.** [The die-back of Raspberry canes.] — *Deutsche Obst- und Gemüsebauzeit.*, lxix, 20, p. 153, 1923.

The die-back of raspberry canes caused by *Didymella applanata* [see this *Review*, ii, p. 128] is constantly increasing in severity and a particularly virulent form of the disease, resulting in the production of 'witches' brooms' on the canes, has been observed in some parts of central Germany. None of the well-known varieties appears to be immune from the disease, which may be controlled to some extent by spraying the young shoots with solbar or Bordeaux mixture, liming the soil, using artificial fertilizers in preference to fresh organic manure, and by removing and burning diseased shoots.

It is recommended that nursery gardeners and other purchasers of raspberry canes should insist upon guarantees to the effect that the material is free from die-back.

GRAULUND (R.). **Ein gutes Mittel gegen den amerikanischen Stachelbeermehltau.** [A good remedy for American Gooseberry mildew.]—*Deutsche Obst- und Gemüsebauzeit.*, lxix, 21, p. 163, 1923.

At Eskilstuna (Sweden) the American gooseberry mildew [*Sphaerotheca mors-uvae*] has been successfully combated by the application of a 6 to 7 per cent. solution of the best quality of soft soap at the rate of 2 to 3 litres per bush. The soft soap solution completely destroys the conidial stage of the mildew but not the perithecial stage. Vigorous young bushes require repeated sprayings during the summer, but for mature bushes one application given in the evening or when the sky is overcast, usually suffices. Very occasionally a negligible russeting of the foliage or dropping of the fruit may ensue.

Rose mildew [*Sphaerotheca pannosa*] has been controlled by 3 to 4 per cent. solutions of the same material.

TISDALE (W. H.), TAYLOR (J. W.), & GRIFFITHS (MARION A.) **Experiments with hot water, formaldehyde, copper carbonate and chlorophol for the control of Barley smuts.**—*Phytopath.*, xiii, 4, pp. 153–160, 1923.

The results obtained by the use of various seed treatments for the control of loose smut (*Ustilago nuda*) and covered smut (*U. hordei*) of barley are given in this paper.

Experiments begun in the autumn of 1919 on three varieties of barley. in which seed was either (1) presoaked 4 to 6 hours, immersed in water at 52° C. for 10 minutes and then dried, (2) immersed 10 minutes in formalin (1 in 320), covered overnight and spread to dry, or (3) sown without treatment, were interesting, as the second treatment produced plants as free from loose smut as the hot water treatment, normally used against this disease.

Similar experiments were carried out in 1921 and 1922 using five varieties of barley. Full figures regarding these experiments are given. They show that formalin was just as effective in controlling loose smut as the modified hot water treatment (0·1 against 0·15 per cent. infection) whilst it is less effective against covered smut (4·4 against 2·16 per cent.) for which it has been recommended. Little was gained in the yields, however, by either treatment. Varieties differ in their response to the treatments, which might be recommended for some and not for others.

In the autumn of 1921, chlorophol, an organic mercury compound, and copper carbonate were tried on heavily smutted seed and the results of the year's trial were striking. Copper carbonate, though favourable to the germination of the seed, did not satisfactorily control either of the barley smuts, whilst chlorophol was very effective, reducing the percentage of loose smut from 0·82 to 0·15 and covered smut from 5·08 to 0·45 and causing increased germination.

HEALD (F. D.), ZUNDEL (G. L.), & BOYLE (L. W.). **The dusting of Wheat and Oats for smut.**—*Phytopath.*, xiii, 4, pp. 169–183, 1 fig., 1923.

In this paper the authors give results obtained in the control of bunt of wheat [*Tilletia tritici* and *T. levis*], some of which have been previously noticed [see this *Review*, ii, p. 264], and also figures relating to the efficiency of copper carbonate in controlling oat smut (*Ustilago levis*).

The new experiments recorded on bunt consisted of a series of farm demonstrations to show the comparative effect of copper sulphate, formalin, and copper carbonate in the control of bunt carried out in 1921–22. In the autumn of 1921 over 10,000 acres in Washington were seeded with wheat treated with copper carbonate (2 oz. per bushel) and the results compared with those of the farmers' own treatment with copper sulphate or formalin. The average percentages of bunt for the various treatments were as follows:—copper sulphate 10·9, copper carbonate 7·2; copper sulphate + lime afterbath 11·0, copper carbonate 8·5; formalin 9·1, copper carbonate 3·1; formalin + lime afterbath 10·2, copper carbonate 3·4. Seed treated with copper carbonate germinated 1 to 5 days earlier than normal and there was very little seed injury, whilst with copper sulphate and formalin severe injury resulted in a number of cases.

In the first experiment against oat smut, carried out in the spring of 1922, five field demonstrations were made to test the comparative value of the standard treatment and copper carbonate 2 oz. per bushel. The average percentage of smut in the five demonstrations were as follows: untreated 8·9; formalin 0·20; formalin + lime afterbath 1·10; copper carbonate 1·17.

In a second experiment against oat smut, artificially smutted seed of the varieties Swedish Select, Abundance, and Chinese Hull-less was treated with copper carbonate at the rate of 2 oz., 3 oz., and 4 oz. per bushel, and the average percentages of smutted panicles were 3·01, 2·14, and 2·26 respectively whilst the control gave 39·12. The most striking figures were obtained with the hull-less variety, Chinese Hull-less, for which the figures were 0, 0, 1·00 and the control 70·45. The use of 2 oz. copper carbonate gave practically as good control as larger amounts. The protection afforded by copper carbonate, however, was not equal to that ordinarily obtained with standard formalin treatment.

Fraser (W. P.) & Simmonds (P. M.). **Co-operative experiments with copper carbonate dust and other substances for smut control.**—*Scient. Agric.*, iii, 9, pp. 297–302, 1923.

In 1922 a series of experiments in the control of bunt of wheat (*Tilletia tritici* and *T. levis*) was conducted at the Saskatchewan Laboratory of Plant Pathology, in co-operation with the Dominion Experimental Farms at Indian Head, Scott, and Rosthern (Saskatchewan), and Lacombe (Alberta). At Indian Head the treatments were also tried on oats against smut (*Ustilago levis*). The treatments tested were (1) formalin, 1 in 320, immersion for five minutes and subsequent covering for one hour; (2) copper carbonate 2 oz. per bushel; (3) a mixture of dehydrated copper sulphate dust and hydrated lime (0·43 lb. to 0·57 lb.), 2 oz. per bushel. The fourth plot was left untreated as a control.

In all the experiments the formalin gave perfect control. Copper carbonate was effective where the bunt percentage was low, while copper sulphate and lime was less satisfactory. Both in field and greenhouse tests formalin appreciably retarded growth. For wheat the percentage of germination averaged 82·78 for formalin, 93·56 for copper carbonate dust and 94·90 for copper sulphate and lime dust, against 96·64 for the control, whilst the average percentages of bunt in the resulting crops were 0, 0·65, 1·98 and 12·26 respectively. For the single trial on oats the corresponding figures were 93·6, 96·6, 97·6, 95·3 and 0, 1·0, 5·6, 7·5 respectively. Additional trials will be carried out with copper carbonate, which presents several advantages over formalin.

Further tests on wheat were made with copper carbonate mixed with lime, infusorial earth, and talc, as well as with various combinations of copper sulphate, Bordeaux mixture, and sulphur dust. The last-named reduced the amount of bunt to 2·5 against 15·8 in the control and deserves a further trial on grounds of economy. In a somewhat similar series of tests in the control of smut on the hull-less Liberty oats, which are liable to a serious reduction of germination when treated with formalin, copper carbonate alone gave fairly satisfactory results (1 per cent. against 7·5 in the control) but the addition of talc, lime, or infusorial earth reduced its effectiveness (6·3, 5·6, and 6·9 per cent. smut respectively). Seed-o-San, chlorophol, and the 'Gas Grain Pickler' method did not give very encouraging results, the last-named causing injury to germination.

ANDERSON (P. J.) & OSMUN (A. V.). **An improved formaldehyde tank for the Onion drill.**—*Phytopath.*, xiii, 4, pp. 161–168, 3 figs., 1923.

In this paper the authors describe in detail a tank attachment for an onion seeding machine which will deliver formalin at a constant and any desired rate for the control of onion smut [*Urocystis cepulae*]. In all the types used at present, the rate of delivery varies according to the head of liquid in the tank and this has been surmounted by making the tank air-tight and placing the air inlet at the bottom of the tank in close position to the outlet for the liquid. The rate is regulated by the size of the hole in a disk inserted in the outflow pipe.

YOUNG (H. C.). **The toxic property of sulphur.**—*Ann. Missouri Bot. Gard.*, ix, 4, pp. 403–433, 4 diag., 1922. [Rec'd, 1923.]

In this work the author has attempted to determine the exact nature of the fungicidal property of sulphur. After a brief account of the history of sulphur sprays and references to the work of previous investigators, he describes a series of experiments carried out to ascertain the degree of toxicity to *Colletotrichum gossypii*, *Sclerotinia cinerea*, *Botrytis cinerea*, *Glomerella cingulata*, *Gloeosporium venetum*, *Macrosporium sarcinaeforme*, *Phomopsis sojae*, and *Actinomyces scabies*, of flowers of sulphur (ordinary and finely ground), colloidal sulphur, lime-sulphur, and the volatile products of sulphur. The Van Tieghem cell and the hanging-drop culture method were employed. The culture solution was a slightly buffered mixture containing mannite, phosphoric acid, and sodium hydroxide.

Flowers of sulphur were found to be directly toxic only to *Sclerotinia cinerea* and *Phomopsis sojae*. The spores of the remaining organisms germinated and the germ-tubes grew normally when in direct contact with the sulphur particles. The general fungicidal value of flowers of sulphur, if it exists, must be due to some change in form which takes place under different conditions from those obtaining in Van Tieghem cells. Within the usual range, the hydrogen-ion concentration did not appreciably influence the percentage of germination. Finely ground flowers of sulphur were found to be more toxic than unground sulphur, the range of greatest toxicity being between P_H 4·2 and 5·4.

Colloidal sulphur exists in two forms, termed by the author hydrophilic and hydrophobic respectively, depending on the degree of hydration. The hydrophilic form has a high degree of hydration and is identical with the 'soluble colloidal sulphur' of Raffo and Mancini (*Koll. Zeitschr.*, 9, pp. 58–61, 1911) and may be prepared by adding a saturated solution of sodium thiosulphate to concentrated sulphuric acid very slowly, repeated cooling, warming, and standing, and finally filtering until no more insoluble sulphur comes down, the final filtrate being the slight turbid yellowish solution which is subsequently purified. The hydrophobic colloidal sulphur has a very low degree of hydration and is identical with that prepared by V. Weimarn and Molyschew (*Koll. Zeitschr.*, 8, p. 214, 1911) and is the 'milk of sulphur' formed when sulphur is precipitated. Full details of the preparation of these substances used in the following experiments are given.

The toxicity of the hydrophilic and hydrophobic colloidal solutions was tested, in hanging drop cultures, omitting, however, *Glomerella cingulata* and *Actinomyces scabies*. The hydrophilic form proved extremely toxic, only *Botrytis cinerea* and *Macrosporium sarcinaeforme* offering a slight resistance to a dilute suspension. In stronger suspensions the germination of all the organisms was inhibited. The hydrophobic solution, however, only exerted approximately the same slight toxic action as ground flowers of sulphur. The influence of the hydrogen-ion concentration, especially on hydrophilic colloidal sulphur, was very striking, 'settling out' increasing rapidly as soon as the P_H value exceeded 5·4.

Lime-sulphur is extremely alkaline and its initial efficiency as a fungicide may be partly due to free hydroxyl ions. Tests were made of the P_H value of washings from sprayed surfaces exposed to various drying conditions and it was found all gave a final reaction of P_H 6·4, indicating that the protracted efficiency of lime-sulphur is not due to its causticity. The toxicity of the individual compounds of exposed or changed lime-sulphur (precipitated sulphur, calcium thiosulphate, calcium sulphite and calcium sulphate) was next determined, and the lasting fungicidal value of lime-sulphur found to be due almost entirely to the precipitated sulphur. The toxicity of lime-sulphur was somewhat greater than that of hydrophobic colloidal sulphur, but less than that of hydrophilic colloidal sulphur. The hydrogen-ion concentration influenced the toxicity in a similar manner as recorded above. A table is given showing the germinations of the various fungi, with the various forms of sulphur at ten different P_H values.

To determine the degree of toxicity of the volatile products of sulphur (the foregoing results having indicated that sulphur is most toxic in a finely divided state), an experiment was arranged in which the action of the vapours of flowers of sulphur, and of hydrophilic and hydrophobic colloidal sulphur on *Botrytis cinerea*, *Colletotrichum gossypii*, and *Sclerotinia cinerea* was tested. The spores were placed in drops of the slightly buffered solution without sulphur, the sulphur suspensions being placed at the bottom of the Van Tieghem cells. In this way the spores were separated from the sulphur by a distance of 8 mm. The cultures were incubated at 22° C. The flowers of sulphur exercised no toxic action even on the sensitive *S. cinerea* and the hydrophobic colloidal sulphur was only slightly toxic to *B. cinerea* and *C. gossypii.* As in the previous tests the hydrophilic colloidal sulphur exhibited the usual degree of toxicity, especially at concentrations of P_H 4·0 to 5·5. Having determined that the toxic substance is volatile it was thought necessary to eliminate hydrogen sulphide, and sulphur dioxide and trioxide as possible toxic factors. A saturated solution of hydrogen sulphide did not inhibit germination and no toxicity could be noted with sulphur dioxide, in a concentration sufficient to kill when converted into hydrophilic colloidal sulphur by the addition of hydrogen sulphide. Sulphuric acid inhibited growth only in proportion to its acidity. Positive tests for sulphur dioxide and trioxide could not be obtained in aerated sulphur suspensions toxic to *S. cinerea*. These compounds, therefore, do not contribute to the toxic properties of sulphur.

In all the above experiments, the only oxygen available was that present in the closed rings, and an experiment was therefore conducted to determine the effect of unlimited oxygen in increasing the toxicity of flowers of sulphur and precipitated sulphur (hydrophobic colloidal sulphur) using Petri dishes in comparison with closed rings. The germination of *S. cinerea* and *C. gossypii* was found to be much greater in the latter experiments, and the tests proved conclusively that the toxic property of sulphur is due to an oxidation product, and that finely divided sulphur is more readily oxidized at ordinary temperatures than the ordinary sublimed sulphur. Tests in non-air tight cells, with *S. cinerea,* using dry hydrophobic sulphur and the suspension respectively, showed no inhibition of germination with the former. Oxygen and water are therefore necessary factors in the formation of the toxic volatile compound of sulphur.

The results of all the above experiments indicate that hydrophilic colloidal sulphur contains the toxic substance produced by the ordinary forms of sulphur. Having eliminated the more common oxides and acids of sulphur it was thought that the toxic compound may be one of the polythionic acids. It was found that hydrophilic colloidal sulphur not only contains such an acid but that the method employed in the preparation of the former for these experiments was practically identical with that employed for pentathionic acid.

The author tested the toxicity of this substance by freeing a hydrophilic colloidal sulphur solution from it, and it was found that the killing power (using *Botrytis cinerea* and *Colletotrichum gossypii*) was directly proportional to the amount of pentathionic acid present. The fact (ascertained by experiment) that the latter substance is an oxidation product of sulphur at ordinary temperatures, and also that it is volatile, an active absorption compound, and that it is unstable when in acid and alkali solutions, are held to support the view that it is the substance on which the toxicity of sulphur depends.

The study of the practical applications of the above data is not yet complete. A sulphur compound which will retain its fungicidal properties regardless of climatic factors is being sought. The material must readily yield pentathionic acid. The reaction must be kept slightly acid (P_H 4·0 to 5·5) as the toxic compound is destroyed above or below this point. The solution must be readily oxidizable at ordinary temperatures, very adhesive, and not injurious to foliage. Colloidal sulphur combines all these properties when tested in the laboratory and greenhouse, and methods for its preparation in a form suitable for fungicidal use are being tested. Hydrophilic colloidal sulphur appears to be adapted for use as a spray and is not too expensive for practical purposes.

The practical application of the methods devised by various investigators for the preparation of colloidal sulphur are briefly discussed and a bibliography of sixty titles is appended.

RUBAN (G.). **Le permanganate de potasse: agent de traitement de maladies de la Vigne.** [Permanganate of potassium: a method for the control of Vine diseases.] *Rev. de Vitic.*, lviii, 1502, pp. 269–272, 1923.

Excellent results have been obtained in the control of vine mildew (*Oidium*) by washing the stems in winter with a solution of potassium permanganate (300 to 350 gm. per hl. of water).

The permanganate, which must be thoroughly dissolved, is usually curative rather than preventive in its action, destroying the spores of the fungus when they are actually present but not retaining its efficacy more than a few hours. Its adhesiveness may be increased by the addition of lime at the rate of 3 kg. per hl. of the solution.

In the case of varieties which cannot tolerate sulphur—e.g. Othello—the use of the permanganate is practically indispensable.

CHAN (T. A. B.). **Ueber die Mycorhiza der Buche.** [The mycorrhiza of the Beech.]—*Allg. Forst. und Jagdzeit.*, xcix, 2, pp. 25–31, 4 figs., 1923.

The isolation of the mycorrhizal fungus from the roots of beech trees [see also this *Review*, i, p. 304] from Munich and the Tyrol is described in considerable detail. The medium used was 1·5 per cent. agar in a mineral nutrient solution consisting of 1 gm. K_2HPO_4; 0·1 gm. $CaCl_2$; 0·1 gm. NaCl; 0·3 gm. $MgSO_4 7H_2O$; 0·005 gm. $FeSO_4$; 1000 gm. distilled water to which 0·25 per cent. of starch was added.

The fungus isolated was named *Mycelium radicis fagi*. The mycelium was septate, greenish in colour, the longer hyphae 4 to 6 μ and the shorter 2 to 4 μ in diameter. On plum and malt agar a luxuriant aerial mycelium was formed. In cultures three to four weeks old irregular conidia were formed by the constriction and dissolution of the long and short hyphae. The addition of one per cent. peptone to the medium resulted in the dissolution of all the hyphae into conidia resembling those of the orchid fungus. Clamp-connexions were absent and in transverse sections of the root the fungus presented a sclerotial appearance.

Of the various sources of carbon tested, saccharose, mannite, manna, dextrose, gum tragacanth, and arabinose promoted development; amygdalin, aesculin, cacao-butter, and lactose were intermediate; while starch, maltose, asparagin, nucleic acid, malic acid, formic acid, and tartaric acid were unfavourable, these results indicating the probable presence of emulsins. Growth was entirely inhibited on benzoic acid and urea, and also by concentrations of tannin exceeding 0·05 per cent.

Further investigations are in progress.

TITS (D.). **Les excitants de la germination d'un champignon: Phycomyces nitens.** [The stimulants to the germination of a fungus: *Phycomyces nitens.*]—*Bull. Cl. Sci. Acad. Roy. de Belgique*, Sér. 5, viii, 5, pp. 219–227, 4 figs., 1922.

Before commencing his study on the stimulation of germination of fungi preliminary tests were made by the author, using *Phycomyces nitens,* to determine the optimum temperature for germination and the development of the first sporangia of this fungus. Each of a series of tubes containing fresh white bread and prune juice was inoculated with a five days old sporangium and the tubes incubated at various temperatures. One series of tubes was artificially illuminated day and night, while another similar series was maintained in total darkness. The best culture in the illuminated series was obtained at a temperature of approximately 22° C., the tubes incubated at 19°, 23°, and 27° giving markedly inferior growth. Corresponding results were obtained from the tubes kept in the dark, a notable feature of which, however, was the larger size of the sporangiophores.

The effect of various substances on the germination of the spores at 22° C. was then investigated. The spores failed to germinate in solutions of 0·5 to 5 per cent. glucose, saccharose, lactose, and raffinose with and without the addition of various nitrogenous substances (asparagin, leucine, ptyaline, pepsine, and glycocol) and tartaric acid at varying concentrations. With 1 per cent. of peptone, however, germination was secured in less than 24 hours. The process of germination is described and figured. The maximum concentration of peptone compatible with germination is 30 per cent., whilst in solutions from 0·7 to 0·9 per cent. the spores germinated but their appearance was abnormal. The addition of saccharose to the medium reduces the quantity of peptone necessary to ensure germination; thus in a solution of 100,000 parts of water, 8 parts of peptone, and 700 parts of saccharose, the results are equivalent to those obtained in a solution of 100,000 parts of water and 700 parts of peptone.

Bacteriological peptone is composed of an aggregate of amino acids, and is obtained by the hydrolysis of meat albumin in the presence of tartaric acid. In the sample used the presence of tryptophane, tyrosine, phenylaniline, and cystine was detected.

Further studies on the action of amino acids in the germination of *P. nitens* are in progress.

WEIMER (J. L.) & HARTER (L. L.). **Influence of temperature on the pectinase production of different species of Rhizopus.**—*Amer. Journ. of Botany*, x, 3, pp. 127–132, 1923.

In view of the relationship found to exist between the different species of *Rhizopus* with respect to the temperatures at which they cause rots [see this *Review*, i, p. 433], experiments were undertaken to ascertain the influence of temperature on pectinase production in *Rhizopus nigricans, reflexus, delemar, oryzae, nodosus, tritici,* *maidis* (all parasitic on sweet potato), *microsporus*, and *chinensis*. The amount of the enzyme was estimated by the maceration of disks of sweet potato in solutions from cultures or in water suspensions of pulverized mycelium. A table showing the average rate of maceration for each of the eight species at 9°, 20°, 30°, and 40° C. is given. The amount of enzyme, both that exuded into the substratum and that retained in the mycelium, was least at the highest temperature. The quantity of enzyme in the mycelium was found to increase with a decrease in the temperature down to and including 9° C. Similar results were obtained from the solution except for a slight reduction in the quantity of enzyme produced when the temperature was lowered from 20° to 9° C. The non-parasitic species produced a considerable quantity of enzyme, while the parasitic *R. nigricans* manufactured only a very small amount.

A comparison was made of the relative length of time required by the enzyme produced by the different species to macerate the tissue of freshly dug sweet potatoes and those held in storage for several months. The fungi were grown at 9°, 30°, and 40° C., maceration being carried out at the last-named temperature. It was found that, in general, the middle lamellae of old potatoes were dissolved in about half the time required to macerate the tissue of new ones.

PARTRIDGE (G.). **Potato inspection and certification in Canada, 1922.**—*Agric. Gaz. of Canada*, x, 2, pp. 121–123, 1923.

The head-quarters of the Canadian potato inspection service are at the Central Experimental Farm, Ottawa, the service being under the direction of the Dominion Botanist, Dr. Güssow, with the writer in immediate charge. The work of the service, which began on a small scale in 1915, now extends throughout the Dominion. It is organized by provinces, a supervisor in each province being responsible to head-quarters for the work of the permanent and temporary inspectors employed by the service. British Columbia maintains a provincial service conforming, however, to Dominion standards.

During 1922, a total of 3,283 fields, comprising 11,250 acres, was inspected, the average amounts of disease in the fields accepted for certification being as follows: blackleg [*Bacillus atrosepticus*] 0·47 per cent., leaf roll 0·65 per cent., mosaic 1·06 per cent., and wilts [*Fusarium oxysporum* or *Verticillium albo-atrum*] 0·14 per cent.

As a result of the experience gained during the past years, definite and permanent field inspection standards have been decided upon, and will take effect from next season. The standard adopted is as follows: blackleg 3 per cent., leaf roll (including curly dwarf, crinkle, spindling sprout, and streak) 2 per cent., and wilts 3 per cent., provided that in no case shall a total of more than 6 per cent. be allowed.

The following are the standards for tuber inspection: bacterial rot [various bacteria] or wilt 2 per cent.; late blight [*Phytophthora infestans*] and dry rot [*Fusarium oxysporum*] 3 per cent.: common scab [*Actinomyces scabies*] and severe *Rhizoctonia* 5 per cent.; powdery scab [*Spongospora subterranea*] 1 per cent.

Rosa (J. T., Jr.). **Note on an indirect effect of spraying Potatoes with Bordeaux mixture.**—*Amer. Journ. of Bot.*, x, 3, pp. 113–116, 2 figs., 1923.

A spraying experiment conducted at Columbia, Missouri, during 1921 indicated that the application to Irish potatoes of Bordeaux mixture or other preparations tending to increase the yield and prolong the period of vegetation may, under certain conditions, be accompanied by undesirable results.

Early Ohio potatoes were given four applications of 4–4–50 Bordeaux, with and without arsenate of lead and nicotine sulphate, the sprayed plants remained green three weeks longer, and gave an average yield 34·2 per cent. higher than the controls. In the absence of early and late blight [*Alternaria solani* and *Phytophthora infestans*], these results must be ascribed to the control of tipburn and hopperburn. The tubers from the sprayed plots, however, consisted largely of knobby second growths, so that the actual quantity of marketable potatoes was much less than from the control plots, which showed second growth only to a moderate extent. The knobby growths appeared to be produced during periods of favourable weather, at the tips of previously formed tubers, 4 or 5 growth zones sometimes being identified.

The writer thinks that sharp fluctuations in the soil-moisture content, such as accompany rapidly alternating meteorological conditions, may be largely responsible for the phenomenon of second growth, especially on the Early Ohio variety. Salaman has shown (*Journ. Min. Agric.*, xxviii, p. 43, 1921) that the tendency to produce second growth is not transmissible, and that knobby second growths planted as seed pieces gave a larger yield than pieces from normal tubers. Hence there is no reason to regard such tubers as physiologically defective. It is hoped that further investigations will throw light on the relation of soil-moisture variations and other edaphic factors to tuberization.

Rambousek (F.). **Rübenschädlinge und Krankheiten im Jahre 1921.** [Beet pests and diseases in the year 1921.]—*Zeitschr. für Zuckerind.*, [Prague], xlvii, 24, pp. 324–329, 1923.

The author gives an account of the diseases of [sugar] beet occurring in Czecko-Slovakia during 1921. Root rot was reported during the spring from a good many localities. In many cases, however, the disease was not due to *Phoma betae* but to the type of soil on which the plants were grown. The seedlings are unable to force their way to the surface of heavily encrusted soils without undue pressure and consequently they gradually decay. In order to ascertain whether a plant is affected by the physiological disorder or by *P. betae*, the constricted and decayed portion of the hypocotyl should be examined. A black discoloration denotes infection by the fungus and a brown discoloration the non-parasitic injury.

Chronic root rot was reported from one district in the middle of July, and bacteriosis and chlorosis also occurred. Scab [*Actinomyces scabies*] was reported from two localities; it is most prevalent on acid soils. Heart rot (*Phoma betae*) occurred fairly extensively. It is frequently confused with the cavities under the heart produced by intensive growth, and may best be recognized by the black discoloration of the inner leaves. *Rhizoctonia violacea* occurred principally on beet following clover.

Bourne (B. A.). **Researches on the root disease of Sugar-cane.**—*Dept. of Agric. Barbados*, 17 pp., 5 pl., 1922. [1923.]

Root disease of sugar-cane [see this *Review*, i, pp. 102 and 270] is of greater economic importance in Barbados at present than any other fungous disease or insect pest. The present paper is the outcome of protracted research on the possible factors governing the incidence of the disease in that island. The author points out the confusion existing with regard to root disease and has been careful to limit his investigations to 'decomposition of roots taking place on account of the invasion of fungi'.

Numerous isolations which are described in detail were made from typically affected canes. The first plantation to be investigated yielded a species of *Rhizoctonia* closely resembling *R. solani*. From another plantation a species of *Rhizoctonia* nearly allied to *R. pallida* Matz was recovered in pure culture, whilst from a third plantation in 1921 *R. solani* was again isolated a number of times, but in addition a species of *Fusarium* occurred, this being thought to be the first record of *Fusarium* sp. in connexion with the root disease of sugar-cane. It was observed that neither *Marasmius sacchari* nor *Trichoderma lignorum*, both of which were repeatedly recovered from dead cane roots, was isolated from freshly diseased material. Further isolations showed that either *R. solani* or *R. pallida*, with or without *Fusarium* sp., *T. lignorum*, or *M. sacchari*, was associated in every case with a dirty reddish discoloration of the internal tissues of the basal portion of the stems.

The various fields affected by root disease were observed to show a complete absence of the trash generally used in the covering of young plant canes, resulting in a very high temperature of the soil. This has been shown by Peltier (*Illinois Agric. Exper. Stat. Bull.* 189, 1916) to be correlated with the maximum virulence of attack by *R. solani*. The age of the affected plants varied from first to fourth ratoons, and whilst root disease is not restricted to any specific kind of soil, in every case a period of excessive drought preceded the first report of the disease.

The results of inoculation experiments, details of which are given, proved conclusively that both *R. solani* and *R. pallida* are parasitic on the sugar-cane and capable of producing the typical symptoms of root disease. Control plants maintained under the same conditions showed no signs of disease, whilst inoculation experiments with *M. sacchari* and *Fusarium* sp. gave negative results.

The reaction of the medium between $-15°$ and $+30°$ Fuller's scale has no effect on the growth of *R. solani* [see also this *Review*, ii, p. 419], but *R. pallida* develops best between $+25°$ and $+30°$ Fuller's scale, with comparatively good growth between 5° and 20° and fair growth between $-15°$ and 0°. The best growth of both fungi was obtained on *Diaprepes* grub agar, glucose and glycerine peptone beef agar, sweet potato agar, and cornmeal agar.

During the examination of the basal portions of an infected stool a typical rot of the fibro-vascular bundles resembling that described by Matz as due to *Plasmodiophora vascularum* [see this *Review*, i, p. 314] was noticed. A histological investigation of sections of the diseased material revealed the presence of very active, ciliate, protozoan organisms. The numerous encysted forms of these protozoa bore a striking resemblance to the spherical, smooth, or coarsely granulated spores with thick, hyaline walls described by Matz. After several days the cysts turned from hyaline to orange-yellow or brownish. Their diameter, when mature, varied from 13·5 to 16 μ, occasionally 8 to 19 μ. As in the case of *P. vascularum* germination was never observed. The adventitious roots of the stool in question and others from which the organism was isolated were all infested by one or other of the root-destroying fungi. A full description of the protozoan organism, which is stated to grow well on potato agar, sterilized cane stem and cane juice, is appended.

HIND (R. R.). **Toledo Cane: a mosaic-immune variety.**—*Sugar Central and Planters' News*, iv, 3, pp. 105–107, and 110, 5 figs., 1923.

Dr. E. W. Brandes has discovered that a variety of sugar-cane growing on the estate of Señor Toledo. Del Carmen, Pampanga [Luzon, Philippine Islands], is immune from mosaic disease. The variety, in appearance and size, greatly resembles D–1135, being erect in habit, thick in growth, and with longer internodes than are usually found in local canes. The rind is tough, purple in colour, and the pith yellowish; the leaves are dark green, narrow, and quite straight. The leaf sheaths adhere tenaciously to the stalk even when dead, forming a protective covering which may partially explain the complete absence of attack by the maize aphis [*Aphis maidis*]. Some idea of the luxuriant growth and prolific yield of the Toledo variety may be given by the statement that from six stools cut for seed in December 1920 there are now seven hectares of cane. Some stools of ratoons produced forty-two stalks, the latter rarely exceeding $1\frac{1}{4}$ in. in diameter.

In view of the prevalence of mosaic disease of sugar-cane in the Philippines, the discovery of an apparently immune variety is of considerable interest.

WILBRINK (G.). **Warmwaterbehandeling van stekken als geneesmiddel tegen de serehziekte van het Suikerriet.** [Hot water treatment of setts as a remedy for the sereh disease of Sugar-cane.]—*Meded. Proefstat. Java Suikerind.*, 1, 15 pp., 1923.

In July 1921 a series of experiments was carried out at Cheribon [Java] to test the effects of hot water treatment on sugar-cane setts affected by sereh disease. A preliminary test with healthy EK 28 setts indicated that 30 minutes' immersion in water heated to a temperature of 52° to 55° C. was not injurious to germination in that particular variety. For comparative purposes a test was also made with Black Cheribon setts suffering from gummosis. It was found that the hot water treatment almost completely inhibited germination in this case, so that the possibility of controlling the latter disease on these lines appears very slight. Setts affected with gummosis are destroyed at lower temperatures than healthy ones, which may facilitate the selection of sound setts for planting, but this has not yet been fully investigated.

The results of the experiments with Black Cheribon and White Preanger setts affected by sereh disease may be summarized as follows. The immersion of Black Cheribon setts in water heated to a temperature of 52° to 55° C. for 30 minutes somewhat impaired germination but absolutely controlled the disease. The general condition of the crop was excellent. Immersion at the same temperature for 15 minutes gave slightly less satisfactory results both as regards freedom from the disease and general vigour. The untreated controls were nearly all diseased.

The germination of White Preanger setts was not impaired by immersion at 50° to 55° C. for 30 minutes, but complete control was also not obtained. Some of the setts were planted in February 1922 after 30 minutes' immersion at 45° C. and another 30 minutes at 50° to 52° C., with excellent results. The idea of preliminary heating was suggested by the author's discovery that some 15 minutes elapse before the interiors of moderately thick setts reach the temperature of 52°. Immersion at a temperature of 48° to 50°, even after a preliminary heating, gave less satisfactory results. Further tests in February 1922 with the EK 28 variety confirmed the previous results. The outcome of a few preliminary tests indicates that the method is suitable also for the control of the root rot fungus [? *Marasmius sacchari*], but not for that of stripe disease [mosaic].

The fact that sereh disease can be controlled by the exposure of the affected setts to a certain temperature strongly suggests that it is caused by a parasitic organism, the thermal death point of which lies between 50° and 55° C. Further investigations will be necessary to ascertain the nature of the organism involved, but in the meantime the theory that sereh disease belongs to the 'degeneration' group appears to be definitely disposed of. Mosaic and allied diseases are known to thrive at considerably higher temperatures than that which destroys the sereh organism.

On account of the possible reduction of germination it is not at present advisable to recommend the hot water treatment on a large scale. It is believed, however, that a method can be devised whereby the injury to germination is eliminated. In the meantime the practice of the hot water treatment on a small scale, particularly in experimental stations and the like, can safely be recommended.

LEE (H. A.). **Sereh disease of Sugar-cane in Singapore.**—*Phytopath.*, xiii, 3, p. 145, 1923.

In 1922 whilst at Singapore Botanic Gardens the writer found sugar-cane affected with the typical symptoms of the sereh disease of Java. The canes had been imported from Java. He calls attention to the risk of sereh, Fiji disease, downy mildew [*Sclerospora*] and cane smut [*Ustilago sacchari*] diseases being transmitted on canes imported from oriental countries into the western hemisphere where these diseases are unknown or at least not general.

Müller (K. O.). **Ueber die Beziehungen von Moniliopsis aderholdi zu Rhizoctonia solani.** [On the relations between *Moniliopsis aderholdi* and *Rhizoctonia solani*.]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 4, pp. 321–325, 1 fig., 2 diag., 1923.

Several investigators, references to whose work are given, have endeavoured to throw light on the systematic position of the so-called 'propagation fungus' ('Vermehrungspilz'), which causes considerable damage in seed-beds. The fungus, which has been referred to a variety of genera, including *Mortierella*, *Botrytis*, and *Sclerotinia*, was later named *Moniliopsis aderholdi* by Ruhland (*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, 6, pp. 71–76, 1908), and more recently it has been identified by Duggar (*Ann. Missouri Bot. Gard.*, iii, p. 1, 1916) with *Rhizoctonia solani* or its basidial stage *Corticium vagum* var. *solani*.

The results of comparative cultural experiments, the technique of which is fully described, with strains of *Moniliopsis aderholdi* (identical with authentic cultures of this fungus) from cyclamen leaves and of *R. solani* from potato roots revealed a number of differences between the two fungi. The maximum, minimum, and optimum temperatures for the growth of the mycelium of *M. aderholdi* were 31·8° to 35°, 14°, and 29° [C.] respectively, the corresponding temperatures for mycelial growth of *R. solani* being slightly over 30°, 7°, and 25° [C.]. Morphological differences were also noticed. The mycelial texture of *M. aderholdi*, especially at the higher temperatures, was finer than that of *R. solani*, the average diameters of the hyphae being 7 μ and 8·3 μ respectively.

In order to test the influence of osmotic concentration and the chemical reaction of the medium on the development of the mycelia, varying concentrations of the Van 't Hoff salt mixture (100 Mol NaCl, 2 Mol $CaCl_2$, 2·2 Mol KCl, and 7·8 Mol $MgCl_2$) were added to the potato leaf agar. The cultures were incubated at a temperature of 26·5° [C.]. The initial concentration p was 4 per cent. NaCl and the corresponding mixtures of the other salts. Marked differences in the reaction of the two fungi were perceptible. Whereas the *Rhizoctonia* cultures developed normally at and beyond the concentration $p/2$, those of *Moniliopsis* made only feeble and irregular growth at the same concentration. At p the development of *Moniliopsis* was virtually inhibited. In general, the mycelium of *Moniliopsis* was denser than that of *Rhizoctonia*. At the higher concentrations *Moniliopsis* showed a much stronger tendency to develop involution forms than *Rhizoctonia*. At $p/4$ abnormal formation of the hyphae of *M. aderholdi* were frequent, and at $3p/4$ there was hardly a normally shaped hypha to be seen. In *R. solani*, on the other hand, only isolated irregularities of hyphae formation were observed, even at the highest concentrations.

Fragments of *M. aderholdi* grew in liquid cultures at acid concentrations which inhibited the mycelial growth of *R. solani*. The optimum acid concentration for the development of *M. aderholdi* was $p/2$, and for that of *R. solani* $p/1$. The hyphae of *R. solani* in liquid cultures gradually wove themselves into a firm, membranous, mycelial weft; while those of *M. aderholdi* developed in coils and finally formed a more or less spherical mycelium.

Inoculation experiments with *M. aderholdi* on thirty potato tubers previously disinfected with formalin resulted in the formation, close to the point of inoculation, of isolated, dark brown, sclerotial bodies, resembling those described by Ruhland as 'pseudosclerotia'. No injury to the young shoots was observed, and the hyphal network on the roots and underground portions of the stem, which is typical of *Rhizoctonia* infection, was entirely absent. Parallel tests with *Rhizoctonia* cultures gave positive results both on tubers and shoots, all the well-known symptoms of infection being present.

It is apparent from the above investigations that *M. aderholdi* cannot be regarded as identical with *R. solani*, and that, for the present, the systematic position of the former remains obscure. The fact that *M. aderholdi* can only flourish at temperatures between 14° and 35° C. explains its incidence at medium and high temperatures in greenhouses and seed-beds.

Müller (K. O.). **Ueber die Beziehungen zwischen Rhizoctonia solani Kühn und Hypochnus solani Prill. et Del.** [On the relations between *Rhizoctonia solani* Kühn and *Hypochnus solani* Prill. & Del.]—*Arb. Biol. Reichanst. für Land. und Forstwirtsch.*, xi, 4, pp. 326–330, 1 fig., 1923.

After a brief review of the work of Rolfs and other investigators on the connexion between *Rhizoctonia solani* and *Hypochnus solani* Prill. et Del. (*Corticium vagum* B. & C.), the author describes his own experiments in the same field.

In September 1922 a number of flower-pots were half filled with sterilized soil and in each two tubers, previously disinfected with formalin, were planted on the surface of the soil. Fragments of potato stems attacked by *Hypochnus* mycelium were attached to the under side of the glass panes covering the pots, so that the spores from these fragments fell on to the tubers. After 36 hours the tubers were covered with sterile soil and placed in the greenhouse. By December, 60 per cent. of the seedlings from the inoculated tubers showed the typical symptoms of infection by *Rhizoctonia*. The underground portions of the young shoots were covered with brown hyphae and a partial disintegration and brown discoloration of the epidermis was observed. The uninoculated control tubers remained healthy. *Hypochnus* spores therefore are capable of producing the typical *Rhizoctonia* disease, and further experiments showed that mycelium developed from *Hypochnus* spores (which was identical in all respects with that obtained from *Rhizoctonia*) also behaved similarly.

The results of comparative cultural experiments also point to the identity of the two fungi. For all the *Hypochnus* strains the maximum temperature for growth was about 30° [C.], the minimum between 5° and 7·3°, and the optimum about 23° [C.]. These figures agree closely with the temperature relations of *R. solani* [see preceding abstract]. There were, however, discrepancies in some of the strains which seem to indicate that the species *H. solani* includes a variety of biological forms. Thus two strains grew less rapidly than the others, their mycelia being correspondingly sparse. The virulence of the strains also varied considerably. Apart from negligible divergences, the reaction of *H. solani* to the osmotic concentration and to the acidity or alkalinity of the medium approximated to that of *R. solani* [see preceding abstract].

In order to produce the fructifications of *Rhizoctonia*, four tubers artificially inoculated with *Rhizoctonia* were placed in each of seven flower-pots in the greenhouse. At the time of flowering four of the resulting plants were covered with the typical *Hypochnus* mycelium at the base of the stem. Similar tests were conducted in the field, 150 tubers being inoculated with *Rhizoctonia* and a further 150 serving as controls. It was impossible entirely to preclude natural infection by *H. solani*, however, the control plants giving 17 per cent. infection whilst those artificially inoculated gave 38.

The basidial stage of *Rhizoctonia* was also obtained in pure culture in Erlenmeyer flasks filled with 50 cc. of a solution containing 1 per cent. Witte peptone and 0·5 per cent. potato starch. Within 17 days the mycelium was sufficiently developed to be transferred, after washing, to tubes containing filter paper saturated with water, maintained at a temperature of 20° to 21° [C.]. The mycelium developed aerial hyphae, and on the fifth day basidia were detected in two of the cultures. The measurements of the basidia averaged 9·5 by 5·7 μ and thus agreed with those obtained by Saccardo. The sterigmata appear to be somewhat smaller than those figured in Engler's 'Natürlichen Pflanzenfamilien' (i, 1, p. 115, 1900). Such a minor discrepancy, however, is probably due to the action of certain external factors on the cultures, and do not invalidate the conclusions mentioned above.

MAINS (E. B.). **Evidence of the seed carriage of the Euphorbia rusts, Uromyces proeminens and U. dictosperma.**—*Proc. Indiana Acad. Sci., 1921*, pp. 137–139, 1922. [Rec'd 1923.]

The author describes his experiments relating to the seed transmission of *Uromyces proeminens*, occurring on *Euphorbia dentata* and *E. preslii*, in the vicinity of Lafayette, Indiana, and *U. dictosperma* occurring on *E. arkansana* and other species in the western States. He also presents additional facts relating to the identity of the systemic aecidia on the latter hosts with *U. dictosperma* and to the production of uredospores in the life-cycle of this fungus.

In the autumn of 1920 seed was collected from plants of *E. dentata* heavily rusted with the teleutospores of *U. proeminens*. The seed was sown on 22nd January [1921] and the first symptoms of infection were observed on 1st March, when pycnidia appeared on one capsule of one plant. Subsequently other plants developed pycnidia or aecidia, or both. A brief discussion of the symptoms on each affected plant is given.

Seed from plants of *E. arkansana* heavily infested with teleutospores of *U. dictosperma* was collected in July 1920 and planted in the following August. On 12th November one branch of one plant became infected and died. After this all the plants remained healthy till March [1921] when eleven of the forty-two plants showed infection by aecidia or pycnidia, or both. Later uredo- and teleutospores appeared on most of the plants, presumably from aecidial infection. The branches infected with aecidia died without setting seed and the plants finally showed only teleutospores.

Aecidia from the above-described material were sown on healthy plants and produced uredospores, which were, however, soon replaced by the characteristic teleutospores of *U. dictosperma*. It is evident therefore that the systemic aecidia found on *E. arkansana* represent the aecidial stage of *U. dictosperma*. The subsequent production by these aecida of uredo- and teleutospores denotes that *U. dictosperma* is a full-cycled, autoecious species.

The above evidence is considered sufficient to prove that these two rusts are seed borne. The manner of their dissemination will form the subject of further investigations.

PETCH (T.). **Black rot of tea.**—*Trop. Agric.*, lx, 2, pp. 89–90, 1923.

During the last year a comparative examination has been made of thread blights on various plants from Java, India, Ceylon, the West Indies, and West Africa. An examination of the Java and Sumatra specimens proved conclusively that the species of *Corticium* causing black rot of tea in Ceylon is not *C. theae*. The latter is a true thread blight, forming a definite white cord running along the stem of the host plant. On the other hand, the mycelium of each of the Ceylon black rot fungi runs along the stem in a very thin, hyaline film which is invisible to the naked eye unless in the act of producing a fructification.

Recent investigations indicate that there are at least two species of *Corticium* causing black rot in Ceylon. One of these occurs on tea, *Oxyanthus tubiflorus*, *Calophyllum burmanni*, and *Hemidesmus indicus*, and will probably be found to be a general parasite on jungle shrubs. The other occurs on coca (*Erythroxylon coca*), but owing to the difficulty of obtaining mature fructifications it is not easy to distinguish one species from another.

Black rot of tea was originally discovered in the low country, but has since been found at an elevation of nearly 6,000 ft. Its distribution, therefore, is probably general.

PETCH (T.). **Cercosporella leaf disease.** — *Trop. Agric.*, lx, 2, pp. 87–89, 1 pl., 1923.

The symptoms and distribution of the leaf disease of tea, caused by *Cercosporella theae*, are described. The essential features of the disease have already been reported [see this *Review*, i, p. 331, and ii, p. 294]. A plate shows affected leaves and a typical spore of the parasite.

WOLF (F. A.). **Wildfire of Tobacco.**—*North Carolina Agric. Exper. Stat. Bull.* 246, 26 pp., 7 figs., 1922.

In North Carolina wildfire of tobacco, caused by *Bacterium tabacum*, makes its first appearance in the seed-beds during the last week of April or beginning of May. A wet rot stage not previously described by the present writer occurs on the smallest plants, the leaves of which are often completely rotted, whereas in other cases the infected tissues wither and fall away. A water-soaked zone divides the healthy from the diseased tissues. The bud leaves of affected plants are pale, erect, and slow to develop, and the plants may perish in the seed-bed or not survive transplantation. The areas affected are usually on the lowest and dampest portions of the beds.

Observations in North Carolina, extending over a considerable period, show that wildfire invariably originates in the seed-bed. This confirms the results obtained by other investigators in Virginia, Massachusetts, and Connecticut.

The remainder of the *Bulletin* deals with the effects of the disease, the results of experimental work, the factors governing the transmission of wildfire, and appropriate measures of control, notes on which have already been published from other sources [see also this *Review*, i, pp. 93, 94, and 376, and ii, p. 37].

TISDALE (W. B.). **Tobacco diseases in Gadsden County in 1922.**—*Florida Agric. Exper. Stat. Bull.* 166, pp. 77–118, 1922.

The following tobacco diseases occurring in Gadsden County [Florida] are described and figured, appropriate measures of control being recommended in each case.

Mosaic was not serious in 1922, as it appeared very late and affected chiefly the sucker leaves. Infected horse nettle [*Solanum carolinense*] and ground cherry [*Physalis*] plants are common in the tobacco fields of Gadsden County, and are believed to promote the spread of the disease. In both these plants the symptoms of the disease are much less conspicuous than in tobacco, and one species of ground cherry is said to act as a carrier of mosaic without itself showing any signs of infection. Mosaic may spread for a distance of several hundred feet among the weeds, and during the past season it was observed that mosaic was transmitted from plant to plant by labourers poisoning for budworm. Mosaic plants should be pulled out and the hands thoroughly washed before touching healthy plants. The eradication of weeds and covering the plant beds with cloth to prevent the transmission of the disease by plant lice and flea beetles are also recommended.

Wildfire, caused by *Bacterium tabacum*, was reported from Florida in 1921, but the diagnosis was regarded as somewhat uncertain. In 1922, however, the disease appeared in three two-acre fields, the source of infection being traced to two plant beds, one of which was covered with second-hand cloth from Connecticut. In all probability the germs were carried on this material. A description of this disease, together with suitable measures of control, has already been published [see this *Review*, ii, p. 37]. Granville wilt, caused by *Bacterium solanacearum*, appears to be decreasing in prevalence in Florida, and the attack in 1922 was extremely mild. The hope of developing strains of tobacco resistant to this disease has not been realized, but a method of shallow cultivation may be devised, which would reduce root injury and thereby lessen infection. All possible measures to localize the outbreak should be taken.

Leaf spot, due to *Phyllosticta nicotianae*, appears to be limited in distribution and of minor importance. No definite control measures can be recommended until more is known of the life-history of the causal organism, but observations made in 1922 suggest that the injury may be reduced by sowing the seed thinner, or thinning the stand on the poorer spots of soil.

Root rot, caused by *Thielavia basicola*, was widespread in 1922; growers report that during average years the plants finally outgrow the disease and produce fairly good yields, the crop, however, being two to four weeks late in maturing. Attempts are in progress to develop strains of tobacco resistant to root rot, the most promising of which are Connecticut Round Tip and (according to Valleau and Kinney) White Burley [see this *Review*, ii, p. 37.]

Frog-eye or 'specking', caused by *Cercospora nicotianae*, was very prevalent in 1922. Very little damage was sustained by the crop in fields where the leaves could be primed early, but wherever this process was delayed by rain considerable losses were caused by the disease. Vigorous, rapidly growing plants appear resistant, the fungus attacking mainly those weakened by unfavourable weather and soil conditions; in 1922 a fortnight's rain in June appeared to be the predisposing factor. The following suggestions are made for control: (1) root rot predisposes to frog-eye and hence varieties resistant to it should be selected where root rot is prevalent; (2) deep cultivation late in the season should be avoided, as this tends to check the growth and thus causes premature ripening of the leaves.

'Black shank', which made its first appearance in the United States in 1915 in Decatur County, Georgia, is rapidly gaining a foothold in Gadsden County, where it was the most serious disease of tobacco in 1922. Big Cuba was the most resistant variety and Connecticut Round Tip and White Burley the most susceptible. Conspicuous symptoms of the disease, which only attacks tobacco, are damping-off of seedlings, a dry black rot of the basal portions of the stalks of older plants, and a sudden wilting of the leaves. The roots of such plants are partially or entirely decayed, with a brown or black discoloration, but plants with apparently healthy roots may show the typical lesions on the stalks. As a rule these appear on the stalk at soil level and advance in both directions. Mycelial hyphae are usually present in streaks of brown, woody tissue; the pith within the diseased area is dry and brown and usually split into plate-like disks.

The disease may also affect the leaves, stalk, petioles, or leaf-blade during damp, cloudy weather, producing large brown blotches varying from one to three inches in diameter. On the Big Cuba variety these blotches are circular and marked with concentric bands of different shades of brown, whilst those on Connecticut Round Tip and Wisconsin No. 1207 are dark brown and at first have the consistency of wet rot. In this condition the diseased plants resemble Irish potato plants suffering from late blight [*Phytophthora infestans*]. Conidiophores and conidia of the causal organism have been observed in small numbers in the leaf lesions during cloudy weather, accompanied in lesions a few days old by species of *Fusarium*. When priming takes place during damp weather as much as 20 per cent. of the leaves from infected fields may rapidly develop greenish blotches, mottled with brown, after being hung in the barn. No further development has been observed to occur in the packing house.

The specific organism has been isolated from typical 'black shank' plants and proved by inoculation experiments to be highly pathogenic to healthy tobacco plants. The morphology of this fungus corresponds closely with that of *Phytophthora nicotianae* de Haan, with which it is in all probability identical. The conidia are mostly ovoid and apiculate, 25 to 33 μ in diameter, olivaceous, with a granular content. They begin to germinate in distilled water in about 15 minutes, producing ten to twenty zoospores, oval or bean-shaped, about 6·5 μ in diameter, and then after 15 minutes they cease activity, enlarge, and apparently disintegrate.

A difference in resistance between individual plants and varieties appears to exist. Until more information regarding the disease is available, its spread should as far as possible be localized by appropriate measures which are given in detail.

VALLEAU (W. D.). **An important period in the life history of two bacterial organisms causing leaf-spots on Tobacco.**—*Phytopath.*, xiii, 3, pp. 140–144, 1 fig., 1923.

Angular leaf spot [*Bacterium angulatum*] and wildfire [*Bact. tabacum*] of tobacco have been shown by Fromme to be transmitted by the seed [see this *Review* i, p. 94, and ii, p. 244]. There is some evidence, however, that the organism of the former disease at least may live in the soil some considerable time and as a few infected plants in the field can start infection of large plantings, treatment is desired which will remove all traces of the disease in the seed-bed.

By adding sulphur at the rate of 500 lb., 1,000 lb., and 2,000 lb., per acre to trial plots in a greenhouse, the author controlled the disease completely although infected seed was used, whereas in untreated plots numerous infections occurred where the tips of the cotyledons curled back and touched the soil. The treatment, however, was disastrous to the young plants, which were reduced severely in numbers, and it cannot be recommended for practice. The work, however, is considered to indicate that soil infection occurs first and leaf infection follows and that complete control of the disease may be obtained by suitable applications of disinfectants to the soil.

Departmental Activities : Botany.—*Journ. Dept. Agric. S. Africa*, vi, 3, pp. 202–203, 1923.

Nicotiana rustica, which until recently was free from parasitic diseases in S. Africa, except the disease known as brown spot, caused by *Macrosporium longipes*, has now been reported from Vereeniging to be attacked by the root parasite *Striga orobanchoides*. In all probability this plant's life-cycle is similar to that of the related broom rape [*Orobanche*] which is a common parasite on tobacco and other plants in many parts of the world, and its spread may, therefore, be checked by persistent uprooting and destruction before the seed matures.

The tobacco-growing districts of the Transvaal, owing no doubt to the exceptional rainfall during the month of March of this year, have suffered severely from disease. Wildfire [see this *Review*, ii, p. 37] has been prominent and widespread, and one farmer from Groot Marico reported the ruin of his entire crop of 60,000 plants from this cause. Angular leaf spot [*Bact. angulatum*] is now also mentioned as occurring in the Transvaal as well as brown spot, mildew, mosaic, and frenching, which all occurred to a greater or less extent.

CLAYTON (E. E.). **The relation of soil moisture to the Fusarium wilt of the Tomato.**—*Amer. Journ. of Botany*, x, 3, pp. 133–146, 3 pl., 1923.

Investigations were conducted at the University of Wisconsin during 1919 and 1920 to ascertain the relation between varying amounts of soil moisture and the development of tomato wilt (*Fusarium lycopersici*). The technique of the experiments and of the methods used in the control of soil moisture is described in considerable detail.

Tomato plants were grown in crocks of sterilized soil inoculated with a spore suspension of *F. lycopersici*. The soil in the crocks was held at moisture contents ranging from 13 to 35 per cent., the latter representing complete saturation, and for the experiments the temperatures were finally raised to the optimum for the disease (about 28° C.). The results of a series of experiments showed that plants growing very rapidly under optimum moisture conditions for vegetative growth are most susceptible to wilt. The plants grown in soil with a low moisture content (13 to 19 per cent.) were very resistant to the disease, a moisture shortage which checked growth bringing about a proportional check in symptoms of the disease. The plants grown in saturated soil were immune from the disease.

Rapidly growing plants in inoculated soil held at a temperature below 20° C. remained healthy, but when they were brought into a temperature favouring the disease (25° to 30° C.), they were soon attacked by wilt, unless the soil was allowed to dry out, in which case the appearance of the disease was retarded. Conversely, plants growing in soil with a low moisture content lost their resistance to the disease if a rapid, succulent growth was induced by the addition of sufficient water to keep the soil moist. Plants growing in the saturated soil also developed the disease as soon as the moisture content was lowered.

With regard to the resistance of plants grown under dry soil conditions, it was found that even when these plants showed no signs of disease they were frequently discoloured in the vascular region and if incubated long enough were killed by wilt. As the fungus produces the disease very slowly, the host is regarded as being resistant under these conditions.

The reason for the relative immunity from wilt of plants grown in saturated soil was also investigated. From microchemical analyses it was found that the nitrogen relations in the saturation plants differed markedly from those of normal ones. Resistance appeared to be correlated with the absence of nitrate nitrogen. To test this theory plants were grown in sand cultures to which nutrient solutions were added. Part of the plants received a complete nutrient solution and the remainder a solution minus nitrate. The tissues of the plants grown in the latter solution were not infected while those which had received the complete nutrient solution developed the disease.

Jardine (N. K.) **Inspection for plant pests and diseases.**—*Trop. Agric.*, lx, 2, pp. 90–92, 4 pl., 1923.

The Department of Agriculture, Ceylon, has divided its Plant Pests and Diseases Inspection Branch into two divisions, a central one at Peradeniya and a southern one at Avisawella. The work of the divisions is educational, advisory, and official. Special attention is given to the gardens of small native cultivators, who are gradually being educated to realize the importance of pest control as a means to the production of better crops. Advice is given as to the adoption of remedial measures and, if necessary, the regulations for the control of the shot-hole borer of tea and other pests are enforced.

Traverso (G. B.) **L'organizzazione dei Servizi fitopatologici in Italia.** [The organization of the phytopathological services in Italy.]—Reprinted from *Atti XVI Congr. naz. Unione delle Cattedre ambulanti di Agricoltura italiane*, 12 pp., 1923.

A short account is given of the legislation leading up to the present organization of the phytopathological services in Italy, which is based on the Act of 26th June 1913 for the prevention and control of plant diseases, the regulations governing its application passing into law in 1916. The general objects in view are as follows: (1) the study of plant diseases; (2) the control of production and of trade in vegetable products with a view to preventing the introduction of exotic parasites and to circumscribing certain dangerous diseases which are still confined to specified areas; (3) the carrying out officially of control measures; and (4) the organizing and directing of agricultural societies with the object of combating certain plant diseases.

Apart from the administrative section which forms a special department of the general administration of agriculture under the ministry and is aided by a consultant commission (the *Phylloxera* Commission formed in 1879 modified by the Acts of 1911 and 1915), the machinery of the above services consists of: (1) experimental institutes; (2) regional phytopathological observatories or stations; (3) special phytopathological delegates; and (4) plant disease inspectors. On the first devolves the scientific study of diseases and the experimental application of remedies. The observatories have to collect phytopathological material, carry out statistical enquiries and study the behaviour of plant diseases in their own districts. They also issue phytopathological certificates for the dispatch of plants and seeds inland or abroad. The special delegates' duty is to inspect horticultural establishments, nurseries, gardens, markets, &c., to ascertain the health of vegetable products destined for marketing, and to report to their immediate superiors, the directors of the observatories. They have, moreover, to supervise the inspection at the ports and at certain frontier stations of all imported plant material, and function as judicial police in cases of contravention of existing regulations, the reports concerning these being also drawn up by them. The inspectors are in charge of campaigns on a large scale against plant diseases carried out by, or with the aid of, the State but under the immediate direction of the regional observatories. They are also made use of in propaganda work.

The author states, that although theoretically the organization, as outlined is perfect, its working in practice leaves much to be desired. Lack of Government support, financial insecurity, indifference on the part of agriculturists, unsuitable buildings, absence of adequate experiment grounds, and insufficient remuneration of workers, are responsible for the fact that the experimental institutions, namely, the Cryptogamic Laboratory of Pavia, the Station of Agricultural Entomology at Florence, the Station of Plant Pathology at Rome, and the Laboratory of Agricultural Entomology attached to the College of Portici, have failed to maintain their old-established fame as leaders in scientific research on the diseases and pests of plants. These central phytopathological institutions should be placed in a position to undertake serious research and experiment. The technical and scientific personnel for the various services should receive its training there; this is at present obligatory for the inspectors but should be extended to include the special delegates also. The foundation of new experiment stations should not in any way imply that the existing ones are allowed to decay.

Of the twenty-three regional observatories formed in 1917 only about a fourth are independent, the others being branches of various experiment stations, laboratories attached to higher or special schools, or other agricultural institutes, where phytopathological interests are secondary and where this additional and responsible work is undertaken by the local staff without adequate remuneration. The author, while not denying the advantage of the proximity of other experimental or teaching institutes, thinks that the regional observatories ought to have their own properly trained personnel. He is also of opinion that their cost should not fall entirely on the State, as is the case at present, but that the major portion should be borne by the various agricultural and commercial interests concerned.

The special delegates, of whom there are about one hundred, were appointed provisionally from amongst directors and assistants at experiment stations, botanical and research institutes, &c. The composition of the existing staff is regarded as too heterogeneous and the author advocates the appointment of persons who have had more opportunities of getting into touch with farmers and horticulturists. The forestry inspectors and also the staffs of the ambulant agricultural chairs and of anti-*Phylloxera* societies, are thought most suitable. They should not be specialists in either mycology or entomology, but a practical knowledge of the diseases covered by legislation and of the legislation itself, of the most recent research work connected with control measures, and of the manner of taking satisfactory samples for scientific study, is essential, and may be imparted by means of courses to be organized by the Union of Ambulant Agricultural Chairs. The provincial branches of this body might perhaps organize local phytopathological services, but always in co-operation with the regional observatories. Such an arrangement would make for greater uniformity and efficiency.

The plant disease inspectors should be increased in number in proportion to the increase of the regional observatories on which they are dependent. It is also necessary that the State should fix their remuneration at a level to attract young students of promise in agricultural or natural science subjects, likely to profit by the two years training prescribed by law for these posts.

Under the existing legislation the formation of communal, inter-communal, or provincial organizations for the control of certain plant diseases on the lines of the anti-*Phylloxera* societies, is optional. The author would like to see this made compulsory in certain cases.

From an international standpoint an efficient organization of the phytopathological service is of the greatest importance. It is equally important in the interests of the country itself. Export business depends on it, as is shown by the certificates required in the case of certain important commodities, which are not admitted into other countries without these guarantees. An efficient service may be expected to effect a progressive reduction in the losses caused by the diseases and pests of plants as has been the case in regard to human and animal diseases. The text of a resolution embodying the reforms outlined in the present paper is appended.

A decree to make provision for the protection and preservation of plantations (No. 18 of 1922), Zanzibar, 14th August, 1922.

The Plantations Preservation Decree, 1922, provides for the destruction of clove, lime, orange or other trees or shrubs infected by deleterious fungi of any description, or by the parasites *Loranthus* var. and *Cassytha* var. Similar provision has been made for the destruction of coco-nut trees infested with insect pests. The occupier of land whereon clove or coco-nut trees are grown is required to clean and weed such land at least once every year to the satisfaction of the Director of Agriculture or his representatives. Any inspector may, at his discretion, order the destruction of any tree or heaps of decaying matter attacked by or likely to become a breeding place for any parasite, and, in the event of such order being disregarded by the occupier, may himself take the necessary measures for its execution at the occupier's expense. For the purposes of this decree 'occupier' shall mean the person entitled to the immediate profit of any land, and by a recent amendment (Decree No. 7 of 1923) the term has been further extended to apply also to persons licensed to gather crops and to tenants, irrespective of the period of the licence and of the tenancy.

Amendment No. 2 to regulations governing the importation of Potatoes into the United States (revised).—*U. S. Dept. Agric. Fed. Hort. Board, January* 1923.

As from 1st February 1923, the regulations governing the importation into the United States of potatoes from Canada and Bermuda [see this *Review*, 1, p. 408] have been amended to read as follows:—' Potatoes grown in the Dominion of Canada and Bermuda may be imported into the United States without permit, when accompanied by a certificate issued by a duly authorized officer of the country concerned, indicating the district or locality where grown and apparent freedom from injurious potato diseases and insect pests. Such importations shall be subject to such inspection on arrival as may be required by the United States Department of Agriculture.'

IMPERIAL BUREAU OF MYCOLOGY

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Humphrey (C. J.). **Diseases of ornamental and forest trees.**—*Ann. Rept. Wisconsin State Hort. Soc.*, lii, pp. 92–99, 3 figs., 1922.

In the case of forest and ornamental trees, leaf-inhabiting fungi are not of such importance as they are in fruit trees. A conspicuous representative is the tar spot of maple (*Rhytisma acerinum*) which may be controlled by the burning of the fallen leaves in autumn in order to prevent infection by ascospores in the spring. Chestnut bark disease [*Endothia parasitica*], which has practically destroyed the native chestnut stands north of North Carolina, can be combated only by the breeding of resistant varieties.

Wisconsin, however, is more vitally affected by the serious white elm disease, caused by *Sphaeropsis ulmicola*. The most striking symptom of the disease is the sudden death of certain smaller branches scattered throughout the crown, due to girdling. Below the girdle water-sprouts very often develop. Over the attacked areas the smooth bark becomes somewhat sunken and loses the normal healthy green appearance. From these girdled regions the fungus grows into adjacent healthy tissues so that the whole crown may in time become involved. Every possible effort should be made to eradicate this epidemic and destructive disease. Infected limbs should be excised and burnt, while ample watering and fertilization also assist in the recovery of diseased trees. Infected seedlings should be destroyed.

Near Madison *Armillaria mellea* is most commonly found on scarlet and black oaks, and sometimes on white and bur oaks. In the fruit-growing regions it occurs on various stone fruits, especially the cherry, while on the Pacific coast it is reported to cause a serious disease of small fruits. The main line of control should be the prevention of the spread of the infection. The isolation of infected areas by trenching is useful only in the case of definitely localized infection.

For the treatment of wounds shellac is recommended for small wounds and for larger ones a 50 : 50 mixture of coal-tar creosote and asphaltum. In the case of such delicate trees as the peach, cherry, plum, magnolia, and tulip a 25 : 75 mixture of coal-tar creosote and asphaltum may be substituted for the above. The cut bark and adjoining wood should be painted with shellac before the creosote mixture is applied.

The author concludes with a brief discussion on the care of trees in the public parks and highways and urges the necessity of municipal control for the prevention of injury and disease.

König. **Ueber Rotfäulebestände und deren Behandlung.** [Stands infected with red rot and their treatment.]—*Tharandter forstl. Jahrb.*, lxxiv, 2, pp. 63–74, 1923.

During his administration of the Lossnitz [Saxony] crown lands, the author observed numerous cases of red rot of fir trees cultivated, for the most part, on what was formerly arable land. Resin was exuded from the trunks of affected trees and the fructifications of *Trametes radiciperda* [*Fomes annosus*] were frequently observed. The entire root system of fallen trees was often found to be decayed, the weaker strands being severed. As a rule the base of the trunk was only fit for firewood. The affected trees sometimes formed a circle round groups of completely healthy firs, which became infected one by one. The stiff clay soil of the Lossnitz forests also favoured the disease by preventing the penetration of the roots, which were frequently severed in one or more places, thereby affording easy access to the spores of the fungus.

The presence of smoke gas is another frequent source of trouble, the acids impeding the decomposition of the humus in the soil. The local practice of planting the seedlings in groups, instead of singly, also increased the danger of infection by weakening the individual development of the trees. The use of fir trees on the borders of plantations, where they are exposed to the full force of the wind, is another fault of cultivation. They should be replaced on the north, east, and west by shade trees, if the soil is deep enough, or by larches or white pines in shallow soil. Gaps in the interior of the stand should be filled with hornbeam, beech, or ash trees.

Boyce (J. S.). **The deterioration of felled western Yellow Pine on insect-control projects.**—*U.S. Dept. Agric. Bull.* 1140, 7 pp., 1923.

The losses from decay in western yellow pine (*Pinus ponderosa*), felled and barked in order to control insect epidemics, in the Klamath Lake region of southern Oregon are relatively slight (13 to 18 per cent.) during the first year. In the second year, however, they are so heavy (63 to 76 per cent.) that the cut trees must be regarded as lost if they cannot be utilized within twelve months. Among the fungi causing decay were *Polyporus anceps, Lenzites saepiaria*, and *Fomes pinicola*.

SCHELLENBERG (H. C.). **Die Empfänglichkeit der Ribesarten für den Rost der Weymouthkiefer.** [The susceptibility of *Ribes* species to White Pine blister rust.]—*Schweiz. Zeitschr. für Forstwesen*, lxxiv, 1–2, pp. 25–50, 1923.

Since the writer first detected blister rust (*Cronartium ribicola*) on *Pinus cembra* in the Engadine, he has collected data on the comparative susceptibility to the disease of the various species of *Ribes*. Taking 10 to represent the highest degree of susceptibility and 0 as immunity, the species may be classified as follows :—*Ribes nigrum*, 10 ; *R. petraeum*, 9–10 ; *R. alpinum*, 7–9 ; *R. uva crispa*, 6–8 ; *R. grossularia*, 2–8 ; *R. aureum*, 5–7 ; *R. rubrum*, 2–4.

R. nigrum appears to exhibit no varietal differences in the degree of attack, while *R. grossularia*, formerly supposed to be immune, varies considerably in susceptibility. Of two bushes in the author's garden one bearing pink berries was regularly and severely infected, while on a yellow variety the attacks were extremely rare and negligible in extent. Other similar instances have also been observed. The author's investigations do not confirm Klebahn's theory that the stock in grafted bushes exerts an influence on the susceptibility of the scion.

R. rubrum appears to be exceedingly resistant to the disease even in the immediate vicinity of heavily infected black currants. This statement applies primarily to the Dutch red currant, which is extensively cultivated in Switzerland. The Versailles and the white and striped varieties are also resistant, but slightly less so than the Dutch.

As regards the ornamental currant species, both *R. sanguineum* and *R. gordonianum* are very susceptible, *R. aureum*, which is always used as a stock for espalier currants or gooseberries, is less susceptible than *R. sanguineum* and *R. gordonianum* but more so than *R. rubrum*.

The susceptibility of the wild species, *R. petraeum* and *R. alpinum* is of no great importance, since they occur only in the Alpine regions where the pine is not cultivated. Much more serious is the liability to the disease of *R. uva crispa*, which is constantly found in localities where the white pine is grown on a large scale, and which must undoubtedly be regarded as the natural intermediate host in cases where the blister rust occurs on white pines at a distance from cultivated *Ribes*.

In view of the impossibility of eradicating the wild currant from the forests in which it has once gained a foothold, the cultivation of the white pine in its neighbourhood cannot be recommended.

HOTSON (J. W.). **Blister rust—a menace to prosperity.**—*Univ. of Washington Forest Club Quarterly*, i, 2, pp. 18–25, 3 figs., 1922.

White pine blister rust (*Cronartium ribicola*), the symptoms, life-history, and distribution of which are described, has been definitely located in four different parts of Washington. An account is given of the legislative measures formulated at the White Pine Blister Rust Conference in December 1921, and an appeal made for general co-operation to prevent the further spread of the disease in the States of Washington, Oregon, California, Idaho, and Montana.

It is estimated that there are a billion feet of white pine in the commercial areas of north-eastern Washington and 600,000,000 feet in Oregon.

WEIR (J. R.). **The genus Polystictus and decay of living trees.**—*Phytopath.*, xiii, 4, pp. 184–186, 1923.

In this paper eleven species of *Polystictus* (*P. abietinus*, *P. biformis*, *P. cinnabarinus*, *P. conchifer*, *P. floridanus*, *P. hirsutus*, *P. lacteus*, *P. pergamenus*, *P. pinsitus*, *P. versicolor*, *P. zonatus*) are listed as causing decay of trees. Notes regarding the parasitic action of each species are given, usually showing that the decay makes slow progress in otherwise healthy trees. The rots are usually white or yellowish or of a slight reddish tinge in the case of *P. cinnabarinus*, but are not specially differentiated. These fungi are primarily scavengers of the forest, destroying timber débris, but may become important in the decay of useful material left too long in the woods.

MALAQUIN (A.). **La maladie des Ormes.** [The disease of Elms.]—*Renaissance agric.*, iv, pp. 91–94, 1923.

This disease of elms, now reported from the neighbourhood of Lille, is evidently the same as that already described in Holland and Picardy [see this *Review*, i, p. 334, and ii, p. 431]. The author believes it to be due to the attacks of *Scolytus* beetles, but states that it has also been attributed to the injurious effects of gas and to the drought of 1921.

PETERS. **Die Kräuselkrankheit der Rüben.** [The curl disease of Beets.]—*Deutsche landw. Presse*, l, 13, p. 117, 3 figs., 1923.

Sugar and fodder beets, mangolds, and other cultivated varieties of *Beta vulgaris* are liable to occasional attacks of downy mildew (*Peronospora schachtii*). The first symptom of the disease is usually a marked retardation of the growth of the heart in early summer. The heart in such cases consists of small, discoloured, very crumpled leaves with short petioles, encircled by fully developed leaves with petioles of the normal length. The young heart leaves are completely diseased, the older ones remaining healthy at the tip. The under side of the diseased leaves is covered with the whitish, subsequently grey, fructifications of the fungus. The dissemination of the spores (the average dimensions of which are 24 by 20 μ) is presumably effected by the wind, possibly also by insects. The incubation period seems to be very short; in any case, continuous new infections have been observed during the growing season in cool, damp weather. The disease is rapidly arrested, however, even by a brief spell of dry, warm weather, and the decayed heart leaves are then replaced by small, narrow ones. In this stage of the disease the affected plants resemble those suffering from heart rot [attributed by some to *Phoma betae*, by others believed to be a physiological disorder] except for the absence of the dry patches of decay on the sides of the root. Early infections generally cause some reduction in yield and in the sugar content of the beet owing to the temporary disturbance of metabolism; on the other hand, the frequent cases of reinfection in the autumn are of little practical significance. Tests carried out at the Uckermark Sugar Factory at Strasburg showed a reduction in the sugar content of diseased beets of only 0·2 to 0·4 per cent.

Gäumann has shown that the species of *Peronospora* are usually very highly specialized in their parasitism, rarely affecting more than one host plant. It is therefore very improbable that the mildew of beet can be transmitted from or to other members of the Chenopodiaceae. The conidia of the fungus remain viable only for a very brief period, and the formation of resting spores, in Germany at any rate, is very uncommon. The mycelium of *P. schachtii*, however, can overwinter in the tissues of infected beet roots and infect the new shoots. When beet for seed bearing is planted out the diseased shoots from the infected roots can be recognized by their stunted growth, curled or crumpled leaves, and copious spore production. The common practice of locating the seed-beds next to fields planted with seed bearers ('stecklings') favours the spread of the disease and should be discontinued. All the infected portions of seedlings and seed bearers should be removed and buried. At harvest it is advisable to discard all suspected plants from use as seed bearers. The fields in which the latter are planted should be situated in such a position that the prevailing winds do not pass over them before reaching the seed-beds. By the adoption of these simple measures complete control of the disease is stated to be ensured.

TAKIMOTO (K.). **On the vitality of Cercospora beticola.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 43–44, 1923. [In Japanese, with English summary.]

Spores of *Cercospora beticola* kept in a dry condition at the laboratory remained viable for 16 months, while those on the seeds were capable of germination until the sowing season, at the end of April, of the following year. The spores on diseased leaves kept in cellars were not able to germinate at the beginning of May, but sclerotial bodies or mycelia in the tissues were viable throughout the winter. The results of field experiments showed that sclerotial bodies and mycelia were frequently viable after the spores had lost their germinating power. In the laboratory the spores of diseased leaves mixed with wet soil died in three to four weeks.

GARDNER (M. W.) & KENDRICK (J. B.). **Bacterial spot of Cowpea.**—*Science*, N. S., lvii, 1470, p. 275, 1923.

Since 1919 a destructive bacterial disease of the cowpea (*Vigna sinensis*) has been noted in Indiana, leaves, stems, and pods being affected. On the leaves the symptoms consist of irregularly circular spots, 1 to 3 mm. in diameter, with maroon edges and buff centres. The young lesions are greasy and water soaked. On the pods the spots are also irregularly circular, 1 to 8 mm. in diameter, and maroon in colour, often with a depressed centre and water soaked border. Early infection may cause a constriction of the pod and stunting of the distal portion, and the seeds under the pod lesions may be stunted, shrivelled, or discoloured. Dark red, elliptical to linear, sunken lesions are formed on the petioles and stems. In addition to lesions on cotyledons, first leaves, hypocotyls, and epicotyls, localized vascular infection and partial wilting may occur among seedlings grown from diseased seed.

Numerous isolations and successful inoculations proved the disease to be due to an apparently undescribed bacterium, the diagnosis of which is as follows: *Bacterium vignae* n. sp. Cylindrical rods, rounded at ends, solitary or in pairs; individual rods, 1·5 to 2 by 0·5 μ; motile by 1 to 5 polar flagella at one or both poles; aerobic; no spores or capsules. Gram negative; staining readily with gentian violet. Superficial colonies on potato agar round, smooth, shining, raised, pulvinate, or umbonate, finely granular, often showing a concentric pattern, greyish-white in reflected light, slightly greenish fluorescent in transmitted light. Gelatine rapidly liquefied; casein digested and no acid produced in milk; nitrates not reduced; no gas with various carbohydrates and no acid except for small amount with dextrose and saccharose; starch not hydrolized. Growth and greenish pigment formation in Fermi's and Uschinsky's solutions; no growth in Cohn's solution; slow liquefaction of blood serum and Loeffler's blood serum. Growth inhibited by 5 per cent. sodium chloride. Growth in broth at $+12$ and -15 and at P_H 4·8. Greenish pigment formation in alkaline broth. Thermal death point 50° C.; killed by one hour's exposure to sunlight, and slowly killed by freezing in water. Rapidly killed by desiccation on glass but very resistant to desiccation on cowpea seeds. Group number 211.2232033.

The disease is seed borne and can probably be controlled by the use of seed from healthy pods.

Harter (L. L.), Lauritzen (J. I.), & Weimer (J. L.). **Mottle-necrosis of Sweet Potatoes.**—*Phytopath.*, xiii, 3, pp. 145–146, 1 fig., 1923.

This disease is characterized by brown, irregularly formed and sometimes completely isolated patches of dead tissue occurring throughout the sweet potato. In mild cases there is no external symptom, but in advanced stages dead areas occur at the surface of the tuber.

The disease has been observed at digging time and is reported from various parts of the United States. So far no causal organism has been isolated, and sometimes the spots are free from mycelium. The authors are continuing their investigations on the disease.

Stell (F.). **A fungus disease of Cabbages.**—*Bull. Dept. Agric. Trinidad and Tobago*, xx, 2–4, p. 116, 1922.

The disease known as cabbage yellows, due to a species of *Fusarium* [*F. conglutinans*], has recently been reported from the San Juan district of Trinidad. The author briefly describes the symptoms and life-history of this disease and states that efforts are being made to introduce resistant varieties from the United States, the Wisconsin variety being under trial at St. Clair Experiment Station.

GRAM (E.) & ROSTRUP (SOFIE). **Oversigt over Sygdomme hos Landbrugets og Havebrugets Kulturplanter i 1922.** [Survey of the diseases of cultivated agricultural and horticultural plants in 1922.]—*Tidsskr. for Planteavl*, xxiv, 2, pp. 236–307, 2 figs., 1923. [English summary.]

The period under review (1st October 1921, to 30th September 1922) was characterized in Denmark by a dry, sunny autumn with several heavy storms, a cold and dry period in January and February, a late spring, and a cool, moist summer. The fungous diseases are classified under the following headings, many other records being given besides those enumerated below.

CEREALS. Serious attacks of stripe disease of barley (*Pleospora graminea*) occurred in various localities, especially on the susceptible Karl and Prentice varieties. Leaf spot disease of barley (*P. teres*) was very severe on Tystofte Prentice. Mildew (*Erysiphe graminis*) attacked late-sown barley on damp soil and in the vicinity of winter barley. Severe attacks of covered smut of barley (*Ustilago hordei*) on the Abed and Tystofte Prentice varieties were reported. Wheat sown at the end of September also suffered from mildew while that sown a month later was free from the disease. Bunt of wheat (*Tilletia caries*) is notably decreasing in prevalence, partly as a result of seed disinfection. Loose smut of oats (*U. avenae*) was much in evidence, and there are some indications that it is correlated with insufficient fertilization. Flag smut of rye (*Urocystis occulta*) was prevalent on the Petkus, Bretagne, and Borris varieties. The aecidial stage of black rust of wheat (*Puccinia graminis*) was found on barberry bushes in several localities, including Møen's Klint [an island off the south-west coast of Zealand] where the cultivation of the shrub is permitted. It is regarded as urgently necessary to extend the barberry eradication regulations to this island. Foot rot of wheat and barley (*Fusarium*, *Leptosphaeria*, and *Ophiobolus* spp.) was specially severe in fields previously under barley or beets and mildest on ground which had lain fallow for some time.

LEGUMINOSAE. *Ascochyta pisi* completely destroyed the pea crops in a number of gardens, and *Sclerotinia sclerotiorum* also occurred with great severity during the damp late summer.

ROOT CROPS. Mosaic and downy mildew (*Peronospora schachtii*) resulted in severe damage to the beet crops; it is believed that insects and implements may be concerned in the transmission of the former disease. *Phoma betae* and *Pythium de Baryanum* were frequently found in non-calcareous or very compact soils. A severe wilt disease occurring in conjunction with deep sowing was reported from the north of Denmark. The Elvetham and Eckendorfer beet varieties were severely infected by *Hypochnus* [*Corticium*] *solani*.

CRUCIFERAE. Club-root (*Plasmodiophora brassicae*) occurred extensively on numerous varieties of cabbage, turnips, and mustard. The disease was frequently associated with non-calcareous or cold soils, and there were fresh instances of the transmission of infection through refuse. Dry rot (*Phoma napobrassicae*), which had been in abeyance since 1914, occurred on well-limed clay soil.

POTATOES. Mosaic and leaf roll occurred with unprecedented severity in the hot, dry summer of 1921, and in 1922 the proportion of healthy fields was alarmingly low. The Magnum Bonum, Up-to-date, and Juli varieties were most susceptible. The absence of any organized scheme for the investigation of these diseases in Denmark is very regrettable. Blackleg (*Erwinia* [the new name given to various species of the genus *Bacillus* at the suggestion of the Society of American Bacteriologists] *phytophthora*) [*Bacillus atrosepticus*] was prevalent and severe in many parts of Jutland. Various other diseases of minor importance were recorded.

FODDER CROPS. The usual diseases were reported without any particulars of special interest.

FRUIT. On the whole, the damage caused by fungous diseases to apples and pears was not extensive. Raspberries were badly attacked by *Didymella applanata* on excessively nitrogenous soils in Fünen. Tomatoes were attacked by *Ascochyta lycopersici* [*Didymella lycopersici*], which also appears to prefer nitrogenous soils. *Cladosporium fulvum* attacked the Fillbasket, Denmark, Comet, Kondine Red, Tuckswood, and Queen Mary varieties.

CUCURBITACEAE. *Cercospora melonis* attacked the Tottenham variety of cucumber very early and severely. *Cladosporium cucumerinum* and *Macrosporium melophthorum* [mentioned as distinct fungi] were also prevalent.

ONIONS AND LEEKS. *Peronospora schleideni* caused severe damage to leeks and shallots.

VEGETABLES. Mildew of spinach (*Peronospora effusa*) was very severe on spring-sown plants and was observed as early as March on the Victoria variety under glass. *Bremia lactucae* was prevalent on outdoor salads at Lyngby in August. *Glomerella lindemuthianum* occurred with great severity on wax and French beans in August and September.

TREES, SHRUBS, AND ORNAMENTAL PLANTS. Among the diseases recorded were *Macrosporium caudatum* on zinnias [*Zinnia* sp.]. *Graphiola phoenicis* and *Exosporium preisii* on imported Phoenix palms [*Phoenix* sp.], *Pestalozzia guepini* on camellias [*Camellia* sp.], and *Bacterium tumefaciens* on marguerites.

In the section of the report devoted to diseases presumably of physiological origin, mention is made of the leaf edge disease of red Dutch and red Spanish currants, yellow apricots, and Cox's Orange apples. The disease was aggravated by the application of saltpetre. Bright speck disease [see this *Review*, i, p. 421, and ii, p. 403] was recorded on oats, barley, rye, Panser wheat (in conjunction with frost injury), beets, potatoes, and carrots. Indoor tomatoes were affected by a similar disease, presumably in consequence of plentiful applications of lime, bonemeal, and organic manure.

A brief account is given of the results of experiments in the control of plant diseases carried out during the year. Apples and climbing roses were injured by the application of 2 per cent. Burgundy mixture with the addition of 0·5 gm. Schweinfurt green per litre. The sale of this mixture is illegal on account of the free arsenious acid formed in it. Moltke pears suffered from scalding after spraying with 0·5 per cent. formalin. At the Lyngby Experiment Station 2 per cent. Bordeaux mixture injured Bismarck apples and several pear varieties, whereas lime-sulphur 1 in 35 produced no ill effects. In North Jutland the application of a tobacco extract, containing only a small proportion of nicotine, resulted in complete defoliation [crop not specified] owing to the presence of free ammonia in the compound.

[Bewley (W. F.)]. **Mycological Report.**—*Eighth Ann. Rept. Cheshunt Exper. and Res. Stat. Hertfordshire, 1922*, pp. 34–45, 1923.

Among the diseases not hitherto reported but observed during the year were the following: bronzing of roses, due to an unknown cause, dropsy or oedema of tomatoes and ivyleaved geraniums (of physiological origin), bulb rot of narcissus (due to *Botrytis* sp.), and mosaic diseases of ash, black nightshade (*Solanum nigrum*), *Petunia*, potato, tobacco, and passion flower [*Passiflora*].

The main object of research during the period under review was mosaic disease of the tomato and cucumber, but the new tomato root rot reported last year [see this *Review*, i, p. 372] and stem rot were also investigated.

The new tomato root disease was first observed in 1919, and in 1921 it was frequently found on roots of wilted plants. The results of local observations indicate that the disease is more serious than was at first assumed, most soils on which tomatoes have been grown for any length of time being infected.

The normal development of affected plants is checked, the lowest leaves turn yellow and die prematurely, and any new growth which may be formed is weak and pale in colour. In advanced stages the stem becomes hollow and yellow, a dark brown discoloration, usually about a quarter of an inch wide, sometimes appearing at one side of the base of the stem. 'Hollow stem' disease is often associated with this disease at the roots. In the final stages all the leaves wither and the plant dies. The distinctive feature of the disease is the presence of innumerable minute, globular, black sclerotia, both within the larger wood vessels in the pith cavity and on the outside of the wood. Those within the tissues are irregular in shape and rarely develop setae. Though generally confined to the roots, the sclerotia may also, in severe cases, be found on the base of the stem and the lower portion of the aerial parts. The infected wood is usually of a darker shade of brown than that attacked by *Verticillium albo-atrum* or *Fusarium lycopersici*.

The causal organism, *Sclerotium setosum* Bewley & Shearn, was readily isolated. The fungal filaments produced comparatively few conidia on short branches, and numerous black sclerotia approximately 1/200th of an inch in diameter and covered with black setae.

The fungus enters the plant through the roots and spreads rapidly upwards, sometimes reaching 32 inches above the ground level. Healthy plants grown in sterilized soil, copiously inoculated with sclerotia from a pure culture showed signs of root rot within six weeks and in three months the typical symptoms developed, the controls remaining healthy in each case. The fungus was readily re-isolated from the decayed roots. The results of inoculations above ground were negative, but both green and red tomato fruits were rapidly rotted by the fungus. The above results indicate that the disease is contracted in the soil and that infection of the aerial portion rarely, if ever, occurs.

The investigation of control measures is still in progress. Available data point to the probable introduction of the disease in straw manure. An examination of tomato roots at the Experiment Station has shown that where no stable manure has been applied for five years the plants are healthy, while those which receive annual dressings of stable manure are badly diseased.

Stem rot of tomatoes, caused by a species of *Botrytis*, may be recognized by the grey or greyish-brown, slightly depressed, smooth patches extending up the stem and girdling it near the leaf or truss bases. In moist atmospheres the diseased portion becomes covered with a luxuriant grey mould composed of the spore-bearing filaments of the fungus. Infection takes place through jagged, badly pruned, half-dead leaf bases or leaves, and broken tissues, and the fungus attacks the cortex, vascular tissues, and pith, producing a brown discoloration. Spreading rapidly through the stem, the fungus causes the death of all parts above the lesion. Spore production takes place abundantly on leaves and fruits, which thus become a source of infection to the stems.

Preventive control measures should be based on a careful regulation of the ventilation, circulation, and humidity of the air, and on correct methods of pruning and defoliation. Severely infected plants can only be saved by the excision of the diseased portion of the stem and the sterilization of the wound with a strong solution of liver of sulphur or copper sulphate. In some cases the application of a paste of liver of sulphur to the outside of the lesion may suffice. Spraying with a 2 per cent. solution of calcium bisulphite is recommended for the destruction of the spores.

Mosaic disease of the tomato, the symptoms of which are described in some detail, is rapidly assuming considerable economic importance. Five main types of symptoms are distinguished, the first consisting of a simple mottling of the foliage without any distortion; the second type resembles the first, but the spots are indistinct in outline and deep yellow in colour (probably similar to the Aucuba mosaic of potatoes); the third type is characterized by a distortion of leaf margins with no mottling; in the fourth type the leaf surface is blistered and the margins distorted; and in the fifth type the lamina is severely reduced, resulting in the formation of tendril-like leaves. The evidence available at present goes to show that all these types are different manifestations of the same disease. Besides the mottling or blistering of the leaves, cohesion and twisting of the various parts of the flowers and sterility of the anthers are common symptoms of mosaic disease, but mottling of the fruits is uncommon in Great Britain. A mottling of tomato leaves also occurs as the result of unsuitable soil conditions, but this form of chlorosis differs materially from mosaic in the degree of infectiousness of the plant juices.

The results of inoculation tests on young Kondine Red tomato plants (*a*) with raw unfiltered juice and (*b*) with filtered juice showed that in the latter case infectivity, though present, is considerably reduced by filtration. The plants inoculated with unfiltered juice all became infected in a fortnight. Of the ten varieties tested Fillbasket was the most susceptible. In another experiment three out of forty Ailsa Craig plants inoculated with infected juice showed no signs of disease after two months. The juice of these three plants was then inoculated into ten healthy plants with positive results in every case, thus indicating that a tomato plant may occasionally be infected without showing any external symptoms of disease. Such a plant is termed a 'carrier'.

Further tests indicated that the disease is readily transmissible by means of infected juice carried on the fingers and by the pruning knife. Aphids and white flies were transferred to healthy plants after feeding on diseased ones and transmitted the infection in every case. It was observed that low temperatures, by retarding the rate of growth, prevented the development of the typical symptoms found in rapidly growing plants at high temperatures. In the early part of the year there was a tendency towards blistering and distortion without mottling of the leaves, while the latter symptom was common at the higher midsummer temperatures.

The results of a large number of pot experiments showed that, with the exception of rather heavy feeding with a well-balanced fertilizer, none of the manurial treatments tested had any effect on the progress of the disease. This line of investigation is being continued.

It has been shown by cross-inoculation experiments that mosaic disease of tomato is readily transmissible to Petunia, tobacco, bittersweet (*Solanum dulcamara*), and black nightshade, and with difficulty to the potato, while it is also possible to cross-inoculate any of these from the other. Mosaic disease of cucumber has not been transmitted experimentally to any of the above plants.

Two types of cucumber mosaic have been observed in Great Britain, one resembling the Aucuba type, characterized by localized yellow patches, and the other marked by mottling and blistering of the leaves and stunting of the plants. Little damage is caused by the former type, but the latter frequently results in a considerable reduction of the crop. The observations on the effect of environmental conditions given above under tomato are applicable also to the cucumber. Butcher's Disease Resister is a very resistant variety.

No alternative hosts for cucumber mosaic have been discovered in Great Britain, and it must therefore be assumed that infection is transmitted by the seed. Control measures consist chiefly in the elimination of possible centres of infection on the lines suggested by the experimental work on tomato mosaic.

Annual Report of the Director, Wisconsin Agricultural Experiment Station 1921–1922, 121 pp., 53 figs., 1923.

Among the items of phytopathological interest not already separately noticed in this *Review*, the following may be mentioned. The prevalence of stripe disease (*Helminthosporium gramineum*) in the Wisconsin barley fields necessitated experiments carried out by Johnson and Holden to discover appropriate measures of control. In 1921 the seed of several plots was treated with formalin, and then by roguing out any infected plants before any discharging lesions occurred, apparently disease-free seed was obtained. The latter was sown in 1922 and yielded a healthy crop with no trace of disease. The entire removal of infection was also accomplished by seed treatment with formalin, combined with planting at a period unfavourable to the development of the disease.

The season was favourable for the development of apple scab [*Venturia inaequalis*], experiments in the control of which were conducted by Keitt and Jones at Madison and Sturgeon Bay. The most satisfactory spray schedule consisted of lime-sulphur 1 in 40 (with powdered arsenate of lead, 1 lb. per 50 galls.) applied on the following dates: (1) 12th–13th May (pre-pink); (2) 18th–20th May (pink); (3) 29th May–1st June (calyx); (4) 8th–14th July; and (5) 5th–11th August. In most of the tests, the results from dry lime-sulphur 4 in 50 were similar to those obtained with liquid lime-sulphur 1 in 40. Bordeaux mixture 4–4–50 gave adequate control but seriously russeted the fruit. The addition of glue and gelatine as adhesives to lime-sulphur somewhat lessened the efficacy of the latter, whilst calcium caseinate added to lime-sulphur and Bordeaux mixture respectively, improved slightly the effect of these sprays. Trials to substitute dusting for certain liquid applications gave conflicting results, the success of the treatment apparently depending on the relation between the time of application and meteorological conditions. On the whole, three liquid lime-sulphur sprays followed by two sulphur dustings gave as good control as the five-spray lime-sulphur schedule.

The same workers carried out a series of experiments in the control of cherry leaf spot [*Coccomyces hiemalis*]. As in former years, excellent results were obtained by three applications of Bordeaux mixture 3–3–50, (1) just after the fall of the petals, (2) a fortnight later, and (3) just after harvest. Similar schedules of Bordeaux mixture 2–2–50, lime-sulphur 1 in 40, and dry lime-sulphur 4–50 failed to control the disease adequately. The addition of gelatine, glue, or calcium caseinate to Bordeaux mixture and lime-sulphur did not materially increase the adhesiveness of these sprays.

The investigations of the possible relation between the pigment, volatile oils, or associated substances in the onion and resistance to smudge (*Colletotrichum circinans*) were continued. From the chemical analysis the onion pigments appear to contain (1) a yellow non-glucoside, (2) one or more yellow glucosides, (3) a red non-glucoside, and (4) one or more red glucosides. A yellow glucoside or a mixture of glucosides has been crystallized from both the red and yellow onions, but so far has not been entirely purified. In the case of the yellow onions this mixture was found to be toxic to the fungus. These results open up an interesting field in the problem of the immunity of yellow onions and the susceptibility of white onions respectively to the disease.

Crown gall (*Bacterium tumefaciens*) of raspberries has for some years past been responsible for very heavy losses to Wisconsin growers, and experiments have therefore been carried out by A. J. Riker to ascertain the exact relation between the organism and its hosts. Inoculation experiments on the tomato showed that wounds are necessary for infection. When needle punctures were made for inoculations the release of liquid caused the formation of water-soaked areas round the wounds. As the galls developed they were found to coincide closely in outline with the water-soaked regions. Expressed tomato sap was found to exert a positive attraction on the bacteria: the latter are thought to migrate through the water-soaked tissue and produce galls at points removed from the site of inoculation.

The results of further tests by Jones in the control of anthracnose [*Gloeosporium venetum*] of black raspberries showed that two applications of lime-sulphur alone controlled the disease sufficiently for commercial purposes, but that better results were obtained if glue, gelatine, casein, lime, or saponin were added to the spray as an adhesive. In general, Bordeaux mixture, either alone or with an adhesive, was slightly less satisfactory than lime-sulphur. A third application of Bordeaux or lime-sulphur about a week after blossoming reduced the amount of disease but caused severe foliage injury.

ARNAUD (G.). **Biologie des 'tumeurs marbrées' de la Luzerne.** [The biology of 'marbled galls' of Lucerne.]—*Comptes rendus Acad. d'Agric. de France*, ix, 18, pp. 494–497, 1923.

Since 1916, when the 'marbled gall' [*Urophlyctis alfalfae*] disease of lucerne was first recorded in France, the writer has continued his observations on the development of the galls and the immunity of other plants from the disease.

Various plants were sown in August 1916, the seed being mixed with fragments of lucerne galls. Lucerne was the only plant infected, and the disease has persisted in the plots since that date. The dissemination of the disease appears to be slow, since it has not yet spread to a plot of lucerne situated only about ten yards from the experimental plot.

As a rule the galls appear on the surface of the soil in the spring, persist throughout the year and die in the following spring. In the dry season of 1921 the disease did not appear at all, but was observed anew in 1922. Drought, therefore, appears to arrest the progress of the disease. The development of the galls of plants pulled up for examination and replanted was definitely checked and the hosts recovered their original vigour. On one occasion an attempt was made to control the disease by covering the soil with a layer of earth 5 cm. in depth. The following year, however, the galls reappeared at the original level. They were lighter in colour and had formed small roots on the surface.

So far the damage caused to the French lucerne crops by the marbled gall disease has been inconsiderable.

LEVIN (I.) & LEVINE (M.). **The action of buried tubes of radium emanation on neoplasias in plants.**—*Journ. Cancer Res.*, vii, pp. 163–170, 1 pl., 1922 [1923].

The clinical results of the insertion of buried capillary glass tubes containing radium emanation into animal tumours appeared to be of such importance that it was imperative to investigate biologically the mechanism of the action of this method of radium therapy upon tumours in plants. The writers have previously shown (*Proc. Soc. Exper. Biol. & Med.*, xv, p. 24, 1917) that the main immediate action of X-rays on crown gall [*Bacterium tumefaciens*] in plants consists, not in a direct destruction of the cells, but in the arrest of their proliferating power. The death of the cells follows as a result of the ageing of the individual tumour cell.

In the present investigations capillary tubes 3 mm. long and 0·25 mm. in diameter containing radium emanation were introduced into artificially induced club-roots [*Plasmodiophora brassicae*] on cabbage and kohlrabi, and crown galls on the geranium, and left buried in the tissues from one to fifteen days. Empty tubes were similarly inserted in controls. The irradiated and non-irradiated tissues were then fixed and sectioned. These experiments showed that in normal adult tissue the only perceptible consequence of the insertion of a radium emanation tube is the complete destruction of tissue in the immediate vicinity. The insertion of radium emanation tubes into the crown gall tissue, however, is followed by an inhibition of the proliferation of the tumour, evidenced by its reduced size as compared with controls. The soft beta rays affect mainly the tissues in the immediate vicinity of the tubes, and in this region the cells collapse radially, forming a cushion of cellulose round each tube. The hard gamma rays penetrate beyond the cushion region, the cells becoming devoid of both nucleus and cytoplasm, and although no apparent morphological changes in the tumour cells may take place, the proliferating power is inhibited and the increase in size stopped. The rôle of the cellulose cushion in plants, in walling off the necrotic area around the radium emanation tubes and filtering off the soft beta rays, appears to correspond with that played by the connective tissue stroma in animal tumours. In club-root tissue the degenerated cells immediately adjoining the so-called cellulose cushion do not seem to contain *Plasmodiophora brassicae*, which, however, is present in the cells at a distance farther from the capillary tube.

Levin (I.) & Levine (M.). **The rôle of neoplasia in parasitic diseases of plants.**—*Journ. Cancer Res.*, vii, pp. 171–178, 1 pl., 1922. [1923].

In a previous investigation (*Journ. Cancer Res.*, v, p. 243, 1920) on the malignancy of the crown gall (*Bacterium tumefaciens*) and its analogy to animal cancer, the writers have demonstrated that the gall does not develop through the specific neoplastic 'gall producing' properties of the bacterium. The present paper reports further studies on the cause and mechanism of the formation of neoplasia in plants after their invasion by parasites.

After discussing the mechanism of gall formation in leafy crown gall [see this *Review*, ii, p. 396] and on *Ficus elastica* [see this *Review*, i, p. 54] the writers describe their studies on the club-root of cabbage (*Plasmodiophora brassicae*) and on potato wart (*Synchytrium* [*endobioticum*]).

Inoculations of young cabbage plants with an infusion of old club-roots in water were successful in producing infections, and suitable portions of the resulting hypertrophies or hyperplasias were fixed and sectioned. Club-root is a plant tumour similar to crown gall in its derivation, mechanism of formation, and effect on the host plant. The most striking phenomenon observed in a study of club-root is the fact that the large groups of cells containing the parasite are always surrounded by layers of small young cells which do not contain the parasite. Kunkel (*Journ. Agr. Res.* xiv, p. 543, 1918) thinks that this is due to the growth stimulus travelling in advance of infection or that the uninfected cells are immune to the parasite. The author is of the opinion that these young undifferentiated cells are not only immune to the parasite but present a reactive protective barrier against further inroads of the latter (although this does not exclude the possibility of the parasites ultimately breaking through the barrier).

Examination of prepared slides of potatoes affected by wart disease showed substantially the same relationship between the parasite, the normal adult tissue of the host plant, and the reactive neoplastic tissue, as in crown gall and club-root.

In discussing these results, the authors state that neoplasia in parasitic diseases of plants, unlike the neoplasia in animal cancer, always represents a protective action of the plant organism against invasion of the parasite. It has a period of progressive proliferation of undifferentiated cells, which are frequently transformed into adult differentiated tissue, regression and death occurring before the destruction of the host, the gall thus behaving more like reactive neoplasia in an animal than animal cancer. Neoplasia in plants never represents a malignant tumour in the true meaning of the term in animal pathology. The points under consideration in these investigations make it evident that the study of neoplasia in plants should become an integral part of all phases of cancer research, etiological or therapeutical.

Tabor (R. J.) & Bunting (R. H.). **On a disease of Cocoa and Coffee fruits caused by a fungus hitherto undescribed.**—*Ann. of Bot.*, xxxvii, 145, pp. 153–157, 3 figs., 1923.

Liberian coffee cultivated in the Gold Coast Colony is attacked by a fungus which produces a dark purplish-brown discoloration, especially of young berries, which eventually shrivel and harden. The discoloured area later becomes covered with a white or pinkish-brown mealy incrustation formed by the conidia of the fungus. In wet seasons the whole crop may be endangered by the attacks of the fungus, which is also responsible for a disease of cacao fruits. Cross inoculations from coffee to cacao and vice versa gave typical symptoms of the disease, the fungus being re-isolated in both cases.

In natural infections of cacao the symptoms of the disease—locally known as mealy pod [see this *Review*, ii, p. 203]—resemble those caused by *Phytophthora faberi*. The discoloured area at the point of infection rapidly extends until, under suitable conditions of humidity, the whole pod is involved, the white, later pinkish-brown, mealy conidia form dense encrusted masses, and the pericarp of the fruit becomes decomposed.

The results of inoculation experiments, while not conclusively proving the parasitic character of the fungus, indicate that the latter develops more readily on wounded or moribund fruits than on healthy ones. It has never been found on the vegetative parts of its hosts. The effects of the disease are particularly serious on young pods in which the protective sclerotic tissues have not yet been formed, as the fungus is able to penetrate to the seeds.

The fungus produces in the host tissues a non-septate mycelium of rather coarse hyphae, which spreads rapidly through the intercellular spaces. Narrower branches arise from the intercellular hyphae and penetrate the walls of the cells, which are destroyed and their contents discoloured. The conidiophores are very variable in form, some consisting merely of upright hyphae terminating in a single conidium, while the more complex types bear terminal vesicles to which one or more whorls of pedicellate conidia or lateral fertile branches are attached. The conidia are spherical and markedly echinulate with an average diameter of 35 μ, borne on pedicels up to 30 μ in length. On cacao the conidia occur on the inner surface of the ovary wall, the mucilage sacs, and even in the wider intercellular spaces, as well as on the outer surface of the fruit. The conidia found in the internal cavities of the fruit (probably chlamydospores) are often larger than the normal type and always have thicker walls. Their germination has not been observed.

The normal conidia germinate readily in water and nutrient media, each producing a germ-tube which gives rise to a mycelium and subsequently to conidia as described above.

Sexual organs of the Peronosporaceous type are found, singly or in groups, in the host cells and occasionally in the mucilage cavities of the pericarp. They arise from the intracellular mycelial branches and may be accompanied by groups of rounded vesicles. The oogonia average 40 by 24 μ and are rather thick-walled with irregular sac-like excrescences. The antheridia are amphigynous, surrounding the stalk of the oogonium in the manner previously described for species of *Phytophthora* by Pethybridge (*Sci. Proc. Roy. Dublin Soc.*, xiii, 35, p. 529, 1913) [and this *Review*, ii, p. 181] and Dastur (*Mem. Dept. Agric. India*, v, 4, p. 177, 1913). The general relation between the sexual organs is also similar to that described by these authors. In ripe oogonia from desiccated pods the antheridia are readily detachable, the walls being intact and a distinct antheridial membrane surrounding that covering the stalk of the oogonium.

Preliminary cytological investigations indicate that the young oogonium is multinucleate, that little or no periplasm remains after the delimitation of the oosphere, and that the oosphere and the ripe oospore are uninucleate. The oospore has a fairly thin wall and practically no epispore. All attempts to induce the germination of the oospores gave negative results. The constant association of both sexual and asexual fruit bodies suggested a definite relation between them, and this was finally proved by tracing in artificial cultures the continuity of hyphae bearing conidia with those bearing oogonia. Up to the present no sexual organs have been found either in the tissues of the coffee pericarp or in artificial media prepared from coffee fruits.

Though certain morphological characters indicate a close relationship to the genus *Phytophthora* and others point to an affinity with *Muratella*, the authors consider that the fungus in question differs sufficiently from both to justify the creation of a new genus, of the Peronosporaceae and it has accordingly been named *Trachysphaera fructigena*, a Latin diagnosis of both genus and species being given.

BUNTING (R. H.). **Mealy pod disease—a new foe to Cocoa.**—*Journ. Gold Coast Agric. & Comm. Soc.*, ii, 2, pp. 92–94, 1 pl., 1923.

The mealy pod disease of cacao, a scientific description of which is published elsewhere [see preceding abstract], has so far been recorded only from the Gold Coast. The causal fungus (*Trachysphaera fructigena*) penetrates the most minute wounds on young pods and destroys the beans, while it can also attack quite healthy, intact pods which have become detached from the tree.

The fungus flourishes as a mealy, white to pinkish mass of spores on the heaps of cacao husks from which the beans have recently been extracted. The spores [conidia] on the outside of the pod, transmitted by wind, rain, insects, &c., serve for the rapid propagation of the disease, while other spores [oospores] which are borne later, serve to tide the fungus over periods of drought.

For the control of the disease it is absolutely essential to remove and bury all diseased pods from cacao trees, and to bury all husks as soon as the beans have been extracted, thereby serving the double purpose of controlling the disease and providing food for the trees, which should be kept in a good state of cultivation to enable them the better to ward off the disease.

ROSEN (H. R.). **Septoria glume blotch of Wheat.**—*Arkansas Agric. Exper. Stat. Tech. Bull.* 175, 16 pp., 4 figs., 1921. [Received 1923.]

A marked spotting of the glumes and rachis of a large number of wheat varieties has been observed in Arkansas for several seasons. The most conspicuous symptoms appear on the outer glumes, the affected parts of which are covered with brownish or purplish-brown spots or blotches, with a hoary, brownish or greyish-white centre. On the rachis the discoloured areas are found at or near the joints, occasionally extending over the entire internode. The attacked parts are not sharply delineated, and there is no tendency to form streaks. The disease is not confined to glumes and rachis, but has also been noted on the leaves, leaf sheaths, and blades.

An examination of the diseased Arkansas material showed the causal fungus to be identical with *Septoria nodorum* [see this *Review*, ii, p. 211], which is synonymous with *Phoma hennebergii* Kuehn and *S. glumarum* Pass. There is little doubt that the Arkansas fungus differs from *S. gramineum* and *S. tritici*. In some respects it resembles *Ascochyta graminicola*, but a comparison of the spores revealed considerable differences. The following is a provisional technical description of the fungus: spots indefinite, often elliptical, varying in colour from greyish-brown to dark or purple-brown, often appearing light grey on a purple background;

occasionally a yellow, indefinite halo appears round the brownish discoloration. Pycnidia gregarious on spots of glumes, stems, and leaves, inconspicuous, subepidermal, opening by a small oval or roundish pore, golden-brown at first, finally blackish, globoid, 60 to 100 μ in diameter. Spores cylindrical, curved or straight, hyaline, often adhering to and issuing from the pycnidia in the form of serpentine threads, one to three septate, 18 to 25 by 2·8 to 3 μ, rounded above and truncate below, with or without guttulae.

Inoculations of wheat plants, under bell jars, resulted in various leaf and glume infections with the production of pycnidia on the spots. The spores from the pycnidia agreed in every respect with those observed in natural infections. Spores from the glumes infected leaves and vice versa.

The damage caused by the disease has not yet been fully investigated, but is known to be very serious. Standard winter wheat varieties, especially Red May and Kanred, are particularly liable to attack. Further investigations are in progress, and in the meantime the use of clean seed is strongly recommended.

WENIGER (WANDA). **Diseases of grain and forage crops in North Dakota.**—*North Dakota Agric. Exper. Stat. Bull.* 166, 92 pp., 32 figs., 1923.

In this bulletin the author describes the principal diseases of cereals (including also flax, proso or broom corn millet, buckwheat, and sorghum) and of forage crops (alfalfa, clovers, brome grass, millet, timothy, Sudan grass, wild grasses, and sunflower) as they occur in North Dakota, and then gives an account of the measures of control to be applied against them.

The work is prefaced by a table giving the losses caused by cereal diseases in North Dakota in the years 1919 to 1921, during which period the average loss of wheat was 26 per cent., the corresponding figures for oats, barley, rye, and maize being 7, 6, 2·3, and 1·8 per cent. respectively. The text is fully illustrated and many references to original papers are given. A feature of the report is the section dealing with the diseases of wild grasses, which constitute an important hay crop in North Dakota, covering over two million acres of land.

In the section on disease control, the author states that in North Dakota the formalin method of seed disinfection has proved extremely effective against all cereal diseases which are carried on the outside of the grain, such as barley stripe (*Helminthosporium gramineum*), wheat blights, anthracnose (*Colletotrichum cereale*), and bacterial diseases, and that such enormous injuries to germination as reported in the Western States have not been encountered. The dust treatment is not advocated at present. Very good results have also been obtained in the control of ergot of rye (*Claviceps purpurea*) by the immersion of seed in a 20 per cent. solution of common salt (40 lb. in 25 galls. of water) when the ergot bodies float to the surface and can be skimmed off. The grain should then be washed at least once with water to remove the salt, and it is recommended that the treatment should then be followed by the regular formalin disinfection.

STAKMAN (E. C.). **Barberry eradication prevents black rust in Western Europe.**—*U. S. Dept. Agric. Circ.* 269, 14 pp., 3 figs., 1923.

The present paper, written mainly for propaganda purposes, is the outcome of the author's visit to Western Europe during the spring and summer of 1922 to study the results of the eradication of barberry bushes in the control of black stem rust [*Puccinia graminis*] of cereals. In England and Scotland, where the farmers have eradicated the barberry, even without the aid of a law, black rust is very scarce, and in every case the few unimportant outbreaks still occurring could be traced to the immediate proximity of a forgotten barberry bush. In Wales, on the other hand, where the barberry has not yet been destroyed, the disease occurs frequently and causes appreciable losses. The most striking results were obtained in Denmark, which solved its black rust problem by a law passed in 1903 for the eradication of the barberry: since 1904 there has not been a single general epidemic of the disease in that country; the rust is seldom found, and when it does occur a guilty barberry is also found. In some districts of Sweden there are still large numbers of barberries, and in those regions the attacks of black rust are very heavy. Between Stockholm and Upsala, in the summer of 1922, fields of oats were black with rust, which could be traced directly to the barberry bushes, such a condition occurring year after year. In Holland, France, Germany, Czecho-Slovakia, and Hungary the correlation between the occurrence of the disease and the existence or absence of the barberry was also found. Even in the most southern European countries, Spain, southern Italy, and southern Greece, where the climate is sufficiently warm during the winter that the summer stage of the rust is sometimes not killed, the rust is evidently most destructive near barberry bushes.

LUDWIGS (K.). **Beobachtungen über die Bodensäurekrankheit an Getreide.** [Observations on soil acidity disease of cereals.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 6, pp. 41–42, 1923.

During the spring of 1923 a disease of cereals (especially rye), which began to attract attention in 1920 and is believed to be due to excessive acidity of the soil, caused very severe damage in various parts of the province of Brandenburg.

The symptoms of the disease include arrested development of the entire plant, yellowing of the leaves, a dark discoloration of the markedly elongated roots, and a great reduction in the number of root hairs. During periods of protracted drought the young plants collapse entirely. In many cases the leaves become covered with irregular, dun-coloured spots surrounded by a dark edge, such as are associated with bright speck disease of oats [see this *Review*, i, p. 421, and ii, p. 403]. Oats are usually less severely attacked, recovery after sufficient rain being frequent, and wheat is only slightly affected in the districts west of the Oder. The loss of this year's oat crop in Westhavelland is, however, estimated at 50 to 80 per cent.

There seems to be little doubt that the local practice of applying large quantities of acid fertilizers (potassium, superphosphate, and sulphate of ammonia) to the soil is largely responsible for the occurrence of the disease. The deficiency of lime, from which, according to Gisevius and other authorities, more than half the soils of North Germany and Bavaria are suffering, has led of late years to an increasing reduction in the German harvests. The liberal application of lime is the only means of remedying this serious defect and cannot be recommended too strongly.

Lipscomb (G. F.) & Corley (G. L.). **A new treatment of Cotton-seed to destroy anthracnose.**—*Amer. Fertilizer*, lviii, 6, pp. 32–34, 1 fig., 1923.

Repeated attempts have proved the impossibility of adequately controlling anthracnose of cotton (*Colletotrichum gossypii*) by means of fungicides, as the disinfectants are incapable of penetrating the seed coat and reaching the fungus. The selection of uninfected seed for planting, by the inspection of the bolls, has proved quite impracticable, whilst the selection of resistant varieties does not appear promising. The hot-water treatment of the seed was also abandoned, the thermal death-point of the fungus being too near that of the seed. The claim that the use of three-year-old cotton seed eliminated anthracnose is not supported by the results of recent germination tests, which have shown that infection may even occur in five-year-old seed.

The authors' investigations indicate that one of the most important factors governing the vitality of cotton seed in high temperatures is the presence or absence of oxygen. By thoroughly drying and heating the cotton seed in a vacuum or any inert atmosphere, such as nitrogen, to prevent oxidation of the fats and proteins in the seed, they will endure 100° C. for hours without any diminution of vitality, and even 110° to 120° C. for several hours without destroying life. The heating for 26 hours at 100° C. of Weber 49 seed not only stimulated germination to a remarkable extent, but also controlled anthracnose. In all the tests highly infected Weber 49 seed was used; further experiments with other varieties are now in progress.

The apparatus used in the drying and heating of cotton seed is constructed as follows: A glass tube about 12 in. in length and 0·8 in. in diameter is drawn out at the top and a small tube sealed on, to which a rubber tubing can be fastened. The cotton seeds are placed in the bottom of the glass tube and, in order to hold them in position and prevent the calcium chloride from mixing with them, a thin layer of glass wool is placed over the seeds, and above the glass wool calcium chloride is placed to a length of 4 to 5 inches. A thermometer is inserted in the tube, the bulb extending to about the middle of the cotton seeds, and the oxygen is removed by means of a mercury or oil vacuum pump. When the manometer connected in the circuit registers one mm. or less, the small glass tube is sealed. After the cotton seeds have been dried in this way for several days the tube is placed in boiling water to such a depth that the water stands just above the seeds.

When nitrogen was substituted for air, the cotton seeds were thoroughly dried and placed in the tube with calcium chloride as described above. The air in the tube containing the seeds was displaced by nitrogen being passed in (through a tube which led to the bottom of the seed container), until all the oxygen was expelled, a small side tube forming an outlet for the air. Both tubes were then sealed. After the cotton seeds had remained in the tube for several days at the ordinary room temperature or heated several hours in water at 50° to 60° C. they were then heated for 26 hours in boiling water. The seeds germinated, with the result that no anthracnose appeared and the percentage of germination was higher than in the control.

Other samples of cotton seeds were treated in the same way except that the seed was heated to the boiling-point of toluene, 109° C., and also to that of glacial acetic acid, 119° C., for several hours. After heating for 10 hours at 110° C. the percentage of germination was somewhat lower than the control and some of the seedlings were less vigorous.

KING (C. J.). **Cotton rootrot in Arizona.**—*Journ. Agric. Res.*, xxiii, 7, pp. 525–527, 1923.

The Texas root rot of cotton has been generally regarded as being caused by *Ozonium omnivorum*, although definite proof of this has been lacking. During the seasons of 1921 and 1922 the fungus was abundant at Sacaton, Arizona, especially the conidial form *Phymatotrichum omnivorum* previously described by Duggar (*Missouri Bot. Gard. Bull.* v, 3, p. 11, 1916) and a study of the disease (which also attacks alfalfa) was therefore undertaken.

The behaviour of the fungus as shown by the spread of the disease in alfalfa fields was very suggestive of fairy rings. The outer ring of the circle consisted of recently dead plants, an inner ring or 'bare zone' was occupied only by the stubble of dead plants, and a patch in the centre contained re-established plants arising from the fragments of partially destroyed crowns or roots. It is evident, therefore, that the disease spreads from a centre in ever widening circles, leaving the spots over which it has passed free from the disease until re-infected. In badly infected fields the crossing and re-crossing of the widening circles may entirely obscure the fairy ring effect.

Under Arizona conditions abundant crops of fruiting bodies, which enhance the resemblance to fairy rings, appear on the periphery of the circles, shortly after the occurrence of rainy weather. The newly formed fruiting bodies appear as felt-like mats on the surface of the ground, or in cracks or depressions, seldom being found more than six or eight inches from the outer circle of recently wilted plants. They have been known to cover more than 300 sq. ft. of soil surface in a 22-acre alfalfa field where three or four acres of the plants had died.

In alfalfa fields it was found possible to prevent the further spread of the disease in small, circular areas by thoroughly saturating the soil to a depth of 4 ft. with a solution of 40 per cent. formalin 1 in 100. The mycelium evidently extends a foot or more in advance of the last affected plant, since it was found necessary to include the soil 18 inches outside the apparent periphery in alfalfa fields. With cotton plants the mycelium appears to extend for at least $2\frac{1}{2}$ ft. in advance of the recently wilted ring. In no case, however, has the disease reappeared where the treated area extended as far as 3 ft. outside the wilted ring. The best method of applying the treatment is to throw up a small dyke round the affected area and pour in the solution gradually. None of the areas in alfalfa fields treated as described above in July and August 1922 showed further disease activity after two months. In the control areas, where the dykes were thrown up but no fungicide applied, the infection progressed from 4 to $4\frac{1}{2}$ ft. during that time. In the treated areas of cotton fields there was no reappearance of the disease at the end of seven weeks, whereas in the control areas the disease advanced from 6 to 8 ft. during the period.

Artificial inoculation experiments were undertaken in August 1922, normal cotton plants in healthy soil being exposed at the roots and one-inch sections of cotton roots infected by root rot placed in direct contact with them. After three weeks following a rainy period one of the plants treated in this way wilted suddenly, and on being pulled up was found to be covered with the characteristic mycelium of the root rot fungus. Within five days four other inoculated plants died in the same way, but owing to the depletion of the moisture on the sides of the trench the disease could make no further progress.

Pure cultures were prepared from the mycelium isolated from the first wilted plant, and were used for further inoculations. Two rows of cotton plants were separated by a trench, and on one side ten plants were inoculated with the pure culture and four left as controls, and on the other, the fourteen were treated with diseased roots as described above. By 20th September the disease had appeared in all but a few plants on both sides of the trench, including the four controls, which were attacked by the mycelium spreading through the soil from the inoculated plants. By 1st October the mycelium had spread from the pure culture row to plants growing $3\frac{1}{2}$ ft. away. None of the plants of a corresponding series, the roots of which were inoculated with spores of the fungus, showed any sign of infection after seven weeks.

Spores collected from fresh fruiting roots were induced to germinate in distilled water and artificial media after several days, but the resulting growth was extremely slow. This is not surprising, since, if the conditions necessary for the development of the spores were not very exacting, the enormous quantities in which the latter are produced would long ago have ensured the universal distribution of the disease.

It is of great importance to ascertain whether the promising results of the control experiments are applicable in other regions.

Nakata (K.) & Takimoto (S.). **Studies on Ginseng diseases in Korea.**—*Bull. Agric. Exper. Stat., Chosen*, v, pp. 1–18, 6 pl., 1922. [Abs. in *Japanese Journ. of Botany*, i, 3, pp. 43–44, 1923.]

The most important fungous diseases of ginseng [*Panax quinquefolium*], which is very extensively cultivated in Korea, are red rot (*Bacterium araliavorus* Uyeda), leaf blight (*Colletotrichum panacicola* n. sp.), and amber-coloured rot (*Bact. panaxi* n. sp.). The first-named disease has already been described by Uyeda (*Bull. Centr. Agric. Exper. Stat., Tokyo*, xxxv, 1909).

Leaf blight attacks leaves, stems, and seedlings, causing a reduction of 50 per cent. in the yield. The affected parts have a felt-like appearance, in which they differ from the leaf spot caused by *Alternaria panax* Whetzel. The disease is promoted by the filtering of sunlight through the chinks of the sun-screen and by humidity. Spraying with Bordeaux mixture is an effective control measure.

Amber-coloured rot causes the decay of roots and stems, to which a water-soaked appearance is imparted. In advanced stages of the disease only the vascular fibres remain. Infection occurs in the winter and is therefore frequently overlooked. No effectual remedy has been found.

Other diseases of minor importance are: sclerotial disease, caused by a species of *Sclerotinia* which differs morphologically from *S. libertiana* and in growth temperature from *S. panax*: black dry rot (*Phoma panacicola* n. sp.), stem-rot (*Phoma panacis* n. sp.), snake-eye disease (*Phyllosticta panax* n. sp.); damping-off (*Corticium vagum* [*solani*]), bending-off (*Phytophthora cactorum*), dry rot (*Cladosporium* sp.), soft rot (*Mucor* sp.), and white spot imilar to papery leaf).

HILTNER (L.) & LANG (F.). **Ueber den Einfluss der Düngung, insbesondere mit Kalkstickstoff, auf die Stärke des Brandbefalls des Getreides.** [The influence of fertilization, especially with calcium cyanamide, on the intensity of smut attacks on cereals.]—*Mitt. deutsch. landw. Gesellsch.*, xxxvii, 16, pp. 253–257, 1922.

In the autumn of 1919 a series of experiments on the effect of the fertilization of winter wheat (Ackermann's Dickkopf) on the incidence of bunt [*Tilletia tritici* and *T. levis*] was carried out at two separate branches of the Bavarian Plant Breeding and Plant Protection Institute, near Munich, the soil in one locality being stony with an admixture of humus, and in the other consisting of heavy loam. Calcium cyanamide (30, 90, and 120 kg. per hect.), Rhenania phosphate (45, 135, and 180 kg. per hect.), and potassium chloride (60, 138, and 240 kg. per hect.), were applied to the soil the day previous to sowing with wheat, which was infected with the spores of bunt.

On both soils the application of potassium chloride resulted in an increase in the incidence of attack. Rhenania phosphate (180 kg. per hect.), however, considerably reduced the percentage of infection, whilst the effect of the calcium cyanamide applications was much more marked. Even at the rate of 30 kg. per hect. it reduced the amount of infection on the stony soil from 22·6 to 4·36 per cent. and on the loam from 13 to 10·7 per cent., while at 120 kg. per hect. infection in both places was reduced to a trace (0·84 and 0·57 per cent.). Even more favourable were the results of fertilizing with all three substances (calcium cyanamide 120 kg. per hect., Rhenania phosphate 180 kg. per hect., and potassium chloride 240 kg. per hect.), which reduced the infection to a minimum in both localities (0·52 per cent.). Hitherto such results have only been obtained by the use of first-class seed disinfectants.

Similar results were obtained in 1921 in experiments with smutted millet, the application of 200 kg. of calcium cyanamide per hect. reducing infection from 37·5 to 5·7 per cent. Calcium cyanamide also controlled smut of oats [*Ustilago avenae*] and bunt of summer wheat, while ammonium sulphate saltpetre gave negative results. Applied to wheat infected with loose smut [*U. tritici*], however, calcium cyanamide failed to reduce the percentage of disease. In a further test the incidence of loose smut of barley [*U. nuda*] was found to be greatly increased by fertilizing with sulphate of ammonia (30, 90, and 120 kg. per hect.), with or without the addition of basic slag and potassium chloride. The results of a preliminary test of the effect of sulphate of ammonia on bunted wheat were favourable.

It is suggested that calcium cyanamide should be applied to the soil by means of a drill, or else that the seed should be encrusted with the substance.

Ritzema Bos (J.). **Over den invloed der bemesting met kalkstikstof op de intensiteit van de aantasting van het graan door brand.** [The influence of fertilization with calcium cyanamide on the intensity of smut attacks on cereals.]—*Tijdschr. over Plantenziekten*, xxix, 5, pp. 93–94, 1923.

Referring to the experiments of Hiltner and Lang [see preceding abstract] on the effect of fertilizing with calcium cyanamide on the incidence and severity of smut diseases of cereals, the author questions the utility of the method as a general substitute for seed disinfection with copper sulphate, which combines excellent fungicidal properties with great facility of application.

On the other hand, there is some prospect that calcium cyanamide might be used with advantage in the control of loose smut of oats [*Ustilago avenae*], as in this case treatment with copper sulphate or hot water is injurious to the seed and formalin only gives moderately satisfactory results.

Curtis (K. M.). **Two fungal diseases of the blue Lupin.**—*New Zealand Journ. of Agric.*, xxvi, 4, pp. 240–246, 9 figs., 1923.

The blue lupin (*Lupinus angustifolius*), which is cultivated for cover-cropping in the Nelson District of New Zealand, has recently been attacked by two fungous wilts caused by *Botrytis cinerea* and *Ascochyta pisi* respectively. The diseases usually occur together under conditions of excessive atmospheric and soil humidity, *Botrytis* wilt tending to predominate. This disease is also the more economically important of the two, since it attacks particularly the cultivated lupin. In severe cases of stem infection the upper portion of the plant gradually wilts, the leaves turning yellow and eventually falling. The stem lesions, which vary in length from one half to nine inches, occur principally at soil level, but may also be found on any part to a height of two feet upwards. The affected epidermal cells turn brown and the diseased area assumes a transparent appearance, the edge of the infected area sometimes showing an abrupt rise in level as it merges into the healthy region. As a rule the stem is completely girdled by the fungus, and the outer tissues of the plant become permeated with mycelium. The development of the conidia and sclerotia is described and figured. The latter remain on the ground near the dead plants during the winter, giving rise to a fresh crop of conidia in the following spring. Thus the persistence of the fungus into a second year is secured.

The wilt caused by *Ascochyta pisi* is more prevalent on self-sown than on cultivated lupins. The general symptoms are similar to those described above, but as the plants are generally weakly from the outset they succumb more readily than the vigorous cultivated lupins attacked by *B. cinerea*. The large lesions vary from six to eighteen inches in length and completely encircle the stem, the numerous smaller lesions accompanying them being only about one quarter of an inch in diameter and circular in outline. The dark brown colour of the diseased region merges gradually into the normal tone of the stem, and there is no abrupt change of level between infected and healthy tissue as with *B. cinerea*.

The life-history of the fungus is described and figured. The spores emerge from the pycnidia in long, thread-like masses on to the surface of the plant, where they are freely distributed by the agency of water. The similarity of *Ascochyta* on lupin to that which occurs on pea, bean, and vetch, viz. *A. pisi* Lib. (*Mycosphaerella pinodes* [B. and Blox.] Niessl.), strongly suggests that the two species are identical, especially in view of the fact that lupins growing near peas attacked by *A. pisi* were similarly affected.

Lupins should not be planted in damp soil and great care must be taken to avoid overcrowding. Seed for planting should only be taken from healthy fields and rotation of crops should be practised wherever the disease has become established.

SELBY (A. D.) **Fungus diseases of the Apple.**—*Amer. Fruit Grower*, xliii, 2, pp. 9 & 14, 1 fig., 1923.

The major bacterial and fungous diseases of the apple in Ohio are black rot [*Physalospora cydoniae*], scab [*Venturia inaequalis*], fireblight [*Bacillus amylovorus*], blotch [*Phyllosticta solitaria*], bitter rot [*Glomerella cingulata*], sooty blotch and fly speck [*Leptothyrium pomi*], and the new *Phoma* fruit spot. The adoption of a regular spraying programme for apples has already given good results in Ohio and the following schedule is recommended [see also this *Review*, ii, p. 442]: (1 a) Delayed dormant for control of San José scale. (1 b) Pre-pink application of Bordeaux mixture 4–6–50 for control of scab and black rot. (2) Same materials as (1 b). This is the most important spray of the season and should be applied when the buds show pink before the opening of the blossoms. (3) Calyx spray, to be given just after petals fall. (4) Bordeaux mixture and arsenate of lead, applied two weeks after the foregoing. This is a critical time in the control of midsummer diseases (blotch, scab, black rot, and the new *Phoma* fruit spot). (5) Special blotch spray, applied $2\frac{1}{2}$ weeks later than (4). This may be omitted in the absence of severe infection. (6) Second brood codling moth spray, Bordeaux mixture 2–4–50 and arsenate of lead, should be applied 9 to 10 weeks after (3). This is important in the control of blotch, bitter rot, scab, sooty blotch, codling moth, and *Phoma* fruit spot. (7) In cases of severe late season infection an additional application of the same material as (6) should be given during the second half of July in southern Ohio, and late July or early August in the north of the State.

FARLEY (A. J.). **Dry-mix sulphur lime. A substitute for self-boiled lime-sulphur and summer strength concentrated lime-sulphur.**—*New Jersey Agric. Exper. Stat. Bull.* 379, 16 pp., 2 figs., 1923.

The difficulties involved in connexion with the preparation and handling of the various sulphur fungicides for fruit trees have been largely overcome in New Jersey by the adoption of the following formula known as the 'dry-mix sulphur lime': sulphur 8 lb., hydrated lime 4 lb., calcium caseinate 8 oz. (for 50 gallons of spray mixture). The results of a series of experiments in the control of peach scab [*Cladosporium carpophilum*] and brown rot [*Sclerotinia cinerea*] showed that spraying with dry-mix sulphur lime gave almost complete control, being superior to self-boiled lime-sulphur, atomic sulphur, and a New Jersey dry-mix sulphur lime containing only 2 lb. of sulphur. Good control was also obtained with New Jersey sulphur glue mixture (sulphur 8 lb., hydrated lime 4 lb., and ground glue 8 oz.). Atomic sulphur and sulphur dusts caused serious defoliation.

Dry-mix sulphur lime was also found to cause much less russeting and defoliation of apple trees than the ordinary lime-sulphur compounds.

MASSEY (L. M.) & FITCH (M. W.). **Some results of dusting experiments for Apple scab and for Peach leaf curl in 1921–1922.**—*Proc. New York State Hort. Soc. 1922*, pp. 42–60, 1923.

Excellent results in the control of apple scab [*Venturia inaequalis*] and codling moth were obtained in 1921 on the Greening, Fall Pippin, Baldwin, Ben Davis, and Northern Spy varieties at Ravena, Albany County, by the application of 15 lb. dry lime-sulphur, 10 lb. arsenate of lead, and 75 lb. finely ground sulphur. Very satisfactory control was also given by a sulphur-lead arsenate dust (90:10), and by liquid lime-sulphur (1 in 15 at the delayed dormant application and 1 in 40 at subsequent treatments) plus lead arsenate ($2\frac{1}{2}$ lb. per 100 galls. of spray). Black leaf 40 was also added at the delayed dormant and calyx sprays at the rates of $\frac{3}{4}$ and 1 pint per 100 galls. respectively. The seven applications of both dusts and sprays were given on the following dates: 13th April, 25th April, 12th May, 28th May, 27th June, 23rd July, and 19th August.

In 1922 similar experiments were carried out at Waterport and Medina, Orleans County, on the Greening, Baldwin, Dutchess, Wealthy, and Wolff River varieties. The best results were given by the application of liquid lime-sulphur 1 in 40, but various dusts also controlled the disease adequately.

The most satisfactory control of peach leaf curl [*Exoascus deformans*] was obtained by the application of liquid lime-sulphur (1 in 40 and 1 in 20) and by Corona 'coppercarb' dust (60 per cent. soluble sulphur and 40 per cent. inert material, 7 lb. on nine trees).

BUTLER (O.). **Bordeaux mixture. II. Stimulatory action.**—*New Hampshire Agric. Exper. Stat. Tech. Bull.* 21, 49 pp., 24 tables, 1922. [Rec'd. 1923.]

After a somewhat detailed review of the work of previous investigators on the stimulatory effect of Bordeaux mixture, the author gives an account of his studies on the nature of the response in sprayed plants.

Dealing first with the effect of the composition of Bordeaux mixture on the dry matter formed and on the transpiration per gram of dry matter, the author describes experiments in which tomatoes, beans, and radishes were sprayed weekly with 1 per cent. Bordeaux mixture in which the ratio of copper sulphate to quicklime used was 1 to 1, 1 per cent. Bordeaux mixture in which the ratio of copper sulphate to lime was 1 to alkalinity, and milk of lime containing 1·32 per cent. calcium hydroxide. The plants were grown in glazed pots filled with soil containing water to 70 per cent. of saturation. As regards the elaboration of dry matter, in six-sevenths of the experiments the application of 1 per cent. Bordeaux mixture 1 to 1 and milk of lime was accompanied by loss of weight, whilst the plants sprayed with 1 per cent. Bordeaux mixture 1 to alkalinity behaved approximately like the controls.

Spraying with 1 per cent. Bordeaux mixture 1 to 1 always increased transpiration per gram of dry weight, an effect which was also produced in five-sevenths of the tests with milk of lime. Taking the experiments as a whole there was only a negligible difference in the rate of transpiration per gram of dry matter between the plants sprayed with Bordeaux mixture 1 to alkalinity and the controls.

The data obtained from the above experiments show that the physiological effect produced by Bordeaux mixture is due to the ratio of copper sulphate to quicklime, and not to the amount of copper present. The ratio of copper sulphate to lime does not, within the limits used, affect the composition of the copper precipitate, and it therefore follows that a Bordeaux mixture made with an excess of lime should produce a response of the same order that the calcium hydroxide present would. This is actually the case, since 1 per cent. Bordeaux mixture 1 to 1 has the same physiological effect as 1·32 per cent. calcium hydroxide.

The author next describes his experiments on the effect of the percentage of water in the soil on the response of plants sprayed with Bordeaux mixture 1 to 1. Tomato, bean, and radish, were again used. The degree of saturation in the different series of pots ranged from 50 to 90 per cent. and the plants were sprayed at weekly intervals. In general the application of the mixture was detrimental to the formation of dry matter in the plants investigated, especially the tomato. In the case of the latter and of the bean the percentage of water in the soil in no way influenced the result. With radishes, however, 11·2 per cent. of those grown at 70 and 80 per cent. saturation, 25 per cent. of those at 90 per cent. saturation, and 66 per cent. of those at 50 per cent. saturation showed an increase in dry weight as a result of spraying. The percentage of water in the soil, however, has a modifying influence, sprayed plants growing in too dry a soil being less deleteriously affected by spraying than plants growing under more favourable conditions as regards soil moisture.

The effect of spraying on the transpiration of plants growing in soils of varying degrees of saturation (50 to 90 per cent.) was investigated and it was found that transpiration per gram of dry matter produced was increased in 94·5 per cent. of the cases when tomatoes were used, and in 68·9 and 64·3 per cent. when radishes and beans respectively were employed. When this criterion is considered the plants fall into the same relative position as when dry weight is taken as a criterion. Both in the case of dry weight and transpiration per gram of dry matter the degree of illumination was without perceptible effect.

The effect of the Bordeaux mixture on the dry weights of the plants (also grown in soils of varying degrees of saturation) was not materially modified by the addition of nutritive elements to the sand in which they were grown. The transpiration of both sprayed and non-sprayed plants, however, was less when grown in fertile than in poor sand. Comparative observations on the coloration of the foliage of sprayed and unsprayed plants indicate that the action of Bordeaux mixture, whatever its nature, is indirect.

In a further series of experiments on potato, tomato, Russian sunflower, *Coleus* Golden Bedder, and *C. verschafftei*, it was shown that spraying has no effect on the rate of transpiration (irrespective of the relation to dry weight) when the data are calculated for the entire 24-hour period or for the day alone, while during the night there may or may not be an increase in the rate of transpiration of the sprayed plants. In the case of tomato and *C. verschafftei* increased transpiration at night was recorded in all the tests; in *Coleus* Golden Bedder it occurred in 50 per cent. of the experiments, in the sunflower in five out of seven instances, and in the potato once only. Plants sprayed with Bordeaux mixture 1 to 0·2 behaved similarly to those sprayed with 1 to 1 under the same environmental conditions, though the increased transpiration obtained was less. Milk of lime also produced comparable results except in the case of two experiments on the sunflower. The available data indicate that spraying the under surface of the leaves affects the rate of transpiration in the same way as when the mixture is applied to the upper surface.

It was further ascertained by experiments, the technique of which is described in detail, that Bordeaux mixture 1 to 0·2 transmits 1·62 times more light than Bordeaux mixture 1 to alkalinity; the 1 to alkalinity wash 1·53 times more than milk of lime; and milk of lime 2·2 times more than Bordeaux mixture 1 to 1. Considering the spectrum as a whole, Bordeaux mixture 1 to 1 and milk of lime are about equally transparent and much more opaque than Bordeaux mixture 1 to alkalinity, and there is an agreement between the physical properties of the solutions and the response of the plants sprayed with them. Bordeaux mixture 1 to 1 casts an obvious shadow, and plants sprayed with it remain longer green than the unsprayed controls, thus behaving in all respects like shaded plants. The quality of the light received by the leaf was found to play no part in the effect produced. An investigation of the transmission of radiation by the solutions in question showed that all were relatively opaque to the infra-red, Bordeaux mixture 1 to alkalinity and 1 to 1 especially showing a high degree of athermancy.

The action of Bordeaux mixtures on plants is seen from the above experiments to be one of shade, using the term in the sense of opacity to the spectrum as a whole. The magnitude of the physiological response produced in plants by the application of Bordeaux mixture depends, broadly speaking, on the intensity of the shadow cast. A Bordeaux mixture transparent to the spectrum permits a plant to grow in all respects like unsprayed plants, whereas milk of lime and opaque mixtures cause a decrease in dry matter and an increase of transpiration. As Bordeaux mixtures and milk of lime are opaque to radiation of long wave length, sprayed plants, under conditions favourable for radiation, cool less rapidly than unsprayed ones and thus transpire more freely.

The practical conclusions to be drawn from the above facts are as follows. When shading is injurious to the plants to be sprayed, only a small amount of lime should be used, the composition of the mixture being 1 to 0·5. When shading is desirable a 1 to 1 Bordeaux mixture should be used for the control of parasitic organisms, and milk of lime employed when fungicidal properties are a secondary consideration.

Stutzer (A.). **Die Steigerung der Ernteerträge durch Beizung des Saatgutes.** [The increase of crop yields through seed disinfection.]—*Deutsche landw. Presse*, l, 5, p. 42, 1 fig., 1923.

Some years ago the writer ascertained that lead salts (lead nitrate) were extremely effectual as a seed disinfectant. Not only were the various parasitic organisms adhering to the seed destroyed, but a portion of the lead remained in the epidermis and adjoining layers of the seed, where it exerted a remarkable influence on the development of the root system and eventually resulted in a higher yield than that obtained from untreated seed. There was no reduction of germination such as so frequently accompanies the use of copper sulphate.

Similar results have more recently been secured by the use of uspulun. Reports have been received from a Mexican cotton farm to the effect that seed treated with uspulun in 1921 and 1922 yielded a cotton the fibre of which was longer and finer and fetched a considerably higher price than that from the untreated plants.

Appel (O.). **Die Steigerung der Ernteerträge durch Beizen des Saatgutes.** [The increase of crop yields through seed disinfection.]—*Mitt. deutsch. Landw.-Gesellsch.*, xxxviii, 8, pp. 37–39, 1923.

After describing the various types of seed disinfection apparatus, the author selects a few instances in which such treatment is of special use. Smut diseases of cereals, stripe disease of barley [*Helminthosporium gramineum*], and *Fusarium* disease of rye, are now very generally controlled by immersion of the seed in disinfectants. The farmers of Bavaria, where conditions predispose to *Fusarium* disease, set the example in this direction. It is now customary also to control root rot (*Phoma* sp.) of beet by steeping the seed for 20 to 24 hours in 5 per cent. carbolic water or 2 per cent. Bordeaux mixture. The immersion of various vegetable and flower seeds in mercury preparations, especially with a view to stimulating germination, is rapidly gaining ground.

In 1922 experiments in the immersion of seed potatoes in uspulun gave excellent results both as regards speedy germination and general vigour, although it is not possible to say if this result is due to control of *Rhizoctonia* or to stimulation of the potato. Further experiments with seed potatoes are planned which it is hoped will give data as to the value of the process.

GEHRING (A. A.) & POMMER (E.). **Ueber die Wirkung verschiedener Beizmittel auf Rüben.** [On the effect of various disinfectants on Beets.]—*Deutsche landw. Presse*, l, 16, p. 147, 1923.

During 1922 a series of field tests was carried out at the Brunswick Agricultural Experiment Station in continuation of the laboratory experiments already reported [see this *Review*, ii, p. 224]. Owing to the absence of root rot [*Pythium de Baryanum* and *Phoma betae*] the efficacy of the fungicides in this respect could not be put to the test, but various other points of interest were noted.

The 'seed clusters' were immersed, after one hour's preliminary soaking, in germisan 0·25 per cent., uspulun 0·25 per cent., segetan 10 cc. in 1 l., or carbolic acid 1 per cent., for one hour, and subsequently planted out, on 5th May, on heavy clay soil. On 19th July it was observed that the treated plants had developed much more regularly and vigorously than the controls. On 20th October the plants were harvested, the highest yield being obtained from those treated with segetan and the lowest (except the controls) from the plot treated with carbolic acid. The highest sugar-content was found in the beets treated with uspulun, but the other fungicides also gave an increase over the controls.

In a second test carried out on good soil in the Weser valley, the 'seed clusters' were immersed for one hour in 0·1, 0·25 or 0·50 per cent. germisan. There was no increase in yield, but the sugar-content was augmented in this case also.

REMY (T.) & VASTERS (J.). **Untersuchungen über die Wirkung von Chlorphenol-Quecksilber, Sublimat und einigen andern Pflanzenschutz- und Desinfektionsmitteln.** [Investigations of the action of mercury chlorophenolate, sublimate, and some other means of plant protection and disinfection.]—*Landw. Jahrb.*, lviii, 3, pp. 379–480, 5 figs., 1923.

The opening section of this very comprehensive survey of the composition, application, and effects of certain well-known fungicides deals with the work of previous investigators from 1913 to 1920, with numerous bibliographical references. The second part of the paper is devoted to the authors' original research work at Bonn Agricultural College, extending over the period 1915 to 1920.

The authors present their results under two headings: (*a*) the effect on germination and yield; (*b*) the disinfection efficiency.

The results of the germination tests, which were carried out with formaldehyde, copper sulphate, mercury chlorophenolate, and sublimate on selected seed of wheat, rye, barley, and oats, showed that much greater injury was caused by excessive concentrations of the fungicide than by protracted immersion in a solution of normal strength. Unfortunately, prolonged immersion does not increase the protective action of the substances, or only slightly. A series of experiments was also carried out on wheat in which the period of steeping lasted one hour but in which the concentrations of the fungicides varied so as to determine the safety limits for their use. Formaldehyde, 2 in 1,000, greatly reduced germination and at 4 in 1,000 completely inhibited it. The safety-limit for formaldehyde is between 1 and 2 in 1,000, probably nearer 1. Copper sulphate impaired germination only at the strongest concentration of 40 in 1,000, and the limit therefore lies between 20 and 40 in 1,000. Mercury chlorophenolate in no case reduced germination, which was, however, somewhat delayed at the highest concentration, 2 in 1,000. Sublimate adversely affected germination at 1 or 2 in 1,000, and slightly retarded it even at the lowest concentration of 0·5 in 1,000. The final results of the latter treatment, however, were satisfactory. In judging these results it must be remembered that the susceptibility of cereals to the action of the different fungicides varies considerably from one season to another and is also to some extent an individual peculiarity. The locality of origin and the variety of grain must also be taken into consideration.

Disinfection tests were carried out on wheat and other cereals inoculated with *Tilletia caries*, *Rhizopus nigricans*, *Aspergillus niger*, *Penicillium glaucum*, *Fusarium metachroum*, and *F. rubiginosum*. Mercury chlorophenolate was almost uniformly more effective than sublimate in the control of all the fungi tested.

Laboratory and field experiments were made on naturally infected seed of wheat, oats, barley, rye and beet to test the value of germisan, uspulun, and formaldehyde (separately and in combination), fusariol, and copper sulphate. No improvement in the germination of seed which had been damaged during harvesting or storage was ever obtained by any of the substances tested. In the case of rye infected with *Fusarium* [*nivale*], mercury chlorophenolate, sublimate, and formaldehyde, stimulated the germination. Good results in the control of the diseases were secured with formaldehyde (0·5 in 1,000). Mercury chlorophenolate and sublimate were equally effective in the control of *Fusarium* and stripe disease of barley [*Helminthosporium gramineum*]. Sublimate was slightly superior to mercury chlorophenolate in the control of bunt. Sprinkling the seed with sublimate, 0·787 in 1,000, and mercury chlorophenolate, 1 in 1,000, very considerably reduced the incidence of bunt, but even better results were obtained by immersion at much lower concentrations (mercury chlorophenolate 0·25 in 1,000, and sublimate 0·098 in 1,000).

In 1921–22 complete control of bunt was secured by germisan 25 in 1,000, formaldehyde 1 in 1,000 (or 2 in 1,000 with subsequent rinsing), and sublimate 1 in 1,000. Approximate freedom from infection was obtained by immersion in uspulun 2·5 in 1,000, in a mixture of germisan 0·83 in 1,000 + uspulun 0·83 in 1,000 + formaldehyde 0·67 in 1,000, and in fusariol as directed. None of the preparations was completely effective in guarding against subsequent reinfection; the best results from this point of view were obtained by the use of copper sulphate. Solutions of uspulun, sublimate, germisan, and formaldehyde could safely be used three times in succession. In no case were uninjured spore balls completely destroyed, though in a recent experiment (1923) copper sulphate almost entirely inhibited their germination. Low concentrations of sublimate and uspulun even appeared to stimulate the germination of the balls. The removal of the spore balls before or during treatment is therefore an essential preliminary.

Cattle, pigs, and poultry can safely be fed on grain treated with uspulun, sublimate, formaldehyde, copper sulphate, or germisan.

Uspulun deserves special consideration at the present time on account of its relative cheapness [British price 13*s.* 0*d.* per lb.] It has the further advantage of causing comparatively little damage even at excessive concentrations. Germisan [7*s.* 10*d.* per 500 gm. or 1·1 lb.] has also given excellent results, which, however, require further confirmation before the preparation can be widely recommended.

Dufrénoy (J.). **La lutte contre les maladies des plantes par la sélection des races immunes.** [The campaign against diseases of plants by the selection of immune varieties.]—*Rev. Bot. appliquée*, iii, 20, pp. 241–246, 1923.

In a brief survey of the practical importance of the selection of immune or resistant varieties of plants in the fight against disease, the author gives a number of well known examples of the success of this method. Its value has been fully demonstrated in such cases as wart disease of potato (*Synchytrium endobioticum*), cereal rusts, sugar-cane diseases, chestnut diseases, and the like. In certain instances, however, such as *Sclerotinia trifoliorum*, little success has been met with, since all varieties of clover appear to be susceptible to this fungus, and the same is true of *Plasmodiophora brassicae* on cabbage.

Doolittle (S. P.) & Walker (M. N.). **Cross-inoculation studies with Cucurbit mosaic.**—*Science*, N.S., lvii, p. 477, 1923.

Cross-inoculation experiments with cucumber mosaic have been continued with the result that 8 genera, 23 species, 8 varieties, and 96 horticultural varieties from Europe, Asia, and Africa are now known to be susceptible to the disease. In the genus *Citrullus* infection was secured only in the case of the green-seeded citron. It was shown in an earlier paper [see this *Review*, i, p. 122] that cucumber mosaic was transmissible to *Martynia louisiana*, pepper (*Capsicum annuum*), and milkweed (*Asclepias syriaca*), and more recently pokeweed (*Phytolacca decandra*) was also found to be susceptible. Further studies have demonstrated that cucumber mosaic is readily transmissible to these hosts and back to the cucumber. The disease has also been transmitted from milkweed to both *Martynia* and pepper and back to milkweed. The most uniformly successful method of inoculation was by means of aphids. Inoculation with the crushed tissue or expressed juice of mosaic plants gave satisfactory results.

The authors also found that cucumber mosaic was readily transmissible to tobacco through pepper and vice versa, the pepper apparently acting as an intermediate host. Their numerous direct inoculations from cucumber to tobacco have hitherto given negative results, though Elmer [see this *Review*, ii, p. 21] reports the successful inoculation of cucumbers with tobacco mosaic and vice versa.

A high percentage of infection was secured in several series of inoculations on the cucumber from potato plants previously inoculated with cucumber mosaic. Potato plants inoculated from the cucumber in 1921 yielded tubers which when planted in the greenhouse during the past winter produced plants showing symptoms of mosaic. The results of preliminary experiments indicate that potato mosaic may possibly be transmitted to the pokeweed. During the summer of 1922 it was discovered that cucumber mosaic was transmissible also to the pigweed (*Amaranthus retroflexus*) and a cultivated ground cherry (*Physalis* sp.).

KOTILA (J. E.) & COONS (G. H.). **Trypanosome-like bodies in Solanaceous plants.**—*Phytopath.*, xiii, 7, pp 324–325, 1923.

Nelson's paper relating to the occurrence of protozoa in plants affected with mosaic and related diseases [see this *Review*, ii, p. 227] stimulated the authors to investigate whether similar phenomena were to be met with in potato and other plants affected with other degenerational diseases.

Diseased material from plants showing severe symptoms of potato mosaic, streak, and leaf roll was killed and fixed with both chrom-acetic and Zenker's solutions. Longitudinal sections 7 μ thick were prepared and stained with Heidenhain's haematoxylin.

The phloem cells of the diseased potato plants were found to contain inclusions resembling the trypanosome-like bodies described by Nelson, and similar bodies were also found in the phloem cells of midribs and lateral veins of leaves of tobacco and petunia plants affected with mosaic.

As a control the same work was done on material from healthy potato and tomato plants. In order to ensure the supply of healthy potato material for these tests, the stock from which it was taken was indexed during the winter 1921–1922 (that is, an eye of a tuber was sprouted and grown in the greenhouse to about 10 inches in height and if any plants showed disease the parent tubers were rejected). The stock thus obtained was grown in an isolated plot in 1922 and found to be healthy. Some of the progeny of this stock was indexed again during the winter 1922–1923 in a greenhouse. No aphids were observed on the plants selected for study, nor were signs of mosaic or leaf roll detected by the time the plants had reached a height of 8 inches and the material was cut and fixed. The variety used, Bliss Triumph, allows of an easy and prompt recognition of either mosaic or leaf roll. Tomato material was obtained by planting disinfected seed on agar in Petri dishes and transferring the seedlings after germination to test tubes (plugged with cotton) containing Shive's nutrient agar. Allard and others contend that tomato mosaic is not transmissible through the seed, so the precautions taken are believed to exclude the possibility of infection.

The phloem elements of healthy potato and tomato plants were found to contain inclusions similar in size and form to those found in severely diseased material and equally abundant. No degree of uniformity was possessed by these bodies in either diseased or healthy material. All attempts to show definite structure by using such protozoal stains as Wright's, Romanowski's, tetrachrome, &c., failed, the bodies staining a uniform blue, nor has it been possible to prove motility, in sections of fresh material or in extracted juice of diseased or healthy plants.

The conclusion is reached that the correlation of the trypanosome-like bodies described by Nelson with mosaic and leaf roll has not been proved.

DOOLITTLE (S. P.) & MCKINNEY (H. H.). **Intracellular bodies in the phloem tissue of certain plants and their bearing on the mosaic problem.**—*Phytopath.*, xiii, 7, pp. 326–329, 1 pl., 1923.

This paper records the results of the authors' study of phloem tissue of both mosaic and healthy plants. The material consisted of stem and petiole phloem of navy beans, tomatoes, cucumbers, and red clover, both healthy and mosaic-infected, and of healthy garden peas, sweet peas, and alfalfa. In most cases free-hand sections of fresh material were studied side by side with material fixed, embedded, sectioned, and stained by the usual methods.

The precautions taken in order to obtain mosaic-free plants are described. The mosaic-free bean and tomato plants used for the experiments were grown in an isolated greenhouse at the University of Wisconsin, in which no mosaic plants were found either before or after the material for study was removed, although light and temperature conditions were favourable to the development of the disease. As an additional safeguard, healthy tomato plants were inoculated with the juice from the healthy plants sectioned, but the former developed no mosaic, while similar healthy plants inoculated at the same time with material from the mosaic plants studied developed the disease. The other plants were selected with similar care.

Certain intracellular bodies very similar to those described by Nelson as protozoa in the phloem of certain mosaic plants, were found in the phloem of both mosaic-free and mosaic-infected plants [see also preceding abstract]. In beans, three to six weeks old, they were discovered in fresh and in microtomed material, the latter being stained either by Fleming's triple stain or by Heidenhain's iron-alum haematoxylin. The bodies were found singly in the sieve-tubes and adjoining cells, oriented longitudinally. In shape they varied from irregularly ovoid to narrowly ellipsoid and usually had one or more slender strands extending from each end, sometimes to the ends of the cells and sometimes shorter distances from the bodies. Though the stains employed should have brought out cytological details if these had been present, the characteristic nuclei, blepharoplasts and rhizoplasts of protozoa were not observed by the authors, nor were they able to note in free-hand razor sections of fresh material an active motion of the bodies such as might suggest that of a protozoon. Similar bodies were observed in healthy and mosaic-infected red clover, as well as in healthy garden peas, sweet peas, and alfalfa, except that the terminal strands were only occasionally seen in clover and alfalfa and not at all in garden or sweet peas.

Strasburger (*Histologische Beiträge*, iii, pp. 193–194, Jena, 1891) reported finding in the sieve-tubes of *Robinia pseudacacia* certain slime-bodies which resemble in many respects those found by the writers in beans, clover, garden peas, and sweet peas. He described them in some detail and found them to colour a yellow-brown with iodine and to react intensively to Millon's reagent, the threads being only weakly stained. Strasburger's original figures are reproduced by the authors.

Haberlandt also states that these bodies occur generally in the Leguminosae, but not in the Cucurbitaceae, this statement agreeing with the findings of one of the authors, who was unable to detect them in the phloem tissues of stems and petioles of either mosaic-infected or mosaic-free cucurbits.

The intracellular bodies, which appear to be identical with those interpreted by Nelson as trypanosome-like protozoa, are not found as regularly in the tomato as in the bean, but they seem to be as abundant in the mosaic-free as in the mosaic-infected tissues, and the most careful investigation has failed to reveal structure typical of trypanosomes or other protozoa. Both healthy and diseased plants show the cytoplasm of the phloem cells frequently collected in lightly stained, long or short, irregular, spiral, wavy forms in all stages up to the deeply stained forms referred to, but an undulating membrane characterizing the trypanosomes has never been observed by the authors.

BAILEY (I. W.). **Slime bodies of Robinia pseudo-acacia L.**—*Phytopath.*, viii, 7, pp. 332–333, 1 pl., 1923.

Robinia pseudacacia is characterized by having curious 'slime-bodies' (Strasburger's Schleimklumpen) [see preceding abstract] in its sieve-tubes, which stain intensively in Millon's reagent and vary greatly in size and shape during different stages in the differentiation of the sieve-tubes. At first small, slender, spindle-shaped structures, they enlarge later, frequently tending to be bifurcated at the ends and are held in place by slender threads attached at the ends of the spindle. As the 'slime-bodies' enlarge laterally, these strands become thicker and more conspicuous. The author thinks that the structures described and figured by Nelson in the phloem of bean and clover affected with mosaic are identical with the slime-bodies occurring normally in the sieve-tubes of *Robinia* and other Leguminosae. All the forms described by Nelson are taken on by the slime-bodies of *R. pseudacacia* during various stages in the differentiation of the phloem, although in the case of these large trees they are somewhat larger in size.

The movements recorded by Nelson in fresh sections of living material mounted in boiled water must be considered normal, as the stresses and strains in the various tissues are changed in cutting the sections, the osmotic and other equilibria being also disturbed by immersion in water. The liquid or semi-liquid contents of the cells must also contribute to this disturbing influence through their circulatory motion.

Kofoid (C. A.), Severin (H. H. P.), & Swezy (Olive). **Nelson's spiral bodies in Tomato mosaic not protozoa.**—*Phytopath.*, viii, 7, pp. 330–331, 1923.

The authors record their total disagreement with Nelson's interpretation of the bodies found in plant tissues affected with certain mosaic diseases [see also preceding abstracts]. In material from both healthy and mosaic-infected tomato plants, fixed in hot Schaudinn's fluid and stained in the usual way in iron haematoxylin, structures clearly similar to those described and figured by Nelson were found, but the absence (1) of the undulating membrane, (2) of the flagellum having a definite, clear-cut, marginal fibril arising from a centrosome, and (3) of the parabasal body near the end of the fibril and joined to the centrosome by the parabasal rhizoplast, exclude the possibility of their being trypanosomes, nor is their spiral form characteristic of either trypanosomes or of any known protozoa. Other characters generally associated with the latter bodies are also lacking. These spiral bodies of the tomato do not belong to the same category as the clearly established trypanosomes of the latex of Euphorbiaceous plants.

No evidence of motility was detected at any time by the authors in the spiral bodies, but it is stated that occasionally reagent bottles, particularly those containing physiological salt solution, in use in the laboratory, become contaminated with a species of *Bodo*, a small, rapidly-moving flagellate, and these might appear in preparations made up with such contaminated solutions, deceiving the observer as to their origin.

Similar spiral bodies have been found by the authors in mosaic-free seedling tomato plants and in the diseased phloem of older plants, with the difference that in the former they were smaller, but whether this has any connexion with the age or the disease of the plant the authors are unable to say ; the peculiar relations of these spiral structures, in their elongated, trumpet-shaped phase, to the sieve-plates in some instances, their relative homogeneity, and their spiral structure, induce, however, the belief, that they are dexiotropic cell contents of an albuminoid nature.

Doran (W. L.). **Effect of external and internal factors on the germination of fungous spores.**—*Bull. Torrey. Bot. Club*, xlix, 11, pp. 313–336, 2 diag., 1922.

In this work the effect of various factors on the germination of spores of the following fungi was studied: conidia of *Venturia inaequalis, Sclerotinia fructigena, Alternaria solani, Botrytis cinerea*, and *Rhizopus nigricans*, aecidiospores and uredospores of *Cronartium ribicola*, aecidiospores of *Gymnosporangium clavipes* and teleutospores of *Puccinia malvacearum*. In all cases except that of *A. solani* the spores were obtained fresh from the living host, being thus presumably possessed of their full natural vigour.

In the experiments (the technique of which is described) on the relation of the viability of the spore to its age, it was found that mature spores (especially those which have just reached maturity) can germinate through a wider range of environmental conditions than either immature or old ones. As the spores advance in age viability decreases, sharply at first and then gradually. The longevity of spores is dependent on conditions of storage after detachment from the host, moisture being of more importance than temperature in this connexion.

Dealing with various external factors on germination the author first discusses that of temperature. A table is given of 33 records of the cardinal temperatures of various fungi. From this it is seen that the minimum temperatures for spore germination are 1° to 7·4° C., the optima 13° to 23·1° C., the maxima 22° to 39·6° C. The Phycomycetes can germinate at the lowest minimum temperatures, followed in order by the uredospores, aecidiospores, and teleutospores of the Uredinales. Aecidiospores have the lowest optimum temperatures for germination, followed in order by uredospores, conidia of Phycomycetes, teleutospores, and spores of Fungi Imperfecti. The writer determined the minimum temperature for the germination of conidia of *Venturia inaequalis* as 3°, the optimum 14°–15°, and the maximum 31° C., the decrease in germination being more rapid from the optimum to the minimum than from the optimum to the maximum. From a study of the published figures the length of time required for spore germination was found to be about 12 hours, the different groups varying from 4 to 21 hours, and the author adds his own figures for six other species which varied from 2 to 27 hours. The nearer all conditions approach to the optimum, the shorter is the time required for spore germination. With regard to oxygen relations, the literature is reviewed on this subject and the author points out that competition or crowding inhibits germination and this is attributed to a deficiency of oxygen. The spores of the fungi studied germinated indifferently in light or darkness. Precipitated moisture was found to be essential to the germination of the conidia of *S. fructigena* and *Peronospora pygmaea*, which was also studied in this connexion, but *G. clavipes* germinated equally well merely in water vapour. In the case of *A. solani* and *V. inaequalis*, both germinated very poorly in water vapour but very well in a drop of distilled water.

A bibliography of 59 titles is appended.

SPIECKERMANN (A.). **Wie kann die weitere Verbreitung des Kartoffelkrebses in Deutschland verhindert werden?** [How can the further spread of wart disease of Potatoes in Germany be checked?]—*Mitt. deutsch. Landw.-Gesellsch.*, xxxviii, 13, pp. 175–178, 1923.

Wart disease of potatoes [*Synchytrium endobioticum*] first began to cause serious alarm in Germany in the summer of 1922, when it appeared on a large scale in the potato-growing districts east of the Elbe. The disease had occurred in a sporadic form in Germany since 1908, but until recently it was confined almost entirely to small holdings in the manufacturing districts, and therefore did not materially affect the agricultural population. Subsequent developments, however, have thrown an entirely new light on the situation and demonstrated the need for the most stringent legislative measures to combat the further spread of the disease.

The symptoms of the disease and life-history of the causal organism are briefly described. It is pointed out that, besides the usual agents of dissemination (rain, labourers, and animals), particles of infected soil adhering to apparently healthy tubers are responsible for a certain amount of infection (10 per cent. in recent tests in Westphalia). The danger of infection by this means is particularly great from starch factories, where potatoes of widely varying origin are washed before use.

The amendment and extension of the legislative measures against wart disease which came into force in September 1922 [see this *Review*, ii, p. 335] will doubtless cause serious inconvenience to distillery owners and others, but from the standpoint of national welfare they are absolutely justified.

All attempts to control wart disease by seed tuber disinfection have hitherto given negative results, and although further experiments on these lines are in progress, the only reliable method of suppression at present is the cultivation of immune varieties. Among the latter, Paulsen's Juli and Goldperle combine early maturity with delicate flavour and yellow flesh. Modrow's Johannsen and Preussen are good medium-early varieties, though both are unfortunately apt to 'degenerate'. Immune early varieties with white flesh are Thiele's Früheste, Kuckuck, Magdeburg Blaue, and possibly also Bürkner's Früheste. There are as yet no immune medium-early, white-fleshed varieties, but a number of valuable medium-late ones, the best of which is Richter's Jubel, followed by Pepo, Arnica, Marshal Hindenburg, Helios, and Nepeta. Parnassia deserves special mention as being the only immune variety with a high starch content. This list will doubtless be amplified by investigations now in progress.

In 1922, 30 per cent. of the potatoes grown in Brandenburg were immune varieties, in Pomerania 31 per cent., and in Hanover and East Prussia 12 per cent. During the last three years the area occupied by immune varieties has increased considerably in all parts, especially in Silesia and Brandenburg.

The author regards the danger of the importation of wart disease with consignments of potatoes from abroad as comparatively slight. Of far greater importance than frontier inspection, essential though it be, is the reduction of the infected area at home. This object can be attained only if the legislative measures are reinforced by the willing co-operation of all classes concerned.

SCHRIBAUX. **Sur la dégénérescence de la pomme de terre et sur les moyens de la conjurer.** [The degeneration of the Potato and the means of preventing it.]—*Comptes rendus Acad. Agric. de France*, ix, 3, pp. 95–97, 1923.

Potato cultivation in France appears to be passing through a serious crisis as potato growers, in addition to mildew and filosity, now have to contend against various insidious and obscure diseases, such as verticilliose, rhizoctoniose, leaf roll, curl (frisolée), &c.

Experiments conducted at Grignon by Ducomet in 1921 and 1922 have shown that none of the 180 varieties tested was absolutely immune from 'degeneration' diseases. In view of the hereditary character of these diseases, individual (not mass) selection of healthy tubers between the end of June and middle of September is absolutely essential. Of 440 'families' from 40 varieties cultivated by Ducomet, three-quarters had to be eliminated; in 11 varieties not a single 'family' was preserved. These figures show the necessity of rigorous and persistent individual selection.

BOTJES (J. O.). **Die Verwendung unreifer Kartoffeln als Saatgut.** [The use of unripe Potatoes for seed.]—*Deutsche landw. Presse*, l, 13, pp. 118–119, 1923.

The use of unripe potatoes for seed has given very conflicting results both in Germany and elsewhere. In a series of experiments carried out by Dr. Münter at Halle during the years 1918 to 1921 there was a marked improvement in the yield, especially of the Wohltmann variety, from unripe tubers on soil where potatoes are liable to 'degeneration' but in stocks free from such diseases no such improvement took place.

In the writer's opinion this increased yield is due to the fact that the unripe tuber is severed from the vegetative portion of the plant before the virus of mosaic and other similar diseases has time to pass from the former to the latter; such a tuber would in all probability produce sound offspring.

NEWTON (R. G.). **Experimental work with potatoes.** — *Agric. Journ. Brit. Columbia*, viii, 4, pp. 80–81 & 86, 1 fig., 1923.

For the last four years experimental work on virus diseases of potatoes has been in progress at the Invermere Experimental Station, which is situated at an altitude of 2,700 ft. in the Kootenay Valley. Varieties affected with mosaic to the extent of 100 per cent. have increased in yield during the period under review and shown no signs of degeneration. This is believed to be due much more to environmental and climatic conditions than to selection. Leaf roll, curly dwarf, and allied diseases can be virtually eliminated by roguing and rigid individual tuber selection at planting time.

In spite of the general adoption in British Columbia of seed disinfection with corrosive sublimate, *Rhizoctonia* causes a heavy reduction in the yield. Common scab [*Actinomyces scabies*] is also very severe, but may be controlled, at any rate on the resistant Cambridge Russet variety, by the application of 600 lb. of agricultural sulphur per acre.

MILLARD (W. A.). **Common scab of Potatoes II.**—*Ann. Appl. Biol.*, x, 1, pp. 70–88, 2 pl., 1923.

Following his previous work [see this *Review*, ii, p. 138] on common scab (*Actinomyces scabies*) the author in this paper deals first with green manuring treatment for the disease, secondly with the action of liming on the organism, and thirdly with theoretical considerations arising from the above.

The three manuring experiments recorded were carried out in

1920 when the amount of disease present was small, but they indicated that green manuring was very effective in reducing scab.

Further experiments in 1921 using seeds hay ($2\frac{1}{2}$ and 5 tons per acre) and spent hops as substitutes for green manure showed that the former was very little use, while in the latter case the heavier dressing gave very good results and further trials with this apparently worthless product are warranted.

The effect of lime dressings on scab varies with the reaction and type of soil to which they are applied. In the experiments described, two acid soils and two approximately neutral soils were limed. In the former case, scab followed, whilst in the latter case there was no effect, and there is little doubt that many of the conflicting statements regarding the results of liming might be reconciled if the initial soil reaction was known. The lime requirement serves as a useful guide in predicting the action of lime on scab.

Further experiments are described which show that the appearance of scab following liming may be counteracted by green manuring.

In examining the theories advanced to account for the occurrence of scab and its prevention by green manuring the author first discusses the soil reaction theory. He has not found the hydrogen-ion concentration of the soil to be a direct factor in controlling scab, a statement which is supported by the fact that (1) scab, although usually absent from acid soils, may occur in soils with as low a P_H value as 4·4; (2) in more nearly neutral soils the P_H value of the soil and the incidence of scab are not related, as is shown by the fact that one soil having a hydrogen-ion exponent of 7·0 may yield absolutely clean crops, whilst another with the same P_H value may bear very scabby crops, a distinction which cannot be explained by supposing the former soil to be virgin and uncontaminated with scab; (3) the application of green manure seems to decrease rather than increase the hydrogen-ion concentration of the soil.

The most plausible explanation of the established facts in connexion with the occurrence or absence of scab is thought by the author to lie in his preferential food theory. If the soil is well supplied with vegetable matter in a palatable state for the *Actinomyces*, the crops will be clean. The organisms remain saprophytic until their natural food supplies are exhausted, and only under the stress of hunger will their parasitic tendencies be developed. The freedom of peat soils from scab may be explained by the large natural reserve of organic matter present, and whilst the author agrees that high acidity depresses the *Actinomyces* flora, a peat soil which has a P_H value of 7·1 was found to contain 5,000,000 organisms per gram and yielded clean crops. Scab is most prevalent on light sandy and gravelly soils, where the well aerated conditions bring about the rapid disappearance of farmyard and vegetable manure. The fact that the incidence of scab sometimes resulting from liming may be counteracted by heavy dressings of green manure also supports the author's theory.

Dry seasons are more favourable to scab than wet, no doubt owing to the higher soil temperature in dry weather, but rainfall, which modifies the air content of the soil and thus regulates the development of the strongly aerobic scab organisms, is the most important factor, as is seen in clay soils where the disease is almost entirely inhibited by a wet season.

Goss (R. W.). **Relation of environment and other factors to Potato wilt caused by Fusarium oxysporum.**—*Agric. Exper. Stat. Nebraska Res. Bull.* 23, 84 pp., 5 figs., 1923.

A critical review of the literature dealing with potato wilt caused by *Fusarium oxysporum* shows that the general opinion of the widespread activity and serious character of the disease is based upon insufficient data. Much of the experimental evidence is contradictory and there has been a general failure to reproduce the symptoms of the disease as it occurs in the field. On the whole, the available data do not justify the conclusion that *F. oxysporum* is an extremely virulent parasite, but rather suggest a lack of knowledge of the influence of various factors upon the occurrence of the disease. The object of the present work was to determine the effect of some of the complex of factors which influence the development of the disease.

There are three methods of infection of potato plants by *F. oxysporum*: (1) infection from the soil through the seed tuber; (2) from the soil through the roots and stem; and (3) infection from the seed tuber. The results of experiments showed that the second is the most prevalent method of infection in Michigan and Nebraska. The distribution of the disease is widespread, the organism being universally present even in virgin desert and forest soils. The accurate determination of the losses caused by this disease is almost impossible owing to the complexity of the factors governing its incidence and to the liability of confusion with other troubles. Of recent years the highest reported losses in the six leading potato-growing States are 6 and 5 per cent. in 1918 and 3 per cent. in 1919 and 1920.

As a preliminary to the study of the influence of temperature on the disease, the growth-temperature relations of the organism in pure culture were investigated. It was found that different strains of *F. oxysporum* vary by at least 5° C. in their optimum temperature for development, the differences being more marked in liquid than in Petri dish cultures. By the use of different liquid media it was possible to cause a reduction of 5° to 10° C. in the optimum temperature for growth. These data may account for the varying results reported by different investigators, and also show that the manifestation of the disease at certain temperatures may depend on the strain of organism studied.

Pathogenicity tests indicated that *F. oxysporum* is not a very virulent parasite and they also showed that potato plants are most susceptible to infection in the early stages of growth. Under conditions favourable to the plant infection may often occur without producing any external symptoms of the disease. On the other hand, a discoloration of the vascular system of both stem and tubers is often apparent under conditions of high temperature and low soil moisture, even in the absence of a specific causal organism. It is, therefore, not a reliable indication of infection by *F. oxysporum* unless associated with a wilting of the plant. Only a small percentage of tubers with a vascular discoloration contain *F. oxysporum*, and such tubers do not usually reproduce the disease except under conditions very favourable for this type of infection. They should not, however, be used for seed, as they produce weak plants which are very susceptible to soil infection.

A large number of experiments are described showing the effect of soil temperature and moisture on the disease, but the amount of infection secured by artificial inoculations was so small that definite interpretations of the results were difficult to make. Temperatures of 18° C. and below, however, are very unfavourable for the development of the disease, the amount of infection increasing with a rise in the soil temperature up to 30° C. The disease develops most rapidly when the temperatures are too high for the vigorous growth of the host. Plants started at a temperature of 18° C. and later transferred to higher temperatures showed as much disease as those kept at a constant high temperature. Conversely, plants started at a high temperature and afterwards transferred to a low one showed practically no symptoms of disease although the organism was present to a slight extent in the finer rootlets. Constant low soil moisture is unfavourable for infection. After the plants have become infected, however, a reduction of the soil moisture accelerates the wilting of the plant. With increasing soil moistures the amount of rotting of the stems and roots of infected plants increases and the wilting symptoms are less marked. The results of experiments with seed inoculations under three different environmental conditions showed that the greatest amount of disease developed in the plot with low soil temperatures during the early period of growth, and with a decreasing soil moisture content and rising soil temperatures in the later stages. The application of two irrigations during the later period of growth rendered the plants more vigorous and reduced the amount of disease. Practically no disease developed in another plot with the same general type of temperature and moisture curve as in that showing the greatest amount of disease, but with much higher temperatures and soil moistures throughout the experiment.

Cook (F. C.). **The influence of copper sprays on the yield and composition of Irish Potato tubers.**—*U.S. Dept. of Agric. Bull.* 1146, 24 pp., 1923.

The results of experiments with (*a*) ordinary Bordeaux spray, prepared by mixing milk of lime and copper sulphate solutions; (*b*) Pickering spray, prepared by mixing a saturated solution of lime water with a dilute solution of copper sulphate; and (*c*) a barium water spray, prepared by mixing barium hydroxide with a dilute copper sulphate solution, showed that the tubers of sprayed potato plants were usually higher in solids, starch, and nitrogen than those from the untreated controls. The starch content of the sprayed plants increased approximately 50 per cent. as the tubers matured, while the dextrose disappeared and the sucrose was materially reduced. The early varieties of potatoes showed a decrease in their sugar content and a corresponding increase in their starch content in the copper-sprayed tubers during the early stages of development. In sprayed plants also the proportion of insoluble ash decreased during the growth of the tubers, though the total ash content remained constant. The total nitrogen increased, and the figures for soluble, coagulable, and mono-amino- and amido-nitrogen increased as the tubers matured. The proportion of tubers to green vines appeared to be higher for sprayed than unsprayed plants.

Average data for seven States obtained in 1919 showed the food value of copper-sprayed potatoes to be equivalent to a yield of 839 lb. per acre more than that for those unsprayed. Two factors, increased yield (48 bushels per acre) and an increase of solids (5·6 per cent.), are involved.

Some results obtained at Arlington Experimental Farm, Virginia, comparing a 10–10–50 with a 5–5–50 Bordeaux, indicate that the former spray has no advantage over the latter, and may possibly furnish an excess of copper for the maximum stimulating or protective effect. Results from New Jersey, where a 4–4–50 Bordeaux spray was applied eight times, compared with results from only four applications of the same mixture, show that the tubers were lower in solids in the former than in the latter case. This again suggests that an excess of copper, in the absence of late blight (*Phytophthora infestans*), mitigates the stimulatory action of the spray.

Tubers from several varieties of potatoes grown in the north were higher in solids than tubers of the same varieties grown in the south.

A larger yield of potatoes was secured from copper-sprayed than from control or non-copper-sprayed vines, the three sprays tried giving essentially the same increase in yield and in solids.

FRANCHINI (G.). **Action des latex végétaux sur différents protozoaires.** [The action of plant latex on various protozoa.]—*Bull. Soc. Path. exot.*, xvi, 4, pp. 256–263, 1923.

The results of further experiments on the action of plant latex on various trypanosomes and other protozoa [see this *Review*, ii, pp. 229, 230] showed that trypanosomes of human origin maintained their vitality longest in the latex of different species of Euphorbiaceae, Asclepiadaceae, Apocynaceae, Artocarpaceae, and Urticaceae. Whereas the latex of certain plants, e.g., *Asclepias curassavica*, *Gomphocarpus fruticosus*, and an undetermined species of *Euphorbia* rapidly produced a fatal effect on the protozoa [excluding trypanosomes], that of *Tanghina venenifera* (Apocynaceae), which inhibits the development of bacteria, conserved their vitality. The trypanosomes lived longer in the latex of any of the plants used than in the physiological or citrated solutions.

Crithidia melophagi and *C. gerridis* were more resistant to the action of the latex than most of the trypanosomes. The vegetative forms of the amoebae of human dysentery, *Lamblia* (*Giardia*) *hominis*, *L. muris*, *Trichomonas hominis*, *T. muris*, *Cercomonas hominis*, *Hexamitus muris*, and *Tetramitus muris* rapidly succumbed to the action of the latex, but living encysted forms were found several months after the inception of the cultures, those of human *Lamblia* being the most resistant.

During the progress of the experiments it was observed that the latex of certain plants exercised a remarkable preservative action on the bacterial flora of the human intestinal tract. Such latex, even in a very diluted form, would probably be a valuable substitute for bouillon and other culture media.

Nakata (K.), Nakajima (T.), & Takimoto (S.). **Studies on Sugar beet diseases and their control.**—*Bull. Agric. Exper. Stat. Chosen*, vi, pp. 1–118, 8 pl., 1922. [Abs. in *Japanese Journ. of Bot.*, i, 3, p. 43, 1923.]

Since 1913 the writers have made a special study of the diseases of sugar beet and their control in Korea. These include leaf spot (*Cercospora beticola*), snake-eye disease (*Phoma betae*), sclerotial disease (*Sclerotium rolfsii*), bacterial leaf spot (*Bacterium aptatum*), crown gall (*Bacterium tumefaciens*), 'Mompa' disease (*Septobasidium mompa*), stem and root rot (*Corticium vagum* [*solani*]), *Alternaria* leaf spot (*Alternaria* sp.), white rot (*Bacterium destructans*), black heart leaf spot (probably *Colletotrichum omnivorum*), white hollowed disease (*Rhizoctonia* sp.), and *Physarum* disease (*P. cinereum*).

The most serious of these diseases is leaf spot, which causes 20 per cent. loss of yield and 40 per cent. loss of sugar content. The causal organism, *C. beticola*, remains viable for 16 months at room temperature, for 5 months on the surface of the field, and for 8 months in the soil under winter conditions at Suwon (southern Korea). The sclerotium-like bodies embedded in the host tissue play the chief part in overwintering. The disease may be controlled by spraying and seed disinfection.

The disease of leaves and roots caused by *Phoma betae* ranks next to leaf spot in severity and is prevalent in sandy soil or during dry seasons. The causal organism is disseminated on the seed and the spores retain their vitality even after passing through the alimentary canal of live stock. Seed treatment and rotation of crops are effective in controlling the disease. *Corticium vagum* affects the stems, roots, and leaves of the plants and may remain viable for six months in the soil of Suwon. The removal of soil round the crown of the roots to facilitate aeration, and sterilization of the soil with formalin are recommended.

Sclerotium rolfsii is widely spread throughout all regions of Korea.

Bruner (S. C.). **Mosaic and other Cane diseases and pests in Cuba.**—*Louisiana Planter*, lxx, 22, pp. 452–455, 4 figs., 1923.

The symptoms of mosaic disease of sugar-cane are briefly described and Brandes' report of its transmission by *Aphis maidis* [see this *Review*, ii, p. 381] confirmed as a result of the writer's experiments in Cuba.

Generally speaking, very few systematic efforts are being made to control the disease in Cuba, with the result that it is steadily increasing, though less rapidly than in Porto Rico. Although infection can be considerably reduced, when the percentage is not too high, by the destruction of the diseased plants in a given field, the method ultimately adopted in Cuba will probably be the use of resistant and immune varieties. Under Cuban conditions the

Crystalina variety is highly resistant, although reports (not yet verified) from Oriente state that the variety is heavily attacked. Preliminary experiments with this variety carried out on the typical red soil at the Experiment Station have shown that under conditions where Yellow Caledonia, Morada, and Blanca varieties break down severely and develop large cankers and stunted stalks, the Crystalina variety bears practically no cankers during the first year's growth and there was no noticeable difference in the size or appearance of healthy and infected stools, except for the mottled condition of the leaves. An occasional stalk of diseased Crystalina was found, showing a few very superficial white cankers, so that possibly, under certain conditions, the variety may be more susceptible than is usually the case.

In Central Soledad, where the disease was first observed in Cuba, it is spreading very slowly and, according to a report dated May 1923, causing no appreciable damage.

The highly resistant Hawaiian variety, Badila, has been introduced into Cuba, where it is giving excellent results. It compares favourably with Crystalina in purity and in the percentage of glucose and sucrose. It is being propagated at the Experiment Station for distribution on a large scale.

Excellent yields have been obtained from the immune Kavangire or Uba cane, amounting in Porto Rico to 81 tons per acre. In the Argentine an average of seven crops of Uba cane is reported to have yielded 3½ times the tonnage of the ordinary Cinta or Rayada and three times the quantity of sugar per acre. In Cuba the highest yield in 1921 was 58·6 tons of cane and 8·54 tons of sugar per acre. This refers to cane grown without irrigation or fertilizers. The standard of purity in certain lots of the present year's crop was also extremely high, (91·92) [quotient of purity]. Uba is especially valuable for planting in poor, exhausted soils where Crystalina often has to be abandoned owing to its liability to deteriorate under unsuitable conditions. Since 1919 cuttings of Uba cane have been distributed to more than 230 agencies and individuals.

Other diseases of sugar-cane are of minor importance in Cuba. Root rot, attributed to *Marasmius sacchari* and *M. stenophyllus*, and black rot, caused by *Melanconium sacchari*, principally attack injured or weakened canes. The latter fungus may also cause considerable damage to over-ripe cane. Red rind disease (*Colletotrichum falcatum*) and various leaf spot diseases due to *Leptosphaeria sacchari*, *Helminthosporium sacchari*, *Cercospora vaginae*, and *C. kopkei* are common but not destructive, while *Diplodia cacaoicola* [*Botryodiplodia theobromae*], *Thielaviopsis paradoxa*, *Hypochnus sacchari*, and *Sclerotium rolfsii* are relatively innocuous.

EARLE (F. S.). **Experiences with mosaic disease. Uba found to be immune in Cuba.**—*South African Sugar Journ.*, vii, 5, pp. 427–428, 1923.

During a recent visit to Cuba the writer was greatly impressed by the rapid spread of mosaic disease of sugar-cane in the island. Some fields in the Pinar del Rio province are infected to the extent of 50 per cent., while in the Guantanamo district the disease is also extremely severe. The yield in the latter locality has declined by one half since last year, partly on account of the drought, but also owing to the epidemic of mosaic. In spite of the wide publicity given to the Porto Rico experiments in the control of the disease [see this *Review*, i, p. 342 and also ii, pp. 88, 241], no concerted plan for the adoption of similar measures has been organized in Cuba, where the situation is becoming increasingly serious.

Uba, Zwinga, Cayania 10, and some of the slender North Indian varieties are immune from mosaic disease, and Crystalina is resistant. With the last-named variety the losses from mosaic under ordinary Cuban conditions vary between 20 and 50 per cent. Good cultivation and the liberal application of nitrogenous fertilizers. together with a plentiful rainfall, may keep the percentage of infection down to the lower figure. Infected fields cannot be kept in production for nearly so long a period as healthy ones, and this strikes at the root of Cuba's great advantage over most other cane-growing countries—the capacity to produce many ratoon crops without the expense of replanting the fields.

The use of healthy 'seed' and the roguing of partially infected fields (where the incidence of disease does not exceed 25 to 30 per cent.) will do much to prevent the spread of mosaic.

KUYPER (J.). **Het Wortelrot op Java, speciaal in verband met de Rietsoort EK 28.** [Root rot in Java, especially in connexion with the Cane variety EK 28.]—*Meded. Proefstat. Java Suikerind.*, 4, pp. 117–161, 2 diag., 1923.

Towards the end of 1921 root rot of sugar-cane was observed to be causing considerable damage in Java, especially on the variety EK 28.

The roots of affected plants were frequently stunted, crooked, or swollen, the shoots small and sickly, and the leaves yellow, crinkled, and covered with irregular withered spots. Sections through the base of the diseased shoots revealed grey, red, or reddish-brown discoloration of the tissues, which were slightly spongy in texture and sometimes dead. The growing points were more vividly coloured than those of healthy cane and the buds had a tendency to run out.

The etiology of the disease is still rather obscure. There appear to be two distinct kinds of root rot; the so-called 'anaerobic' root rot, which occurs chiefly on heavy, badly aerated soils saturated with stagnant water, and 'dry' root rot, which is primarily an affection of the setts, due to an insufficiency of water in the soil.

There is no evidence of a parasite being implicated, and whilst the similarity of the disease to grey speck of oats [see this *Review*, i, p. 417 and ii, p. 403] suggests that soil alkalinity may be the cause, experiments on this point have not yet been carried out.

Biennial rotation greatly increases the incidence of root rot; at least three years should elapse between one crop of sugar-cane and the next.

Exhaustive evidence is adduced to prove that there has been no increase in the percentage incidence of root disease in Java. EK 28 has been susceptible from the very first, but even allowing for a certain amount of disease it shows no sign of 'degeneration' and there can be no justification for a reduction of the area under this prolific and valuable variety.

Bertus (L. S.). **Grey blight of Tea and Coco-nut: a comparative study.** *Trop. Agric.*, lx, 2, pp. 109–112, 3 pl., 1923.

A study of the *Pestalozzia* spp. causing grey blight of tea and coco-nut leaves was made to ascertain the identity of the species affecting each host [see this *Review* i, p. 413]. Typical *Pestalozzia* spores on tea and coco-nut are fusiform, divided by four septa into a row of five cells of which the three central are light brown and the terminal hyaline. The apical hyaline cell is crested with one to four hyaline cilia and to the lower hyaline cell is usually attached the stalk on which the spore is borne. Abnormalities occur in the dimensions of the spores and in the number of coloured cells.

The species of *Pestalozzia* occurring on coco-nut was cultured on maize meal, French bean, and quaker oats agar. In all three media the chief feature of growth was the aggregation of the hyphae into white, later pinkish tufts, from the centre of which arose black pustules of spores. In the French bean and oatmeal media a stroma was formed, while in the maize meal a pseudostroma was present. The spores originated in distinct pycnidia of diverse shapes and sizes, consisting of a yellowish, pseudoparenchymatous wall, with no ostiole, the spores being liberated by a rupture of the wall at any point. They occurred singly or in groups, but a few spherical pycnidia were found embedded in the stroma or pseudostroma. The average dimensions of the spores on leaves in nature are 20·2 by 5·7 μ; on French bean agar 18·7 by 5·4 μ; on oatmeal 18·8 by 5·5 μ and on maize meal 18·5 by 5·7 μ respectively. The cilia were generally 2 to 5 μ in length, occasionally 10 to 12 μ; the stalk, when present, 1 to 3 μ, rarely 4 to 5 μ. In culture the cilia are shorter than in nature, and do not bear knobs at their ends.

Spores of the *Pestalozzia* found on tea were grown on the same media as above. A rich, flocculent growth of aerial hyphae ultimately developed into a thick, heavy, compact felt, spread over the medium, no tufts of hyphae being formed. A characteristic feature was the production of spores on loose hyphae. The growths on three different media are described in detail, a stroma or pseudostroma being formed on which pycnidia were mainly found. The latter varied in shape and dimensions and were enclosed by a pseudoparenchymatous wall, from which the spores were liberated at any part, but frequently the rupture occurred at the base. The average dimensions of the spores on tea leaves in nature are 25·6 by 6 to 7 μ; on French bean agar 27·3 by 6·7 μ; on oatmeal 27·4 by 6·9 μ, and on maize 26·6 by 6·8 μ. On all the media the cilia, which varied in number between two and four, were very long (up to 40 μ), and mostly knobbed. The length of the stalk varied from 3 to 10 μ.

The morphological and cultural differences between the two species are considered to justify the retention of the distinction which obtains at present. The Ceylon species on the coco-nut leaf is *Pestalozzia palmarum* Cooke and that on tea *P. theae* Sawada.

Gard (M.). **L'apoplexie de la Vigne. Les moyens de la combattre et d'y remédier.** [Apoplexy of the Vine. The means of controlling and curing it.]—*Rev. de Vitic.*, lviii, 1509, pp. 399–401, 1923.

Apoplexy of the vine [caused by the fungus *Fomes igniarius*: see this *Review*, i, p. 416, and ii, p. 437] may be effectually controlled by the application, during the winter, of arsenite of soda made up of 30 kg. carbonate of soda and 30 kg. of arsenious acid, dissolved in 60 l. of boiling water. Between 90 and 100 vines can be treated with 10 l. of the solution at an average cost of 1 to 1·5 fr. [about 3d. to 4½d.], exclusive of the price of labour. The vines may either be sprayed or painted with the solution.

Directions are also given for the excision of the diseased parts and for a special system of grafting to be practised on infected vines.

McGinty (R. A.). **Head Lettuce in Colorado.**—*Colorado Agric. Exper. Stat. Bull.* 283, 26 pp., 7 figs., 2 diag., 1923.

The most serious disease of lettuce in Colorado is tip burn, which causes a blackening of the edges of the inner leaves and the partial or total decay of the interior of the head. The disease appears to be of a physiological nature, and in the Imperial Valley it is correlated with excessive alkalinity of the soil. It is most prevalent when bright, hot weather succeeds a rainy period, and soils with an inadequate water supply are more favourable to the disease than those of high water-holding capacity. During storage or transit a slimy soft rot will often start in the tissues weakened by tip burn, causing total loss of the affected head. Even slightly diseased heads invariably develop a disagreeable bitter flavour.

The best remedies for tip burn are good seed and strict attention to cultural measures, with frequent light irrigations during hot, dry spells. Attempts to develop a resistant strain of lettuce are in progress.

The Uganda Customs (Amalgamation) Ordinance, 1918, Notices 5th May, 1923.—*Official Gazette, Entebbe*, p. 294, 15th May, 1923.

The importation into Uganda of sugar-cane plants or parts thereof, except under a written permit previously obtained from the Director of Agriculture, is prohibited.

Amendments to the Regulations under the Destructive Insect and Pest Act.—*Canada Dept. Agric. Exper. Farms Branch Div. Bot.*, 2 pp., 1923.

Amendment No. 20 (No. 3 of 1923) to the Regulations prohibiting the importation of certain species of *Berberis* into Canada provides for the addition of European buckthorn (*Rhamnus cathartica*) to the list of prohibited plants on account of its being a host of the crown rust of oats [*Puccinia coronata*].

Amendment No. 21 (No. 4 of 1923) provides for the addition of *R. cathartica* to the list of plants excluded from admission to the Prairie Provinces (Manitoba, Saskatchewan, and Alberta), and for its extermination, without compensation, within the aforesaid Provinces.

IMPERIAL BUREAU OF MYCOLOGY

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NICOLAISEN. **Solbar gegen die Braunfleckenkrankheit der Tomaten.** [Solbar as a remedy for the brown spot disease of Tomatoes.]—*Deutsche Obst- und Gemüsebauzeit.*, lxix, 19, pp. 147–148, 1923.

The brown spot disease of tomato leaves and stems, caused by the fungus *Cladosporium fuscum* [*C. fulvum?*], was very severe in the spring of 1922 on greenhouse plants of the Lucullus variety at Calbe [Saxony]. The plants were attacked quite suddenly and had a sun-scorched appearance. Four days after the affected plants and the surrounding soil were sprayed with 2 per cent. solbar; they recovered completely, and at the end of a fortnight they were equal to their healthy neighbours in size and vigour.

S. (G. N.). **Pine branch twist. A fungus disease on Pine, Melampsora pinitorqua.**—*Cyprus Agric. Journ.*, xviii, 1, p. 19, 1923.

Young pines [*Pinus*] up to twelve years of age have frequently been known to be attacked by a fungus, *Melampsora pinitorqua*, which interferes seriously with their growth, and recently two cases have been observed in the Paphos forest (Cyprus) although many other instances probably exist. The leading shoot bends over in the shape of a hook and usually dies, and the lateral shoots which subsequently grow up to take the place of the dead leader become infected in their turn. Occasionally the leading shoot recovers, but it is safer to cut it off below the diseased part. Young trees killed by the fungus or diseased parts excised from living trees should be burnt.

The reason for the twisting of the shoots is that the attacked side does not grow at the diseased spot while the other side grows normally and so causes the twig to bend over.

TROUP (R. S.). **The Cedar fungus.**—*Report on Forestry in Kenya Colony*, pp. 25–26, 1922.

The East African cedar [*Juniperus procera*] is attacked by a wood rot fungus, *Fomes juniperinus* [sec. Lloyd *F. demidoffii*] which also occurs on junipers in the United States. In Kenya it causes enormous losses in timber production, attacking the heartwood of standing trees. As a rule there is no external sign of attack, the presence of the disease being revealed only when the tree is cut open. Occasionally, however, the perennial ungulate fructifications may be found on the side of the tree, nearly always where a branch has been broken off. In its early stages the disease is characterized by the presence of small pockets of whitish, decaying tissue, and later by large, irregular hollows containing masses of brownish-yellow, felty mycelium. The tissues in the wood are disintegrated and permeated by the hyphae of the fungus.

To a large extent the disease may be controlled by the following preventive measures: (*a*) protection from fire and other injury; (*b*) cultivation in close crops in suitable permanent mixtures in order to effect natural pruning of the branches before they have begun to form heartwood; (*c*) periodical removal in thinnings of all stems with broken branches or wounds in which the heartwood is exposed.

CHAVASTELON. **Sur un traitement pratique et efficace des plaies des arbres.** [On a practical and efficacious treatment of the wounds of trees.]—*Comptes rendus Acad. d'Agric. de France*, ix, 17, pp. 474–476, 1923.

An efficient wound dressing, which will encourage thorough healing and at the same time preserve the exposed wood, is made as follows: hot solutions of potassium or sodium bichromate (6 per cent.) and copper sulphate (6 per cent.) are allowed to cool and then mixed. The resulting compound consists of undecomposed copper sulphate, potassium or sodium sulphate, and bichromate of copper ($Cr_2O_7.CuO.2H_2O$). The object of mixing the solutions cold is to prevent the formation of $CrO_4.Cu.2H_2O$, a reddish-brown chromate of copper which diminishes the strength of the solution.

The immediate effect of the application is a slight browning of the wood, any bichromate oxidizing and coagulating in the presence of the albuminoids and gums. The bichromate of copper, which is only slightly soluble, closes the pores and forms a durable reserve of chromic acid which is liberated by progressive dissociation, under the influence of the sap or of exterior water, of the chromate of copper into basic chromates. This weak concentration of chromic acid, while acting as a complete disinfectant, has no toxic effect on the plant and does not interfere in any way with the functions of the healing zone formed round the wound. Furthermore, the albuminoid substances of the exposed cells, coagulated and immobilized by the bichromates, contribute to the preservative action by completing the decay-proof crust formed by the chromate of copper.

Vertical and horizontal incisions on a variety of fruit trees and walnuts have been treated by the above method with complete success for the last seven years. Applied to the vine at or before the unfolding of the buds the same solution has proved highly beneficial, and also effectively controls fungous diseases, especially [downy] mildew [*Plasmopara viticola*] and *Oidium* [*Uncinula necator*]. For the latter purpose the solution may be reduced to half the strength recommended above.

WEIR (J. R.). **The effect of broadcast burning of sale areas on the growth of cull-producing fungi.**—*Journ. of Forestry*, xxi, 2, pp. 183–184, 1923.

The most important cull-producing fungi found on stumps and slash on sale areas in Idaho and Montana after the merchantable timber is removed, and the ground burnt over, are as follows: *Poria subacida* (form), chiefly on stumps and cull butts of spruce and white pine; not fruiting. *P. weirii*, completely destroying all cull butts of western red cedar [*Thuja plicata*] and in the duff [dead leaves, broken branches, &c., accumulated in a forest] around the stumps. *Polyporus schweinitzii*, chiefly on stumps, cull butts, and in the duff of Douglas fir, larch, white pine, spruce, and in a lesser degree on other species. The fungus is more apt to reappear from infected roots at some distance from the stump than at the stump itself; the root crotches tend to hold the fire and the mycelium is destroyed. *Trametes pini* on stumps, cull logs, and large branches of white pine, larch, Douglas fir, spruce, and other species; not fruiting. *Fomes roseus* on stump cull logs of Douglas fir; not fruiting. *F. laricis* on stump cull logs and tops of larch, yellow pine [*Pinus ponderosa*], and Douglas fir; rarely fruiting from the charred ends of large cull butts. *F. pinicola* on stumps and cull logs of grand fir [*Abies grandis*] and larch; fruiting occasionally. This fungus is the least important of the group. *F. annosus* entirely destroying stump cull butts of grand fir, larch, and white pine. *Echinodontium tinctorium* on cull logs of grand fir, lowland and mountain hemlock [*Tsuga heterophylla* and *T. mertensiana* Sargent]; not observed to produce sporophores. *Armillaria mellea* on reproduction chiefly of Douglas fir, larch, and white pine, also mature trees attacking roots and débris in the duff; rarely appearing after the fire.

The majority of the cull fungi fruit with difficulty in the open exposed conditions of a clean cut area except on infected standing trees. Only when there is a large amount of slash and vegetation reproducing the moisture and shade conditions of the closed forest do sporophores appear in excessive numbers on the débris of a sale area. Such conditions may be expected to obtain in the white pine belt of Idaho. The destruction of the vegetation and the smaller kinds of slash and the charring of the stumps and logs prevents a return to the closed forest conditions.

Charred stumps and logs are rarely re-infected by the cull fungi of the living tree. Such sporophores as do appear must in most cases be produced by the living mycelium in the heartwood that did not succumb to the heat of the fire.

True saprophytes, such as *Trametes odorata*, *Lenzites saepiaria*, *Polystictus abietinus*, *Poria selecta*, *P. carbonaria*, and various species of Thelephoraceae regularly infect and destroy the inner wood of charred slash, entrance being effected through the season checks. The evidence shows that from the standpoint of a diminution of the sources of infection to standing timber broadcast burning may, in certain cases, be regarded as good silviculture.

Eastham (J. W.). **Sweet Potato diseases.**—*Agric. Journ. Brit. Columbia*, viii, 4, pp. 83 and 86, 1923.

The writer emphasizes the importance of preventing the introduction into British Columbia of black rot (*Sphaeronema fimbriata*) and other diseases of the sweet potato. Short of placing a total embargo on the importation of sweet potatoes, which would be a very severe handicap to trade, the only measures which can be adopted for the protection of British Columbian crops are the use of certified seed from healthy plants, the rejection of any roots showing signs of disease, and the disinfection of seed, before planting, with 1 oz. corrosive sublimate to $6\frac{1}{4}$ imperial gallons of water. Fresh soil should be used every year for the hot-bed, the woodwork being previously sterilized by swabbing with 2 lb. of copper sulphate or 3 lb. formalin to 40 galls. of water.

Diffloth (P.). **Les ennemis de la Vigne. Galles et cryptogames.** [Enemies of the Vine: galls and cryptogams.]—*La Vie agric.*, xxii, 22, pp. 367–370, 4 figs., 1923.

The following fungous diseases of the vine [in France] are briefly described and appropriate measures for their control recommended: black rot, caused by *Guignardia bidwellii*; grey rot [*Botrytis cinerea*]; powdery mildew (*Uncinula necator*); anthracnose (*Sphaceloma ampelinum*); canker (*Cryptosporella viticola* and *Glomerella cingulata*). One bacterial disease (crown gall, caused by *Bacterium tumefaciens*) is also briefly noticed.

Stiegler (A.). **Der echte Meltau (Oidium tuckeri) und der falsche Meltau (Peronospora viticola) sowie deren Bekämpfung.** [Mildew (*Oidium tuckeri*) and downy mildew (*Peronospora viticola*) and their control.]—*Allg. Weinzeit*, xl., 4, pp. 51–52, 1923.

The first application of sulphur for the prevention of mildew (*Oidium tuckeri*) [*Uncinula necator*] should be given as soon as the fruit is set and the second towards the close of the blossoming. Further applications need only be given if there is reason to fear a severe outbreak of the disease. For the control of downy mildew (*Peronospora* [*Plasmopara*] *viticola*) a 1·5 per cent. Bordeaux mixture or Bosna copper paste should be given just before, and a second spray (1·75 to 2 per cent.) immediately after, flowering. One or two more applications at 1·5 per cent. should be given if the weather conditions appear favourable for the outbreak of the disease. This treatment will also be found useful in the control of 'rotbrenner' [*Pseudopeziza tracheiphila*], which has caused much damage of recent years in the dry, stony soils of Styria [Austria].

The author particularly recommends for the spraying operations the 'Flick' apparatus, the construction and use of which is described.

Hengl (F.). **Vergleichende Versuche gegen verschiedene Rebenschädlinge.** [Comparative experiments in the control of various Vine pests.]—*Allg. Weinzeit.*, xl, 2, p. 5, 1923.

The continuation is reported of the regular annual experiments in the control of vine pests carried out by the Vienna Plant Protection Institute and the Association of Austrian Vinegrowers. Owing to the abnormally dry weather conditions during the 1922 season, fungous pests were very little in evidence. The results of the tests may be summarized as follows: I. Experiments in the suppression of 'roter Brenner' (*Pseudopeziza tracheiphila*) on Veltliner grapes. Satisfactory results were obtained by the use of alkaline Bordeaux mixture, 'Bosna' copper paste, 'Bosna B' (copper zinc paste), and kurtakol. II. Downy mildew (*Peronospora* [*Plasmopara*] *viticola*). Good results were secured by three applications, on 6th June, 20th June, and 14th July respectively, with alkaline Bordeaux mixture, Bosna, Bosna B, Caffaro-Bosna, cuprolpasta, and kurtakol. III. Mildew (*Oidium tuckeri*). A number of wet and dry fungicides were tried against this disease but owing to the mildness of the mildew attack their efficacy could not be gauged.

RECKENDORFER (F.). **Die Rotbrennerbekämpfung.** [The control of 'rotbrenner'.]—*Allg. Weinzeit.*, xl, 4, pp. 52–53, 1923.

The 'rotbrenner' disease [caused by *Pseudopeziza tracheiphila*] has for some years past been very prevalent in all parts of Austria [see also this *Review*, ii, p. 302] where the red, red-white, and brown Veltliner vines are extensively cultivated, the red-white Veltliner variety being especially susceptible.

The fungus overwinters on the fallen leaves, where it produces ascospores in the spring. The young leaves nearest the ground are infected by the ascospores, the affected parts turning red (in black varieties) or whitish-yellow (in white varieties) and withering. In severe cases defoliation ensues and the fruit is also attacked. The development of the roots is arrested, the wood matures badly, and the fruit fails to ripen. The disease also affects the next year's growth.

Treatment with 2 per cent. Bordeaux mixture or Bosna copper paste is recommended, beginning about the middle of May.

TAYLOR (W. H.). **Vine culture under glass. Diseases and pests of the Vine.**—*New Zealand Journ. of Agric.*, xxvi, 3, pp, 172–177, 1923.

Powdery mildew (*Uncinula necator*) attacks the vine during the early stages of growth and also in the autumn. The disease can be controlled by a dusting of dry flowers of sulphur applied immediately the first symptoms appear. Should an epidemic occur during the stoning period, however, more drastic measures must be adopted. A good handful of sulphur should be mixed with sufficient milk to make a thin paste, and diluted with about 2 galls. of tepid water. All the vines and walls of the house should be syringed with the solution about an hour before the sun leaves the roof. The top ventilator should be closed during the treatment and reopened before daybreak in order to dry the vines before the sun reaches them. On the evening of the next day but one, the vines should be syringed with clean tepid water.

The germination of the spores of *U. necator* is favoured by excessive cold on tender vegetable surfaces. The sun in the early morning, or more frequently newly admitted air, causes sudden evaporation of the moisture collected during the night, lowering the temperature and thereby producing conditions favourable to infection. Hence the ventilators should be opened early before the sun shines and care taken to avoid draughts.

Vine *Sclerotinia* (*S. fuckeliana*) occurs only in a very damp atmosphere and may be prevented by proper ventilation. The mould form of the disease can be checked by spraying with liver of sulphur at the rate of ½ oz. per gall. of water.

Grape spot (*Gloeosporium fructigenum*) is usually restricted to thin-skinned white grapes. Spraying is not practicable and the only remedy is to increase the ventilation and prevent an accumulation of moisture during the night.

Shanking or withering of the pedicels of the berries and stems of the bunches, which results in sour and uneatable fruit, is due to an imperfect balance between the root and top. An excess of organic matter in the soil induces the formation of soft, spongy roots and a correspondingly excessive growth of soft foliage early in the season. Later the death of the spongy roots leaves the vines with insufficient roots to feed the superfluous foliage. The remedy for this trouble is to restrict the activity of the roots by rigid and timely suppression of early lateral growth. Cold and acid subsoils and very thin leaves are predisposing causes of shanking.

Scalding, due either to the direct action of the sun's rays or to sudden variations in temperature, sometimes causes serious losses during the stoning period. A frequent cause of scalding is an unduly wide range between day and night temperatures, combined with atmospheric moisture. Damping down should therefore be reduced to a minimum and a little top air left on all night, being increased in the very early morning to prevent a sudden rise of temperature. During the day the temperature should be kept as low as is consistent with proper ventilation.

Warted leaves are generally found on vines growing in rich soil in the warmer districts. The damage is done by a sudden evaporation of moisture from the gross foliage, usually caused by a current of cold air.

Aerial roots may be due to the defective action of roots in cold soil, or to a warm or moist atmosphere combined with a lack of proper ventilation due perhaps to poor drainage.

PLUNKETT (O. A.), YOUNG (P. A.), & RYAN (RUTH W.). **A systematic presentation of new genera of fungi.**—*Trans. Amer. Microscop. Soc.* xlii, 1, pp. 43–65, 1923.

The new families and genera of fungi described since Volume xxii of Saccardo's *Sylloge Fungorum* was compiled, are here assembled from all the available literature and presented in a concise, classified form with the reference accompanying each new name.

As far as is known, there has been no previous compilation of the new genera of fungi described since 1910, and its absence has necessitated a constant searching of extensive and scattered literature for any special type required. This paper will be of value to mycologists who require a survey of the systematic work carried out during the last twelve years. There are, however, many omissions.

The list of genera covers about 7,000 new species of fungi. It is an abbreviation of a catalogue entered on cards in taxonomic order, and giving the citation, classification, name of the genus, and generally the host of the fungus. Of the new species 800 belong to the Sphaerioidaceae, 700 to the Agaricaceae, 300 to the Pucciniaceae, 200 to the Dematiaceae, 200 to the Microthyriaceae, 200 to the Pleosporaceae, 150 to the Mycosphaerellaceae, and 100 to each of the following families: Dothideaceae, Hypocreaceae, Melanconiaceae, Moniliaceae, Polyporaceae, Sphaeriaceae, Thelephoraceae, Tuberculariaceae, and Valsaceae.

A bibliography of the publications consulted for the work, comprising 89 titles, is appended.

Астраханская Станция Защиты Растений от Вредителей.—Отчет за год Окт. 1921—Окт. 1922 г. [Astrakhan Plant Protection Station.—Report for the year Oct. 1921–Oct. 1922], 40 pp., 1922. [Rec'd. 1923.]

The year under review was marked by continued difficulties arising mainly from financial stress, which greatly hindered the scientific research work of the Station. The latter was, however, able to extend its activity by the creation of three branch offices and by establishing an instructor in phytopathology in each of nine districts into which the province was divided. Considerable additions were also made to the collections and library of the Station.

Most noticeable among the diseases of cultivated plants during the year were: black rot canker of apple (*Sphaeropsis malorum*), which killed a large number of trees in the best orchard districts and was also occasionally found on pear trees; apple and pear scab (*Fusicladium dendriticum*) [and *F. pirinum*], apple leaf spot (*Phyllosticta briardi*), pear leaf spot (*Septoria piricola*), cherry leaf spot (*Cercospora cerasella*), and plum leaf spot (*C. circumscissa*), peach leaf curl (*Exoascus deformans*), plum 'scorch' (*Polystigmina rubra*), and pear rust (*Gymnosporangium sabinae*). Corn crops suffered heavily, especially in irrigated fields, from various kinds of smut and rust. A new functional disease, strongly resembling mosaic, appeared on potatoes, greatly reducing the crops, and attacking also, but more rarely, tomatoes and eggplants (*Solanum melongena*) which perished in a few days. In some cases a rotting of potato tubers was observed in the soil, but the cause has not yet been determined. Vegetable marrows were heavily attacked by the semi-saprophyte *Sporidesmium mucosum* var. *pluriseptatum*. The station recorded for the first time the appearance of *Oidium tuckeri* on the vine in some districts, which caused very appreciable losses.

Borg (P.). **Report of the Plant Pathologist 1921–1922.**—*Malta Govt. Gaz. Suppt.* xxi, pp. 278–280, 1923.

Potato blight (*Phytophthora infestans*) appeared early in November on the winter crop of potatoes and caused a heavy reduction in the yield, the weather being very favourable for its development. The first outbreaks on the spring crop were also rather virulent, but a serious epidemic was averted by extensive spraying and also by the continuation of dry weather.

Owing to the protracted spell of hot, dry weather in March [1922] downy mildew of the vine [*Plasmopara viticola*] did not develop to any great extent, but spraying with normal Bordeaux mixture was carried out on a large scale as a precautionary measure. The treatment of *Oidium* [*Uncinula necator*] has now become a matter of routine in most vineyards. The disease known as 'roncet', the etiology of which is obscure, appeared on many vines of the Rupestris du Lot variety in the American vine nurseries at Gozo and elsewhere. The only known remedy is the removal of infected plants before the second year after the appearance of the disease.

Departmental Activities: Botany.—*Journ. Dept. Agric. S. Africa*, vi, 5, p. 381, 1923.

Leptothyrium pomi, the cause of 'sooty blotch' and 'fly speck' in apples, has been identified on apples from the Transkei and Natal, this being its first recorded appearance in South Africa. Whilst the injury does not penetrate very far, the unsightly appearance of affected fruit impairs its market value, and badly diseased apples often look shrivelled or wizened. The dark coloured blotches on the surface of the fruit are irregular in outline but tending to be circular, and they may be so numerous that the fruit appears as if covered with soot. 'Fly speck' is another aspect of the same disease. In this case groups of six to one hundred black, shiny dots, which appear on the surface of the apple, recall fly-blown specks, hence the name. Damp situations and abundant rain in the summer favour the development of the fungus, which can be controlled by several applications of a lime-sulphur spray, as in the treatment for apple scab.

'Vrotpootje' of wheat is still being studied by the Department. Particulars obtained from diverse sources would seem to indicate that more than one disease is known by this name. Thus, a case from the Koeberg District has been diagnosed as a foot rot, due probably to a species of *Fusarium*, while from another region the disease resembles the 'take-all' and 'whitehead' disease (*Ophiobolus cariceti*) known in Europe and other parts of the world.

Dickson (J. G.). **Influence of soil temperature and moisture on the development of the seedling-blight of Wheat and Corn caused by Gibberella saubinetii.**—*Journ. Agric. Res.*, xxiii, 11, pp. 837–869, 6 pl. (2 col.), 15 graphs, 1923.

Gibberella saubinetii may attack wheat and maize seedlings in varying degrees of intensity, resulting (*a*) in blight before emerging from the soil, with a consequent reduction in stand; (*b*) in a yellowing and wilting of the seedling after it emerges; and (*c*) in a stunting of the seedling owing to the enfeeblement of the root system. In both wheat and maize the invaded tissues turn reddish-brown to carmine red, according to environmental conditions. The chief difference between the symptoms of the disease on the two hosts is the more definite character of the lesions on the larger stems and roots of maize. In both plants the period of severe infection is usually restricted to the seedling stage. Seedling blight develops from two chief sources; scabbed or infected seed and infested soil. The mycelium of the fungus hibernates in or on the scabbed kernels of wheat, many of which show no marked external symptom of disease before sowing, and also in the seed of maize. The organism develops as a saprophyte on decaying crop refuse near the surface of the soil and assumes a parasitic character only when the seedlings are weakened by unfavourable conditions.

The results of pure culture experiments, the technique of which is fully described, showed that the parasite functions normally over a fairly wide range of temperature, namely, from 3° to 32° C. The optimum temperature for spore germination, vegetative development, and sporulation was found to be about 24° on unacidified and 28° on acidified media.

It was further shown by comparative experiments in the development of wheat and maize at different soil temperatures that the former is favoured at all stages of growth by a low temperature (16° to 20° C. for spring wheat and 12° to 16° for winter varieties), and the latter by a high one (24° to 28° C.).

The temperature of the soil is undoubtedly the most important single factor determining the extent of seedling blight. The most favourable soil temperature for the infection of wheat was found to range from 12° to 28° C., while the corresponding figures for maize infection were 8° to 20° C.

It was also shown that low soil moistures favour the infection of wheat seedlings at all temperatures, and at low temperatures may be the factor determining infection. Thus at 8° C. soil temperature, 72 per cent. of the seedlings grown in soils at 30 per cent. of their moisture-holding capacity were blighted, and 44 per cent. of those grown at 45 per cent. moisture, whereas at 60 per cent. soil moisture no blight occurred.

In order to check the results obtained under greenhouse conditions of the effect of temperature and moisture on infection, a series of periodic field sowings were made at Wisconsin during the spring and autumn of 1920 and the spring of 1921. It was thought that such trials might point towards possible remedial measures against this and similar diseases. The results under field conditions corresponded with those obtained in greenhouse tests. Sowing when the soil is cool, that is, spring wheat at the earliest safe date in the spring and winter wheat at the latest safe date in the autumn, reduces seedling blight [see this *Review*, i, p. 168].

Maize, on the other hand, should be sown when the soil is warm, at the latest safe date in the spring. The critical soil temperature for the seedling blight of wheat is about 12° C. as determined both in constant soil temperature tanks and in the field, where the temperature was estimated by the mean daily field soil temperature, the corresponding figure for maize being 20° to 24° under both greenhouse and field conditions. Mean soil temperatures for periods of considerable duration are more influential as factors in the production of seedling blight and similar diseases than brief extremes of soil temperature. The influence of environmental factors on the hosts appears to be the fundamental cause of susceptibility to the disease, the seedlings becoming susceptible when they are unable to respond favourably to the environment.

A bibliography of 34 titles is appended.

DREGER (C.). **Praktische Erfahrungen eines Züchters mit der Bekämpfung von Pflanzenkrankheiten.** [The practical experiences of a breeder in the control of plant diseases.]—*Weiner landw. Zeit.*, lxxiii, 25–26, pp. 102–104, 1923.

After many years' experience in the cultivation of cereals, the writer recommends the control of diseases by selection only when the disease cannot be more speedily and effectually combated by mechanical or chemical treatment. Yellow rust of wheat (*Puccinia glumarum*) has not yet been adequately controlled by mechanical or chemical means, and the same applies to brown rust of wheat and rye (*Puccinia triticina* and *P. dispersa*) and to barley leaf spot (*Helminthosporium teres*). With the exception of the first-named, however, these diseases do not cause sufficient damage [in Austria] to justify any great expenditure of time and labour on plans for their control.

The hot water treatment of loose smuts of wheat (*Ustilago* [*tritici*]), barley (*U.* [*nuda*]), and oats (*U.* [*avenae*]) is described at length. As regards loose smut of barley, the seed may safely be heated to a temperature of 53° to 53·5° C. for ten minutes after a preliminary soaking of eight hours at a normal temperature, without any risk of reduced germination. It has frequently been stated that the thick-eared or 'erectum' varieties of barley are immune from loose smut, but the writer has not found this to be the case. For the control of loose smut of wheat the seed should be heated to a temperature of 52° for ten minutes (54° for summer wheats). Both for barley and wheat the eight hours' presoaking is essential to the success of the treatment. Wheat is considerably more difficult to treat than barley, owing to the variations in the time of treatment required.

In the case of loose smut of oats no preliminary soaking is required, as the fungus is outside the seed. The writer has secured excellent results for many years by a preliminary heating at 45° followed by hot water treatment for ten minutes at 56°. Stripe disease of barley (*Helminthosporium gramineum*), the incidence of which has greatly increased of recent years, was completely controlled by immersion of the seed in 375 gm. of uspulun per hl. of water for one hour. The seed had previously been treated with hot water, but this process alone does not give adequate control.

Bunt of wheat (*Tilletia tritici*) cannot be effectively controlled by the hot water treatment. The writer tested a number of fungicides and obtained the best results by immersion of the seed in 500 gm. 40 per cent. formaldehyde per hl. of water for fifteen minutes. It is essential that the spore balls should be removed by a preliminary immersion in water. The writer has observed that animals are frequently fed on smutted grain, with the result that the infection is perpetuated in manure. The organism is evidently capable of leading a saprophytic existence in the soil for at least two years, since wheat sown by the writer was found to be heavily infected, in spite of treatment with formalin, presumably by the spores of smutted wheat grown in the same field for experimental purposes two years earlier.

Tower (W. V.). **Citrus scab.**—*Porto Rico Agric. Exper. Stat. Agric. Exten. Note* 53. [Reprinted in *Trop. Agric.*, lx, 4, pp. 224–226, 1923].

Scab [see this *Review*, ii, p. 364] is the most severe disease of citrus in Porto Rico. During the early years of the industry only young trees were attacked, but at present many valuable old trees are producing inferior fruit as a result of the disease.

The results of the first season's co-operative spraying experiments on a large estate are very encouraging. The weather was exceptionally wet and the blooming period much prolonged. Four applications of Bordeaux oil [see this *Review*, ii, pp. 363, 364] were given to 3,000 trees on 29th December, 27th January, 13th February, and 9th March respectively. The results were as follows: clean fruit 94·4 per cent.; trace of scab 5·2 per cent.; slightly scabby 0·4 per cent. Check trees in one of the worst infected groves showed only 10 per cent. clean fruit. Sprayed trees in this grove showed 90·6 per cent. clean fruit. Another grove was divided into three sections, one part was sprayed four times, another twice, and the third left as control. The percentages of clean fruit were 91·2, 83·9, and 24·5. Results similar to the above were obtained in other groves.

The author issues a warning with regard to scale insects, however, as the beneficial fungi will be killed and spraying against scale insects may be counted upon as necessary.

Recent tests with oil emulsion have been made at the Experiment Station on grapefruit trees with fruit six months old, the solution being used at 1·5, 2, 2·5, and 3 per cent. strengths. There was no defoliation or injury to the fruit. In all the tests with 3–4–50 Bordeaux plus 0·5 per cent. of oil there was a slight burning of the young shoots but no injury to open blossoms or small fruit.

Details regarding convenient arrangements for carrying out the spraying are added.

Fawcett (H. S.). **Gummosis of Citrus.**—*Journ. Agric. Res.*, xxiv, 3, pp. 191–232, 8 pl., 1923.

Pythiacystis gummosis, which first attracted attention in the Azores in 1834 and subsequently spread to most other citrus-growing countries, is the most widespread and destructive of citrus gum diseases in California. On the highly susceptible common lemon (*Citrus limonia*) the disease is characterized by copious exudations of gum and large dead areas of bark on the trunk and main roots, followed by yellowing and dropping of leaves. On sweet orange (*C. sinensis*) and other semi-resistant forms the dead patches are smaller. The gum may arise not only from the margin of the infected area but also from a large contiguous, outer, non-invaded zone. In the invaded area of the bark the tissues are coloured mineral brown to burnt umber or fawn, and the same discolorations are found usually extending about 2 to 5 mm. into the outer layers of the wood. In the outer gummous zone the cambium is chamois to yellow-ochre in colour. Gum pockets, 2·5 to 5 cm. in longest axis, are frequently formed, the clear, watery gum hardening as it comes to the surface and turning chestnut-coloured. It has been shown by experiments that the disease is readily transmissible to healthy trees by inoculation with fragments of bark tissue cut from the advancing margins of destroyed regions, but not by tissue from the outer gummous zones or by old dead tissue. Cultural tests demonstrated that live mycelium of *P. citrophthora*, the causal organism of lemon brown rot, was present in the narrow band or fringe at the advancing edges of the invaded zone. Elsewhere the mycelium was absent or dead. Numerous inoculation experiments with pure cultures of the fungus on healthy trees under various conditions resulted in the reproduction of the typical symptoms of the disease. *P. citrophthora* was re-isolated from many bark lesions in which it had been present from one to eleven months. Lemon fruits affected by *Pythiacystis* brown rot were shown to be capable of inducing the same type of gummosis as that caused by the fungus from gummosis lesions. The inoculation of branches and large roots produced less severe infection than that of the trunk.

A species of *Fusarium* is commonly found to be associated with *Pythiacystis* gummosis, and the results of a few tests indicated that it aggravates the severity of the disease but is incapable of initiating it.

Observations and experiments both showed the following decreasing order of resistance to *P. citrophthora*: sour orange (*Poncirus trifoliata*), rough lemon (a resistant variety of *C. limonia*), pomelo (*C. grandis*), sweet orange, and common lemon. The inoculation of small roots of young trees indicated that common lemon roots are somewhat susceptible and those of sour and sweet orange and pomelo resistant.

'Mal di gomma', due to *Phytophthora terrestris*, was shown to be similar to the damage caused by *P. citrophthora* at the junction of the main roots and trunk of old orange trees in California. Inoculations with both these fungi, under identical conditions, produced similar lesions.

Experiments showed that the disease may be largely prevented by the application of Bordeaux mixture or paste to the trunks and arrested in its progress by the excision of the affected bark and treatment with a suitable fungicide. The outer gummous zone eventually recovers and need not be removed.

Botrytis gummosis causes a softening of the invaded bark in the early stages and on this area are produced conidiophores and conidia in damp, cool weather. In the later stages the outer layer of bark is killed and hardens long before the inner layer. As in *Pythiacystis* gummosis, there is a non-infected, outer gummous zone. There is a stronger tendency towards the removal of the bark under the dead layer than in *Pythiacystis* gummosis, and the flow of gum is less copious. In California the *Botrytis* gummosis is almost exclusively confined to trees over ten years of age growing in the coastal regions and it is much more dependent than *P. citrophthora* on wounds or other predisposing conditions. A strain of *B. cinerea* has been isolated from numerous lesions on trees affected by gummosis, and the inoculation of healthy lemon trees with fragments of the diseased bark and pure cultures of the fungus resulted in typical symptoms of the disease. Attempts made to induce gum formation by various kinds of wounds on lemon tree trunks gave negative results when the wounds were kept free from contamination by injurious organisms or chemicals. The disease may be effectively controlled by cutting or scraping away the dead bark, leaving intact the live inner layer next to the cambium, and painting the treated area with Bordeaux paste or one of the coal-tar products containing only the heavier oils.

Sclerotinia libertiana is occasionally found associated with rapid drying of the bark on the roots and trunks of citrus trees growing in damp, cool situations, especially after severe frosts. At first there is a plentiful flow of gum and the bark is soft, but subsequently the latter dries into long shreds and usually contains flat, black sclerotia. Though the fungus normally advances more rapidly than *Botrytis*, it is soon arrested and callus begins to form when the gum accumulates. The results of inoculation experiments with pure cultures showed that the fungus is able to produce the typical symptoms of the disease on healthy lemon tree trunks.

A number of other organisms, besides the *Fusarium* referred to above, commonly found on the dead or decaying bark of citrus trees were used in inoculation experiments on lemon and orange trees to ascertain their relation, if any, to gummosis. A slight amount of gum exudation from cuts was produced by *Penicillium roseum*, *Diplodia* sp., *Coryneum beijerinckii*, *Coprinus atramentarius*, *Alternaria* sp., and *Hypholoma* sp. No definite pathological symptoms, however, were produced. Negative results followed inoculation with *Cladosporium* sp., *Rhizopus* sp., *Spegazzinia ornata*, *Penicillium digitatum*, and *Pseudomonas cerasi*.

Gum in citrus is similar to cherry gum and gum arabic, and appears to originate mainly in the xylem tissues by hydrolysis of the cellulose walls. Mechanical injuries, continuous pressure on the bark, and obstructions in the sap current by the insertion of glass or wooden plugs and the like are incapable of causing gum formation in citrus trees when the tissues are healthy and not irritated by such chemical stimuli as hydrocyanic acid, spray mixtures containing copper sulphate not properly neutralized with lime, or ant poison containing arsenic. Injuries by certain insects, e.g. *Tortrix citrana* and grasshoppers, sometimes cause slight gum formation, probably due to secretions by the insects or to contamination.

Observations and experiments indicate that burning, freezing, and partial desiccation are not in themselves important factors in gum formation in citrus but merely aid the wood-rotting organisms which later induce gummosis.

Certain chemical substances, chiefly acids, alkalis, and salts of heavy metals (especially the last-named), can induce gum formation when injected into citrus bark. In no case was it possible, however, to reproduce all the symptoms of any of the gum diseases by such injections.

The results of comparative experiments with filtrates from diseased and healthy tissue show that the former contain a substance capable of passing through a fine clay filter and inducing gum formation. This was destroyed by boiling, indicating the presence of a heat-sensitive enzyme in the filtrate from diseased tissue.

A bibliography of 65 titles is appended.

FAWCETT (H. S.). **Gum diseases of Citrus trees in California.**— *California Agric. Exper. Stat. Bull.* 360, pp. 370–423, 15 figs., 1923.

In this paper the available data on various types of citrus gummosis are presented, with special reference to the incidence of the diseases under California conditions. A full scientific description of the *Pythiacystis*, *Botrytis*, mal di gomma, *Sclerotinia*, and other milder forms of gummosis has been published elsewhere [see preceding abstract].

In California the type of gummosis induced by *Pythiacystis citrophthora* is most prevalent on damp, heavy soils in the coastal districts and occurs chiefly on lemon trees budded low on sweet orange stocks. Temperature also plays an important part in the development of the disease, which would explain the slow progress of the disease during dry, hot periods and in the valleys of the interior. Deep planting or the accumulation of soil next to the stems also assists in the development of the disease. Full directions are given for the control of *Pythiacystis* gummosis by various methods, according to the age and condition of the trees and other factors. Among other forms of treatment may be mentioned spraying with Bordeaux mixture; cutting out infected tissues and painting the wound with Bordeaux paste, benzine-asphalt, or other suitable mixture; cutting back the tops of severely affected trees; and bridge grafting or inarching in certain cases.

Phytophthora terrestris, the causal organism of mal di gomma, has only once been isolated from an orange tree in California, viz. in 1912, though the same or a closely allied species appears to be very prevalent in Florida, Cuba, the Argentine, Jamaica, and India. In Florida it causes a severe type of gummosis known as foot rot. A certain form of this disease so closely resembles the *Pythiacystis* gummosis as to be distinguishable only by careful laboratory examination, and the control methods in both cases are practically identical. The temperature relations of the two fungi are somewhat different [see this *Review*, i, p. 312], the optimum for *Phytophthora terrestris* being about 30° C.

Botrytis cinerea and *Sclerotinia libertiana* each causes a form of gummosis [the symptoms of which are described in the preceding abstract]. The control methods are essentially the same as those recommended in the case of *Pythiacystis* and mal di gomma.

Psorosis or scaly bark, the most conspicuous feature of which is the occurrence on the trunk and large branches of irregular scales of bark, ¼ to 1 inch in diameter, develops extremely slowly and it has not yet been possible to ascertain the cause of the disease. It is believed, however, that a parasitic organism is involved. The disease is usually most active in the summer and early autumn when it is accompanied by gum formation and exudation, the gum appearing to arrest rather than promote the advance of the disease.

Control measures for psorosis vary with the different stages of the disease. At the beginning only an outer layer of bark appears to be injured and the affected bark may be scraped rather deeply and the surrounding bark very lightly for four to six inches in all directions beyond the margin of the diseased areas. When, however, the latter have extended so as to cover about one-third of the circumference of the trunk, they should be scraped and disinfected and the process repeated again six months or a year later. When the disease has been present five, ten, or more years, there is little hope of a permanent recovery, but such trees frequently remain productive for a considerable time, and in cases of only moderate severity the progress of the disease may be checked by drastic pruning and the application of benzine-asphalt or some other covering to the bark after excising the decayed areas. The results of experiments indicate that the best time for treatment is during the late spring and summer months. Mercuric cyanide (1 part in 500 of water) and alcohol (500 parts) is an excellent disinfectant.

Diplodia gumming occurs frequently in California, especially San Diego, in connexion with the 'heart rot' following severe frosts. It may be prevented to some extent by treatment with a suitable non-air-tight disinfectant, and by whitewashing all the pruned parts of the tree to avoid sunburning.

Twig gumming, due to an unknown cause, occurs in California and Arizona. It is characterized by the sudden wilting of leaves and dying back of twigs to a distance of one to two feet from their tips. At the base of the dead portion the bark splits and gum is plentifully exuded. The disease often occurs after periods of drought, and treatment on the lines described under *Diplodia* gumming is recommended.

Exanthema or die-back, of only secondary importance in California, is believed to be due to nutritional disturbances and is characterized by dark excrescences and multiple buds on the branches, the dying back of terminal branches, compact, shortened growth, and dark irregular reddish-brown patches on the surface of the fruit. Clear gum exudes from the pockets on the twigs or is found internally near the centre of the fruit at the angles of the segments. The use of nitrogenous fertilizers, which are considered to aggravate the disease in Florida, has not proved injurious under California conditions.

Minor forms of gumming associated with *Penicillium roseum*, a species of *Fusarium* [see preceding abstract], *Alternaria citri*, *Bacterium citriputeale*, and various fungi, as well as with insect injuries and chemical stimuli, may generally be controlled by the methods outlined above.

Gadd (C. H.). **A possible physiological cause of 'nut-fall' of Coco-nuts.**—*Trop. Agric.*, lx, 2, pp. 112–114, 1923.

The fall of immature coco-nuts in Ceylon cannot always be attributed to the attacks of *Phytophthora* since it frequently occurs in the absence of any pathogenic organism. Comparison with the fall of young fruits after a period of drought in the case of citrus and other plants suggests that a similar cause may be responsible for the nut fall of the coco-nuts. The latter, however, takes place in Ceylon principally on the heavy loam of the Kurunegala district during the rains of the north-east monsoon, which tend to produce a water-logging of the soil and thus interfere with the absorption of water and the aeration of the root system. The author suggests that these adverse conditions may result in premature dropping of the fruits.

Armstead (Dorothy) & Harland (S. C.). **The destructive effect of micro-organisms on raw Cotton and Cotton fabrics: a summary of the literature.**—*Journ. Textile Inst.*, xiv, 6, pp. T 157–T 160, 1923.

Cotton, both in the raw and when manufactured, is subject to fungous attack, which results in 'tendering', due chiefly to bacterial action, or in discolorations with or without pronounced 'tendering'. The various fungi are known collectively to the industry as 'mildew'. The size employed in yarns and fabrics provides an excellent medium for the growth of many fungi, and generally an antiseptic is added in order to prevent such growth.

The authors divide the literature on the subject under the heads: bacteria and fungi. Amongst papers dealing with the former, brief extracts are given of four, which particularly interest the cotton industry, and of those relating to fungi ten are shortly summarized. A list of references terminates the paper.

Ritzema Bos (J.). **Eene nieuwe ziekte van de Zonnebloem.** [A new disease of the Sunflower.]—*Tijdschr. over Plantenziekten*, xxix, 7, p. 128, 1923.

Referring to a disease of sunflower plants in Montana believed to be caused by *Sclerotinia libertiana* (*Phytopath.*, xi, 1, p. 59, 1921), the writer states that the stalks of sunflowers in his garden at Amsterdam were also attacked by the same fungus. The roots, however, were not affected, as in the Montana specimens. Large sclerotia were formed in the interior of the stalks and the whole plant withered above the point of attack. The flowers were growing in a very shady position.

Killian (C.). **Le Polythrincium trifolii Kunze parasite du Trèfle.** [*Polythrincium trifolii* Kunze parasite on Clover.]—*Rev. Path. Vég. et Ent. Agric.*, x, 3, pp. 202–219, 14 figs., 1923.

Trifolium repens is frequently attacked by the fungus *Polythrincium trifolii* Kunze [in France]. The symptoms appear at the end of June as granular black spots on the under side of the leaves and limited by the veins. Their number and diameter vary considerably. When large (at most 1 mm.) the spots are at first few in number, though eventually the whole under surface will be covered. Sometimes they are localized either at the base or on the margins of the leaflets, and this may be explained by the fact that the rain drops carrying the spores tend to accumulate in the lower part of the leaflets, when these take on an erect position at night. Infection in the spring can take place from May onwards. Its initial localization makes it not easy of discovery, but later the disease progresses more rapidly, reaching a climax at the beginning of autumn. Frosts completely arrest further growth, and from January onwards the disease seems to disappear altogether, though plants kept under glass during that period will continue to show the spots.

On *Trifolium repens* the disease is usually benign, and in one case only has *T. pratense* been found attacked. *T. incarnatum*, however, is very susceptible and whole fields of it may be entirely destroyed; conditions which make for vigorous growth in this host also apparently produce increased virulence in the fungus.

The experiments made with *T. repens* have demonstrated that infection by *P. trifolii* is dependent on various circumstances which are difficult to distinguish. Speaking generally, natural conditions favour the success of the inoculations. Under moist conditions in the greenhouse the period of incubation appears to be from four to six weeks, while it may be even longer if the plants are kept in a dry atmosphere. In the field, however, the state of the atmosphere appears to have no influence on the incubation period, which under these conditions only lasts six to nine days, although it greatly affects subsequent growth. In dry weather the spots increase little, or not at all, but growth is normal in damp conditions. Infected leaves disintegrate much more rapidly than healthy ones, and this process is the more intense the more virulent the attack. After some weeks not a trace remains of the fallen and dried leaves, the very minute débris being washed into the soil, and the perithecia are thus enabled to survive for comparatively long periods and re-infect the new crop; a case is cited where the fungus persisted in the soil for five years. Control is very difficult if not impossible, and the only means of checking the inordinate spread of the disease would appear to be to delay the date of sowing.

Pure cultures of the fungus could not be obtained, as although the conidia germinated, the mycelium soon died since *P. trifolii* is an obligate parasite. On the living leaves of clover the relatively short germ-tubes penetrate the epidermis at the radial walls and the mycelium then invades the underlying cells, progressing rapidly in the intercellular spaces rather than in the palisade tissue. In young leaves the mycelium penetrates later on into the cells themselves, but this is not usually the case in older leaves. When inside the cells, the elements of the host and those of the parasite are scarcely distinguishable, recalling an advanced parasitism such as occurs in the rusts, and also, according to the author, in the Ascomycete, *Cryptomyces pteridis*.

After being established in the leaf, *P. trifolii* begins rapidly to form its reproductive organs. The hyphae, isolated at first, become massed together near the epidermis, forming a plectenchymatous cushion which increases in size and finally breaks through the epidermis. The peripheral cells of the plectenchyma then grow out into irregular lobes, in which all the protoplasm and the nuclei from the old cells concentrate. On these lobes arise the conidiophores, which are of a peculiar structure, from which the fungus derives its name. Instead of growing straight they develop spirally, in the form of a screw. The conidia borne on their free ends are two-celled, the larger cell containing a denser protoplasm and a greater number of nuclei than the other, which is attached to the conidiophore by a thick papilla, where at the least contact the conidium becomes detached. Conidia are formed abundantly until December, when their production gradually stops and is replaced by the pycnospores which develop in pycnidia. The latter have their beginning in the interior of the green leaf near the stomata, through which the pycnospores are evacuated as fast as they are formed. Towards the middle of December the pycnospores become less abundant and their production ceases in January. Their place is taken by the perithecia which carry the fungus over the winter. These bodies are formed inside the green leaf simultaneously with the pycnidia. Washed into the soil with the débris of fallen leaves, they mature with the approach of spring. The apical portion of the body then lengthens into a beak, perforated by a narrow channel provided with periphyses. The 2 to 4 large, fusiform asci contain 8 hyaline, two-celled, elongated and slightly curved spores, measuring 26 by 6 μ. These asci are accompanied by some proasci, which will take their place in due course. The covering of the beak becomes much distended and ruptured in places, and its disintegration eventually renders the ejection of the ascospores possible. The latter start the infection in the spring, as the author was able to demonstrate by actual inoculations.

The ascigerous stage of *P. trifolii* was named by Saccardo *Phyllachora trifolii*, but the author, who examined ample living material, states that the ascospores are always bi-cellular and that this forbids the classification of the fungus under the genus *Phyllachora*. He thinks that the choice can only lie amongst the Hyalodidymae in the third section of the Dothideales, *Plowrightia* being the genus selected, and that *Phyllachora trifolii* must therefore be replaced by *Plowrightia trifolii*.

STEWART (F. C.). **Fruit disease problems of to-day.**—*Proc. New York State Hort. Soc. 1922*, pp. 61–69, 1923.

The following diseases are briefly discussed with special reference to the present position of research on each. Raspberry mosaic; fireblight [*Bacillus amylovorus*]; bitter rot or anthracnose of apples [*Glomerella cingulata*], destructive attacks of which occurred during 1922 in Ulster and Orange Counties (New York) and on Long Island; crown gall [*Bacterium tumefaciens*]; and cedar rust of apples [*Gymnosporangium juniperi-virginianae*], which is extremely prevalent in the Hudson Valley.

The problems of peach leaf curl [*Exoascus deformans*] and cherry leaf spot [*Coccomyces hiemalis*] may be regarded as solved by the timely application of appropriate sprays.

DAY (L. H.). **Control of Pear blight in California.**—*Amer. Fruit Grower*, xliii, 6, pp. 3 & 12, 3 figs., 1923.

In 1921 and 1922 the writer carried out experiments on Bartlett pears to test the scarification method for the control of pear blight [*Bacillus amylovorus*].

It was found that the scarifying operation had to be continued for some distance beyond the confines of the visible signs of the disease and not the minutest particle of outer bark left on the shaved area. The addition of glycerine [amount not stated] to Reimer's combination of cyanide of mercury and bichloride of mercury (1 part of each to 500 parts of water) [see this *Review*, ii, p. 274] greatly reduced the incidence of infection. Full directions are given for the scarification treatment.

Experiments were also carried out with numerous disinfectants to ascertain whether the disease could be controlled without resorting to surgical measures. Some success was obtained by painting with cresylic acid, silver nitrate in nitric acid, nitric acid, zinc chloride, zinc nitrate, iodine, and iodine salts. Zinc chloride was the most promising of these substances, 98 per cent. of the treated cankers on trees under eight years old being arrested by its action.

WORMALD (H.). **Blossom wilt of Plum trees.**—*Journ. Min. Agric.*, xxx, 4, pp. 360–363, 3 figs., 1923.

Blossom wilt of plum trees, caused by *Sclerotinia* (*Monilia*) *cinerea* forma *pruni* is responsible for considerable damage in England in certain seasons, the branches as well as the flowering spurs being killed back. Serious outbreaks of this disease have been traced not only to mummified fruits remaining on the trees during the winter, but also to cankers, dead twigs, and spurs, as is also the case in the corresponding blossom wilt of apple trees [*S. cinerea* forma *mali*] (*Journ. Min. Agric.*, xxiv, 5, p. 504, 1917).

In May 1923 the writer examined some Giant Prune plum trees, many young branches of which were killed back from the tip for a distance of six inches to over a foot. At the lower end of every dead portion there was a flowering spur with brown, withered flowers which usually bore green tufts consisting of the spore chains of the fungus. Further examination revealed the presence of a few dead twigs killed by the fungus in the previous year. These had produced spore pustules during the winter and the resulting spores served to infect the opening flowers. The wilt was most severe in the vicinity of such twigs. No mummified fruits had been left on the trees. The Czar and Purple Egg varieties growing in the same plantation were scarcely affected.

The blossom wilt also infects the leaves and shoots, giving rise to the 'wither tip' condition (*Ann. Appl. Bot.*, v, 1, p. 28, 1918) and to 'shoot wilt' (*Ann. Bot.*, xxxvi, 143, p. 305, 1922). Subsequently the fruit may also become infected.

All dead wood should therefore be removed as early as possible and the trees sprayed in the late winter with a solution containing 1 per cent. soft soap and 1 per cent. caustic soda. The disease is liable to spread from plums to sweet cherries where the above precautions are neglected.

DICKSON (B. T.). **Raspberry mosaic and curl.**—*Scient. Agric.*, iii, 9, pp. 308–310, 1923.

After briefly summarizing the literature on virus diseases of raspberry, the author describes the symptoms, varietal susceptibility, and spread of mosaic and leaf curl of this host [see this *Review*, i, p. 218, and ii, p. 17].

The symptoms of mosaic vary with the time of infection and the weather. Canes newly infected in spring and early summer develop new leaves which usually show many dark green blisters in marked contrast to the pale yellow remainder. The petioles are slender, the leaflets rather spindly, and if the dark green areas are near the midribs the margins are rolled down and in. Under dry weather conditions the later leaves are speckled and have somewhat shorter petioles and broader leaflets. Late infections also usually produce the speckled condition, although in the following spring the blistering and distortion of the leaflets occur. As a rule the cane is somewhat dwarfed and spindly. In fruiting canes diseased laterals are liable to be spindly and weak. There is a distinct tendency for infected plants to flower earlier than normal, and the fruit becomes more and more tasteless, with also a reduction in pulp. Once a plant is infected it never recovers, and diseased plants should therefore be removed. Of the varieties commonly grown none is resistant, but St. Regis and Sunbeam seem least susceptible. The agent in the spread of the disease is probably *Aphis rubiphila*; pruning does not appear itself to be an important factor.

Leaf curl is also a systemic disease from which the plants never recover. The leaf symptoms are the dwarfing of the petioles, the arching and ruckling of intervenal areas, and the dark green or quite yellow colour of the leaves. Severely infected leaves are reduced in size, the leaflets sometimes measuring only half an inch. The canes are dwarfed but are thick and stocky. The fruiting laterals are short, have an upright tendency, and bear curled, compact, dark green, small leaves. They flower late and the fruit is small, bitter, and often with no pulp. Columbia and Newman 1, 23, and 24 varieties are resistant. *Aphis rubiphila*, as shown by Rankin, is undoubtedly the infecting agent in leaf curl.

Control measures for both diseases consist in thorough roguing and burning the diseased plants. Early eradication appears to be commercially successful, and when plantations are badly infected they should be scrapped and new ground planted with disease-free stock. Tests regarding insect control are necessary before recommendations on this point can be made.

Hvorledes skal man bekjaempe stikkelsbaerdraeperen? [How is the control of Gooseberry mildew to be accomplished?]—*Norsk Havetid.*, xxxix, 7, pp. 114–115, 1923.

The following results were obtained in a series of spraying experiments against gooseberry mildew [*Sphaerotheca mors-uvae*], carried out in two different districts of Norway on over 250 gooseberry bushes with (1) coarse Spanish common salt; (2) formalin; (3) lime-sulphur 20° Baumé; and (4) solbar. The disinfectants were applied on 8th May (winter spray), and twice in the latter half of June (summer spray) in the following strengths: salt 4 kg. per 100 l. (winter) and 2 kg. per 100 l. (summer); formalin 1 in 40 (winter) and 1 in 100 (summer); lime-sulphur 1 in 4·75 l. (winter) and 1 in 18·25 l. (summer); solbar 4 kg. per 20 l. (winter) and 1 kg. per 100 l. (summer). In all cases the incidence of disease was reduced considerably when both winter and summer applications were given, salt and lime-sulphur giving the best results. The winter spray alone was ineffectual.

KELSALL (A.). **Experiments on the dust method of smut control.** —*Scient. Agric.*, iii, 9, pp. 303–307, 1923.

These experiments, conducted by members of the Annapolis Entomological Laboratory with Professor W. S. Blair, had for their primary object the testing of the fungicidal properties of various insectide-fungicide dusts. The experiments, however, also yielded results of practical value regarding the most efficient and cheapest method of controlling smut by seed dust treatment.

In the experiments carried out in 1921, Liberty oats were treated by sifting the dust over the seed, which was then turned over several times and bagged. Five oz. of dust were used to 20 lb. of grain. The following materials were used on the various plots. Plot 1: grain soaked in water 10 minutes, partly dried and then soaked in formalin, 1 pt. to 40 galls. [American] for 3 minutes, partly dried and sown immediately. Plot 2: control. Plot 3: dusted with 28·5 per cent. dehydrated copper sulphate mixed with 71·5 per cent. infusorial earth (which acted as an inert filler). Plot 4: dusted with 28·5 per cent. dehydrated copper sulphate and 71·5 per cent. hydrated lime. Plot 5: the dust used was made as follows: 53 parts of stone lime were slaked with a little water, 40 parts of crystal copper sulphate being added meanwhile, and the whole thoroughly mixed. The copper in this dust was in the form of an oxide or hydrated oxide. Plot 6: dust contained 10 per cent. dehydrated copper sulphate, 5 per cent. calcium arsenate, and 85 per cent. hydrated lime—a general dust then in use. Plot 7: similar to plot 4 but the grain was moistened with water before applying the dust. The germination of the seed did not appear to be injured in any plot, and the percentages of smut present in the plots were (1) 52·1, (2) 61·3, (3) 2·5, (4) 16·2, (5) 45·3, (6) 72·9, (7) 9·5, from which it is evident that plot 3 gave the only results for practical purposes, and that wetting the grains before dusting with copper sulphate and lime increased the efficiency of this treatment.

In 1922 Liberty oats were again used, but the dusting was carried out in a small churn. In each case 4 oz. of dust per bushel of seed were used. Thirty plots were sown, each one-thirtieth of an acre in extent. The trials were divided into three series. Series A, with dehydrated copper sulphate (10 per cent. Cu) mixed respectively with the following fillers, infusorial earth, calcium carbonate, gypsum, talc, hydrated lime, gave 4·8, 5·4, 7·6, 2·0, and 7·0 per cent. smut respectively; the first mixture, with the proportions altered so as to contain 5, 10, 20, 30 per cent. of Cu gave 18·3, 7·1, 3·4, and 3·3 per cent. smut respectively; the control gave 46·4. Series B, with the following pure chemicals, gave the percentages of smut indicated: dehydrated copper sulphate (3·9), copper carbonate (1·5), copper oxide (24·1), copper sulphide (1·9), copper arsenate (3·4), copper arsenite (1·0), dehydrated aluminium sulphate (17·7), dehydrated nickel sulphate (3·6), dehydrated cobalt sulphate (4·9), and the control 33·6. Series C, with certain miscellaneous dusts, yielded the following percentages of smut; 50 per cent. dehydrated copper carbonate and 50 per cent. tobacco dust (6·8), copper carbonate (25 per cent. Cu) (1·1), prepared Bordeaux (12 per cent. Cu) (8·5), sulphur dust (3·5), inoculated sulphur dust (2·8), whilst the control gave 46·4.

From the above results it is seen that control was in no case perfect but approached perfection in certain cases. Copper arsenite was the most effective substance used, but has the disadvantage of being highly poisonous. From series A, it would appear inadvisable to attempt diluting dehydrated copper carbonate with inert materials, although talc gave good results in this connexion. The fairly effective control with sulphur dusts is important in view of the cheapness of the material, and the results may be improved by using the substance in greater proportions.

When absolute control of smut is not required, the author tentatively recommends the use of copper carbonate dust, or sulphur dust (about one-sixth of the cost of the former) in somewhat larger quantities.

AUSBORN. **Ein Heisswasserbeizversuch gegen den Flugbrand.** [A hot water steeping experiment against loose smut.]—*Deutsche landw. Presse*, l, 14, pp. 125–126, 1923.

In the spring of 1922 the writer immersed some Bordeaux wheat seed, heavily infected with loose smut [*Ustilago tritici*], in water heated to a temperature of 50° to 52° C. for ten minutes, after a preliminary soaking in cold water. After rinsing in cold water the treated grain was spread out to dry. A very good yield was obtained and there was a reduction in the number of smutted ears of one-half to one-third compared with the untreated controls. Complete prevention of the disease, however, appears to be impossible by this means even when the directions of the Biological Institute [Dahlem] are exactly followed, as in the present instance.

MAHNER (A.). **Feldversuch mit Beizmitteln zur Bekämpfung des Haferbrandes.** [Field experiments with disinfectants for the control of Oat smut.]—*Wiener landw. Zeit.*, lxxiii, 13–14, pp. 50–51, 1923.

In the spring of 1922 a series of experiments in the control of oat smut [*Ustilago avenae*] was carried out at Hartmanitz, Czecho-Slovakia. The soil consisted of gneiss decomposed sand, and the slightly sloping field was situated 640 metres above sea-level. The following fungicides were tested; copper sulphate, germisan, formalin, segetan, uspulun, and the Dupuy and Aussig seed steeps. The seed was procured from heavily infected 1921 crops.

The best results were obtained by steeping the seed for four minutes in a 1 per cent. copper sulphate solution after washing it in clean water (Linhart's method), or for half an hour in 0·5 per cent. germisan. The latter method is preferable in practice, as the slightest neglect with copper sulphate leads to a serious reduction or even complete failure of germination.

MÜLLER (H. C.). **Die Bedeutung der ertragsteigernden Wirkung einiger Beizstoffe für die Volksernährung.** [The significance for the national food supply of the increased productivity ensured by certain disinfectants.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 8, pp. 57–58, 1923.

The results of experiments conducted at the Halle Phytopathological Experiment Station have shown that the use of stimulating seed disinfectants (i. e. those containing arsenic, phenol, mercury, and the like) increases the yield of the resulting crops in a very high degree. Thus in one instance the yield per acre of wheat treated with a stimulating disinfectant was increased by about 5 dz. per hect. [4 cwt. per acre], and in another oat crop was augmented by about 2·5 dz. per hect. [2 cwt. per acre]. As the wheat had only absorbed about 51 gm. and the oats approximately 153 gm. of the fungicide, the increase in the yield was out of all proportion to the expenditure on material. This result is approximately equal to that obtained by the application to the soil of 15 kg. nitrate nitrogen.

It is pointed out that, by the judicious use of fertilizers and stimulating seed disinfectants, an average increase in the cereal yield of 4 dz. per hect. [3·2 cwt. per acre] could be obtained, and the necessity of importing large quantities of foreign grain thereby obviated.

Binz (A.) & Bausch (H.). **Versuch einer Chemotherapie des Gerstenbrandes.** [An experiment in the chemotherapeutical treatment of Barley smut.]—*Zeitschr. angew. Chemie*, xxxv, 41, pp. 241–243, 1922.

The successful results of empirical chemotherapy in human infectious disease suggested to the authors that similar treatments may be applied to diseases of plants. Ehrlich's plan was to determine the chemotheropeutical index [the ratio of the minimum healing concentration of the medicine, (c) or *dosis curativa*, to the maximum dose the patient will stand, (t) *dosis tolerata* or *toxica*] for a number of chemicals, and choose the ones for experiment in hospitals in which the index [quotient c/t] was very small; the smaller the index the more certain and less risky being the cure.

The difficulty of applying these methods to plants lies in the absence of a blood stream in the latter. The authors were encouraged by Riehm's work, however (*Mitt. Biol. Reichsanst. Land- u. Forstwirtsch.*, xxi, p. 136, 1921), and attempted the problem. The method they adopted was as follows: spores of the covered smut of barley were introduced with the point of a flamed needle into a tube of the disinfectant to be tested. The tube was shaken and then allowed to stand 30 minutes, after which the liquid was filtered off and the filter paper left overnight exposed to the air to dry [no mention is made of washing]. They then spread out the filter paper, to which a number of spores were attached, on a Petri dish and added a nutrient solution of 0·5 per cent. calcium nitrate as recommended by Riehm, who found that this medium discouraged the development of moulds. The liquid formed a layer 2 to 3 mm. deep in the dishes. The latter were exposed to diffused light at room temperature and spores were taken every day and examined under the microscope to see how the germination had progressed. Using this method [with various concentrations of the disinfectant] they determined the minimum concentration necessary to inhibit germination (the *dosis curativa* of Ehrlich). Spores which were not disinfected but otherwise treated similarly germinated in 2 to 3 days.

For the determination of the maximum concentration the barley seed would stand, healthy seed was placed in the disinfectant to be tested and treated in a similar way except that after drying [on the filter paper] the seed was placed on damp filter paper to germinate, and by determining the concentration which impaired germination the *dosis toxica* of Ehrlich was ascertained.

The authors tested the following substances at the concentrations given: formalin 0 to 1 per cent.; uspulun 0 to 2 per cent.; salvarsan and neosalvarsan 0 to 1·5 per cent.; atoxyl 0 to 1 per cent.; 4-aminophenyl-1-arsenoxide 0 to 1·5 per cent.; 3-amino-4-oxyphenyl-arsenoxide 0 to 1 per cent.; arsenic acid 0 to 1·57 per cent.; and three substances named A, B, and C, the composition of which is not disclosed, at 0 to 1·5, 0 to 2, and 0 to 3 per cent. respectively. None of these substances was any good except formalin, uspulun, and A, B, and C. The substance B was very good and C was excellent, the germination of the seed in the latter case not being impaired until 40 times the *dosis curativa* (0·05 per cent.) was used.

A principal result of these investigations is the knowledge of the fact that Ehrlich's conception of the chemotherapeutical index is applicable to vegetable as well as to human pathology.

RIEHM (E.). **Zur Chemotherapie der Pflanzenkrankheiten.** [Contribution to the chemotherapy of plant diseases.]—*Zeitschr. angew. Chemie*, xxxvi, 1, pp. 3–4, 1923.

Referring to the work of Binz and Bausch on the chemotherapeutical index [see last abstract], the author points out that the term 'chemotherapeutics' is strictly applicable only to the destruction by chemical substances of pathogenic organisms in the interior of cereal or other seeds. The steeping of cereal seed to protect it against smut spores adhering to the exterior, the spraying of vines against downy mildew [*Plasmopara viticola*], and other preventive measures are purely prophylactic. The only genuine chemotherapeutical remedies so far discovered are the cure of chlorosis of vines and fruit trees by spraying with, or injection of, iron sulphate, and the destruction of the *Fusarium* and stripe disease [*Helminthosporium gramineum*] organisms in the interior of seed grain by immersion in mercury salts.

The author's method of determining the [minimum] spore destroying concentration [*dosis curativa*] of a chemical substance (see *Mitt. Biol. Reichsanst.*, xviii, p. 19, 1920), has been modified somewhat as follows: a given quantity (0·3 gm.) of smut spores is placed in a test tube and shaken up with a small quantity of the fungicide, with which the tube is then filled to the brim. One prevents by this means any spores remaining attached to the glass and not being wetted. After half an hour most of the liquid is poured off and thrown away, together with any spores floating on the surface. The remaining spores are then thoroughly shaken and filtered through two separate filters, one of which is left to itself while the spores in the other are immediately washed with water several times. This washing at once prevents further action by the fungicide, which continues to act, however, on the spores in the other filter until they are dry, thus corresponding to normal field conditions. Next day after the spores have dried, a small quantity of the spore mass is removed with a platinum needle and placed in a Petri dish in a solution of 25 per cent. calcium nitrate. The method of Binz and Bausch, whereby the entire filters are placed in the solution, is suitable for covered smut of barley [*Ustilago hordei*] but not for bunt of wheat [*Tilletia tritici*]. The spores of the latter do not germinate when sown in high spore concentrations and should not be used in quantities exceeding 5 mg. per 15 cc. of calcium nitrate. The spores of *U. hordei* germinate in two days and those of *T. tritici* in three to four days in diffused light at a temperature of 20° C. Direct sunlight or total darkness delays germination, as also do temperatures below 20° C. Spores treated only in water should be cultivated for purposes of comparison. There is little danger of the development of moulds in the solution; *Acrostalagmus* sp., however, has been known to occur occasionally.

The *dosis toxica* or *dosis tolerata* was ascertained by Binz and Bausch by exposing barley seeds to the fungicide, drying them, and spreading them out on damp filter paper for germination.

All the authorities are agreed that an accurate and reliable estimate of the germinating power of seed which has been immersed can only be obtained by testing at least 200 seeds. Even when a reliable estimate of germination has been obtained in these tests, however, the effects of the fungicide on the plants in the field cannot be exactly foretold. Numerous experiments have shown that while [percentage] germination is not in the least impaired by many solutions the seedlings do not thrive and are lacking in germination energy ['Triebkraft'] with the result that the stand is defective. This shows that the fungicide has in some way weakened the natural forces of the seed, which may retain sufficient energy to develop under optimum conditions in the laboratory but not when exposed to the rigours of the field. Hiltner has therefore devised the following system of ascertaining such effects on the constitution of the seed: the seeds to be tested (at least 200) are laid on a layer of damp brick dust in zinc tins, covered with another layer of damp brick dust 3 to 4 cm. in height and left for a fortnight. The energy of the seed is judged by the number of plants which have come up at the end of this time. In this connexion it must be remembered that different varieties of wheat vary considerably in their susceptibility to the same concentration of a chemical substance and a comparison between two fungicides should only be made when tests have been carried out on the same variety of wheat.

The theoretical fungicidal value of a chemical substance is determined as follows: the concentration at which germination energy or speed of germination is reduced by more than 10 per cent. is first ascertained, using at least five varieties of wheat. The next step is to discover the [minimum] concentration at which the spores of *Tilletia tritici*—the most important fungus in agriculture—are destroyed. The theoretical fungicidal value of the substance is obtained by dividing the concentration at which germination energy is reduced by more than 10 per cent. by the spore-destroying concentration. The higher the quotient, the better the results to be anticipated in field trials with the disinfectant in question. [This is approximately the reverse of the chemotherapeutical index as calculated by Binz and Bausch and also by Gassner: see last and following abstracts.]

Spores of *T. tritici* steeped for 30 minutes in a 0·1 per cent. copper sulphate solution do not germinate in calcium nitrate and few do so after 0·01 copper sulphate. It might be assumed from these laboratory experiments that the spores were killed by 0·1 per cent. copper sulphate but this is not the case. Hecke has shown that normal germination is restored by rinsing them in diluted hydrochloric acid (0·5 per cent.). Probably in the field the humic acid in the soil is also capable, under certain conditions, of washing the copper off the spores adhering to treated seed, which would account for the appearance of smut on the plants from treated seed when sowing has been immediately followed by heavy rains. It is thus essential to confirm by field tests the results of laboratory experiments.

Gassner (G.). **Biologische Grundlagen der Prüfung von Beizmitteln zur Steinbrandbekämpfung.** [Biological principles underlying the testing of fungicides for seed treatment against bunt.]—*Arb. Biol. Reichsanst. für Land -und Forstwirtsch.*, xi, 5, pp. 339–372, 1923.

While field trials remain the most reliable means of determining the efficacy of the numerous new preparations released by chemical works for the disinfection of seed grain, they are extremely lengthy and costly, and too much dependent on uncontrollable factors such as climate, weather conditions, and lack of scientific training in farm staffs entrusted with the trials. These drawbacks call for laboratory methods which can be conducted under strictly controlled conditions within a short time. Some work has already been done in this direction by Riehm (*Mitt. Biol. Reichsanst.*, xviii, p. 19, 1920), who investigated in spore germination tests the fungicidal action of different chemical compounds on smut spores. It is obvious also that chemical works must test their preparations in the laboratory without, however, being quite clear as to how far their results apply in practice. As a matter of fact, the results of laboratory experiments, as hitherto conducted, seldom, if ever, agree with those of field trials, thus justifying doubts as to the value of such experiments. The present work is an attempt at developing a laboratory technique in conjunction with field trials so as to obtain numerical indices of the comparative value of the different fungicides offered to the public.

The efficacy of a disinfectant depends on two main factors: firstly, on its specific lethal action on the parasite, and, secondly, on its harmlessness for the host. The notion that both factors must be equally considered is old and was unconsciously applied even before pathogenic organisms were known. The numerical computation of the action of a therapeutical preparation on the host and on the pathogen, however, was first applied by Ehrlich (Die experimentelle Chemotherapie der Spirillosen, Berlin, 1910) to the testing and discovery of new remedies in human and animal pathology. According to this author the medicinal value of a chemical preparation is determined by its chemotherapeutical index, which is represented by the symbol ζ and is equal to c/t, c being the *dosis* *curativa* and t the *dosis toxica* [see above, p. 551], both being calculated in relation to unity of weight of the animal body.

In 1918 the author began a series of experiments in the control of bunt of wheat [*Tilletia tritici* and *T. levis*] with the object of applying the principles outlined above to the treatment of plant diseases. The *dosis curativa* may be defined as the minimum concentration of a disinfectant which will destroy the spores of the fungus. The spores must therefore be treated in a certain way and the effect of the fungicide on their subsequent germination carefully noted. The method adopted in the present series of investigations was immersion of the bunt spores for one hour in the fungicide to be tested, at a temperature of 18° C., with subsequent rinsing. The germination medium used was a 0·1 per cent. solution of calcium nitrate in distilled water, the dishes being maintained at a constant temperature of 15° C. Under these conditions untreated spores germinated in 3 to 5 days, whereas the previous immersion in uspulun, formalin, or germisan delayed or prevented germination according to the strength of the concentration. It was frequently observed that spores treated with a solution which was sufficiently strong to control the diseases in the field completely, nevertheless germinated after weeks or months in the laboratory. Therefore the action of such solutions is not, strictly speaking, destructive but merely in a very high degree repressive. The results of field experiments with treated Schlanstedter summer wheat showed that even a slight retardation in spore germination (five days) greatly reduced the incidence of infection, while absolute control was secured when germination was delayed for seven to eight days. Hence the *dosis curativa* is represented by the minimum concentration of a solution which, under the conditions described above, retards germination for ten days. In the present series of experiments the *dosis curativa* was as follows: formalin 0·13 per cent.; germisan 0·12 per cent.; uspulun 0·08 per cent.; mercury cyanide (with a 17·5 Hg-content) far above 10 per cent.

The *dosis toxica* (equivalent to Ehrlich's *dosis tolerata*) is that concentration of a disinfectant which, at the end of a given time, shows the first indications of a deleterious effect on the grain. In calculating the *dosis toxica* several factors arise in connexion with the germination of the seeds which need consideration.

From experiments on the action of different formalin solutions on wheat grain, it was found that an increase of the percentage of germination was also accompanied by a corresponding improvement in the speed of germination. Conversely a lowering of the germination percentage gave also a retardation in germination. The full germination percentage, however, was also reached in certain cases of retarded germination. Thus immersion for one hour in 0·2 per cent. formalin resulted in a delay of germination of about eight hours, although practically all the seeds germinated. The decline in the germination percentage on the one hand and the retardation of germination on the other must therefore be considered in judging the effect of a fungicide on the treated seeds, and it is advisable that the figures for the *dosis toxica* should take into account both these effects.

When the injurious action on the seed increases there is a decline in the germination percentage and, at the same time, an increase in the time taken for germination. The figure expressing the real effect on the grain is therefore found by the division of germination percentage by the speed of germination (expressed in days). In order to obtain comparative values between experiments not simultaneously undertaken, the quotient, germination percentage/speed of germination, is compared with that quotient obtained from seed treated only with water in place of the disinfectant. The quotient from the water treated seeds is taken to be equal to 100, and from this is calculated the values for seeds treated with the fungicides, which values are taken as the index figures of the effect of the fungicide on the grain.

The author's method of determining the *dosis toxica* was as follows: the seed (20 gm.) was immersed in at least 60 cc. of the fungicide for exactly one hour, rinsed, washed for 30 minutes in six changes of water, and dried. Seeds were also treated in water in the same way for control. At least 200 seeds were used in each germination test in each experiment and for the control 400 were used. The seeds were germinated on filter paper in Petri dishes in the dark at a temperature of 15° C. Every day they were examined, the standard for germination being a leaf and three healthy roots. The tests lasted 6 days. From data obtained in this way the percentage germination, the speed of germination, and finally the index figure (the control being 100) was calculated.

Tests have shown that the experimental error does not exceed 5 per cent. of the index figure as a rule, and all index figures under 95 per cent. indicate that there is a slight injury to the seed. The *dosis toxica* therefore is that concentration at which the index figure falls below 95 per cent. on the average in several parallel series of experiments. It is necessary always to use the same variety of cereal; the author used Strubes Schlanstedter summer wheat.

After having determined the *dosis curativa* and the *dosis toxica* by the methods described above, the calculation of the chemotherapeutical index is made by dividing the *dosis curativa* by the *dosis toxica*. In the case of the fungicides used in the author's experiments the *dosis curativa* was: formalin 0·13; germisan 0·12; uspulun 0·08, and mercury cyanide over 10: the *dosis toxica* was: formalin 0·1; germisan 0·35; uspulun 0·25; and mercury cyanide 0·9 (all in percentage strengths of the solution) and the index worked out as follows: formalin 1·3; germisan 0·34: uspulun 0·32; mercury cyanide (17·5 per cent. Hg) over 11. It will be seen that the resulting quotient places germisan and uspulun in a much more favourable light than formalin, while mercury cyanide occupies a very inferior position.

The above calculations of the chemotherapeutical index are made only in reference to the effect of the fungicide when used for immersion, and the author in the latter part of his paper discusses a modification of the method to express the efficiency of the fungicide applied by sprinkling. He determined the *dosis curativa* for sprinkling experimentally, taking wheat strongly infected with bunt, and using 25 gm. which was sprinkled with 5 cc. of disinfectant, the seed being then stirred for 2 minutes and immediately after spread on a filter paper in a layer 1 cm. thick to dry. After drying the spores were germinated at 15°C. in 0·1 per cent. calcium nitrate solution. It was found that the *dosis curativa* from sprinkling was as follows: formalin 0·05; germisan 0·14; uspulun 0·33; mercury cyanide 2 per cent.

In order to define these differences between immersion and sprinkling the author introduces the sprinkling coefficient B (the number by which the factor c in immersion must be multiplied in order to obtain the *dosis curativa* (cB) as determined for sprinkling). Hence the factor B for formalin is 0·5 [the author taking c = 0·1 in this calculation]: for germisan 1·2; for uspulun 4·1; and for mercury cyanide less than 0·2.

The determination of the *dosis toxica* by sprinkling was made and it was found that the alteration in the effect of the sprinkling as compared with immersion moved in the same direction as in the case of the *dosis curativa*. Hence by multiplying the factor for immersion by B he obtained a figure approximately equal to that of the *dosis toxica* for sprinkling, i. e. the concentration in sprinkling which produces the first signs of injury to the seed.

In conclusion the author discusses the chemotherapeutical index of the four substances tested. He points out that formalin with an index of 1·3 is unsatisfactory, as a certain amount of seed injury must be expected at a concentration which will kill the fungus spores. Germisan and uspulun with indices of 0·34 and 0·32 respectively are quite satisfactory, but mercury cyanide with an index of more than 10 is extraordinarily unsatisfactory. Generally speaking, the limits of the index of a satisfactory substance should not be allowed to exceed 0·5.

GASSNER (G.) & ESDORN (ILSE). **Beiträge zur Frage der chemotherapeutischen Bewertung von Quecksilberverbindungen als Beizmittel gegen Weizenstinkbrand.** [Contributions to the problem of the chemotherapeutical value of mercury compounds as disinfectants against bunt of Wheat.]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 5, pp. 373–385, 1923.

A series of experiments, based on the principles outlined in the preceding abstract, was conducted with a view to ascertaining the fungicidal properties of a number of substances, the mercury content of all of which was equalized at 17·5 per cent. by the addition of the necessary quantity of sodium chloride and sodium sulphate.

The values for the inorganic mercury preparations tested were as follows: (P 1 = Preparation No. 1) Corrosive sublimate; c (*dosis curativa*) 0·025; t (*dosis toxica*) 0·1; c/t (chemotherapeutical index) 0·25; cB (*dosis curativa* by sprinkling) 0·08; B (sprinkling coefficient) 3·2. (P 6) Disodium mercurous thiosulphate; c 3·0; t 5·5; c/t 0·55; cB 3·5; B 1·2. (P 4) Mercuric cyanide: c over 10; t 0·9; c/t over 11; cB 2·0; B 0·2. (P 3) Mercuric oxycyanide; c 0·1; t 0·28; c/t 0·36 cB 0·21; B 2·1. (P 5) Double salt of the cyanides of mercury and potassium; c over 10; t 0·9; c/t over 11; cB 3·0; B < 0·3.

The following list gives the corresponding values for the organic preparations tested: (P 30) Mercury methyl iodide; c 0·001; t 0·015; c/t 0·07; cB 0·008; B 8·0. (P 21) Sodium hydroxynitrophenylmercury sulphate; c 0·07; t 0·3; c/t 0·23; cB 0·28; B 4·0.

(P 15) Sodium hydroxychlorphenylmercury sulphate; c 0·08; t 0·25; c/t 0·32; cB 0·33; B 4·1. (P 8) Hydroxysulphophenylmercury hydrogen sulphate; c 0·18; t 0·7; c/t 0·26; cB 0·4; B 2·2. (P 7) Sodium salt of hydroxycarboxyphenylmercuric hydroxide; c 2·0; t 2·5; c/t 0·8; cB 1·0; B 0·5. (P 10) Sodium salt of methylhydroxycarboxyphenylmercuric hydroxide; c 0·22; t 1·1; c/t 0·2; cB 0·4; B 1·8. (P 19) Sodium hydroxychlorphenylmercury sulphate, dissolved in sodium thiosulphate; c 2·5; t 2·4; c/t 1·0; cB 1·5; B 0·6. (P 17) Sodium hydroxymethylphenylmercury sulphate, dissolved in sodium thiosulphate; c 3·2; t 2·5; c/t 1·3; cB 1·3; B 0·4. (P 25) Sodium salt of hydroxymethylphenylmercuric cyanide; c 0·12; t 0·35; c/t 0·34; cB 0·14; B 1·2. (P 28) Sodium salt of mercury carboxyphenyl cyanide; c 0·2; t 0·8; c/t 0·25; cB 0·6; B 3·0. (P 29) Sodium salt of mercury hydroxycarboxyphenyl cyanide; c far above 5; t 1·6; c/t far above 3; cB 2; B much $<$ 0·4. (P 23) Sodium salt of symmetrical dihydroxy mercury diphenyl; c 0·05; t 0·17; c/t 0·29; cB 0·18; B 3·6. (P 24) Sodium salt of symmetrical dihydroxydicarboxy mercury diphenyl; c 1·0; t 1·4; c/t 0·7; cB 1·0; B 1·0. (P 27) Sodium salt of mercury phenolphthalein; c 1·8; t 1·3; c/t 1·4; cB 2·0; B 1·1. (P 22) Sodium salt of mercury fluorescein c 2·0; t 1·7; c/t 1·2; cB 3·0; B 1·5. [The formula for most of these compounds is given.]

Four decisive factors must be considered in determining the utility of a mercury disinfectant. These are (1) a sufficiently low chemotherapeutical index; (2) a sprinkling factor approximating as nearly as possible to the figure 1: this factor indicates the higher or lower concentration to be employed in the sprinkling method in order to obtain the same results as with immersion, and the more closely the strengths for both methods coincide the more valuable is the substance in question; (3) the preparation should combine efficiency with as low a mercury content as possible in order to promote its use on a commercial scale; (4) the degree of toxicity to human and animal organisms should be as low as possible. As regards the last-named point the majority of the organic mercury compounds are less toxic than some of the inorganic, e. g. corrosive sublimate. Other things being equal, these relatively innocuous products should be preferred.

An analytical survey of the values given above shows that the mercury compounds with the lowest *dosis curativa* have the most favourable chemotherapeutical index and vice versa. Thus all the preparations with effective action on the spores are at the same time comparatively harmless to the seed; the *dosis curativa* in such cases is $\frac{1}{3}$ to $\frac{1}{5}$ smaller than the *dosis toxica*. On the other hand the higher the *dosis curativa* the less favourable is the relation between spore destroying and seed impairing activity.

A comparison between the chemotherapeutical index and *dosis curativa* on the one hand and the sprinkling coefficient B on the other also reveals, with striking regularity, that the mercury compounds with the most favourable chemotherapeutical index and the lowest *dosis curativa* generally have the highest sprinkling coefficient and vice versa (cf. P 30, P 1, P 23 with P 4, P 5, P 29).

The chemotherapeutical index is the fundamental criterion for the determination of a given substance. All the compounds in which this index is higher than 0·5 must be rejected as disinfectants since the necessary strong concentrations involve risk of injury to the germinative capacity of the seed.

In addition to P 30, P 1, P 23, P 21, and P 15, shown above to combine low concentrations with high fungicidal efficiency, P 10, P 28, P 8, P 25, and P 3 may also be recommended.

By far the most efficient of the products tested was P 30, mercury methyl iodide, but on account of the extremely poisonous nature of the compound it could not possibly be recommended for practical purposes.

It was difficult to determine the respective merits of some of the other compounds tested. Corrosive sublimate combines fungicidal efficiency with a low spore destroying concentration, 0·05 per cent. for immersion and 0·15 to 0·2 per cent. for sprinkling. On account of its toxicity to animals, corrosive sublimate may well be replaced by P 25, which also has a very favourable sprinkling coefficient. P 3 is inferior to P 23, P 21, and P 15 in respect of the *dosis curativa* and the chemotherapeutical index, but superior to these preparations in its very favourable sprinkling coefficient. Any of these compounds may safely be recommended as disinfectants, adequate quantities for practical purposes being approximately for immersion: P 3 0·2 per cent.; P 23 0·1 to 0·15 per cent.: P 21 0·2 per cent.; P 15 0·2 per cent.; and for sprinkling: P 3 0·4 per cent.; P 23 0·3 to 0·4 per cent.; P 21 0·75 per cent.; P 15 0·75 per cent.

The remaining three preparations with favourable chemotherapeutical indices, P 8, P 28, and P 10, require to be applied at comparatively high concentrations and are therefore impracticable on economic grounds.

Discussing the comparative efficacy of various inorganic and organic mercury compounds, the author points out that the efficiency of corrosive sublimate compared with mercuric oxycyanide and other compounds is connected with the question of dissociation. Of the organic mercury compounds P 30 combines the simplest construction, CH_3—Hg—I with the utmost efficiency, far exceeding that of corrosive sublimate. In comparison with this simple combination of the fatty series, the benzene compounds were much less efficacious. An increased carbon content appears to depress the activity of the mercury, while the introduction of a carboxyl group into the mercury compounds produced a similar effect.

P 23, which is constitutionally incapable of dissociation, is almost equal in efficacy to P 1, and there are various other instances (e. g. P 25) of fungicidal efficiency in the absence of dissociation. P 27 and P 22, the structures of which are exceedingly complex, are of no value for seed disinfection in spite of their high reputation in the medical world.

In preparations where the sprinkling coefficient B is lower than 1, the more favourable effect of the sprinkling method is due to the prolongation of the disinfection process and the increased efficacy of the preparation owing to the absorption and consequently augmented concentration of the solution. In preparations with a high sprinkling coefficient, however, the reduced efficiency is due to the deprivation of the toxicity of the product by the seed. Experiments showed that the adsorption coefficients of the simple mercury compounds CH_3HgI and CH_3HgOH were very high; a portion of the mercury content of the solutions is taken up by the dead outer layers of the grain and thus rendered innocuous to the externally adhering fungous spores and to the inner tissues of the seed.

The fundamental difference between immersion and sprinkling is that in the former method large quantities of disinfectant are brought into contact with a relatively small amount of seed and are thus not noticeably deprived of their toxicity, whereas in the latter method the potential loss of toxicity is increased with the diminution of the amount of liquid. The inverse ratios between the *dosis curativa* and sprinkling coefficient, which indicate that mercury compounds with a low *dosis curativa* have a high sprinkling coefficient and vice versa, are readily explained by the fact that sprinkled seed deprives efficacious compounds at weak concentrations of toxicity more completely than inferior fungicides at high concentrations.

In discussing the importance of having a relatively high *dosis toxica* in obtaining a low chemotherapeutical index, the author points out that only those fungicides can exercise a toxic action on the seed which penetrate to the interior, after traversing the dead outer layers of the pericarp and testa, which, as stated above, adsorb a certain amount of the solution. Thus the liquid first reaches the interior as an innocuous solution; it is only after protraction of the process or an increase of the concentration, resulting in a saturation of the outer layers with the fungicide, that the toxic solution penetrates the seed and the *dosis toxica* is reached.

An ideal fungicide should contain as little mercury as possible, have the lowest possible chemotherapeutical index, and be equally efficient both in immersion and sprinkling. The two first requirements are mutually compatible, but not the third, since the same cause which results in the favourable chemotherapeutical index removes the sprinkling coefficient farther away from 1 in an upward direction. Disinfectants which have to be applied at a ten times higher strength for sprinkling than for immersion are impracticable owing to the impossibility of securing the necessary exactitude on a large agricultural scale.

It has already been shown [see preceding abstract] that formalin combines a very unfavourable chemotherapeutical index (1·3) with a strikingly low sprinkling coefficient (0·5). Chromic acid behaves similarly, while ammoniacal copper oxide and sulphuric acid unite a very low chemotherapeutical index with an extremely high sprinkling coefficient.

DUFRÉNOY (J.). **La transmission des maladies des plantes par voie biologique.** [The transmission of plant diseases by biological means.]– Reprint of a paper read before the *Société de Pathologie comparée* on 10th April, 1923, 8 pp., 2 figs., 1923.

The author reviews the various biological means of transmission of plant diseases, dealing briefly with cases where one parasite opens the way to another by simple wounding of the host tissues. Wounds caused by cutting tools act in a similar manner, but in these cases the parasitic organism may be inoculated at the same time, if the implement has previously been used on diseased plants. Both man and domestic or wild animals may carry diseases considerable distances, the former on clothing and boots, and the latter on pelt, hoofs, and the like. An equally important source of infection is the alimentary canal of animals, *Fusarium* wilt of melon (*F. solani*), for instance, being often transmitted through larval faeces. In the soil, nematodes and other insects transport bacteria and spores from one root to another.

The relationship of predatory animals to cryptogamic organisms is frequently made closer by the predilection of the former for parasitized tissues. Thus, in the American pine forests squirrels are fond of gnawing the tumours produced by a species of *Peridermium*, the spores of which are inoculated into healthy pines subsequently attacked by these animals. Many insects have a preference for galls and tumours on account of their succulent tissues. Cases of infection have been traced to the symbiotic relationship existing between insects and fungi (i.e. *Xyleborus dispar* always carries in its pharynx *Monilia candida*, which grows in its bore holes and on which it flourishes) and even ordinary soil organisms, such as *Bacillus mycoides*, have been isolated from tumours, a species of *Chermes* being responsible for the transmission of the organism, thus indicating that a pathogen need not necessarily be obtained from a diseased plant.

But beyond being a simple carrier of, or living in symbiosis with, a parasitic organism, an insect may form with the plant an alternative host, in which the parasite completes its life cycle. The incubation period sometimes necessary for the transmission of diseases of the mosaic type suggests this possibility.

Informazioni [Notes.]—*Boll. mensile R. Staz. Pat. veg.*, iv, 1–3, pp. 13–31, 1923.

Mancini in the *Coltivatore* of November–December, 1922, publishes the results of his investigations into a malformation ('ginocchiatura') of the ears of wheat, which, however, only occurs rarely and is of little economic importance. The most usual symptom is a kink in the last sheath below the ligular collar and plants affected become severely deformed. In affected ears a certain sterility of the flowers is found to occur, especially in the portion above and in that immediately below the kink in the unexpanded ear. The weight of individual grains in deformed ears is slightly higher than normal, but this is largely compensated by their small numbers due to the sterility of the flowers. The author's opinion is that the trouble is due to traumatic causes produced by strong winds, and experiments with some varieties of Todaro on soil heavily treated with stable manure have demonstrated that trophic conditions have a great influence on the disease. It has been found possible to reproduce the disease by bending the last sheath, before the ear emerges. The author has also noted a singular malformation in certain late varieties of grain, characterized by twisted and shortened ears and by an undulating or zigzagging rachis, which he thinks is due to unduly accelerated and disharmonious growth in the last stages of development.

In the *Giornale d' Agricoltura della Domenica* of 4th February, 1923, Boni gives an account of tests carried out with lime-sulphur (20° Baumé diluted to 60–80 per cent. strength) in the winter treatment of fruit trees. The results are stated to have been satisfactory so far as apple mildew is concerned.

Gramatica in the Trentino province, and Topi in that of Senese, have carried out tests with copper preparations for the control of the vine *Peronospora* [*Plasmopara viticola*], which they discuss in the February number of *Italia agricola*. The first-named author obtained poor results with De Haen's colloidal copper in 1 per cent. solutions, as well as with List's of 0·5 per cent. strength, and he ascribes the failure to the minute quantities of copper contained in these preparations. Topi experimented with 'Nosperal', prepared by Meister, Lucius, [and Brüning], of Hoechst [see this *Review*, ii, p. 223], which contains copper in combination with resin and is sold in the form of a very fine, grey powder. This is dissolved in water in the proportion of 1 : 1000 and 0·5 per cent. lime is added. The results were satisfactory, but not more so than those obtained with ordinary Bordeaux mixture.

Seaver (F. J.). **Mycological work in Porto Rico and the Virgin Islands.**—*Journ. New York Bot. Gard.*, xxiv, 281, pp. 99–101, 1923.

A brief account is given of a ten weeks' visit paid by the author to Porto Rico and the Virgin Islands at the request of the Insular Government to study the fungi of these Islands, more especially those which attack coffee and citrus crops. In 1918 a summary of the mycological work carried out in Porto Rico appeared in the form of a check list of the local fungi (*Journ. Dept. Agric. Porto Rico*, ii, 3, 1918) and this work is at present being extended and revised by the writer and Mr. C. E. Chardon, Sugar Expert at the Insular Experiment Station.

Altogether, over a thousand fungi were collected, a considerable number of which are new to science, and detailed reports of the results of microscopical examination of the new material will be published in due course. Particular interest attaches to the specimens collected in the Virgin Islands owing to the scarcity of the information on the subject hitherto available.

Morstatt (H.). **Einf hrung in die Pflanzenpathologie. Ein Lehrbuch für Land- und Forstwirte, Gärtner und Biologen.** [Introduction to Plant Pathology. A textbook for agri- and sylviculturists, gardeners and biologists.]—Sammlung Borntraeger, i, Berlin, 159 pp., 4 figs., 1923.

The present little volume is the first to appear of a series in course of publication in Berlin under the title 'Sammlung Borntraeger', the purpose of which is to supply students and practical workers in a compact but yet strictly scientific form with outlines and general principles of various branches of natural science. In its preface the aim of the author is stated to be to attempt to unite applied botany in its relation to plant diseases with economic entomology in a single branch of applied biology.

The book is divided into four chapters, namely: 1. Identification of plant diseases; 2. Etiology of plant diseases; 3. Causes of plant diseases; 4. Plant protection. The compilation is well arranged and clearly written, and the discussions on the pathological anatomy and physiology of plants in chapter II are of particular interest.

FERDINANDSEN (C.) **Ukrudtets Betydning for plantesygdomme.** [The importance of weeds in plant diseases.]—*Tidsskr. for Landøkonomi*, 6, pp. 265–278, 1923.

In the first section of this paper the author quotes a number of statistics illustrating the part played by weeds in depriving cultivated plants of their proper share of water, potassium, phosphorus, nitrogen, and other nutrient constituents of the soil. The utility of weeds as cover crops is also briefly explained.

The second section is devoted to a discussion of weeds as carriers of infectious plant diseases. Clover, cereal, and other crops cultivated near railway banks, roadsides, chalk pits, or waste ground are readily attacked by fungous diseases, which originate on the related wild hosts. In many cases, however, the causal organism has been introduced with cultivated plants from abroad and thence spread to the wild indigenous hosts, e. g. gooseberry mildew (*Sphaerotheca mors-uvae*) and oak mildew (*Microsphaera alphitoides*) [*M. quercina*]. The cabbage fungi *Pythium de Baryanum*, *Cystopus candidus*, and *Plasmodiphora brassicae* were certainly already present on their wild hosts at the remote epoch when cabbage was introduced into Denmark. Recent investigations have shown that *Cystopus candidus* is divided into several biological strains, the spores from radishes being capable of infecting only 50 per cent. of the inoculated mustard plants and 1 per cent. of cabbage seedlings.

Both *Peronospora schachtii* and *Uromyces betae* are found on the wild beet; *Hypochnus solani* occurs on chickweed, &c.; *Puccinia graminis* spreads from various wild grasses to rye and oats. Certain species of juniper are indispensable to the development of *Gymnosporangium* on apple and pear trees; *Puccinia pringsheimiana* requires the proximity of various species of *Carex* to complete its life cycle. Wart disease (*Synchtrium endobioticum*), powdery scab (*Spongospora subterranea*), and leaf roll disease of potatoes are all transmissible to deadly nightshade.

NARASIMHAN (M. J.). **Casein as an adhesive in spraying against Areca koleroga.**—Reprinted from *Journ. Mysore Agric. & Exper. Union*, v, 1, 4 pp., 1923.

For the last twelve years the resin-soda-Bordeaux mixture (5–5–24 plus 2 lb. resin and 1 lb. soda heated in 1 gall. water) has been used with success in the control of the 'koleroga' disease [*Phytophthora arecae*] of the areca palm [*Areca catechu*] in Mysore [see this *Review*, ii, p. 22].

Experiments were conducted in the laboratory to ascertain the efficacy of casein as a substitute for resin-soda. The Bordeaux mixture was first prepared in the usual way. To 24 galls. of this mixture was added 1 gall. of solution containing 0·5 lb. of casein and 0·5 lb. of lime. Glass plates were sprayed with resin-soda-Bordeaux and casein-Bordeaux, dried in an oven, and then placed under an artificial shower of water for eight days. On re-drying, the casein-Bordeaux was found to be still intact on the plates while the resin-soda-Bordeaux showed signs of washing off. In the field casein spraying was tried in areas where the rainfall varied from 100 to 300 inches, the operation being carried out in June and July while the nuts were immature. The results of the tests were very satisfactory, the incidence of the disease on the sprayed trees being very low indeed. The occasional instances of infection were chiefly found in areas where showers of rain had fallen soon after the application of the mixture. The use of 0·25 lb. of casein appears to give as good results as that of 0·5 lb.

Casein possesses several advantages over resin-soda. It is easier to use and is readily obtainable in the Bangalore and Kolar districts, while resin-soda has to be imported. Owing to the smaller quantities required, the cost of the spraying is reduced by one rupee per acre.

Casein-Bordeaux forms a less conspicuous coating on the nuts than the resin-soda-Bordeaux, partly on account of its natural bluish colour and also because of its very fine spreading qualities. The film adhering to the surface can, however, be clearly seen even after the heavy rains.

WEIMER (J. L.) & HARTER (L. L.). **Temperature relations of eleven species of Rhizopus.**—*Journ. Agric. Res.*, xxiv, 1, pp. 1–39, 23 graphs, 1923.

It has previously been shown, in connexion with the soft rot of sweet potatoes produced by various species of *Rhizopus* [see this *Review*, i, p. 272] that temperature played an important part in the process of infection. The fungi were placed roughly in high, low, and intermediate temperature groups. In the present paper the effect of temperatures on the spore germination, mycelial growth, and fruiting of eleven species of *Rhizopus* is discussed. These species fall into three groups as regards their response to temperature, the time required for germination to begin (i.e. the hours necessary for germ-tubes to reach the length of the diameter of the spores) being used as the measure of the influence of the temperature. *R. chinensis* has maximum and optimum temperatures higher than any of the other species (52° and 43° to 45° C. respectively); *R. nigricans, microsporus, reflexus,* and *artocarpi* constitute a group having low optima (*nigricans* and *microsporus* 26° to 28°, *reflexus* 30° to 32°, *artocarpi* 26° to 29°) and a low maximum (34°, 38°, and 34·5° respectively); while *R. tritici, nodosus, delemar, oryzae, arrhizus,* and *maidis* form an intermediate group (optimum 36° to 38°, maximum 45·5°). Discussing the results obtained, the authors point out that the cardinal temperatures for spore germination, growth, and fruiting of the fungi studied vary somewhat. In general, spores will germinate at a temperature too low for mycelial growth, and a higher temperature is required for fruiting than for growth. The optimum for germination is always higher than that for growth and fruiting, while in most cases the optimum for fruiting is about the same as that for growth. The optimum for fruiting is often not so well defined as that for growth, and the latter less so than for spore germination. In each case there is a gradation from the maximum at which the spores will germinate to that at which fruiting will take place, the maximum for growth being about midway between that for germination and that for fruiting.

The effect of temperature on the continued growth of the germ-tubes was next studied. This was done by measuring the daily growth increment in Petri dishes. Graphs are given (the growth being plotted against temperature) of the eleven species. The minimum temperature for growth varies with the time for the first 5 to 15 days according to the species, after which the true minimum, below which growth will not take place regardless of time, is reached. With reference to the maximum temperature, although the graphs appear to indicate that this did not change, very careful measurement showed that a so-called shifting of the maximum did occur in some cases. Most of the fungi appeared to reach their maximum rates of growth during the second 24-hour period.

The results of experiments on the influence of temperature on fruiting showed that this takes place over a considerable temperature range. The optimum for some species is sharp and easily determined, while in others it extends over several degrees. Tables are given of the maximum, optimum, and minimum temperatures for spore germination, mycelial growth, and fruiting for each of the eleven species studied.

Further studies were made concerning certain environmental factors influencing germination and growth. The temperature at which the spores are produced influences in some degree the rate of germination and the early period of the growth of the resulting mycelium. Spores of *R. nigricans* produced at 10° C. germinated in 30 minutes less time than those formed at 20° and 26°. Spores of this species from different cultures grown under similar conditions germinated equally well up to 20 days irrespective of age.

Spores of *R. nigricans* germinated in a considerably shorter time in a nutrient solution than in water. Sweet potato decoction was the best liquid and string bean agar the best solid medium tried. In the comparative tests this fungus grew nearly twice as fast on string bean as on Irish potato agar. The presence of 20 per cent. dextrose in Irish potato agar changed the cardinal temperatures of the strains of *R. nigricans* studied by 1° to 2° C. *R. nigricans*, the most virulent member of this genus, is somewhat limited in its scope under natural conditions by temperature relations. The spores in the experiments described in the present paper were invariably killed at 35° C. and growth was very sparse and slow at 6·5° C. At 1·5° no appreciable development was made on potato agar in 30 days.

Harter (L. L.) & Weimer (J. L.). **The relation of the enzym pectinase to infection of Sweet Potatoes by Rhizopus.**—*Amer. Journ. of Botany*, x, 15, pp. 245–257, 1923.

The cause of soft rot of sweet potatoes in storage has long been suspected to be *Rhizopus nigricans*, although the causal relation of this fungus has hitherto been somewhat difficult to prove. The authors' investigations have shown that *Rhizopus nigricans* cannot infect sweet potatoes through the unbroken skin, and that infection is only rarely produced by smearing spores and hyphae on a freshly cut surface. However, when the fungus is given a saprophytic start by growing on dead rootlets, in synthetic agar solidified on the cut surface of the potato, or in dead cells charred over a Bunsen burner, infection readily takes place. It can also be readily induced by growing the organism for a day or two in sweet potato decoction, the latter, with the mycelium, being poured into a 'well' made in the potato and then sealed over with a cover glass to prevent evaporation. Infection is accomplished only after the dissolution of the middle lamellae by means of the pectinase secreted in the growing hyphae [see this *Review*, ii, p. 418]. This enzyme appears to be secreted in advance of the growth of the fungus, a sterile zone always being present between the healthy and mycelium-infested regions. In almost all cases infection takes place in wounds where the fungus is able to secure a saprophytic start on some dead tissues. During the growth of the mycelium in these dead cells, the pectinase is produced which dissolves the middle lamellae of the living cells of the host. These cells then die and provide a suitable substance for the further development of the fungus.

Several other species besides *R. nigricans* were found to be able to cause decay in sweet potatoes, and in every instance the authors' experiments were duplicated with *R. tritici*. All the species were found to secrete pectinase and to macerate the host tissue.

The practical significance of these results is that wounding is a necessary preliminary to infection. Rough handling during harvesting, storage, and preparation for market should be avoided as far as possible.

The titles of 37 references to literature are cited.

NADSON (G. A.) & JOLKEVITCH (A. I.). **Spicaria purpurogenes n. sp.** К вопросу об антагонизме микробов. [*Spicaria purpurogenes* n. sp. On the question of antagonism of microbes.]—*Bull. Chief Bot. Gard. Russian Republic*, xxi, Suppl. i, pp. 1–12, 3 col. pl., 1923.

In one of the authors' cultures of common bread yeast (*Saccharomyces cerevisiae*) on malt agar a fungous contamination appeared, probably from the air, which produced a red pigment. The yeast cells near the fungus were killed and differentially stained as in a well-made microscopic preparation.

The fungus in question belongs to the genus *Spicaria* and is described as a new species *S. purpurogenes*. The mycelium is about 0·75 μ in diameter, septate, profusely branching, forming a weft of varying thickness according to the conditions of growth. By itself the mycelium is colourless but may when old become stained with its own pigment. It grows comparatively slowly, the production of conidia starting in one to two weeks, or sometimes later, depending on the cultural conditions; the latter also affect the colour of the pigment which may be yellowish, brownish, or red.

When about to fructify the mycelium appears to be covered with a white down. This is formed by nascent conidiophores which are tree-like and pyramidal in shape, 70 to 175 μ high, the branches usually being disposed in whorls. Oblong bodies are generally detached from the tips of the branches and each of these bodies subsequently divides into two conidia by constriction in the middle; in some cases, however, chains of conidia are abstricted from the tips of the branches. The conidiophores may measure up to 3·75 μ at the base.

The conidia are elliptical, 1·5 to 2·25 by 2·25 to 3 μ, or occasionally round. Mature conidia give the fungus a greenish or dove-coloured appearance. When germinating they swell slightly and produce 1 to 4 germ-tubes.

In older cultures chlamydospores are found. These are elliptical or round cells with thick, clearly double, shining walls and dense contents, and are borne on short lateral branches.

Details are given of the cultural characters of the fungus which appear to show that carbohydrates (sugar or starch) stimulate the development of the fungus and that they are necessary for the production of the red pigment, which is favoured more by glucose than by saccharose, and by a weak acid than by a weak alkaline medium. Pigment production was better at 15° C. than at 23° C., but light had no effect on it.

The authors tested the reciprocal action of *S. purpurogenes* and *Saccharomyces cerevisiae* by sowing them in parallel or crossed streaks on agar plates. These tests showed plainly the aggressive behaviour of the fungus on the yeast, although the latter also affected the fungus by weakening its growth, suppressing the production of conidia, and stimulating the production of the red pigment. The toxicity of the red pigment on the yeast was clearly manifest, and there is no doubt that the struggle between fungus and yeast is carried on by chemical substances, by mutual poisoning, the advantage lying with the fungus. A transfer of red stained *Spicaria* to a fresh dish gives rise to normal unstained or very slightly stained cultures. The yeast therefore clearly stimulates the production of pigment. On media lacking carbohydrates the fungus does not produce the pigment even in the presence of the yeast.

Another species of yeast, *Nadsonia elongata*, proved to be even a weaker antagonist than the former one, although in this case sporulating cells are frequently seen whereas they were observed only once in the case of *Saccharomyces*. The common milk mould, *Oidium lactis*, was found to be still more susceptible, and similar results were obtained with *Endomyces vernalis*, a 'fat yeast'. *Penicillium glaucum* was also found to be susceptible to the *Spicaria*, being differentially stained by it, even in its young, immature conidia. The use of chemical substances and pigments by fungi to protect themselves from the aggressive action of other fungi and bacteria appears to be widely employed and to play an important part in the biology of micro-organisms.

Millard (W. A.) & Burr (S.). **The supposed relation of Potato skin spot to corky scab.**—*Gard. Chron.*, lxxii, p. 355, 1923.

Shapovalov's conclusion [see this *Review*, ii, p. 389] that skin spot of potatoes [previously referred to *Oospora pustulans*] is an immature stage of corky scab [*Spongospora subterranea*], would, if satisfactorily established, be of considerable importance from a practical point of view. The pustules of skin spot are uniformly present on many well-known Scotch and English varieties of seed potato, including King Edward and Ally, and the prospect of corky scab being transmitted in this way is very alarming. However, as a result of thorough investigations on the pathogenicity of *Oospora pustulans*, details of which which will be published later, the authors believe they have obtained overwhelming evidence that skin spot is caused solely by *Oospora pustulans* and that it is in no way related to corky scab.

Une nouvelle maladie de la Pomme de terre. [A new Potato disease.]—*Bull. Agric. Algérie-Tunisie-Maroc*, xxix, 2nd ser., 4, p. 69, 1923.

The article reports the observation of *Spongospora subterranea* on potatoes in the coastal district of Algeria, and states that the disease is new to Algeria. No great losses are anticipated from this source as climatic conditions are rarely favourable to the development of the trouble, but brief instructions are given for preventing its spread.

PERRET (C.). **La dégénérescence des Pommes de terre.** [The degeneration of Potatoes.]—*La Vie agric.*, xxiii, 30, pp. 61–66, 6 figs., 1923.

During 1921 and 1922 the author carried out a series of investigations at the Merle (Loire) Experiment Station which furnished some data in connexion with leaf roll and other virus diseases of potatoes.

Early in 1921 a sack containing the tubers harvested from two pure line plants of the Paul Kruger [President] variety (susceptible to leaf roll) was supplied by Professor Quanjer to the Merle Experiment Station. Six of these tubers were each cut in two and the sections numbered 1 and 1′, 2 and 2′, &c. The halves 1 to 6 were planted in a field formerly under clover at a distance of 10 metres from other potatoes, in April 1921, and the corresponding sections 1′ to 6′ interspersed among plants of Institut de Beauvais suffering severely from leaf roll. The resulting plants in both plots were healthy and vigorous, but towards the end of August those in the vicinity of the diseased Institut de Beauvais began to show signs of leaf roll. The yield, however, was not reduced, and it was thought that the symptoms might be due to drought. In order to settle this point the tubers from each plot were kept separate, the crop from the tubers 1′ to 6′ being sent to the Grignon Experiment Station and those from the series 1 to 6 retained at Merle. In 1922 the plants grown from the latter were all healthy while those from the tubers 1′ to 6′ showed, with one exception, the typical symptoms of leaf roll. There seems, therefore, to be no doubt that infection was actually transmitted from the diseased Institut de Beauvais plants to the Paul Kruger plants.

Discussing the difficulty of accurately diagnosing leaf roll on account of the similarity of the symptoms to those produced by *Rhizoctonia*, blackleg [*Bacillus atrosepticus*], basal injuries, premature desiccation, and other causes, the author recommends the use of the iodine water test. The leaves of suspected plants should be gathered in the early morning, boiled in Eau de Javelle, rinsed in ordinary water, dipped into water containing a few drops of iodine, and rinsed again. The leaves of diseased plants show a dark brown discoloration owing to the accumulation of starch. Leaves detached in the evening and placed overnight with the petioles in water retain their starch if diseased and lose it if healthy. According to Murphy [see this *Review*, i, p. 306] the results of this reaction are nearly always positive in cases of secondary leaf roll.

The part played by aphids in the transmission of virus diseases is briefly discussed, no original theories, however, being advanced. The effect of altitude on the incidence of these diseases has been studied in the Loire Department, but the investigations are complicated by the different reaction of certain varieties to high and low-lying situations. Thus, at 400 m. above sea-level the percentage of leaf roll among Institut de Beauvais potatoes increases from 30 to 90 in three years. On the other hand, Violette du Forez has been cultivated for fifty years in the mountains at an elevation of 1,000 to 1,200 m., and Merveille d'Amérique which 'degenerates' at 400 m. seems to recover in the mountains.

The method of field inspection adopted in the Loire Department is outlined. No field of Violette du Forez potatoes containing more than eight defective plants out of forty is passed. Excellent results are stated to have been obtained during the last three years by this method and the scope of the inspection is now to be extended by the Departmental Agricultural Bureau.

ARTSCHWAGER (E. F.). **Occurrence and significance of phloem necrosis in the Irish Potato.**—*Journ. Agric. Res.*, xxiv, 3, pp. 237–245, 6 pl., 3 figs., 1923.

Since 1916 the author has carried out investigations on the phloem of a large number of cultivated and indigenous South American varieties of potatoes in order to arrive at some definite basis as to what constitutes a healthy potato plant from the anatomical point of view and under what conditions the phloem will remain normal. To guard against erroneous diagnoses in the case of certain diseases, such as leaf roll, it is necessary to distinguish between normal histological changes and induced abnormal states, the latter alone being truly pathological.

The vascular tissue of the potato plant shows a bicollateral arrangement of its elements which is most clearly seen in the larger stem bundles. The primary phloem external to the cambium is composed of small groups of more or less continuous cells, but the groups constituting the inner phloem are very variable in size and scattered. Later secondary phloem elements become differentiated and participate in the translocation processes; the primary phloem groups remain active until the plant is mature. Apart from a slight thickening of the cell walls and occasional callus deposits on the plates of the sieve-tubes, there are no noticeable characteristic structural or chemical changes in the phloem of the mature plant.

Local necrotic changes in the parenchymatous tissue, however, due to a variety of causes, may be observed in any potato plant.

The study of numerous varieties at the Fort Lewis high altitude station, Colorado, revealed the influence of ecological factors on anatomical modifications in the vascular tissue. Thus, a superabundance of water induced a discoloration of the secondary elements of the wood and the primary xylem, the lumina being filled with a brown, gummy deposit. A greatly reduced water supply, or alternate wetting and drying, produced a dense and more strongly lignified wood. Shading reduced the xylem and the lignification of the cells was less pronounced. The occurence of these and other changes of a purely environmental character must not be confused with true pathological modifications.

External insect injuries frequently cause internal stem lesions and a dark discoloration of the tissues. In extreme cases entire cells or cell groups may be obliterated.

In connexion with the stem streak disease [see this *Review*, ii, p. 285] severe necrosis may be observed both in the inner and outer phloem, the cells being brownish in colour and the lumina may be partly closed by the pressure of the surrounding cells. The necrotic phloem groups, however, show no regularity either in vertical or lateral distribution and it remains to be seen whether this disease is definitely connected with leaf roll.

Stem sections of a typical leaf roll plant exhibit, as a diagnostic internal symptom, a necrosis and lignification of the phloem groups, which is described in some detail. When severe external symptoms are apparent the diseased groups pervade the entire plant, with the occasional exception of the underground organs. The distal stem region is commonly severely affected, and the basal stem region always shows necrosis when the symptoms appear early. The nodal tissues are more severely attacked than the internodal ones, especially in the early stages of the disease.

In the petiole and midrib necrosis may appear later but is usually correlated with the severity of the rolling. In the underground organs of diseased plants the phloem strands are usually normal but may show necrosis in bad cases.

The lateral distribution of phloem-necrosis is subject to a great deal of variation. Perfectly healthy phloem groups are often seen side by side with diseased ones. In the apical stem region, the first stages of necrosis are found in the external phloem and only later in both regions. In the base of the stem both inner and outer phloem may be attacked, but often the inner is completely destroyed whilst the outer remains healthy.

Before there is any apparent evidence of lignification of the phloem tissue, the development of the vascular tissue in the distal stem region shows a deviation from its normal course, represented by an irregular maturing of the xylem. Close examination of sections stained with phloroglucin and hydrochloric acid reveals a slight degree of lignification in parts of the walls of the phloem cells centrifugal to the depression in the cambium. The cells of the pericycle in this region have a greater radial diameter than the normal. The first cells to show lignification are usually those adjacent to the fibres, but occasionally lignification may start at the centre of a phloem group and extend centrifugally.

Prior to lignification of the phloem, a swelling of the walls of the diseased cells extends centrifugally from the fibres. Large quantities of pectic substances in these walls are indicated by the deep blue colour imparted at this stage by ferrous sulphate and potassium ferrocyanide. Gradual lignification of the cells ensues, and in severe cases most or all of the primary phloem is destroyed. The intercellular spaces formed by the separation of the primary walls of adjacent cells become filled with a brown deposit, which at a certain stage takes the lignin stain. Following the gradual degeneration of the cells and subsequent loss of turgor, the phloem elements collapse unless rapid lignification lends rigidity to the walls.

Obliteration of the phloem is constantly associated with leaf roll, and Quanjer (*Meded. R. Hoog. Land-, Tuin, en Boschbouwsch.; Wageningen*, vi, p. 41, 1913) regards it as an infallible symptom of that disease. It is, however, also a concomitant of various other disturbances, and its value as a diagnostic internal symptom in leaf roll depends less on its mere presence than on its universal distribution and the absence of necrosis in other tissues.

BOTJES (J. O.). **Onbekende Factoren bij het kweeken van ziektevrij pootgoed.** [Unknown factors in the propagation of disease-free seed.]—*Tijdschr. over Plantenziekten*, xxix, 7, pp. 113–126, 1923.

The possibility of regenerating, by means of judicious selection, some of the more important potato varieties is discussed. Encouraging results in this direction have been obtained in Friesland with the Eigenheimer variety, and in several different localities with Roode Star, Bravo, and Zeeuwsche Blauwe. In Germany several growers have succeeded in selecting resistant strains of the 'degenerating' Industrie variety. There are, however, limits to the efficacy of this method, as has been shown by the repeated failure of attempts to cultivate the Eigenheimer and Paul Kruger [President] varieties in the sandy soil of the Veen Colony districts. The latter variety is fast losing its commercial importance owing to the difficulty of growing it on a large scale. For breeding purposes, however, it is very valuable, and in a recent series of hybridization experiments the best product was obtained from a cross between Franschen and Paul Kruger.

With reference to the transmission of the so-called 'degeneration' diseases, the author investigated the possibility of their being transmitted, in the absence of potatoes, from weeds or other plants, by the following experiment which he carried out in 1920.

He divided each of four potato tubers into six parts and planted them in six plots, one part of each potato in each plot, in an enclosed garden containing no other potatoes or Solanaceae. Six of the progeny from these developed leaf roll, and one mosaic. The diseased plants came from different tubers, so that infection very probably did not originate in the seed tuber and was more likely to be due to some external cause. The author considers that the virus probably originated from other plants (not Solanaceous) in the garden.

The importance of early digging of seed tubers, based on the theory that the mosaic virus spreads from the plant to the tuber [see this *Review*, ii. p. 519] is discussed. With early-ripening varieties this method is quite practicable, but in a late-maturing variety, e. g. Paul Kruger, the tubers are too small for digging in the middle of June (the critical time for infection). Possibly the removal of the foliage would serve the same purpose, since the object of early digging is to sever the connexion between the infected leaves and the tubers. The actual degree of maturity of the tubers at the time of digging is a secondary consideration.

Dorst (J. C.). **Aantasting van de Aardappelplant door Rhizoctonia solani en haar bestrijding door sublimaat.** [The infection of the Potato by *Rhizoctonia solani* and its control by corrosive sublimate.]—*Tijdschr. over Plantenziekten*, xxix, 6, pp. 97–106, 1923.

The symptoms and distribution of the *Rhizoctonia* disease of potatoes, caused by *R. solani*, are described. The incidence of the disease in Holland is stated to be very heavy on the varieties Eersteling, Midlothian Early, Schotsche Muis, Geeltjes, Eigenheimer, and Zeeuwsche Blauwe, but whether this is due to the inherent susceptibility of these varieties or to their continual cultivation on infected soil is difficult to determine. The disease is very prevalent in Holland on sandy clay soil and on reclaimed pasture land. A striking feature of the crops grown in the latter type of soil is the tendency to tuber formation above the ground. The application of fresh organic manure appears to increase the incidence of the disease.

The eradication of the causal organism from the soil can only be gradually accomplished by suitable crop rotation, by the removal of weeds and potato refuse, and by seed disinfection. The latter can be thoroughly effected by immersion for one hour and a half in a solution of 1 per cent. corrosive sublimate (0·5 hl. to 1 hl. of potatoes). The temperature of the water used in the solution should not be lower than 5° C. or injuries to the tubers may result. Excellent results have been obtained in Friesland by disinfection with corrosive sublimate, the advantages of which are briefly described.

De Long (W. A). **Sulphur and soil acidity.**—*Scient. Agric.*, iii, 10, pp. 354–356, 1923.

It has been definitely shown that the development of potato scab [*Actinomyces scabies*] can be controlled by the application of sulphur to the soil. In order to determine the requirements for optimum results from this method of treatment under Nova Scotia conditions, investigations were undertaken at the Truro Agricultural College on the effects of the application to infested soil of 300, 400, 500, and 600 lb. of sulphur per acre. The sulphur was applied at three different periods, namely, four weeks before, during, and four weeks after planting the potatoes. The inoculated form of sulphur [see this *Review*, i, p. 82] was chiefly used, but for comparative purposes a series of the same amounts of flowers of sulphur applied at the time of planting was included. The experiment recorded in this paper was started in boxes in the greenhouses in January 1922, although field experiments are also being carried out. The soil in the boxes was fertilized at the rate of 500 lb. per acre with a 4–8–4 mixture composed of nitrate of soda, acid phosphate, and muriate of potash. The sulphur applied was thoroughly mixed with the top four inches of soil.

The results of monthly determinations of the lime requirements showed a marked increase of acidity in all cases where sulphur was applied. Up to 500 lb. the amount of acidity produced increased with the quantity of sulphur applied, beyond this amount the results were conflicting, an increase of the lime requirement sometimes being produced and sometimes not. The uninoculated form produced as much acidity as the inoculated. The maximum lime requirement was obtained in every case at the second test, namely, about eight weeks after the planting of the potato setts.

Since the control boxes were treated in all respects similarly to the others, except for the absence of sulphur, it appears reasonable to conclude that the increase of acidity shown by the increased lime requirement was due, directly or indirectly, to the application of the sulphur.

The actual increase in lime requirement was found to be largely in excess of that expected theoretically, even supposing the whole of the sulphur to be oxidized to sulphuric acid. The sulphur may have caused the plants to produce more acid, or there may be some stimulation of the bacterial population of the soil. Of these possibilities the second seems to be the most promising and is supported by the work of others, although further investigation is necessary before the matter can be cleared up.

Rosa (J. T., Jr.). **Spraying Irish Potatoes.**—*Missouri Agric. Exper. Stat. Bull.*, 198, 8 pp., 2 figs., 1923.

Spraying potatoes with Bordeaux mixture has not yet become general in Missouri, probably owing to the relative scarcity of early and late blight [*Alternaria solani* and *Phytophthora infestans*] in the spring and early summer. In other States experiments have shown that proper spraying with Bordeaux generally increases yields even when these diseases are absent.

Experiments with the varieties Early Ohio in 1921, and Irish Cobbler in 1921 and 1922, at Columbia, are described in this paper, which indicate the beneficial action of such sprays in the prevention of tipburn and hopperburn. A serious objection to the spraying of the Early Ohio variety with Bordeaux mixture is the formation of second growths on the tubers [see this *Review*, ii, p. 466]. This objection, however, does not apply in the case of Irish Cobbler. In 1922 spraying this variety four times, when the plants were four to six inches in height, with lead arsenate alone and with Bordeaux plus lead arsenate, gave increased yields of 21·2 and 123·6 per cent., respectively, over the control. Leaf hoppers became abundant at the end of June, and severe burning appeared early in July on the unsprayed plants. The increased yield is probably due almost entirely to tuber growth made by the sprayed plants after the untreated controls have begun to die. Thus by digging comparatively late (August) a considerably larger crop can be obtained from the sprayed plants.

Köhler (E.). **Ueber den derzeitigen Stand der Erforschung des Kartoffelkrebses.** [On the present position of research on wart disease of the Potato.]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 4, pp. 289–313, 2 pl., 1923.

In this paper the author gives a detailed resumé of the present knowledge regarding wart disease (*Synchytrium endobioticum*), including its distribution, life-history, and symptoms, and incidentally adds the results of his own investigations of this disease. His series of experiments on the development and cytology of the organism, while differing in certain aspects, agreed in the main with those obtained by Miss Curtis [see this *Review*, i, p. 80]. The main points of difference may be summarized as follows. According to the author, the first extrusion of chromatin from the nucleolus into the nuclear cavity of prosoral nuclei is effected solely by means of the linin network, which stains exactly like the nucleolus. The linin network does not become detached from the nucleolus until the extrusion of granules of chromatin into the nuclear cavity has been affected. In the final stages the linin network is visible only as a structure devoid of chromatin (the 'amoeboid body' of Percival), which remains until the division of the primary nucleus, or dissolves and becomes dispersed in the nuclear cavity. Both resting sporangia and prosori were observed to contain 'amoeboid bodies'. In subsequent extrusions the chromatin is exuded drop by drop from the nucleolus and absorbed by the linin network of the nuclear space.

According to Miss Curtis the full complement of nuclei of the prosorus at the time of cleavage and after mitosis has taken place is about 32, but the author observed a considerably larger number. As regards the fate of the chromatin immediately after its extrusion from the nucleus of the resting sporangium the author differs from Miss Curtis. According to him the chromidia extruded into the protoplasm swell owing to the formation of one or more vacuoles which increase considerably in size, and the actual chromidial substance is finally concentrated in a somewhat thin, irregular layer at the periphery of the vacuoles. This layer is ruptured by the progressive increase of the latter and the chromidial mass divided into irregular fragments which are further disintegrated into fine granules and are then distributed in the protoplasm. The fusion of the zoospores was not observed by the author.

In 1922 the author carried out an experiment on the resistant Citrus potato variety, the results of which showed that the degree of infection decreased as the size of the tubers increased. Tubers weighing over 40 gm. were not attacked, and even on the smaller tubers the warts were no larger than a pea, in spite of the presence of numerous summer sori. Further observations on the Adonis variety, on which the warts were also small, indicated that the parasite flourishes independently of abnormal cell division in the affected tissues. It is highly probable that susceptible varieties exert some powerful attraction, the nature of which is obscure, which induces the zoospore to penetrate the epidermis. Conversely, immune varieties appear to owe their freedom from the disease to the absence of this specific attraction.

By means of pure line selection, immune types of the varieties Tannenberg, Wohlgeschmack, and Romaner were obtained.

Further investigations were made on the causes which bring about immunity, but the results were chiefly negative. Dealing first with the colour of the sprouts, the author divided potatoes into the three following groups, according to this character. 1. Those with green sprouts (without anthocyanin). 2. Those with predominantly reddish-purple anthocyanin (denoting an acid reaction of the cell sap). 3. Those with predominantly bluish-purple anthocyanin (denoting an alkaline reaction of the cell sap). There appeared, however, to be no correlation between the potatoes in these various groups and immunity.

It was also ascertained by means of experiments with susceptible, resistant, and immune varieties that there was no connexion between the solanin content of the various organs and susceptibility to, or immunity from, the disease. It was thought that the hydrogen-ion concentration of the epidermal cells might have an important bearing on immunity and susceptibility. In order to test this hypothesis it was necessary to find an indicator which could be absorbed by the living cells. Neutral red was found to be the only colour indicator thus absorbed and it was found that both susceptible and immune varieties took on a similar coloration.

Regarding the control of the disease, the author is of the opinion that the use of immune varieties is the only practical solution, and lists eight German varieties which are immune, as well as various English and American immunes. He summarizes very fully the evidence at present available on the attempts at sterilizing soil infected with the parasite.

There are numerous references to the work of previous investigators and a bibliography is appended.

SCHANDER & RICHTER. **Ueber den Nachweis von Dauersporen von Chrysophlyctis endobiotica Schilb. (Kartoffelkrebs) in der den Kartoffeln anhaftenden Erde.** [The detection of resting spores of *Chrysophlyctis endobiotica* Schilb. (Potato wart disease) in the soil adhering to Potatoes.]—*Centralbl. für Bakt.*, Ab. 2, lviii, 19–24, pp. 454–461, 1923.

The increasing prevalence of wart disease of potatoes, caused by the fungus *Chrysophlyctis endobiotica* [*Synchytrium endobioticum*], in Germany necessitates the immediate introduction of a method whereby the soil particles adhering to potato consignments can be rapidly and thoroughly inspected for the presence of the causal organism.

The results of a preliminary series of experiments showed that direct microscopical examination of the soil was not a reliable method when the proportion of soil to diseased tissue from the excrescences was 100 to 1, since spores were easily concealed by the larger particles. The possibility that the specific weight of the spores might be less than that of soil particles of the same size suggested that if spores and soil particles were mixed with water and stirred, the latter would sink and form a deposit at the bottom of the tube while the spores floated. This proved to be the case in a series of tests in which 10 gm. of soil, containing 600 to

1,000 spores per gm., were placed in a tube with five times the amount of water, the proportion of soil to diseased tissue being 100 to 1. After one minute the coarser soil particles had settled and the liquid above was decanted into a second tube, where it was left standing for five minutes. Microscopical examination of the sediment in the second tube revealed the presence of resting spores. The latter were also present in the liquid after 24 hours' standing; they were extracted by centrifuging and added to those in the sediment. This was then mixed with a little water and examined under the microscope; it was found that one drop contained 10 to 15 spores, which, surrounded by minute soil particles and cell remains, were easily recognizable. The results of further tests showed that this method was still reliable when the proportion of soil to diseased tissue was 2,000 to 1. At this ratio there are 300 to 500 spores of the fungus per kg. of soil, corresponding to 0·5 gm. or 0·5 cc. of warty tissue.

Suggestions are made regarding the practical application of this method to the inspection of potato consignments transported by rail or sea. Not only should the potatoes be superficially inspected in the vans but a microscopical examination should also be made if possible from the soil fallen on the floor of the wagons. In doubtful cases about 50 tubers should be removed to the laboratory for closer inspection on the lines described above. Should the decay of the tuber be due to *Phytophthora* the consignment may be released, but if there is any trace of wart disease the potatoes must be taken to the nearest distillery or starch factory [see this *Review*, ii, p. 336]. Attention is drawn to the danger of using vans which have been occupied by infected potatoes for the transport of agricultural implements, live stock, hides, and the like, to which the spores of the fungus may easily adhere. Such vans should be disinfected with a 3 per cent. solution of cresol sulphuric acid and the infected soil and other refuse burnt, buried, or mixed with a disinfectant.

PETCH (T.). **A root disease of Hevea (Xylaria thwaitesii Cooke.)**—*Trop. Agric.*, lx, 2, pp. 100–101, 3 pl., 1923.

In 1921 and 1922 mature *Hevea* trees were found to be suffering from a root disease, apparently caused by a *Xylaria*, which had previously been recorded only once, in 1910.

On the affected roots the fungus forms black, flat, irregular bands, sometimes in a network, and extensive patches or plates. The bands, which appear to result from the fusion of small patches into a continuous line, are smooth, sometimes longitudinally ridged, and white internally. They generally exceed 2 mm. in width and are less than 1 mm. in thickness. A root may be partly covered with a network of these bands through which the pale cortex is visible, whilst the remainder is concealed under a continuous black sheet.

In the early stages of the disease the wood of the roots does not show any very marked symptoms. In advanced stages, however, the characteristic features of the disease, which are quite distinct from those of any other root disease of *Hevea*, are readily recognizable. When the root is split longitudinally the central region is moist, but still hard, and dark brownish-grey in colour. Outside this region the wood is drier and yellow-brown in colour, a black line sometimes separating the two zones. Black lines and ovals may be present, but are not a constant feature of the disease, as in *Ustulina*. The hardness of the discoloured wood is noteworthy. The inner tissues of the cortex become brown and friable, being broken down sometimes into fragments united by fine strands of rubber, but the external layer does not show much alteration.

The fructifications generally appear on the ground near a lateral root or the collar of the tree. They occur in clusters, arising from a basal mass in the soil or at ground level. In some cases three or four stout stalks arise from the basal mass and divide above into numerous fructifications; in other cases the fructifications all arise from the same level. They are very variable in shape, up to four inches in height and one inch in breadth, and have a light brown outer layer which usually disappears as they mature, leaving a black surface. They are somewhat corky and white internally.

The appearance of the fructification coincides approximately with the death of the tree. In all material hitherto found, the fungus has not been mature, since the infected trees have naturally not been allowed to remain until the fungus matured. The spores and perithecia of the fungus are rarely developed in the laboratory, but in one case this was successfully accomplished, leaving no doubt that the organism was a *Xylaria*.

In the first record of this disease the species was referred to as *X. zeylanica*, but it would appear from an examination of the type specimens of Ceylon species of *Xylaria* in the Kew Herbarium that its correct name is *X. thwaitesii*.

RINGOET. **La culture de L'Hévéa à la Station agricole de Yangambi-Gazi (Province orientale) durant l'exercice 1921.** [The cultivation of *Hevea* at the agricultural Station of Yangambi-Gazi (eastern Province) during 1921.]—*Bull. Agric. Congo Belge*, xiv, 1, pp. 8–9, 1923.

Thread disease or streepjeskanker [*Phytophthora*] and mouldy-rot [*Sphaeronema fimbriatum*] of *Hevea* rubber, of which the first named is more common, are very often found in association. The damage done in the East Indies by these diseases is considerable, but in the Belgian Congo the dry climate does not encourage their development, and cases are not of frequent occurrence. Regular applications of 5 per cent. agrisol or brunolinum plantarium solutions are made, and affected trees are given a rest.

Brown bast, though not unknown, has not assumed disquieting proportions in the Belgian Congo. At the Station, out of a total of 2,342 trees, 344 or 14·7 per cent. are more or less affected. No treatment has so far been applied, but trees yielding little or no latex are given a rest. It is hoped to make a trial with hot tar, which has been successful in Java.

Root diseases are also reported, but have not, as yet, been identified.

Stevens (H. P.). **Effect of mould on a sheet Rubber compounded with litharge.**—*Bull. Rubber Growers' Assoc.*, v, 6, pp. 341–342, 1923.

A slight retardation in the rate of cure is always noted with sodium silicofluoride prepared rubber when vulcanizing an ordinary 90–10 test mixing of rubber and sulphur [see this *Review*, ii, p. 139]. When the minimal proportion of sodium silicofluoride is used, namely, 1 in 2,000 of latex, the retardation may not exceed 5 per cent., but with larger proportions it may amount to 10 or 15 per cent.

Vulcanizing tests, using the ordinary rubber sulphur 90–10 mixing and the same with the addition of 50 parts of litharge, have been made with samples of rubber (1) coagulated with acetic acid and (2) coagulated with sodium silicofluoride (1 lb. to 150 galls., i. e. 1 in 1,500), soaked for half an hour in a saturation of sodium silicofluoride, drip dried, and smoked as usual. The samples were packed in a case exposed to rain for one night. On unpacking the case a fortnight later the acetic acid coagulated sheet was found to be covered with mould, whereas the sample coagulated with and soaked in sodium silicofluoride was clean.

Tests of the two samples, compounded in one case with sulphur only and in the second with litharge, showed that in the former case the acetic acid control cured more rapidly than the sodium silicofluoride prepared rubber, while with the addition of litharge the reverse was the case. In the case of the litharged samples the mouldy condition of the acetic acid prepared sheets probably accounts for the low rate of cure as compared with that of the sodium silicofluoride sheets. This reversion in the order of the rate of cure by the addition of litharge demonstrates the importance of its inclusion in the tests until a final decision as to the comparative merits of acetic acid and sodium silicofluoride as coagulants is reached.

North (D. S.). **The control of Sugar-cane diseases.**—Reprinted from *Australian Sugar Journ.*, xiv and xv, 46 pp., 1923.

This paper is stated to be the first of a series which will embody the results of investigations on sugar-cane diseases in Australia made since 1907, and also of field measures commenced in 1919 with a view to controlling these diseases on lines similar to those which in Fiji are claimed to have secured such effective control of 'Fiji disease' [see this *Review*, i, p. 187, and ii, p. 288] and other sugar-cane diseases that they have caused no serious losses in the crops of that Island of recent years.

In an interesting discussion of the means by which sugar-cane diseases have reached Australia and Fiji, the author [who is pathologist to the Colonial Sugar Refining Co.] takes both countries together, since the free interchange of varieties between them [the Company having large interests in both areas] has led to their varieties and diseases being practically identical. Nevertheless, though certain diseases have undoubtedly been introduced with interchange of varieties into particular areas, they have not always succeeded in becoming permanently established there. Fiji disease, for instance, has never become established at any of the Company's mills in Queensland, though it has been long prevalent and highly destructive in New South Wales and Fiji; while *Sclerospora sacchari* has not been found in New South Wales, though it occurs throughout Northern Queensland and Fiji.

The author thinks that Australia has a longer list of serious cane maladies than any other country, having been more active than most in introducing new varieties and their diseases from all over the world. None of the diseases hitherto found is regarded as endemic, New Guinea, from which many varieties have come, being considered the home of those Australian diseases of which the origin has hitherto been obscure. There is stated to be definite evidence that this is the case with Fiji disease, while *Sclerospora sacchari* and the hitherto undescribed 'leaf scald' (*Bacterium* sp.) are also suspected to have come from the same source. Little is known of the sugar-cane diseases of New Guinea, and importations from that island are held to be exceedingly dangerous.

Much success has attended the efforts to control diseases by the use of resistant varieties, but the latter appear to have been introduced without due care so that they brought new diseases with them: each variety was sooner or later attacked in its turn, either by a new disease or an old one resuscitated. No universally resistant variety has hitherto been discovered; Badila appears to be the nearest approach to a generally resistant cane, but has been badly damaged by Fiji disease and gumming in certain areas. Furthermore, the use of resistant canes has often entailed a sacrifice of yield and quality. Hence the author believes that other methods of disease control are urgently required in Australia, and he advocates those that have been tested and found effective in Fiji. Each disease requires a different treatment, but they may be grouped to some extent by their salient characters.

The five most virulent cane diseases of Australia constitute a group characterized by the fact that a diseased cutting will always produce a diseased plant. They are gumming (*Bacterium vascularum* (Cobb) Greig-Smith), leaf scald (*Bacterium* sp.), leaf stripe [downy mildew] (*Sclerospora sacchari* Miy.), Fiji disease [*Northiella sacchari* Lyon (*Phytamoeba sacchari* McWhorter)], and mosaic disease. Each of these diseases is also highly infectious by some aerial (not, so far as is known, soil-borne) means of spread to other canes in the vicinity. Each is caused by a strict parasite, unable to thrive for long apart from its living host. Each is 'incurable', that is, the infected plant is permanently diseased. The main source of infection is undoubtedly the use of diseased stools for 'seed'. For this group effective control is to be sought in the measures of field sanitation outlined by the author. The first of these is 'seed' selection, the aim being to avoid the planting of diseased setts. With gumming and leaf scald, no field in which infection may reasonably be suspected should be used for seed. For success in seed selection an exact knowledge of the symptoms is required, and much use has also been made of the known factors which influence the occurrence of these diseases, such as the prevalence of Fiji disease on rich land, of leaf stripe on poor, of gumming in badly drained areas, of leaf scald on higher, dry land, and of mosaic in hilly country. The second measure required is the removal of sources of infection by ploughing out badly diseased fields after harvest and by eradicating all the diseased stools in milder cases. In widespread outbreaks, as when all the fields of a farm have become severely infected, such drastic measures are impracticable, and slower methods, such as the introduction of resistant varieties as an adjunct to seed selection and eradication, must be adopted. Other measures, applicable to certain diseases only, are desirable. Such are the avoidance of knife infection with gumming and leaf scald, improved drainage and cultivation, and the like.

In a second group are included red rot (*Colletotrichum falcatum* Went), root disease of the type said to be caused by species of *Marasmius*, and the sclerotial disease of the leaf sheath. Top rot [see next abstract], rind disease (*Melanconium sacchari* Massee), and pineapple disease (*Thielaviopsis paradoxa* (de Seynes) v. Höhnel) may, perhaps, be added to this group, though the two last apparently only attack parts already dying or dead from other causes. These are all considered to be due to weak facultative parasites, capable of persisting on rotten cane or in the soil for long periods. In soil so contaminated, cane may be severely attacked under unfavourable conditions for its growth, such as during periods of drought or floods. These diseases are not incurable in the sense used above, for a healthy plant may sometimes develop from an infected sett. With them seed selection and the eradication of diseased plants are measures of secondary value; the reduction of soil infection by crop rotation, and the use of resistant varieties are more important, while good cultivation, manuring, and drainage will also help by promoting a thrifty, even growth.

In the third group a great variety of leaf spots, such as true rust [*Puccinia kuehnii* (Krueger) Butler], eye spot (*Cercospora sacchari* van Breda) [? *Helminthosporium sacchari* Butler], and ring spot (*Leptosphaeria sacchari* van Breda), are included. The majority of these, though conspicuous, are not usually sufficiently harmful to warrant special control measures. They mostly appear at a particular season, such as winter, and disappear later on without seriously affecting the cane. Occasionally, however, particular varieties have been badly damaged or even killed by certain of these diseases, and new varieties have had to be substituted.

Apart from field control, stringent precautions against the distribution of diseases with cane plants sent from one area to another are required. The safeguards suggested are: (1) strict attention at the forwarding end to ensure that only perfectly healthy plants are sent: (2) planting in quarantine under careful supervision by a plant pathologist, on receipt, until freedom from diseases and pests can be guaranteed; (3) raising new varieties at several different centres within the country from seed, instead of obtaining them from abroad. Within a particular mill district, bulk distribution of plants is sometimes necessary to replace diseased crops, but this should be carefully controlled by technical supervision. Foreign importations should be limited to a few varieties of outstanding promise at long intervals, and a quarantine of two years should be imposed not only in such cases but usually when plants are sent from state to state within Australia, or even from one mill district to another unless adjoining and with similar varieties and diseases. The essentials of an effective system of quarantining are discussed at some length.

The necessity for such rigid precautions is chiefly due to the fact that it is impossible to guarantee freedom from disease at the forwarding end. It has been proved in the case of leaf stripe, Fiji disease, gumming, and leaf scald that the disease may remain latent in the growing cane for a long time with no symptoms that can be detected. Concrete cases in support of this statement are quoted. Mosaic disease was also widely disseminated with cane importations before its symptoms were recognized.

The raising of seedling canes in Australia, where little of this nature has hitherto been effected, is discussed and also the testing of varieties, special emphasis being laid on the common experience that diseases are far more prevalent in variety blocks than elsewhere, and that experiment stations engaged in variety-testing are very liable to disseminate diseases. The growing by farmers of a number of varieties instead of one or two standard canes is deprecated.

An interesting account is given of the application of the above considerations to farm practice in the Richmond River district of New South Wales. Every farm is periodically visited for the purpose of assisting the farmer in the selection of his seed and the recognition of diseases present in his crop. Advice is given regarding suitable varieties to be grown and, when required, on all matters of cultivation, drainage, and the like, as affecting disease control. A history of each field is recorded in field plan books which comprises area, variety, source of seed, incidence of diseases, and cultivation data. From this information the progress of diseases from year to year can be followed and steps taken to renew the stock from safe areas when required. Plot trials are laid out on a number of farms, planting, weighing, and the like being controlled by the Company's scientific staff, and much information as to the resistance of disease of different varieties is thus being obtained.

Mosaic and Fiji diseases are proving fairly easy to control by these measures, but gumming and leaf scald have given trouble for various reasons which delayed the taking of effective measures. Accurate estimates of the losses from these four diseases in one mill district gave over 9 per cent. in each of the years 1920 and 1921, estimated on the cane tonnage.

Tryon (H.). **Top rot of the Sugar-cane. An inquiry into the nature and origin of a disease affecting Sugar-cane in the Herbert River and other districts of Queensland.**—*Queensland Bureau of Sugar Experiment Stations. Divn. of Path. Bull.* i, 56 pp., 9 pl., 1923.

The author states that this memoir was written in 1905 but has not previously been printed, though a summary of it appeared in the *Queensland Agric. Journ.*, xxi, pp. 498–505, 1906. The work on which it is based was carried out in 1903, but the disease appears to have been recorded many years earlier and to have caused losses in Queensland as far back as 1891.

The first external symptom is etiolation of the central shoot of unexpanded leaves, whose tips become, at the same time, dry, somewhat drooping, and brownish-green. Two or three of the expanded leaves nearest this shoot show similar changes, and a brown or reddish streak on each side of the midrib may also be found on them. Later on the central shoot dies and the expanded leaves gradually become more and more affected, until all are withered. As this occurs the shoot itself rots at its base and may fall over or be easily pulled out from the top of the cane. The leaf sheaths belonging to the internal leaves show progressively greater destructive changes as the centre of the apical bud is approached, when exposed by stripping. These changes are greatest at the insertion of the sheath on the stem node, and are always more severe than the changes in the corresponding leaf blades would suggest. The inner sheaths may be completely rotted, those next outside show dark purplish areas extending upward from the base and surrounded by red markings, while those farther out have only red bands, or lines, continuous at the base but broken into spots or blotches, suggestive of splashings from a paint brush, higher up. The apical part of the stem is found, on stripping away all the leaf sheaths, to have markings in continuation of those on the sheaths, at first reddish-brown, then brown and collapsed. These markings extend down from the node into the internode below, and evidently originate in anterior changes in the leaf sheaths.

On sectioning an affected shoot in the earliest stages, before any external symptoms are visible, the innermost white leaves, just above the apical point of the stem and wholly enclosed within the bud, show a purple or brown discoloration on each side of the midrib. Later on this discoloration reaches the stem through the nodes on which the affected leaves are inserted, these being usually a short distance behind the still intact growing point. The upper affected internodes of the stem become soft at the same time as the inner portion of the central leafy shoot rots, while four or five of the next lower internodes show browning of the stem tissues with here and there a red fibre, especially at the nodes. The outer tissues of the stem, immediately below the nodes, are more deeply discoloured than those farther in, corresponding with the brown markings in the epidermis already mentioned. In the lower part of the affected portion of the stem, only the nodes may be discoloured. Sometimes even at this stage of the disease, the apex of the stem completely rots away, leaving a cavity filled with moist brown fragments of disintegrated tissue. This complete rotting of the stem apex normally occurs, however, somewhat later in the course of the attack, and forms a cavity bounded by the bases of the leaf sheaths, and containing a strongly smelling mass of decayed tissue. Longitudinal fissures may penetrate the softer tissues still farther down, and at times nothing but the rind and bundles is left in the internodes. The decay may progress down to the base of the cane or be arrested at some point higher up. The discoloration referred to above, both in the inner sheaths and in the tissues of the stem, originates, according to the author, in the phloem of the vascular bundles. There is no gum flux in the affected tissues.

Quite similar changes, allowing for the differences in size and differentiation, may be found in the tiller-buds below soil level, especially after ratooning. These may be rotted even when still surrounded by a normal bud sheath.

At the same time that the main shoot is checked in growth by the onset of top rot, the dormant buds at many of the nodes lower down commence to sprout. In many cases these shoots develop into canes. Sometimes the apical point of the main shoot escapes damage until such time as the disease lower down is checked; it then continues to grow and a normal cane may be produced except for certain markings in the leaves or in a few nodes. Unless the growing point becomes involved, recovery takes place.

The attack develops irregularly in the cane stool, often affecting only some of the shoots and these not necessarily in the order of their development, though the primary shoots are most commonly the first to be attacked.

The varieties most affected were Rappoe (Rose Bamboo), the chief cane cultivated on the Herbert River, and Striped Singapore. Meerah and white Bamboo (Louzier) were also susceptible. No disease was seen in Lahaina, Violet, or Cheribon.

Top rot is usually most virulent in March in cane nine or ten months old, but can attack much younger plants. There is no evidence that it arises from the use of diseased cuttings for planting, and seed selection does not appear to be a satisfactory method of control. Cuttings from diseased stools may produce healthy plants, and in some cases diseased plant cane appears to have given a healthy ratoon crop. There is some evidence of spread to adjacent plants in the field, and also, though less satisfactory, of persistence of the infection in the soil of certain areas. Soil conditions do not greatly affect its incidence, though it was more common on sandy soils; virgin soils are not immune, while rich manuring appears to have favoured the disease. Low-lying areas were most commonly affected in 1903. The author believes that a low rainfall during the early part of the growing period of the crop (May to October), followed by excessive rain in January, predisposes to attack.

No organism to which the disease could be attributed was found in the innermost sheaths of the apical bud—the first to show symptoms of attack. Later on secondary organisms, fungi and bacteria, attack the disorganized tissues and cause the foul-smelling wet rot already mentioned. The author believes that the early symptoms found at the tip of the shoot result from chemical changes induced by a pathological condition of the roots of affected plants. The lateral roots were found to be softened and decayed from the tip back towards the main roots, and the latter were more or less decayed in their turn. In the early stages of this decay the normal white colour is replaced by a purple tinge. Cases were seen in which the decay had been arrested and new healthy roots had developed. This corresponded with recovery of the diseased shoots.

The root decay is believed to be due to the attack of a parasitic fungus, which is briefly described and figured, but not named. It is suggested that it is possibly identical with an organism found by Kamerling occasionally in the 'Wortelrot' disease of sugar-cane in Java. Various other organisms were found in the affected roots, but no inoculation experiments with pure cultures appear to have been carried out with any of them.

Treatment is not discussed, except for the suggestion that the growing of resistant varieties may lead to control of the disease. Early planted cane is stated to escape injury from top rot in many cases.

COERT (J. H.). **Wortelrot in EK 28 in Kediri.** [Root rot in EK 28 in Kediri.]—*Meded. Proefstat. Java Suikerind.* 7, pp. 291–307, 1923.

The results of recent experiments on the effect of different periods of rotation on the control of root rot in the sugar-cane variety EK·28 [see this *Review*, ii, p. 526] showed that this trouble was more prevalent in biennial than in triennial crop rotation (10·42 as against 3·42 per cent.) The extreme limit of the period of non-occupation of the land by cane in biennial rotation is 17½ months as compared with 29½ months in triennial rotation. With late maturing varieties, however, the period of non-occupation in triennial rotation is only 18 months, this approximating closely to the extreme limit in biennial rotation. The probability of root rot is therefore greater in EK 28 when grown after late maturing varieties, such as DI 52. Hence also the liability of EK 28, itself a late ripening variety, to root rot when grown for many years in succession on the same ground. In one experiment the percentage of root rot in EK 28 immediately following the same variety was 7·17, as compared with 3·13 after other varieties.

Under Kediri conditions the incidence of root rot in EK 28 on red laterite soils is very slight.

BRANDES (E. W.) & KLAPHAAK (P. J.). **Cultivated and wild hosts of Sugar-cane or Grass mosaic.**—*Journ. Agric. Res.*, xxiv, 3, pp. 247–261, 4 pl., 1923.

The results of inoculation experiments, the technique of which is described, carried out from 1919 to 1921 on over forty species of cultivated and wild grasses proved the following thirteen to be susceptible to the disease known as sugar-cane mosaic, but which should be more properly termed grass mosaic: sugar-cane (*Saccharum officinarum*), maize (*Zea mays*), sorghum (*Holcus sorghum*), pearl millet (*Pennisetum glaucum*), eulalia (*Miscanthus sinensis*), wild sugar-cane (*Saccharum narenga*), bull grass (*Paspalum boscianum*), crab grass (*Syntherisma sanguinalis*), yellow and giant foxtail (*Chaetochloa lutescens* and *C. magna*), barn-yard grass (*Echinochloa crusgalli*), *Panicum dichotomiflorum*, and *Brachiaria platyphylla*.

The virus was artificially transmitted in one series of inoculations, one half to two ccs. of cell sap (obtained by squeezing young stalks in a powerful press under mineral oil) being injected near the growing point by Leur all-glass hypodermic syringes. In one instance the virus was passed through a rather coarse Berkefeld filter, but was still virulent in 75 per cent. of cases. In other experiments the virus was shaken with various disinfectants before injection, none of the inoculations being successful except on one plant in a series of four in which the virus was treated with phenol. Virulent virus, kept for 24 hours, was found to be unable to cause the disease.

From these experiments it appears that the virus of grass mosaic is less stable than that of other similar diseases, notably tobacco mosaic. It loses much of its virulence during manipulation or chemical treatment.

The insects used in the insect transmission series of experiments were *Aphis maidis*, *Kolla similis*, and *Draeculacepha mollipes*, only the first of which was proved to act as a carrier of mosaic.

Certain varieties of sugar-cane belonging to the slender North Indian type (which includes Uba, Kavangire, and others) formerly regarded as immune, were found to be susceptible to mosaic, but the disease attacked them in such a mild form as to be scarcely noticeable.

In the course of the experiments a method of transferring aphids from one plant to another was developed by which small bits of infected leaves covered with aphids were clipped off and tied to healthy plants. Controls (*a*) with similar infected portions with the aphids removed and (*b*) with healthy leaves covered with non-virulent aphids were necessary.

The result of tests in Southern Georgia for resistance to mosaic of forty varieties of maize planted in close proximity to infected Louisiana Purple sugar-cane plants showed that of the twenty-three infected, the northern and western varieties were much less liable to attack than the southern ones. This is believed to be due to the subnormal development of the former, which frequently induces resistance to experimental infection, rather than to any inherent immunity. It was shown by data on the yield of seventeen varieties of southern field maize that mosaic caused a reduction in weight ranging from 0·4 to 50·6 per cent.

Field observations in Georgia indicate that natural infection of sorghum (especially the Honey and Sugar Drip varieties), pearl millet, crab grass, bull grass, giant foxtail, and *Brachiaria* is widespread near affected cane in the sugar-cane belt.

The results of experiments to determine the possibility of seed transmission of mosaic were negative. This supports the conclusions of various authorities in Java, who found that sugar-cane seedlings from mosaic parents remain healthy unless infected from external sources. It appears, therefore, that the virus is not transmissible by the seed.

RAGUNATHAN (C.). **The occurrence of teleutospores in Hemileia vastatrix B. & Br.**—*Trop. Agric.*, lx, 2, p. 128, 1923.

In order to obtain information on the occurrence of teleutospores of *Hemileia vastatrix* in Ceylon, periodic observations of *Coffea arabica*, *C. robusta* and *C. liberica* were made at Peradeniya between May 1921 and April 1922. Teleutospores were found in every month except August and October 1921 and April 1922, their absence presumably being due to the development of new foliage in August and April and to the heavy rains in October. No definite statement can be made regarding the reasons for the occurrence of the teleutospores except that it is dependent on climatic conditions.

On 1st February 1922 a single teleutospore of *Hemileia canthii* was observed on *Canthium campanulatum*. This had produced a promycelium in the sorus. The teleutospore was much smaller, and the promycelium more slender and brighter in colour, than in *H. vastatrix*.

ITO (S.). **Uromyces of Japan.**—*Journ. Coll. Agric., Hokkaido Imp. Univ. (Sapporo, Japan)* xi, 4, pp. 211–287, 3 pl., 1922. [Rec'd 1923].

The author gives a complete list of the species of *Uromyces* and *Pileolaria* recognized in the Japanese flora, fifty-six of the former genus, and three of the latter. Nineteen are endemics, twenty-three occur also in America, and twenty-three in Europe. There are eight new records for Japan, nine species, before recorded, are excluded from the flora, six are now recognized as synonyms, and three do not belong to these genera at all. The single new species *U. viciae-unijugae* is allied to *U. heimerlianus* P. Magn., but is distinguished by the thicker wall of both the uredo- and teleutospores. The species are arranged according to the natural orders of their host plants, and where required, a key is given for the species occurring in each order. Under each species are given all references to its literature, a full synonymy, localities with dates and collectors' names, and its world distribution. The work closes with a list of the accepted fungi and a host index.

MAYOR (E.). **Étude expérimentale d'Urédinées hétéroïques.** [Experimental investigation of heteroecious Uredineae.]—*Bull. Soc. Neuchâtel. Sci. Nat.*, pp. 67–78, 1923.

The first part of this paper deals with *Hyalospora polypodii-dryopteridis* (Moug. & Nestl.) P. Magnus, the uredo- and teleuto-spore stages of which occur on *Dryopteris linnaeana* and *D. robertiana* respectively. This fungus is very widely distributed throughout Europe and has also been reported from the United States. Its life-history, however, was hitherto incompletely known as the host of the pycnidial and aecidial stages had not been discovered.

In June 1919, at Perreux [Saône-et-Loire] the author observed aecidia on the three-year-old needles of *Abies pectinata* seedlings growing among ferns which in the previous year had been severely infected by *H. polypodii-dryopteridis*. Subsequent observations showed that the pycnidia of the fungus developed only on two-year-old needles and the aecidia on three-year-old ones. In May 1920, teleutospores were collected on *D. linnaeana* growing near the *Abies* affected in 1919. Four seedlings of *A. pectinata* were inoculated with these teleutospores the same day and developed the typical symptoms of infection in April 1921, numerous pycnidia being present on the needles. Repeated attempts to secure the development of aecidia gave negative results.

In May 1922 aecidia were collected on *Abies pectinata* growing on the site mentioned above and inoculated into very young fronds of *D. linnaeana* and *D. robertiana*. Those of the latter withered almost immediately, while *D. linnaeana* remained healthy until

June, when the first uredospores appeared. The teleutospores developed in the spring of 1923. The fungus therefore requires a minimum period of four years to complete its life-cycle. The pycnidia and aecidia of *H. polypodii-dryopteridis* are very inconspicuous, and infection never takes place on a large scale, which accounts for these stages having been so long overlooked.

FLEROFF (B. K.). К цитологии **Ustilago avenae Pers.** по данным культуры **in vitro.** [Contribution to the cytology of *Ustilago avenae* Pers. based on cultures *in vitro*].—*Trans. Myc. & Phytopath. Sec. Russian Bot. Soc.*, I, *Trans. Moscow Branch*, pp. 23–36, 1 pl., 1923.

After a brief review of the work done by other investigators in the study of the Ustilaginaceae, the author describes his culture experiments *in vitro* by which he established the existence of two races of *Ustilago avenae* differing from each other in the germination of their spores. Both races were collected on unnamed species of cultivated oats, the first in the province of Vladimir, and the second in the vicinity of Moscow.

In water and weak nutritive media the spores of both races produced promycelia with typical clamp-connexions and a small number of sporidia, which fused together (conjugated) and gave rise to a mycelium, but in a more concentrated medium (gelatine 8 per cent., KH_2PO_4 0·05 per cent., $MgSO_4$ 0·02 per cent., glucose 5 per cent., Liebig's extract 1 per cent.) the differences were clearly apparent. The germinating spores of race 1 produced a large number of conidia which were never seen to fuse together or to give rise to mycelium ; in a few days the whole surface of the agar was covered with comparatively large colonies of budding conidia. On transferring such colonies into a liquid medium (the formula of which is given) the fungus continued its budding. After 6 to 7 days the conidia began to increase in size, became rounded and finally formed chlamydospores, which germinated on attaining maturity. These chlamydospores differed from those produced in nature by their thicker walls and by their larger size (some being about twice as large). The mycelium of race 1, produced in a weak nutritive medium as described above and then transferred to a more concentrated one, immediately began to produce sporidia which multiplied by budding and never fused together. Race 2, however, on the same concentrated medium and under similar conditions, produces conidia which after 4 to 5 days give rise to a mycelium. The same occurs in a liquid medium, the growth of the mycelium being like that ordinarily found in smuts. About a fortnight after their development in the liquid medium, the unicellular hyphae start to branch after developing transverse septa, while a few of them begin to swell and to break up into separate cells, with thickened, brown walls, which are finally transformed into spores. The formation of spores is, however, considerably less abundant than in race 1, and they much more resemble the natural spores both by their size and the structure of their walls. In germinating these spores produce a promycelium with typical clamp-connexions.

With regard to the cytology of *U. avenae* the author determined that the spores of this fungus obtained *in vitro* are formed from a uninucleate cell without any preliminary nuclear fusion, and that the mycelium on which the spores are borne is uninucleate throughout all the stages of its development. On the other hand a binucleate mycelium develops in those cases in which there is either a fusion of two cells of the promycelium or of two conidia, and a similar condition may arise at times by the simple division of the nucleus, in a conidium developing into mycelium. The reduced type of sexuality already known to exist in the smuts can thus, he points out, be still further reduced in culture.

SMITH (J. H.). **On the apical growth of fungal hyphae.**—*Ann. of Bot.*, xxxvii, 146, pp. 341–343, 1923.

An account is given of detailed observations regarding the growth of fungal hyphae, the tests being undertaken by the author in order to check the generally accepted statement in text-books that the growth of hyphae is apical. The fungi tested were species of *Phytophthora*, *Aspergillus*, *Penicillium*, *Pyronema*, *Rhizoctonia*, *Rhizopus*, *Botrytis*, and *Fusarium*. Spores, or fragments of mycelium were sown on clear prune agar poured on cover-slips, which were then inverted over Van Tieghem cells and the preparations incubated at 24° to 25° C. After germination, when the hyphae had reached a convenient size, the lengths of the segments already formed were measured, at varying intervals of time, over a period of from five to fifty-six hours. Where septa were absent or difficult to distinguish, the intervals between successive branches were determined.

The experiments have demonstrated that growth takes place at the tip and that no appreciable elongation occurs in any other part of the hypha. In view of the wide range of genera tested, this would appear to be the general rule for fungi and may be contrasted with the growth of filamentous bacteria, in which each of the segments expands at the same rate, and of algae, in which both apical and intercalary growth occurs.

BEELI (M.). **Énumération des champignons signalés au Congo Belge.** [List of fungi recorded in the Belgian Congo.]—*Bull. Jard. Bot. de l'État* (*Bruxelles*), viii, 1 pp. 67–101, 1923.

The mycological flora of the Belgian Congo is still very little known. So far only 593 species have been recorded, distributed among about 326 genera and 42 families. The author, in this paper, after a short introduction, gives a list of all records of Belgian Congo fungi, arranged according to their orders; the reference to the work in which each species was first described and the reference in Saccardo's *Sylloge* are supplied in each case. The habitat is noted in many instances, and those species represented in the Congo Herbarium in Brussels are indicated.

DA CAMARA (E. de S.). **Minutissimum mycoflorae subsidium Sancti Thomensis Insulae. I. Mycetes.** [A small contribution to the fungus flora of St. Thomas Island. I. Mycetes.]. Reprinted from *Anais do Inst. de Agron.*, 3 pp., 2 pl., Coimbra, 1923.

Eight species of microfungi are recorded, of which two are new, namely, *Calospora theobromae*, in the cortex of *Theobroma cacao,* which differs principally from *C. bahiensis* Speg., in its smaller ascospores (35 to 45 by 7·5 to 10 μ) and in its asci always containing 8 spores, and *Macrophoma nicotianae* found on the stems of *Nicotiana tabacum*.

COUTINHO (A. X. P.). **Florae mycologicae Insulae St. Thomae (Sinu Guineensi) contributio.** [Contribution to the mycological flora of the Island of St. Thomas (Gulf of Guinea).] Reprinted from *Anais do Inst. de Agron.*, 26 pp., 3 pl., Coimbra, 1922.

This paper gives a list of 76 fungi (of which 74 are Basidiomycetes) collected by the author in the island of St. Thomas during 1920 while he was engaged in pathological work. References to the literature, the hosts, localities, and a short Latin description are appended to each species. The author describes and figures ten new species, of which three are wood-inhabiting Polypores.

The following Polyporaceae are recorded: on *Theobroma cacao*; *Poria ferruginosa*, *Fomes pectinatus*, *Polyporus zonalis*, *Trametes gibbosa*, *T. sprucei*, ? *T. sepium* (Rav.) Berk., and *T. sanguineum*: on *Cocos nucifera*; *Fomes ochrolaccatus*, *F. multiplicatus*, *F. applanatus*, *Polystictus occidentalis*, *P. sanguineus*, and *Trametes ohiensis*: and on *Elaeis guineensis*; *Fomes applanatus* and *F. senex*.

Fruit and Vegetable Quarantine, Notice of Quarantine No. 56, with Regulations.—*U.S. Dept. of Agric. Fed. Hort. Board*, August 1923.

Under this quarantine order, coming into effect on 1st November 1923, and framed with the purpose of preventing the introduction into the United States of certain injurious insects, including fruit and melon flies (*Trypetidae*), the importation into the United States is forbidden of fresh fruits and vegetables (i. e. the edible, more or less succulent, portions of food plants in the raw or unprocessed state, such as bananas, oranges, grapefruit, pineapples, tomatoes, peppers, lettuce, &c.) from abroad and of plants or portions of plants (i. e. leaves, twigs, or other portions of plants, or plant litter or rubbish as distinguished from clean fruits and vegetables or other commercial articles) used as packing materials in connexion with shipments of such fruits and vegetables, the whole subject to the exceptions mentioned below. All special quarantines and other orders hitherto in force restricting the entry of fruits and vegetables remain in full effect, with the exception of Quarantine No. 49 with regulations, on account of the citrus black fly, which is superseded by this Quarantine.

The following is a compendium of the most important regulations appended to the order:

All importation of fruit and vegetables must be free from plants or portions of plants, as defined above. Dried, cured, or processed fruits and vegetables, including dried products, cured figs, dates, and raisins, &c., nuts, and dry beans, peas, &c., may be imported without permit or other compliance with these regulations. Subject to the restrictions now in force or which may hereafter be promulgated as to certain countries and districts, the following fruits may be imported from all countries under permit and on compliance with these regulations: bananas, pineapples, lemons, sour limes, and grapes of the European or *Vinifera* type. Subject to the same restrictions, any vegetables may be imported from any country under permit and on compliance with these regulations, at such ports as shall be authorized in the permits, on presentation of evidence satisfactory to the United States Department of Agriculture that such vegetables are free from infestation with dangerous insects, including fruit flies (*Trypetidae*), and that their importation will not be the means of bringing such pests to the United States.

In addition, the following exceptions are authorized for the countries concerned:

Commonwealth of Australia—States of Victoria, South Australia, and Tasmania. Upon compliance with these regulations and under such additional conditions and safeguards as may be prescribed in the permits, all fruits and vegetables from these three States will be permitted entry at Seattle, Wash., and Portland, Oreg., and at such other ports as may be specified in the permits.

Japan: Upon compliance with the regulations under Quarantine No. 28, oranges of the mandarin class, including satsuma and tangerine varieties, may be imported from Japan through the port of Seattle and such other northern ports as may be certified in the permits.

Mexico and Central America: Avocados or alligator pears may be imported from Mexico and Central America upon compliance with the restrictions of the order of 27th February 1914. Irish potatoes may be imported from Mexico upon compliance with the regulations of the order of 22nd December 1913.

Chile and Argentina: Upon compliance with these regulations fruits and vegetables, other than those already exempted in the first paragraph of the compendium above, may be imported from Chile and Argentina under such conditions and through such northern ports as designated in the permits.

West Indies: Upon compliance with these regulations all citrus fruits from the West Indies may be permitted entry at New York and at such other ports as designated in the permits.

Jamaica: Entry of pineapples from Jamaica is restricted to the port of New York or such other northern ports as specified in the permits.

Canada: Fruits and vegetables grown in the Dominion of Canada may be imported from Canada free of any restrictions under these regulations.

Application for permits to import fruits or vegetables authorized in these regulations is to be made to the Federal Horticultural Board in advance of the proposed shipments, stating the country or locality of origin of the produce, the port of first arrival, and the name and address of the importer in the United States to whom the permit should be sent. If through no fault of the importer a shipment should arrive before the permit is received, the goods will be held in customs custody at the port of first arrival, at the risk and expense of the importer, for a period not exceeding 20 days. A separate permit must be obtained for shipments from each country and for each port of first arrival in the United States.

The permits of importation are issued in quadruplicate, one copy of which is supplied to the applicant for presentation to the customs officer at the port of first arrival.

All importations of fruits or vegetables are subject as a condition of entry, to such inspection or disinfection, or both, at the port of the first arrival as shall be required by the inspector of the Department of Agriculture and shall be subject to re-inspection at destination, at the option of that Department. Should any shipment be found so infected with fruit flies or other dangerous pests that in the judgment of the inspector of the Department of Agriculture it cannot be cleaned by disinfection or treatment, or to contain leaves, twigs, or other portions of plants as packing or otherwise, the whole shipment may be refused entry. All charges for storage, cartage, and labour incident to inspection and disinfection other than the services of the inspector, shall be paid by the importer.

Wart Disease of Potatoes Order of 1923.—*Journ. Min. Agric.*, xxx, 4, pp. 363–366, 1923.

The main features of the Wart Disease of Potatoes Order of 1923, which revokes all previously existing Orders on the subject, may be summarized as follows. The appearance of the disease on any land in England and Wales must immediately be reported to the Ministry of Agriculture. Potatoes visibly affected with wart disease [*Synchytrium endobioticum*] must not be offered for sale. The only potatoes allowed to be planted on land known to have been infected at any time by wart disease are those stocks of approved immune varieties which have been inspected while growing and officially certified as true to type.

The following areas are declared by the Order to be infected. The whole of Wales, the counties of Monmouth, Cheshire, and Staffordshire, the county of Lancashire south of the Ribble, together with Preston and Fulwood, North Salop, Birmingham, and Sutton Coldfield, and certain parishes in the counties of Worcester and Derby. No potatoes grown in an infected area may be removed or consigned to any place in England and Wales which is not in an infected area. This does not apply to 'ware' potatoes of approved immune varieties. All potatoes planted or sold for planting must be officially certified either as having been grown on land free from wart disease, or as having been inspected and found to be free from the disease, or as being of an approved immune variety true to type. When potatoes are sold for planting the seller must furnish the buyer with the number of the relative certificate. Potatoes grown outside Great Britain and Ireland must not be sold for planting in England and Wales except under a licence from the Ministry. The arrangements in connexion with the issue of certificates are explained (a charge of 2*s.* 6*d.* per acre being made when an inspection is required), and the restrictions governing the sale of Scotch and Irish 'ware' potatoes enumerated.

An Act to regulate the sale of Insecticides, Fungicides, Vermin Destroyers, and Weed Destroyers ; and for other purposes. Queensland, 20th August, 1923.

Under the present Act any person in Queensland manufacturing or dealing in insecticides, fungicides, vermin or weed destroyers (called in brief in the Act 'Pest destroyers') must, within 30 days of the passing of this Act or of setting up in such trade, whichever is the later date, and thereafter in each following year on or before the 31st January, give notice in writing in the prescribed form to the Under Secretary of the Department of Agriculture and Stock in Brisbane, of his name and place of business, the distinctive name of every pest destroyer he then sells or proposes to sell during the current year, and the places where the same can be purchased from him. Additional notice is also required to be given of each new pest destroyer or of any alteration in the constituents of those already registered, before commencing to deal in such new or altered pest destroyers.

Every notice is to be accompanied by: the fees prescribed (5*s.* for each pest destroyer to be registered and 2*s.* 6*d.* for each of those already registered for the current year, the constituents of which are altered as above); a fair average sample for analysis of each pest destroyer mentioned; a statutory declaration by the dealer stating the distinctive name of each pest destroyer, that each sample is a fair average sample of the pest destroyer it represents and is not substantially different from the pest destroyer which the dealer will supply throughout the year under its distinctive name, the constituents of each pest destroyer, the constituents thereof which are claimed to be active constituents, the percentage in which each constituent is contained therein and what percentage of each constituent is contained in that part of the pest destroyer which is soluble in cold water, the net weight which shall be contained in each respective package when sold; a specimen copy of the invoice relating to each such pest destroyer; and a specimen copy of the prescribed label to be affixed to each package. Each such label is to show: the distinctive name of the pest destroyer; the net weight contained in the package; a statement of the active constituents; all directions, if any, for the use of the pest destroyer; the name and address of the wholesale dealer; and such other matters as may be prescribed.

A label as prescribed above is to be affixed, on or before delivery to the buyer, on each package of pest destroyer. Every dealer who sells any pest destroyer of a greater value than 5s. must also sign and give to the buyer an invoice showing: the name and address of the dealer; the net weight of the pest destroyer supplied, with the name thereof; a warranty, the wording of which is given, that the constituents of the pest destroyer so sold, and the percentage in which each constituent is contained therein and in that part thereof which is soluble in cold water, accurately correspond with the constituents and percentages stated in the statutory declaration supplied as above. Every buyer shall be entitled, on complying with the regulations, to submit a sample of a pest destroyer bought by him to an official analyst for analysis, and to receive a certificate of the results of such analysis.

Other sections of the Act deal with the appointment and duties of inspectors, penalties, and other details regarding the administration of the Act.

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