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ANNOUNCEMENT

With the beginning of 1919 the sections of the Philippine Journal of Science will be combined, and the publication will be issued as a monthly; each number will be larger than the present bimonthly issues. The policy with regard to the character and scope of the material published will be continued. The Journal is intended to be as it has been, the scientific organ of the Philippine Government, and will be devoted to the scientific and commercial interests of the tropics. Its aim will be to collect and publish in one place original scientific information and material relating to the Philippine Islands. Suitable articles will receive prompt publication in the Philippine Journal of Science, and specialists working on Philippine material will continue to receive hearty coöperation.

The subscription price will be 5 dollars United States currency per annum. A refund of 2 dollars will be made to anyone that has forwarded a subscription for the four sections of the Journal at the old rate of 7 dollars. Any sum received as a subscription to a single section will be credited, and a bill will be rendered for the balance due at the new rate.

The Philippine Journal of Science in its new form will be sent in exchange to all periodicals and institutions with which exchange relations are in force.

THE EDITORS.

MANILA, P. I., *December 31, 1918.*

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. XIV JANUARY, 1919 NO. 1

THE PHYSIOLOGICAL ACTIVE CONSTITUENTS OF CERTAIN PHILIPPINE MEDICINAL PLANTS: III

By A. H. WELLS

(*From the Laboratory of Organic Chemistry, Bureau of Science, Manila*)

ONE PLATE

CONTENTS

Berberine has been found in the following plants:

Berberis aquifolium. (1)
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Hydrastis canadensis. (3)
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Argemone mexicana. (5)
Coptis trifolia. (6)
Xanthoxylum americanum. (7)
Berberis asiatica. (8)
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Toddalia asiatica. (28)

ARCANGELISIA FLAVA (LINN.) MERR. (A. LEMNISCATA BECC.). MENISPERMACEAE

Philippine names: *Albustra, abutra* (Ilocano); *lagtal, lagtan, albotra* (Visayan); *lagtang, bute, ligtang, suma* (Tagalog); *suma* (Pampango).

The names *albustra, abutra, albotra,* and *bute* are all corruptions of the Spanish-American name *abuta,* which was brought from Mexico by the Spaniards. These names are also applied to *Anamirta cocculus* W. & A. of the same family, which has much smaller fruits and white, *not yellow,* wood.

It is a coarse, woody vine, the stems up to 10 centimeters in diameter, with a characteristically yellow wood. The species is widely distributed in the Philippines, occurring in most, if not all, of the larger islands and provinces. However, it is local and widely scattered in thickets and forests, occurring especially on rocky slopes. No data as to its abundance were obtainable.

Chemical examination.—The soft porous wood was freed from the thin outer bark, finely ground while fresh, and macerated with 95 per cent ethyl alcohol. The solution resulting from this exhaustion was quickly evaporated under reduced pressure to one-fifth its volume; it was then cooled and salts made with hydrochloric, nitric, sulphuric, and hydriodic acids. A few grams of the pure alkaloid were obtained by an aqueous extraction of portions of the ground wood in a neutralized solution. Repeated extraction and evaporation with alcohol, and final crystallization from neutral ethyl acetate in a vacuum desiccator over calcium chloride, gave beautiful golden yellow crystals of the berberine base. When compounds of this nature are crystallized in a vacuum desiccator over sulphuric acid it is noticeable that traces of acid sulphates are formed. This was observed particularly when the acetone compound was placed in such a desiccator. The compound was identified as berberine.

Large quantities of salts of the alkaloid were easily crystallized out with nitric, sulphuric, and hydrochloric acids. Upon heating, the sulphate melts to a brown amorphous mass, slightly soluble in water; it has an intense yellow color and a bitter taste, is soluble in alcohol and in hot water, and is almost insoluble in ether and benzene. The solution allows precipitation with alkaloidal reagents and also with potassium iodide solution. In concentrated sulphuric acid it gives an olive green color; a fragment of sodium nitrate added to the sulphuric acid solution gives a characteristic violet color. The acetone compound was obtained by the method of acetone treating the sulphate of the compound in an alcoholic solution. The resultant compound, which is represented as $C_{20}H_{17}NO_4 \cdot C_3H_6O$, was also obtained by treating a hot solution of 50 grams of the crystalline berberine sulphate in 1 liter of water. Five hundred grams of acetone were added to this solution; after mixing, it was made alkaline with sodium hydroxide. This is a method of Gaze.(29) A greenish yellow crystalline substance separates therefrom (see Plate I). The pure crystalline berberine obtained by the decomposition of the berberine acetone compound is dark golden brown, but it is slightly lightened in color by purification with alcohol.

Quantitative determinations made on the plant substance show approximately 4.8 per cent of pure alkaloid in the moisture-free material.

Combustion of the alkaloid, when freed from as much water of crystallization as is possible without apparent decomposition, gave the following results:

Determination No. 1.—0.15 gram of substance gave 0.0788 gram of water and 0.3876 gram of carbon dioxide.

Determination No. 2.—0.15 gram of substance gave 0.0771 gram of water and 0.3854 gram of carbon dioxide.

Theoretically, the combustion of water-free berberine gives carbon 71.64 per cent and hydrogen 5.07 per cent. Determination No. 1 shows carbon 70.47 per cent and hydrogen 5.84 per cent. Determination No. 2 shows carbon 70.47 per cent and hydrogen 5.63 per cent. Nitrogen found in the alkaloid amounted to 4.03 per cent.

Arcangelisia flava (Linn.) Merr. is believed to have a larger percentage of alkaloid than any other plant found in the Philippines; and, should the therapeutic value of berberine become very important, even a small plant for the recovery of this alkaloid would develop into a paying industry. The above calculations, together with the qualitative tests expressed, are sufficient to establish the presence of berberine in *Arcangelisia flava* (Linn.) Merr.

CASSIA SIMEA LAM. (LEGUMINOSAE)

In the Philippines this tree occurs in cultivation only. It is commonly planted as a shade tree in Manila and in other large towns of the Archipelago. It is known by its Spanish name *acacia*, which is also applied to other trees of the same family. *Cassia florida* Vahl is a synonym. I can find no record of the tree serving any other useful purpose in the Philippine Islands than that of giving shade.

A search of the literature revealed no record of any active principles found in this plant. However, a recent communication from Father Algue, director of the Philippine Weather

Bureau, states that the feeding of fresh branches and pods of this tree had caused the death of many of their hogs. For this reason a chemical analysis was made of the pods, branches, and leaves and the presence of a poisonous alkaloid established. 0.1015 gram of alkaloid gave 0.0725 gram of water and 0.2463 gram of carbon dioxide, which gave 7.93 per cent hydrogen and 66.18 per cent carbon; 0.1000 gram of alkaloid gave 0.0685 gram of water and 0.2385 gram of carbon dioxide, equal to 7.61 per cent of hydrogen and 65.04 per cent of carbon; 0.2016 gram of alkaloid gave 0.1415 gram of water and 0.4971 gram of carbon dioxide equal to 7.80 per cent of hydrogen and 67.25 per cent of carbon.

Percentages of carbon, hydrogen, and nitrogen in alkaloid from Cassia siamea.

	Carbon.	Hydrogen.	Nitrogen.
Sample 1	66.18	7.93	5.39
Sample 2	65.04	7.61	----------
Sample 3	67.25	7.80	5.60
Total	198.47	23.34	10.99
Average	66.16	7.78	5.495

These figures furnish data for an empirical formula for the alkaloid found in *Cassia siamea*, namely $C_{14}H_{19}NO_3$. With intraperitoneal injections of 1 cubic centimeter of a 5 per cent solution of the hydrochloride large guinea pigs readily exhibited symptoms of poisoning, usually resulting in death.

GEODORUM NUTANS AMES

Philippine names: *Camaog, lubi lubi* (Visayan); *cola* (Tagalog, from the Spanish word *cola*, meaning "glue").

This plant is a terrestrial orchid that is found in thickets and in uncultivated open lands at low altitudes throughout the Philippines, generally as scattered individuals, but occasionally abundant. Its only known use is that of an adhesive. The rhizomes are split and the pulp rubbed upon the surfaces to be glued. The plant is used throughout the Islands as a glue in the manufacture of stringed instruments. The water extraction of the plant gives a gum which is separated by precipitation with alcohol. This gum has exceptional strength and lasting power. The moisture content of the plant is 79.5 per cent. The yield of dry gum on the fresh plant is about 14 per cent, and on the moisture-free sample, 68.8 per cent.

No substances of therapeutic value were found.

CORIARIA INTERMEDIA MATSUMURA

This is the only representative of the small family Coriariaceae known from the Philippines and occurs at high altitudes in Mountain Province, Luzon; it is called *buacat* by the Igorots of Benguet, who claim that the fruit is inedible because it is poisonous. A glucoside is found to be present in very small quantities in the leaves and fruits of this plant. One hundred kilograms of the fresh plant give 69 grams of crude glucoside, which can be extracted by water or squeezed from the young shoots. The extract is treated in the usual manner with lead acetate, and the filtrate is freed from excess lead by hydrogen sulphide and evaporated to a sirup. From this the glucoside is extracted by alcohol and precipitated by ether.

Two cubic centimeters of plant extract, representing 20 grams of the fresh plant, intraperitoneally injected into a guinea pig weighing 700 grams, resulted in death after thirty minutes.

Coriaria is known in New Zealand as "toot-plant." Landsay (30) has the following to say regarding this plant:

> During a tour through the New Zealand provinces in 1861–1862, I was struck with the abundant evidences, which everywhere presented themselves, of the ravages produced among the flocks and herds of the settlers by the *Toot-plant*, one of the most common indigenous shrubs of these islands. In many cases of losses by individual settlers brought under his [their ?] notice, the amount of loss from this source alone had been from 25 to 75 per cent. In Otago, particularly, were such losses felt during the height of the gold mania there, from July to December, 1861: the traffic between Dunedin and Tuapeka gold-fields required the service of large numbers of bullocks, a great proportion of which were lost by Toot-poisoning. * * *
>
> 1. The Toot-poison belongs to the class of *Narcotico-irritants*. *a.* Its action on man includes the following symptoms:—coma, with or without delirium; sometimes great muscular excitement or convulsions; the details differing in different individuals; during convalescence, loss of memory, with or without vertigo. *b.* In cattle and sheep, they include vertigo, stupor, delirium, and convulsions; curious staggerings and gyrations; frantic kicking, and racing or coursing; tremors.
>
> 2. The poisonous portion of the plant, (*a*) to man, is generally the *Seed*, which is contained in a beautiful, dark-purple, luscious berry, resembling the blackberry, which clusters closely in rich pendent racemes, and which is most tempting to children; occasionally the young *Shoots* of the plant, as it grows up in spring: (*b*) to cattle and sheep, in almost all cases, is the young *Shoot*, which is tender and succulent, resembling in appearance and taste the similar state of Asparagus.

CONCLUSIONS

Arcangelisia flava (Linn.) Merr. (*A. lemniscata* Becc.) contains berberine and shows approximately 4.8 per cent of pure alkaloid based on moisture-free wood. The plant material is soft and porous, and contains but small amounts of extractive matter that interferes in the recovery of the alkaloid. The recovery of the alkaloid is simple and inexpensive, showing the plant to be an excellent source of the drug.

Cassia siamea Lam. contains an alkaloid with the formula $C_{14}H_{19}NO_3$.

The rhizomes of *Geodorum nutans* Ames contain about 14 per cent of a water-soluble adhesive.

Coriaria intermedia Mats. contains a poisonous glucoside in its leaves and fruit.

REFERENCES

(1) Pommerehne, *Arch. Pharm.* (1895), No. 233, 127; Hare, Caspari, Rusby, National Standard Dispensatory. Lea & Febiger, Philadelphia (1908), 307; Allen's Commercial Organic Analysis, 4th ed. (1912), 6, 551.
(2) Bödeker, *Ann. d. Chem. u. Pharm.* (1841), No. 66, 384; (1849), No. 69, 40; Hare, Caspari, Rusby, op. cit., 361; Allen's Commercial Organic Analysis, loc. cit.
(3) Mahla, F., *Am. Journ. Sci.* (1862), II, 33, 43; Allen's Commercial Organic Analysis, loc. cit.; Hare, Caspari, Rusby, op. cit., 824; Perrins, J. D., *Journ. Chem. Soc. London* (1862), 15, 339.
(4) Hare, Caspari, Rusby, op. cit., 1004; Allen's Commercial Organic Analysis, loc. cit.; Gordin, *Arch. Pharm.* (1902), No. 240, 146, contending absence of berberine.
(5) Schlotterbeck, J. O., *Proc. Am. Pharm. Ass.* (1901), 247.
(6) Mayer, F. F., *Am. Journ. Phar.* (1863), 35, 289; Perrins, J. D., loc. cit.; Gross, E. Z., *Journ. Chem. Soc. London* (1873); Allen's Commercial Organic Analysis, loc. cit.
(7) Hare, Caspari, Rusby, op. cit., 1720.
(8) Stavart, L. W., *Phar. Journ.* (1843), 7, 74; Waring, E. D. Pharmacopea of India (1868), 12; Dymock, W., The Vegetable Materia Medica of Western India. Frubner & Co., London 2d ed. (1885), 37.
(9) Mayer, F. F., op. cit., 97.
(10) Buchner and Herverger, *Ann. d. Chem. u. Pharm.* (1837), No. 24, 228; Rudel, *Arch. Pharm.* (1891); No. 229, 631; Allen's Commercial Organic Analysis, loc. cit.
(11) Perrins, J. D., op. cit., 341.
(12) Chevallier and Pelleton, *Journ. Chim. Med.* (1826), 2, 314; Perrins, J. D., op. cit., 342.
(13) Stenhouse, J. W., *Ann. d. Chem. u. Pharm.* (1855), No. 95, 108; (1858), No. 105, 360; *Pharm. Journ. Trans.* (1855), 14, 455.
(14) Pommerehne, loc. cit.
(15) Mayer, F. F., *Journ. de Pharm. et de Chim.* (3) 46, 496. Some authors claim that *Leontice thalictroides* is identical with *Caulophyllum thalictroides.*
(16) Perkin, A. G., *Chem. Soc. Trans.* (1897), 71, 1198.
(17) Bödeker, *Ann. d. Chem. u. Pharm.* (1841), No. 66, 384; *Chem. Gaz.* VI, No. 69, 40; Gordin, loc. cit., contradicting Bödeker.
(18) Schlotterbeck, J. O., *Am. Journ. Pharm.* (1902), 74, 584.

(19) Perrins, J. D., *Ann. d. Chem. u. Pharm.* (1852), **83**, 276; *Journ. Chem. Soc. London* (1862), **15**, 339.
(20) Idem, *Journ. Chem. Soc. London,* (1862), **15**, 340.
(21) Geacosa and Soave, *Am. Journ. Pharm.* (1890), **62**, 500.
(22) Wood, Remington and Sadlter, U. S. Dispensatory. J. B. Lippincott & Co., Philadelphia, 19th ed., 1673.
(23) Steere, *Am. Journ. Pharm.* (1867), **39**, 337.
(24) Stenhouse, *Pharm. Journ. Trans.* [3], **46**, 495.
(25) Gastel, Jahresbericht über die Forstchritte der Chemie und verwandter Theile andere Wissenschaften (1866), 480.
(26) Martin, *Pharm. Journ. Trans.* [3], **13**, 337.
(27) Gordin, loc. cit., contradicting Mayer.
(28) Brill and Wells, *Philip. Journ. Sci., Sec. A* (1917), **12**, 167.
(29) Gaze, *Arch. d. Pharm.* (1890), **No. 228**, 607.
(30) Landsay, W. Lauder, *Journ. Bot.* (1863), **1**, 247.

ILLUSTRATION

PLATE I

Fig. 1. Berberine-acetone compound.

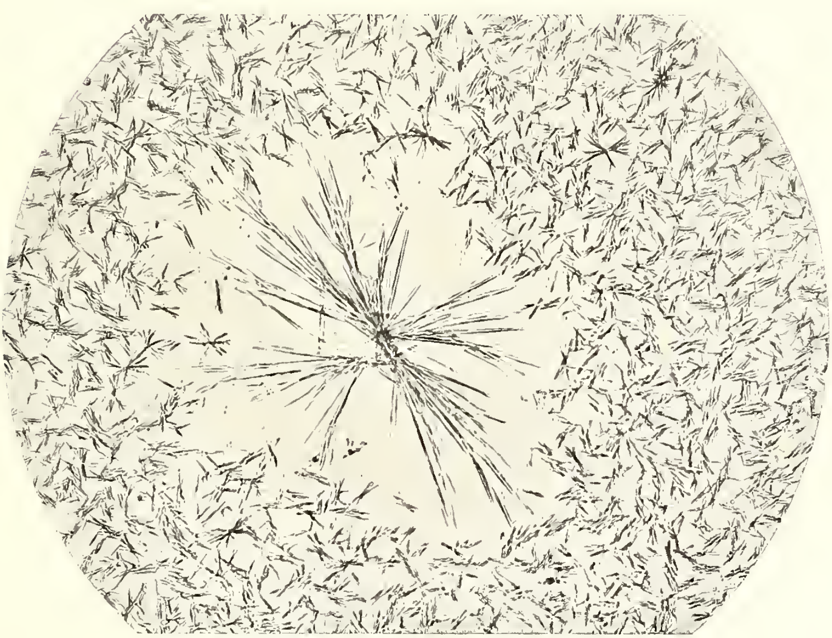


Fig. 2. Quick crystallization of the hydrochloride of the alkaloid.

PLATE I.

THE TREATMENT OF HUMAN BERIBERI WITH AUTOLYZED YEAST EXTRACT

By N. M. Saleeby

(Manila)

The extract of rice polishings has become recognized as one of the most efficient remedies for the treatment of infantile beriberi.[1] However, it does not markedly improve cases of long standing.

Williams and Saleeby[2] have shown that the hydrolyzed extract does have a prompt and decisive action on these more chronic cases, but that it must be administered only under the direct supervision of the physician on account of its poisonous qualities when given in excessive doses. These investigators believe that the poisonous nature of the hydrolyzed extract is due to the choline present.

That polyneuritis in fowls is improved by treatment with yeast has been known for some time.[3] Cooper found that no poisonous effects followed the daily dose of 30 cubic centimeters of autolyzed yeast extract to chickens and that the administration of 100 cubic centimeters did no harm.

In order that this extract might be tried on human beriberi, in 1917 and 1918 the Bureau of Science prepared and delivered to me in 50 cubic centimeter bottles an autolyzed yeast extract and requested me to try its efficacy when given to human patients. Brewers' yeast was obtained from the San Miguel and the Oriental breweries, of Manila, separated from the adhering beer and placed in an incubator at a temperature of 35° C. until it had assumed a mushlike consistency (about forty-eight hours) due to autolysis. The mass was then filtered through paper, washed on the filter, and the filtrate concentrated under a partial vacuum at a temperature below 60° C. to a volume of about one-third of the original.

[1] Albert, J., *Philip. Journ. Sci., Sec. B* (1915), **10**, 81. The Bureau of Science, Manila, manufactures about 400 liters of this extract annually for use in the Philippines.

[2] Williams, R. R., and Saleeby, N. M., *Philip. Journ. Sci., Sec. B.* (1915), **10**, 99.

[3] Cooper, E. A., *Bio-chem. Journ.* (1914), **8**, 250.

A concise summary of my findings when the autolyzed yeast extract was given to human patients is as follows:

1. About two score cases were treated; five were children below 2 years of age; ten were treated in hospital; all others were out-patients.

2. Adults were given from 15 to 40 cubic centimeters three times a day. Children were given from 2 to 4 cubic centimeters every three hours, or six times a day. Bigger doses did not seem to give better results. No sign of poisoning was observed.

3. Only acute and uncomplicated symptoms of beriberi were observed under treatment. Chronic nerve, muscular, or cardiac lesions were actually unaffected.

5. All acute peripheral symptoms of neuritis were affected quickly. Marked results were noted in less than three days, and a week's treatment seemed to give full relief in mild acute cases. Treatment was generally followed up for two weeks at least.

6. Infantile-beriberi symptoms were relieved with comparative rapidity. Œdema yielded quickly, and nutrition improved at once.

7. No special diet was prescribed. Patients were given regular hospital diets in accordance with the state of their digestion.

8. Children receiving the extract continued to nurse at the mother's breast.

9. The effect of the autolyzed yeast extract used is similar to that produced by the hydrolyzed extract of rice polishings; it seemed weaker, however.

A PHOTOGRAPHIC STUDY OF LEPROSY[1]

By Oswald E. Denney

(*Chief, Culion Leper Colony, Culion, P. I.*)

FOUR PLATES

The great variety of typical lesions of leprosy has rendered it impracticable completely to illustrate the disease in the average textbook; it seemed desirable, therefore, to present a photographic study showing the progression of the external lesions.

The clinical manifestations of leprosy have been so fully described by the many students of the disease that discussion at length in the present paper is not necessary. The disease is generally considered to manifest itself in two distinct types—the "nodular" and the "maculo-anæsthetic." A combination of symptoms of these two is recognized as the "mixed" type. In this study the two principal types only will be considered; the mixed type, obviously, may present any composite picture of the nodular and maculo-anæsthetic types.

Since the manner of entrance into the body of the causative agent of the disease (*Mycobacterium lepræ*, or *Bacillus lepræ* Hansen) is unknown, the initial lesion cannot be demonstrated with certainty; however, the earliest recognized lesion can be illustrated (Plate I, figs. 1 to 9; and Plate II, figs. 10 to 15). The progression of the lesions of the nodular type as indicated in the above series may be reproduced in practically any part of the body.

The photographable manifestations of uncomplicated maculo-anæsthetic leprosy are mainly confined to the macules, which appear chiefly on the back and face, but which may appear on any part of the body; the deformities that result from motor-nerve destruction; and the trophic ulcers that result from disturbed nutrition. The deformities of uncomplicated maculo-anæsthetic leprosy in the hands are illustrated by Plate II, figs. 16 and 17; and Plate III, figs. 18 and 19.

Plate III, fig. 20, illustrates the typical perforating ulcer of the foot; this lesion is considered as diagnostic of leprosy by the natives in many parts of the world.

[1] Received for publication, September 6, 1918.

Plate III, fig. 21, illustrates the typical, sluggish, neurotrophic ulcers, which although almost incurable appear to have a strong resistance to the ordinary pyogenic infections. Here, too, is shown the curious parchmentlike skin frequently seen among anæsthetic lepers.

The macules of the maculo-anæsthetic type are reproduced with difficulty, particularly in the dark-skinned races, because of the lack of contrast (Plate III, figs. 22 to 25).

Another lesion of leprosy that, due to its great prevalence among the Filipino lepers, deserves special description is the condition of bone necrosis and absorption commonly seen in the feet and hands. The condition is generally described as of the maculo-anæsthetic type and is probably not entitled to classification as a special type. The condition may be seen rarely among the pure nodular types, commonly among the maculo-anæsthetic and mixed types, and occasionally among lepers who fail to show coincident evidence of progressive nodular or maculo-anæsthetic symptoms. The complete series of changes extends over a number of years and therefore may be followed with great difficulty in individual cases. The sequence appears to be much as shown in Plate IV, figs. 26 to 33.

The process of absorption as indicated above usually does not continue without complications from trauma and secondary infections; the bones being near the surface and unprotected by the normal connective tissue pads of the finger tips, sinuses frequently form, from which necrotic bone is discharged. An instance is recalled of a patient, since dead, in whom the five finger nails of one hand remained attached in a much distorted condition at the site of the radiocarpal articulation, the bones of the entire hand having been absorbed without rupture of the skin from trauma.

It is not to be inferred from this series of photographs that each case of leprosy progresses by rule to a definite classical physical picture; there is perhaps no disease so capricious in the manifestations of its clinical progress.

ILLUSTRATIONS

Plate I

Fig. 1. A maculo-papular lesion of three years' duration on the cheek of a 6-year-old Filipina, which up to the present time is her only demonstrable lesion of leprosy. The spot, about 2 centimeters in diameter, is slightly elevated above the normal skin surface; it is pink and contains numerous small nodules in which the causative organism can be found. A lesion of this character may remain practically unchanged for years; may almost entirely disappear, leaving a pale or pigmented, smooth spot; or it may grow progressively larger with the coincident appearance elsewhere of similar spots, as in fig. 2.

2. Maculo-papular lesions of leprosy on each cheek and on the chin.

3. An apparent latency of the macules of leprosy; which, in this case, are neither elevated nor nodular, but are smooth and faintly pigmented and as such cannot be distinguished from the numerous tinea, etc., that are frequently met with in the tropics. In this and in the succeeding illustrations may be seen the progressive infiltration of the tissues over the inner half of the superciliary ridge, giving rise to overhanging eyebrows, suggesting a frown. Mention is frequently made of the loss of the hair of the outer half of the eyebrows as an early and diagnostic symptom of leprosy; this is not present in the cases shown in figs. 1 to 3.

4. A case of leprosy, relatively older than those of figs. 1 to 3, showing a thinning of the outer half of the eyebrows as well as the early nodular infiltration of the nasal alæ and the helix and lobule of each ear.

5. A somewhat more advanced case of leprosy with a nodular infiltration extending over the face. The nodules are small with the exception of one on the chin. Complete loss of the hair of the outer half of the eyebrows is here shown. A small amount of œdema of the eyelids is present.

6. The nodules are larger and more prominent than in the preceding cases. This and figs. 7 to 9 illustrate the loss of normal contour of the nose from the destruction of cartilaginous tissue.

7. In addition to the diffuse infiltration of the face, there are well-marked infiltration of the lips and slightly pendulous ear lobules.

8. The nodules, as discrete tumors, are surrounded by apparently normal tissue. A considerable loss of the cartilage of the tip of the nose has caused a marked flattening of this appendage.

9. Illustrating shotlike tubercles of leprosy as discrete nodules, scattered over the entire face; the arms and the legs, and to a lesser extent the trunk, showed similar tumors.

Plate II

FIG. 10. Showing a not uncommon condition in leprosy, in which the nodules themselves undergo necrosis with subsequent absorption, leaving smooth cicatrices. Necrosis of the cartilage of the left ear and of one nodule on the left cheek is here in progress.

11. Showing the partial coalescence of large nodules on the cheeks and chin; this condition in advanced cases of leprosy gives rise to the leonine facies.

12. A profile view of a case of early leontiasis, showing a diffuse thickening of the skin of the face. This is an excellent example of pendulous ear lobules.

13. A slightly more advanced case of leontiasis, showing the loss of the normal lines of expression of the face, notably in the distorted lips.

14. A still farther advanced case of leontiasis; the general thickening of the tissues of the face has given rise to a "death-masklike" appearance. Leprous cachexia is well marked in this woman.

15. A fairly typical case of leontiasis. This may be considered as the terminal manifestation of uncomplicated nodular leprosy in the face.

16. A typical "ring and little finger deformity," the earliest recognizable deformity of this type of leprosy in the hands. Both fingers can be straightened with only moderate force and at this stage retain some function.

17. A moderate contraction in all the fingers in leprosy; both thumbs, in this case, appeared to be normal. At the instant the picture was being taken, a moderate pressure was being exerted on the fingers to show the approximate amount of available extension.

Plate III

FIG. 18. A more nearly complete contraction of the fingers than in fig. 17; here, too, the limit of extension is shown. The œdema present in the fingers of the left hand is transient and is due to an infection in the palm of the hand.

19. An example of the claw hand of leprosy, the classical *main en griffe;* the typical atrophy of the interossei is indicated in the left hand. The condition of this hand may be considered as the terminal manifestation of anæsthetic leprosy of the hands in uncomplicated cases. Unfortunately, the disease rarely stops with this deformity. Due to the coincident anæsthesia, the hands are subject to trauma, particularly to burns, which may be very extensive and are usually painless. Other trauma and neurotrophic changes result in various deformities.

20. The typical perforating ulcer of the foot; this lesion is considered by the natives in many parts of the world as diagnostic of leprosy.

21. The typical, sluggish, neurotrophic ulcers of leprosy, which although almost incurable appear to have a strong resistance to the ordinary pyogenic infections. The curious parchmentlike skin frequently seen among anæsthetic lepers is shown.

FIG. 22. A single, large patch on the back of a leper having a slightly pigmented, rugged, central area and a slightly erythematous periphery.

23. An almost diffuse outcropping of small erythematous macules of leprosy, not unlike those of secondary syphilis.

24. The coalescence of numerous macules of leprosy, giving rise to curious circinate designs.

25. A somewhat unusual herpeslike series of macules of leprosy.

PLATE IV

FIG. 26. An undeformed hand, aside from the slight spindle shape of the fingers; the proximal portions being about normal in appearance, the distal phalanges being smaller and pointed.

27. An obviously deformed hand, the spindle shape being greatly exaggerated. Unquestionably in this case of leprosy the osseous tissues are not alone in the retrogressive process.

28. The process of absorption is in progress, and there is some distortion of the digits from coincident nerve involvement. The thumb of each hand in this case is unattacked.

29. A more advanced stage; in this case the nails may be seen in their deformed state almost at the point of articulation of the first and second phalanges.

30. The proximal phalanges are almost completely absorbed, the thumb of the right hand alone having escaped the process.

31. A similar irregularity in the absorption of the fingers, the middle finger of the left hand being unabsorbed.

32. The peculiar "telescoped" appearance occasionally seen, in which the process of absorption of the osseous tissue has proceeded more rapidly than that of the other tissues.

33. The partial absorption of the metacarpals of the left hand; the distorted finger nails remain as horny projections on the palmar aspect of the hand. The right hand shows a long scar at the site of the metacarpo-phalangeal articulation, the result of amputation of infected fingers. The left hand shows no scars since the skin has remained unbroken during the entire process.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

PLATE I.


Fig. 10.


Fig. 11.


Fig. 12.

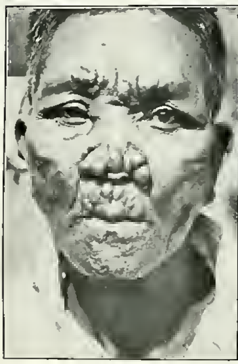


Fig. 13.

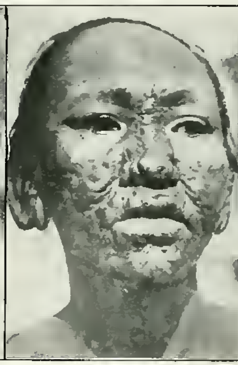


Fig. 14.


Fig. 15.


Fig. 16.


Fig. 17.

PLATE II.



Fig. 18. Fig. 19. Fig. 20.

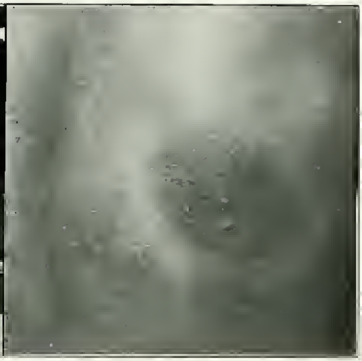
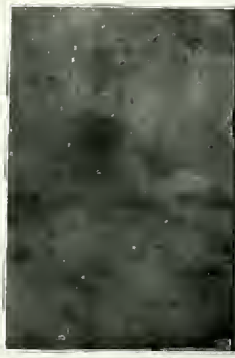



Fig. 21. Fig. 22.



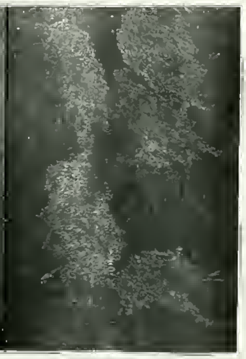


Fig. 23. Fig. 24. Fig. 25.

PLATE III.

Fig. 26.

Fig. 27.

Fig. 28.

Fig. 29.

Fig. 30.

Fig. 31.

Fig. 32.

Fig. 33.

PLATE IV.

A COMPARATIVE STUDY OF DIFFERENT METHODS OF TREATMENT OF TYPHOID FEVER[1]

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TEN TEXT FIGURES

CONTENTS

INTRODUCTION

Life is short and art long; opportunity is fleeting; experiment is dangerous and decision is difficult.—First Aphorism of Hippocrates.

The question of the therapy of typhoid fever has been given considerable attention by scientists for the last three years. It now forms a new field of scientific research, among both clinicians and laboratory workers. Medical literature teems with reports of the favorable results obtained by different observers of the merits of the various methods employed; namely, the use of (*a*) foreign proteins and (*b*) colloidal preparations. These methods of treatment may be said to be still in the experimental stage. After three years of careful trial and observation, the views expressed by leading investigators with particular refer-

[1] Thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Tropical Medicine, in the Graduate School of Tropical Medicine and Public Health, University of the Philippines, February 21, 1918.

ence to the action of vaccines are many, and opinion is far from unanimous. The claims made by some, that the curative effect of vaccines is due to their specific action, have been held to be untenable, so that many look upon the question as still unsettled.

It is my intention to make the present paper the basis of my contribution to this much-disputed question, although conscious of the fact that it requires some temerity to enter a field already occupied by so many distinguished American and European writers. I hope, however, to set forth some facts in connection with these methods of treatment and then to present the conclusions reached through my observations.

PRESENTATION OF THE CLINICAL CASES

Period of observation.—The present investigation covers a period of seven months, beginning August, 1917, and extending to February, 1918. During that time there were admitted to the medical department in the Philippine General Hospital ninety-eight cases of typhoid fever, all Filipinos. Both sexes are represented in the series. The minimum age was 14 years. Another series of twenty cases of typhoid fever has not been included with these ninety-eight cases for the reason that some were in a dying condition on admission and, therefore, short-lived in the hospital; and others were admitted in a convalescent state, in which they showed marked defervescence. In connection with these convalescent cases it was felt that the effects of the treatment under consideration in this paper might lead to erroneously favorable interpretations.

Source of material.—The source of the cases studied was the district of Manila. Relatively few cases came from Rizal, Cavite, Bulacan, and Laguna Provinces.

Type of epidemic.—Many of the patients on admission showed marked toxæmia, frequently associated with pneumonic, cardiac, or renal complications; while other cases were admitted in a condition of collapse, either with intestinal perforation or acute intestinal hæmorrhage. It can be fairly stated, then, that we were dealing with a severe type of epidemic. It should be further stated that, with very few exceptions, these typhoid cases belonged to the laboring class of the community, whose hygiene and dietary were very deficient. Upon falling ill many of them remained in their homes for a number of days without any medical attendance, and only applied to the hospital for admission when their condition had become very serious.

In these ninety-eight cases males predominated over females. The sex incidence is shown in Table I.

TABLE I.—*Sex incidence in typhoid fever.*

Sex.	Cases.	Deaths.	
			Per cent.
Male	65	14	21.5
Female	33	5	15.1
Total	98	19	19.38

Morbidity and mortality.—Out of these ninety-eight cases there were nineteen deaths, a mortality of 19.38 per cent, a very discouraging if not alarming figure. It should be remembered, however, that many of the cases showed little prospect of recovery, on account of their serious condition when admitted to the hospital. In fact, ten of the nineteen cases that died were considered hopeless on admission. Excluding these ten hopeless cases, therefore, reduces the mortality rate to 10.22 per cent. McCrae(31) gives 25 per cent as the mortality rate for British troops in South Africa; Curschmann,(5) 9 to 12 per cent; Osler,(37) 7 to 20 per cent in hospital practice, and 5 to 12 per cent in private practice; Rogers,(42) 16.3 per cent for white troops in the tropics and 26 per cent for Indians. In the Philippines Chamberlain(3) places the mortality rate at 17.65 per cent for Filipinos and 16.8 per cent for white troops in the tropics. Gutierrez,(12) of the Philippine General Hospital, in analyzing one hundred twenty-five cases of typhoid fever in 1913, gives 20.43 per cent; after excluding ten hopeless cases he gives a mortality rate of 13.13 per cent.

Selection of material.—Selection of cases is fraught with no less difficulty. The varying degree of severity of infection in each case, and the fact that some individuals came early for treatment while others came later, rendered comparison a difficult task. However, particular emphasis was laid on the severity of the individual case on admission. The cases were then grouped. It should be stated that the diagnoses in all these ninety-eight cases were established on clinical findings, and laboratory examination was then resorted to for confirmatory purposes. In each instance search was made for malarial parasites.

Clinical grouping of cases.—These ninety-eight cases were divided into groups according to the apparent condition of the individual case on admission or after one or two days' observation in the ward. Thus, cases that presented high fever and delirium, with or without complications, were classified as severe and toxic; those that presented high fever, with or without complications, but not apparently poisoned, were classified as severe and nontoxic; while those with moderately high fever, without complications, and not apparently poisoned, were classified as mild. These classifications are, of course, more or less arbitrary and conventional. Classifications were made under these headings as follows:

TABLE II.—*Classification of cases of typhoid fever.*

	Cases.
Severe and toxic	26
Severe and nontoxic	47
Mild	25
Total	98

VARIETY OF TREATMENT

FOREIGN PROTEIN

Bacteria, being composed of protoplasmic matter, are considered to be protein substance. In fact, Robertson,(40) and Jobling, Petersen, and Eggstein,(17) have called this substance "bacterial protein." My view is that any organism, living or otherwise, becomes foreign protein when introduced into the host.

Typhoid fever, so far as I am aware, is the only disease in the treatment of which protein has been extensively employed. It has been used either in homologous or heterogonous forms. In the great majority of instances, however, vaccines in the form of foreign protein have been used. These consisted of either living sensitized organisms, dead sensitized organisms, or nonliving nonsensitized organisms. Sensitized organisms are bacilli that have been treated with immune serum, while nonsensitized nonliving organisms are killed bacilli that have not been treated with immune serum.

SENSITIZED, OR TREATED, VACCINE ADMINISTERED INTRAVENOUSLY

Vaccine treatment dates from 1893. Eugene Fraenkel(7) was the pioneer in this field. He employed a vaccine of killed typhoid bacilli, subcutaneously administered, for therapeutic purposes in typhoid fever, and he claimed to have modified the course of the disease. His work received scant attention from early investigators. Nine years passed before reports of similar observations came from Petruschy(38) in 1902. Then followed the work of Pescarole and Quadrone(39) in 1908. Ichikawa,(15) in 1914, used the intravenous method of administration of living sensitized typhoid vaccine and secured excellent results. His success awakened interest in this form of treatment; and since then, according to Gay and Chickering,(11) it has received careful trial at the hands of such leading investigators as Koranyi, Biedl, Eggerth, Sladek and Kotlowski, Boral, Holler, Lowy, Luksch, and Wilhelm and Myer.

Variety of sensitized typhoid vaccine.—So far as I am aware, there are four kinds of this type of vaccine; namely, (*a*) Ichikawa's living attenuated sensitized vaccine, (*b*) Besredka's(1) living sensitized vaccine, (*c*) Gay's(9) sediment vaccine, and (*d*) sensitized killed vaccine.

Dosage.—The dose administered intravenously varies according to the kind of vaccine. Thus, of Besredka's vaccine there have been used from 100 to 300 millions; Ichikawa's vaccine, from 200 to 300 millions; Gay's vaccine, from 0.2 to 0.4 milligram (150 to 300 millions). The dosage of killed sensitized vaccine is from 50 to 800 millions as indicated by Jobling;(17) 70 to 300 millions, by Dithorn and Schultz;(6) and equal parts of typhoid and paratyphoid bacilli (500 millions) is the amount employed by Robertson.(40) I have employed a dosage of from 250 to 1,000 millions of killed sensitized typhoid bacteria intravenously, increasing the doses every three or four days according to the case.

Contraindications.—According to eminent writers on the subject, weakness of the heart, presence of pneumonia, and intestinal hæmorrhage are contraindications for vaccine treatment. Thus Sladek and Kotlowski(46) believe that it increases peristalsis of the intestines, with subsequent danger of hæmorrhage and perforation. My experience leads me to believe that vaccine therapy is as yet of very limited applicability, and I do not feel that I am in a position to confirm or controvert their observations. However, I have employed this treatment in all conditions, except in cases of intestinal hæmorrhage, and so far there have been no untoward effects that could be attributed directly to the treatment.

This series comprises fifty-one cases of typhoid admitted during the height of the epidemic, of which thirty cases were subjected to intravenous injection of polyvalent sensitized typhoid vaccine, while twenty-one cases were used as controls.

The clinical grouping of cases given vaccine treatment intravenously is shown in Table III.

TABLE III.—*Condition of patients before treatment.*

	Cases.
Severe and toxic	9
Severe and nontoxic	15
Mild	6
Total	30

Method of treatment.—The view that sensitized typhoid vaccine is considered less toxic than nonsensitized typhoid vaccine seems to be the consensus among investigators at present. Cecil,(2) Garbat,(8) and Nichols(35) have shown by experiments with animals that such is the case. Cecil, however, has found that the lethal dose of sensitized typhoid vaccine is three times as large as that of the nonsensitized bacilli. Reasoning from this point of view, since McWilliams(34) has used intravenously 500 millions of plain nonsensitized killed typhoid bacilli as the initial dose, the safe limit of dosage for sensitized organisms would be 1,500 millions; I have used, therefore, 250 to 500 millions as my dose and, in a very few cases, 1,000 millions. I have never exceeded 1,000 millions, even in repeated doses.

The vein selected for intravenous injection is the median basilic, this vessel being commonly prominent, although the injection may be given in any other vein provided the site is rendered aseptic. The injection should be done under rigid asepsis and preferably by the closed method.

The results of the treatment of thirty cases by intravenous injection of sensitized vaccine are shown in Table IV.

TABLE IV.—*Sensitized typhoid vaccine administered intravenously.*

Classification by results.	Cases.			Total.	Days before treatment.	Duration of treatment.	Duration of disease.
	Mild.	Severe.	Severe and toxic.				
						Days.	*Days.*
Aborted	4	3	0	7	8.2	5.1	13.3
Benefited	2	12	0	14	11.5	14.4	25.9
Relatively unaffected	0	0	3	3	8	25.3	33.3
Deaths	0	0	6	6			
Crisis				4			
Lysis				10			
Average							24.1

In Table IV the cases have been separated into groups according to the results; namely, (*a*) aborted type, (*b*) benefited type, and (*c*) relatively unaffected type.

There were seven aborted cases out of thirty cases treated intravenously, with an average duration of treatment of 5.1 days, in contrast to seven days observed by Gay.(9) McCrae(32) in analyzing fifteen hundred cases found 0.1 per cent that recovered by crisis. In my series, I found 23.33 per cent of aborted cases. It is interesting to note that the aborted cases were observed during the first week, and that they have a direct relation to intravenous injections. This abortive type was observed in mild cases in the majority of instances and in severe cases in a few instances. The temperature record of one of the abortive cases is shown in the accompanying chart (fig. 1).

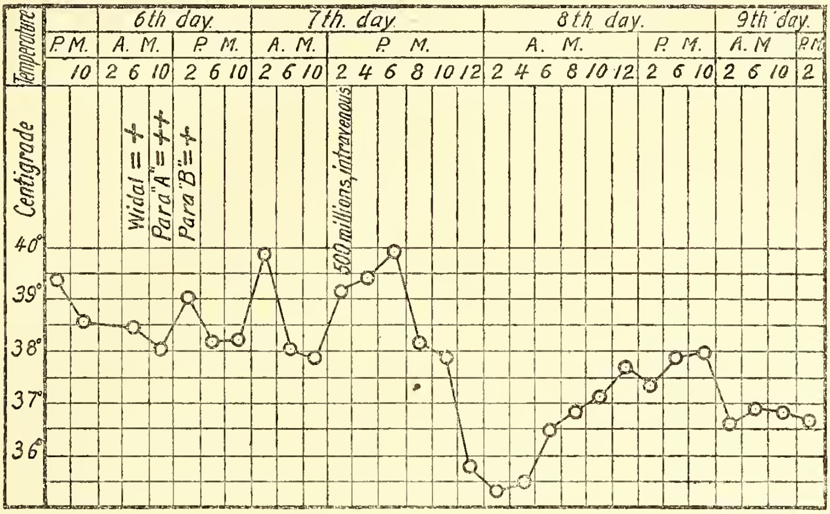

FIG. 1. Temperature chart of B. Y. Abortive type of typhoid fever, treated with sensitized typhoid vaccine intravenously.

The benefited type was observed during the second week. As a rule the temperature drops, either by crisis or by lysis, following each successive intravenous injection; but afterward it rises again temporarily, then becoming permanently normal. The average duration of treatment was 14.4 days in my cases, while in those of Gay it was 15.8 days. Examples of the benefited cases are shown in the accompanying charts (figs. 2, 3, and 4).

The relatively unaffected type was observed in advanced cases. Each injection was followed by a temporary drop in temperature, which subsequently in some cases resumed the original level at which it was before the injection, while in others it became slightly remittent or intermittent. The course of the disease was slightly altered. The average duration of the disease was 25.3 days in this series.

Symptomatology.—From thirty minutes to one hour after the intravenous injection of vaccine, the patient as a rule feels a slight chilly sensation as a prodromal symptom. This lasts for a few minutes; then follows the real shaking of the entire body. This rigor shows varying degrees of intensity according to individual susceptibility, and may last for from fifteen to thirty-five minutes. During this period the pulse and the respiration are slightly increased in rate, and the skin is pale and feels cold; the temperature is usually high, reaching its maximum height in from three to six hours. It then falls, generally either by crisis or by lysis, or else it may become intermittent or remittent. There are cases, however, in which the temperature drops by crisis or lysis without chills or a preceding rise in temperature. Such cases are relatively rare. The crisis may

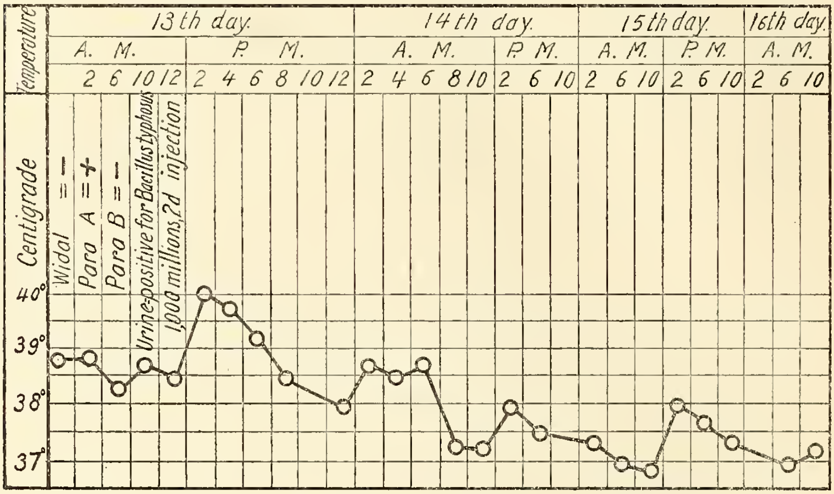

FIG. 2. Temperature chart of E. N. Benefited type of typhoid fever, treated with sensitized typhoid vaccine intravenously.

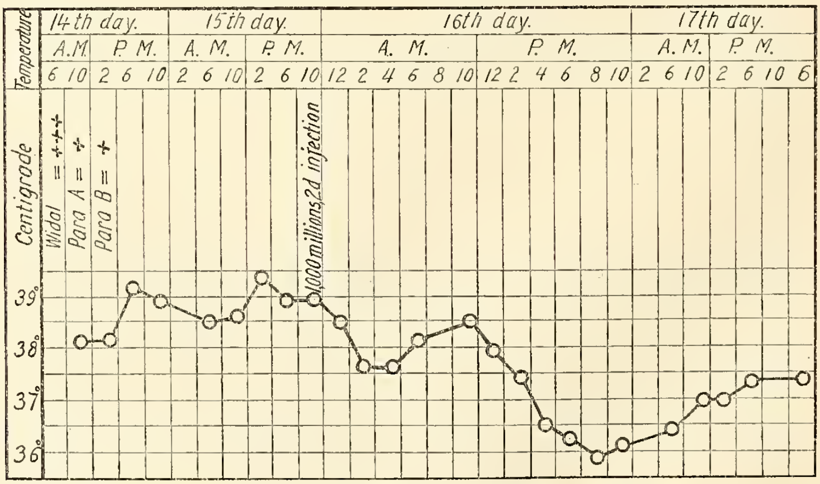

FIG. 3. Temperature chart of M. L. Benefited type of typhoid fever, treated with sensitized typhoid vaccine intravenously.

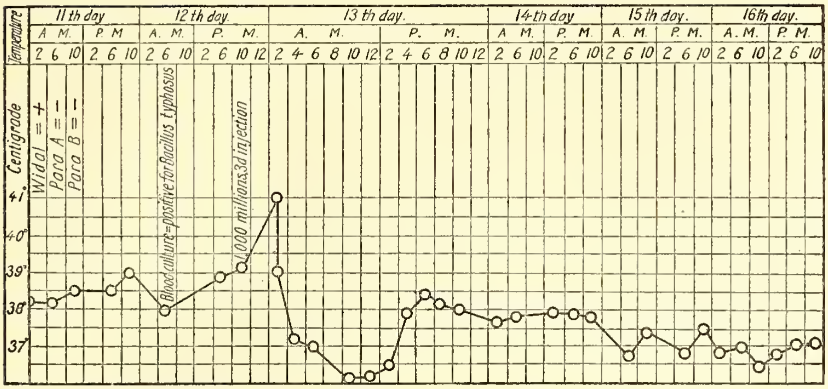

FIG. 4. Temperature chart of N. C. Benefited type of typhoid fever treated with sensitized typhoid vaccine intravenously.

reach a normal or a subnormal level about twelve hours after injection. The rigor is followed by thirst, cold perspiration, and relaxation, but accompanied by a feeling of marked alleviation of subjective symptoms. In the majority of instances the patient, previously sleepless, is able to sleep soundly the following night.

The temperature may remain permanently at the normal level, and in this event no further injection is necessary; but, if the temperature should rise again for a period of three or four days, another injection is needed with increasing dose. My experience is that two or three doses are sufficient to produce the desired result; if without result, further injections seem to be of no value.

According to Gay and Chickering,(11) and McWilliams,(34) there is a leucopenia during the rise of temperature, and hyperleucocytosis during the apyretic period. They were able to observe these phenomena by frequently examining the blood of the patients. I was unable to make frequent examinations of the blood of the patients injected, but examination of the blood twenty-four hours after injection revealed a slight increase in the leucocyte count.

I have observed that a moderate reaction is very necessary to produce beneficial results. Similar observations have been confirmed by Gay(9) and claimed by Leake.(24) To avoid errors in interpretation of results, it is highly advisable to base one's judgment on the effects of treatment; that is to say, not from the subjective symptoms, but rather from the objective phenomena, such as shortening of the duration of the fever or, in other words, the occurrence of the abortive type in relation to injection.

Complications.—Excluding eight cases, in which complications were already present on admission into the hospital, six developed complications during treatment. In ninety-eight cases treated by Gay,(9) he observed thirteen that developed complications; namely, pyelitis, one case; lobar pneumonia, one; laryngitis, two; bronchopneumonia, two; toxæmia, one; hæmorrhage, four; and perforation, two.

Table V shows the complications that were observed during treatment and before treatment was begun.

TABLE V.—*Complications before and during treatment.*

Complication. [a]	Developed before treatment.	Developed during treatment.
Pneumonia	8	3
Intestinal hæmorrhage	0	[b] 2
Bronchopneumonia	1	1
Total cases	9	6

[a] Relapses, three cases.
[b] One case had hæmorrhage four days after injection; another case, during convalescence.

Early investigators, Krumbhaar and Richardson,(22) Waitzfelder,(48) and Robertson,(40) held the belief that vaccine therapy diminishes the complications. But Table V seems to show that it has no advantageous effect on the complications as compared with my controls. Whittington,(49) who has had considerable experience with vaccine therapy, reports that he observed a higher percentage of complications (49.5 per cent) under vaccine treatment, while his controls showed 46 per cent. His observation is based upon one hundred fifteen cases treated with vaccine and another one hundred fifteen under classical treatment.

Relapses.—In my thirty cases, treated with vaccine, three had relapses, lasting only a few days. Gay advised subcutaneous injection of vaccine a few days after the intravenous, so as to prevent relapse. Again, Whittington found a higher percentage of relapses in cases treated with vaccine (10.4 per cent), in contrast to 7.8 per cent observed in his controls. In my controls I had five relapses (23.9 per cent), a higher number than shown by the cases that had undergone vaccine treatment (10 per cent). This difference in results may be due to the limited series that I have had so far.

Concomitant disease.—On examining these thirty cases, two cases of tuberculosis were found. One was a case of incipient pulmonary tuberculosis that later became active during the course of the disease. It seemed that vaccine treatment administered intravenously had done harm to the patient; because, after the injection and consequent shaking up of the body, it was noticed that traces of blood were found in his sputum. This might be a mere coincidence, but it should be regarded with suspicion. It seems advisable to exercise prudence and caution in the use of vaccine for patients suffering from pulmonary tuberculosis. The other case was a tuberculous cervical adenitis. In this particular case vaccine injection was not followed by any untoward effects.

Mortality.—The mortality in these thirty cases is 20 per cent, a very high rate. It should be remembered, as already stated, that these patients belonged to the laboring class who did not realize the advantage of early hospitalization. Consequently they had remained in their respective homes without adequate treatment and care, only coming to the hospital at a time when medical attention would be of little avail because of the advanced stage and seriousness of the cases. In fact, there were three cases in which I considered the outlook on admission as hopeless on the grounds of marked toxæmia and pulmonary complications. By excluding these three hopeless cases, the mortality is reduced to 10 per cent. Autopsy findings will reveal the causes of death, as shown in the following protocols:

Autopsy findings (sensitized intravenous treatment).

File No. 1957: D. H.

Anatomic diagnosis: Bilateral lobar pneumonia with abscess and gangrene of the lung; typhoid enteritis; acute parenchymatous degeneration of the viscera; chronic fibrous pleurisy.

File No. 1830: V. C.

Autopsy findings: Typhoid ulcerated enteritis, healing; acute hæmorrhagic bronchopneumonia; acute pyonephritis; parenchymatous degeneration of the liver; fatty degeneration of the heart; acute myocarditis.

File No. 1875: S. C.

Anatomic diagnosis: Intestinal hæmorrhage; acute ulcerative enterocolitis, typhoid; acute splenitis, mesenteric; parenchymatous degeneration of the heart and liver; acute parenchymatous nephritis with some interstitial nephritis; focal necrosis of the liver; emaciation; ascariasis; trichuriasis.

File No. 1985: F. J.

Anatomic diagnosis: Beginning lobar pneumonia, right; typhoid enteritis; acute parenchymatous nephritis; acute parenchymatous degeneration of the heart and liver; calcareous nodule in the left lung; ascariasis.

The above necropsy records show that no known treatment would have prevented the fatal outcome. Undoubtedly, these patients died of what are commonly known as "accidents of typhoid."

Gay and Chickering,(11) in 1915, had 9 per cent mortality in fifty-three cases, treated with their vaccine; Gay,(9) in 1917, had 6.6 per cent mortality in ninety-eight cases. In my series the mortality is 10 per cent, after excluding the three hopeless cases. Ichikawa,(15) however, in 1914, had 12 per cent mortality in eighty-two cases; but his controls showed 30 per cent mortality, while my controls showed 23.8 mortality. McWilliams(34) has this to say about the rate of mortality:

> The percentage mortality in itself offers but little evidence as to the danger or efficacy of the treatment, as it will necessarily vary according to whether only mild cases, only severe cases, or all types of cases are subjected to the injections. The highest death rate, 23 per cent., was observed by Paulicek. His patients were soldiers who had suffered from severe exposure in cold weather, and they died in most instances from a complicating pneumonia. The high mortality of 23 per cent. represents, he says, a reduction by 20 per cent. from what was obtained without the injection of vaccine. It has already been mentioned that the death rate in Ichikawa's control cases was more than twice as high as in the treated cases.
>
> Of far greater importance than the percentage mortality is the question as to how many, if any, of the deaths could be attributed directly to the action of the vaccine. Five cases (treated by Boral, by Csernel and Marton, by Löwy, Luksch and Wilhelm, and by Paulicek) showed intestinal hemorrhage following the injection and terminated fatally. One case (of Sladik and Kotlowski) resulted fatally from hemorrhage into the thyroid gland. One of Eggerth's patients developed a hemorrhage from the lungs and died three hours after the injection. One of Biedl's had hemorrhage from the nostrils before the intravenous injection of vaccine was given; after the treatment the hemorrhage recurred and could not be stopped.

CONTROLS

The fact is well known to all who have had experience with the disease that, strictly speaking, no two cases of typhoid fever are of equal severity. But this does not mean that we should disregard entirely the value of controls; for, although the results are not necessarily equal, yet, taking them as a whole, the factors concerned are minimized and the results thus obtained are approximate, if not exact.

By the term control, as used in this paper, I mean the classification of typhoid patients into groups of cases showing a more or less equal degree of infection, as a basis of comparison with other groups of patients, similarly affected by the same disease but undergoing different kinds of therapy. That is to say, the controls are grouped conjointly with the cases that are subjected to the intravenous treatment with sensitized vaccine.

These control cases were subjected to classical treatment, which consists in the application of general hygiene and care; the administration of light, nourishing food; the application of hydrotherapy, either cold or tepid; and absolute rest. As an accompaniment to this treatment the patient may be given cardiac stimulation, soda enemata (1.5 per cent solution) every other day, and occasional, small doses of urinary antiseptics. The patient may be given 1,000 cubic centimeters of proctoclysis daily of normal saline solution and should be encouraged to drink plenty of water as an aid to disintoxication.

This series consists of twenty-one cases. Their clinical grouping is shown in Table VI.

TABLE VI.—*Condition of patients before treatment.*

	Cases.
Severe and toxic	6
Severe and nontoxic	11
Mild	4
Total	21

In the sixteen cases remaining after five deaths are excluded the average duration of the disease was 27.7 days, while in the cases treated with sensitized vaccine, as previously stated, it was 24.1 days. Gay,(10) in using similar treatment, found that the average duration of the disease was 27.6 days. McCrae,(33) in analyzing fifteen hundred cases of typhoid, found that the average duration was thirty-one days.

Complications.—Out of these twenty-one cases there were eight cases that developed complications, two of which showed them on admission. Table VII shows the variety of the complications:

TABLE VII.—*Complications in eight cases of typhoid fever.*

	Cases.
Lobar pneumonia (present on admission)	2
Bronchopneumonia	3
Perforation	1
Intestinal hæmorrhage	2
Total	8

In connection with these complications, it is interesting to compare the complications that developed only during vaccine treatment with those that appeared in the controls as shown in Table VIII.

TABLE VIII.—*Complications in control cases.*

	Cases.
Controls (after excluding 2 cases in which complications were present on admission)	6
Sensitized vaccine treatment	6

The above comparison differs somewhat from the results obtained by other investigators, such as Gay(9) and Waitzfelder,(48) who have claimed that vaccine therapy diminishes the incidence of complications. My results, however, are somewhat similar to those of Whittington,(49) who found that well-controlled cases develop a smaller number of cases of complications. The discrepancy between my observations and those of Whittington may be due to the fact that he observed a greater number of controls than I had available for treatment.

Mortality.—The rate of mortality is very discouraging, if not alarming. There were five deaths out of twenty-one cases, a mortality of 23.8 per cent. If we exclude the two cases that I considered hopeless on admission, the rate of mortality will be reduced to 14.3 per cent. Only two cases were autopsied out of five deaths, and the anatomic diagnoses show the following:

Anatomic diagnoses (autopsy findings of control cases).

File No. 1749: I. S.

Anatomic diagnosis: Acute ulcerative enteritis (typhoid); suppurative peritonitis following perforation; acute parenchymatous degeneration of the viscera; cardiac dilatation; œdema of the meninges.

File No. 1834: B. C.

Anatomic diagnosis: Acute enteritis (typhoid), congestion, and beginning necrosis; acute splenitis; acute lymphadenitis, mesenteric; acute dilatation of the heart; acute parenchymatous nephritis; parenchymatous degeneration of the heart and liver; focal necrosis of the liver; chronic caseous lymphadenitis, bronchial; chronic fibrous pulmonary tuberculosis; emphysema, interstitial; ascariasis.

Again, I have to state that the untreated control cases of Ichikawa(15) showed a mortality rate of 30 per cent in comparison with my mortality of 14.3 per cent after two hopeless cases were excluded.

SENSITIZED VACCINE ADMINISTERED INTRAMUSCULARLY

Early in 1911 Metchnikoff and Besredka(27) advocated the use of living sensitized typhoid vaccine intramuscularly for prophylactic purposes and claimed to have secured excellent results thereby. Followers of this school have adopted that practice and have even gone so far as to use this form of vaccine as a therapeutic agent, and they have drawn others into the ranks. Among the leading investigators in this field, according to Gay and Chickering,(11) are Ardin-Delteil, Negre and Raynoud, Boinet, Delearde and Leborgne, Sable, Netter, Roques and Alfaro, Feistmantel, and Garbat.

In this series there were ten cases treated with sensitized typhoid vaccine intramuscularly, and the series was treated just after the series of cases treated intravenously with sensitized vaccine.

TABLE IX.—*Condition of patients before treatment.*

	Cases.
Severe and toxic	3
Severe and nontoxic	3
Mild	4
Total	10

Mode of treatment.—The sensitized typhoid vaccine, as stated previously, was administered intramuscularly. The dosage employed was from 250 to 1,000 millions every three or four days. Gay advised 800 millions every other day and Garbat 500 millions every five or six days. The results of this treatment upon the course of the disease are shown in Table X.

TABLE X.—*Sensitized typhoid vaccine administered intramuscularly.*

Classification by results.	Cases.			Total.	Days before treatment.	Duration of treatment.	Duration of disease.
	Mild.	Severe and nontoxic.	Severe and toxic.				
						Days.	*Days.*
Aborted	4	0	0	4	10	3.2	13.2
Benefited	0	2	0	2	16	11.0	27.0
Relatively unaffected	0	1	0	1	11	32.0	43.0
Deaths			3	3			
Crisis				1			
Lysis				3			
Average							27.7

Thus, it may be seen that there were four abortive cases, all observed in the beginning of the second week, and all of them mild, in which the average duration of the disease was 13.2 days; two benefited cases, during the third week, both of the severe and nontoxic type, with twenty-seven days as the average duration of the disease; and one relatively unaffected case of the same type as the benefited cases, with forty-three days as the average duration of the disease. The total average duration of the disease was 27.7 days. Fall of temperature by crisis was observed in only one case and fall by lysis in three cases, all in cases of the aborted type.

Symptomatology.—The intramuscular injections were not followed by the train of symptoms observed in the case of the intravenous injections. However, there was a slight rise of temperature, appearing in the majority of cases from twelve to twenty-four hours following injection, and rarely after this time. The temperature in such instances may fall by lysis and, very seldom, by crisis. During the course of the treatment it was observed that a mild reaction was necessary in each case to obtain the desired result.

Complications.—The complications are summarized in Table XI.

TABLE XI.—*Complications before and during treatment.*

	Before treatment.	During treatment.
Lobar pneumonia	1	1
Bronchopneumonia	0	1
Hæmorrhage	0	0
Total	1	2

There were two cases that developed complications during the treatment, giving a rate of 20 per cent; one case was lobar pneumonia and the other bronchopneumonia.

Mortality.—The total mortality in these ten cases was three, a death rate of 30 per cent, which is exceedingly high. Excluding two cases admitted in a very serious condition, the mortality rate would be 10 per cent. The deaths that occurred did not follow immediately after injection, but two days later. Only two cases were autopsied; the findings are shown below:

Autopsy findings (sensitized intramuscular treatment).

File No. 1968: J. P.

Anatomic diagnosis: Typhoid enteritis (healing); acute parenchymatous degeneration, viscera; beginning lobar pneumonia, right; chronic fibrous pleurisy; œdema of the meninges.

File No. 1914: V. H.

Anatomic diagnosis: Bilateral bronchopneumonia; typhoid enteritis (healing); cardiac dilatation; acute parenchymatous degeneration, viscera; acute cholecystitis.

It will be seen, therefore, that the patients died of "typhoid accidents."

Garbat(8) in his paper quotes the results obtained by some investigators who employed sensitized typhoid vaccine intramuscularly, thus: Boinet (1913), 15 cases; Szecsy, 112 cases; and Garbat (1911–1912), 17 cases. All of these authors observed good results.

NONSENSITIZED, UNTREATED VACCINE, ADMINISTERED INTRAVENOUSLY

Following the report by Ichikawa(15) in 1914, on intravenous injection of sensitized typhoid vaccine in the treatment of typhoid fever, many investigators used his method, but they employed a vaccine of the plain bacilli killed by heat. Among Ichikawa's leading followers according to Gay and Chickering(11) are Thiroloix and Bardon, Kraus and Mazza, Kraus, Biedl, Csernel and Marton, Rhein, Reibmayr, Mazza, Holler, Lowy, Luksch and Wilhelm, Paulicek, Dithorn and Schultz, and McWilliams. All of these investigators observed beneficial results following the use of this form of vaccine.

There were nine cases in this series treated with nonsensitized vaccine, administered intravenously. However, the patients in this series had been treated at a different time, following the treatment of the series that had undergone treatment by intramuscular injection of sensitized vaccine. The clinical grouping of these cases is shown in Table XII.

TABLE XII.—*Condition of patients before treatment.*

	Cases.
Severe and toxic	1
Severe and nontoxic	6
Mild	2
Total	9

The results of this treatment are illustrated in Table XIII.

TABLE XIII.—*Nonsensitized vaccine administered intravenously.*

Classification by results.	Cases.			Total.	Days before treatment.	Duration of treatment.	Duration of disease.
	Mild.	Severe and nontoxic.	Severe and toxic.				
						Days.	*Days.*
Aborted	2	3	0	5	11.8	3.9	15.1
Benefited	0	3	0	3	15.3	9.6	24.9
Relatively unaffected				0			
Deaths			1	1			
Crisis				1			
Lysis				3			
Average							20.0

As shown in Table XIII there were five aborted cases, observed during the second week of the disease, of which two were mild and three were severe and nontoxic, with an average duration of the disease of 15.1 days. On the other hand there were three benefited cases, all of which were severe and nontoxic, with an average duration of 24.9 days. The total average duration for the aborted and benefited cases was twenty days, in contrast to 24.1 days, the total average duration for the cases treated with sensitized vaccine intravenously. The difference in results may be accounted for by the difference in the severity of the cases, the period of observation, and the relatively fewer cases in the series. An illustration of the abortive type is shown in the accompanying charts (figs. 5 and 6).

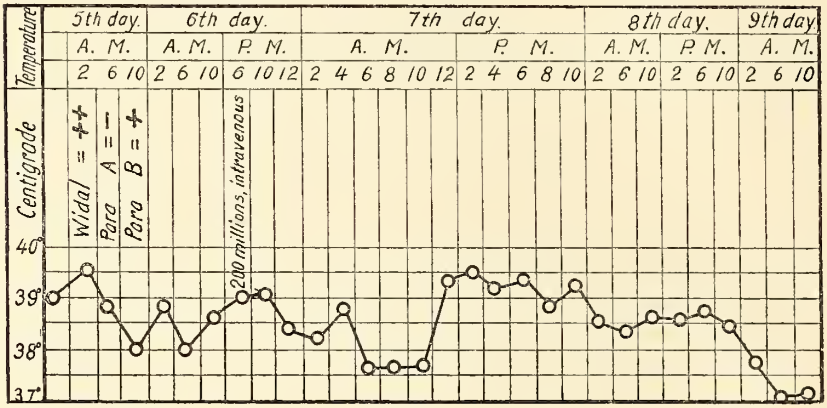

FIG. 5. Temperature chart of J. A. Abortive type of typhoid fever, treated with nonsensitized typhoid vaccine intravenously.

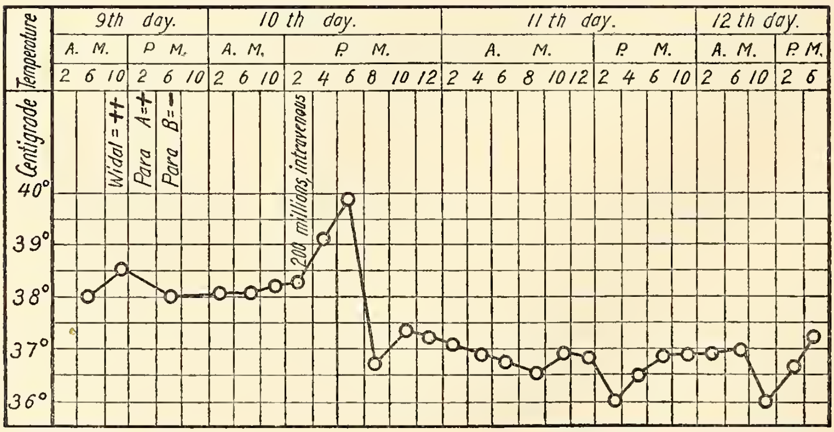

FIG. 6. Temperature chart of C. G. Abortive type of typhoid fever, treated with nonsensitized typhoid vaccine intravenously.

Symptomatology.—The symptoms observed were similar to those that had been met with in the patients treated with sensitized vaccine.

Dosage.—Dithorn and Schultz used 70 to 300 million bacteria as their dosage, Miller and Lusk(29) used 200 millions, and McWilliams(34) used 250 to 500 millions. The doses used in this investigation range from 200 to 250 millions. Gay and Chickering(11) state that, if an overdose is administered, alarming or dangerous symptoms may supervene.

Complications.—There were three cases that had lobar pneumonia as a complication before treatment was begun, and one developed intestinal hæmorrhage three days after injection. Table XIV shows the number of cases and the kind of complication that developed.

TABLE XIV.—*Complications before and during treatment.*

	Before treatment.	During treatment.
Lobar pneumonia	3	0
Intestinal hæmorrhage	0	[a] 1
Total	3	1

[a] Appeared three days after injection and recovered.

It will be seen in Table XIV that there was but one case in which the treatment might be suspected as having been the cause of intestinal hæmorrhage, but there was not sufficient clinical evidence to support the suspicion. In this case the hæmorrhage did not appear until three days after the injection, while McWilliams(34) recorded in her paper five cases reported by Boral, by Csernel and Marton, by Löwy, by Luksch and Wilhelm, and by Paulicek, in which it was evident that intestinal hæmorrhage, terminating fatally, followed the injection. One of Eggerth's patients developed a hæmorrhage from the lungs and died three hours after the injection.

Mortality.—The mortality in nine cases is one, giving a mortality rate of 11.1 per cent. This case was deemed hopeless on admission, and autopsy findings indicate that the patient died of the so-called "typhoid accidents."

Autopsy findings (nonsensitized intravenous treatment).

File No. 2302: P. N.

Anatomic diagnosis: Ulcerative enterocolitis, typhoid; acute splenitis; acute lymphadenitis, typhoid; marked focal necrosis, liver; miliary tuberculosis, pleura; acute parenchymatous nephritis; parenchymatous degeneration of the heart.

PEPTONE

Nolf(36) in February, 1917, published his extended observations made in France during the war, on parenteral injection of peptone solution in the treatment of infectious diseases in general. His experience has shown the efficacy of this treatment in typhoid fever, in the consequent "warding off of intestinal hæmorrhage from reduced coagulating power of the blood." He employed 10 cubic centimeters of a 5 per cent solution intramuscularly in the gluteal region. Intravenous injection should be given slowly and with caution. I was able to apply this form of treatment intramuscularly in a very limited number of cases that were admitted at the end of the epidemic, when morbidity was reduced to the minimum. This series consists of five cases, and the relative severity of the infection in each patient is illustrated in Table XV.

TABLE XV.—*Condition of patients on admission.*

	Cases.
Severe and toxic	0
Severe and nontoxic	2
Mild	3
Total	5

Following the injection of 10 cubic centimeters of a 5 per cent sterile peptone solution every two or three days two mild cases aborted in the beginning of the second week of the disease, with 12.5 days as the average duration of the disease. Three cases were benefited; of these, one was mild and two were of the severe and nontoxic type, with twenty-two days as the average duration of the disease. The total average duration of the disease in this group is 17.2 days. There were but two cases of defervescence by lysis, and none showed a temperature fall by crisis. A summary of the results of the treatment is shown in Table XVI.

TABLE XVI.—*Peptone injection.*

Classification by results.	Cases.			Total.	Days before treatment.	Duration of treatment.	Duration of disease.
	Mild.	Severe and nontoxic.	Severe and toxic.				
						Days.	*Days.*
Aborted	2	0	0	2	8.5	4	12.5
Benefited	1	2	0	3	12.0	10	22.0
Relatively unaffected	0	0	0	0			
Deaths				0			
Crisis				0			
Lysis				2			17.2

Symptomatology.—The symptoms observed were: Slight rise in temperature, supervening from twelve to twenty-four hours after treatment and rarely after forty-eight hours; slight leucocytosis after twenty-four hours; and slight alterations of subjective symptoms. The temperature may assume the lytic, remittent, or intermittent type. An example of the lytic type of temperature curve is shown in fig. 7.

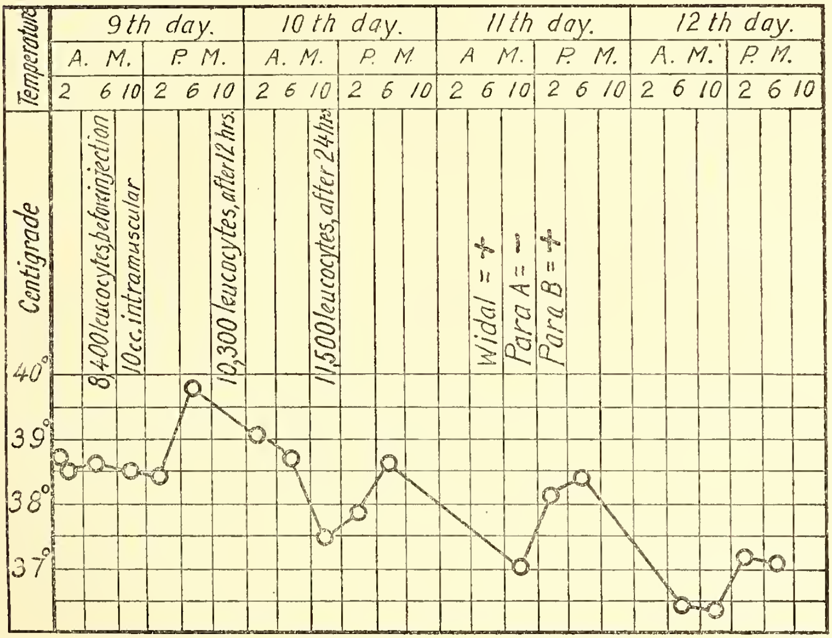

FIG. 7. Temperature chart of F. V. Abortive type of typhoid fever, treated with peptone intramuscularly.

Complications.—Complications observed during the treatment were one case of acute bronchitis and one case of intestinal hæmorrhage (hæmorrhage present at admission).

Mortality.—As these cases were all admitted when the epidemic was in its terminal period and morbidity not at its maximum, none resulted fatally.

MILK

Saxl(45) in 1916 successfully employed sterile milk in typhoid fever, administered intramuscularly. In fact, it is commonly used in Germany. The principle involved in this treatment is the introduction of a heterogonous protein substance, which constitutes a considerable portion of the milk.

The dosage that I have employed was from 10 to 20 cubic centimeters intramuscularly injected in the gluteal region.

Eight cases were treated with milk, all of which were admitted into the hospital when the morbidity of the epidemic was declining.

The condition of the respective patients on admission is shown in Table XVII.

TABLE XVII.—*Condition of patients on admission.*

	Cases.
Severe and toxic	2
Severe and nontoxic	4
Mild	2
Total	8

The results of the treatment in this series are summarized in Table XVIII.

TABLE XVIII.—*Milk injection.*

Classification by results.	Cases.			Total.	Days before treatment.	Duration of treatment.	Duration of disease.
	Mild.	Severe and nontoxic.	Severe and toxic.				
						Days.	*Days.*
Aborted	2	0	0	2	8	4.5	12.5
Benefited	0	2	0	2	9	13.0	22.0
Relatively unaffected	0	2	0	2	11	17.5	28.5
Deaths	0	0	2	2			
Crisis				0			
Lysis				2			
Relapses				0			
Average							21.0

It will be seen that only two mild cases aborted during the second week of the disease, with an average duration of the disease of 12.5 days; two of the severe and nontoxic type were benefited during the second week of the disease, with twenty-two days as the average duration of the disease; and two cases of the severe and nontoxic type were unaffected, with 28.5 days as the average duration of the disease. The total average duration was twenty-one days. There were two cases of temperature fall by lysis, and two that showed an elevation of temperature. The latter two were observed in connection with the formation of an abscess in the gluteal region in each case, as the result of imperfect sterilization of the milk used. Upon evacuation of the abscess the temperature completely subsided after twenty-four hours. Of all the injections made, only these two cases developed such abscess formations. The accompanying chart shows the effect of the treatment (fig. 8).

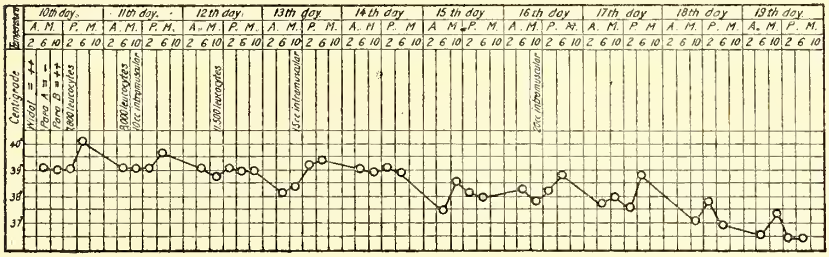

FIG. 8. Temperature chart of E. A. Illustrating the effect of intramuscular injection of milk.

Symptomatology.—The symptoms observed were: A slight rise of temperature; pain and tenderness in the gluteal region; slight leucocytosis; and gradual amelioration of subjective symptoms. The temperature may become lytic, remittent, or intermittent. An example of the benefited type in which the temperature became remittent, finally falling to normal, is illustrated in the accompanying temperature record.

Complications.—The complications that were observed are shown in Table XIX:

TABLE XIX.—*Complications before and during treatment.*

	Before treatment.	During treatment.
Lobar pneumonia	1	1
Intestinal hæmorrhage	1	[a]1
Abscess of the buttocks	0	2
Total	2	4

[a] Hæmorrhage appeared five days after injection and the patient died.

Table XIX shows that four cases exhibiting complications were observed during the treatment, of which one case was lobar pneumonia, one case was intestinal hæmorrhage, and two cases had abscess in the buttocks accounted for by improper sterilization of the milk used.

Mortality.—There were two deaths out of eight cases, giving a mortality rate of 25 per cent. One of these cases that died was delirious and semiconscious, from the time of admission up to death. Autopsy findings of these two cases are as follows:

Autopsy findings (milk injection).

File No. 2662: S. L.

Anatomic diagnosis: Acute ulcerative enteritis with hæmorrhage (typhoid); acute splenitis and lymphadenitis (mesenteric); acute cardiac dilatation; acute parenchymatous degeneration of the viscera.

File No. 100: M. C.

Anatomic diagnosis: Ulcerative enteritis (healing typhoid); intestinal hæmorrhage; subacute splenitis; dilatation of the heart; bronchopneumonia (hypostatic); suppurative nephritis; acute myocarditis; parenchymatous degeneration of the liver; fibroma, left kidney.

The above necropsy records show that the patients died of complications.

COLLOIDAL GOLD INJECTED INTRAVENOUSLY

Colloidal gold, or colibiase as it is sometimes called, has been used extensively by French clinicians for a variety of infectious diseases, such as typhoid fever. Among the leading clinicians following this method, according to Gay,(9) are: Letulle and Mage(25) in 1914, Gay in 1915, Barachon in 1916, Labbe and Mausand in 1916, and Delbet in 1916.

A series of fifteen patients was treated intravenously with colloidal gold in connection with this study. This treatment was carried out when the morbidity of the epidemic was going down. The clinical grouping of the cases is given in Table XX.

TABLE XX.—*Condition of patients.*

	Cases.
Severe and toxic	5
Severe and nontoxic	7
Mild	3
Total	15

Dosage.—The dose employed by Letulle and Mage(25) in connection with their forty-two cases ranged from 1 to 2.5 cubic centimeters intravenously, 1 cubic centimeter for mild cases and 2.5 cubic centimeters for severe cases. The dose administered in my series was from 0.5 to 5 cubic centimeters intravenously, depending upon the severity of the case. In the majority of instances, 2 to 3 cubic centimeters was the initial dose.

The results of the treatment are shown in Table XXI.

TABLE XXI.—*Colloidal gold injected intravenously.*

Classification by results.	Cases. Mild.	Severe and non-toxic.	Severe and toxic.	Total.	Days before treatment.	Duration of treatment.	Duration of disease.
						Days.	*Days.*
Aborted	3	2	0	5	6.6	4.2	10.8
Benefited	0	5	0	5	10.8	11.4	22.2
Relatively unaffected	0	0	3	3	13.0	20.3	33.3
Deaths	0	0	2	2			
Crisis				1			
Lysis				4			
Relapse				1			
Average							22.1

As shown above, the five aborted cases, three of which were mild and two severe and nontoxic, were all observed during the first week of the disease and had an average duration of disease of 10.8 days; the five benefited cases during the second week, all of which were severe and nontoxic, had an average duration of the disease of 22.2 days; the three relatively unaffected cases, all of which were severe and toxic, had an average duration of the disease of 33.3 days. The total average duration of the disease was 22.1 days. In one of the cases temperature fall by crisis was observed, in four cases decline by lysis was noted, and in only one case did a relapse develop. The charts, figs. 9 and 10, show the effect of the treatment.

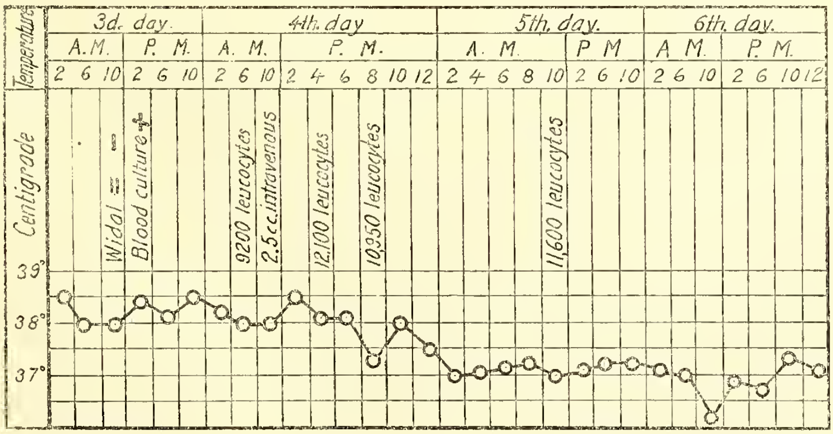

FIG. 9. Temperature chart of J. R. Abortive type of typhoid fever, treated with colloidal gold intravenously. Widal negative till discharge.

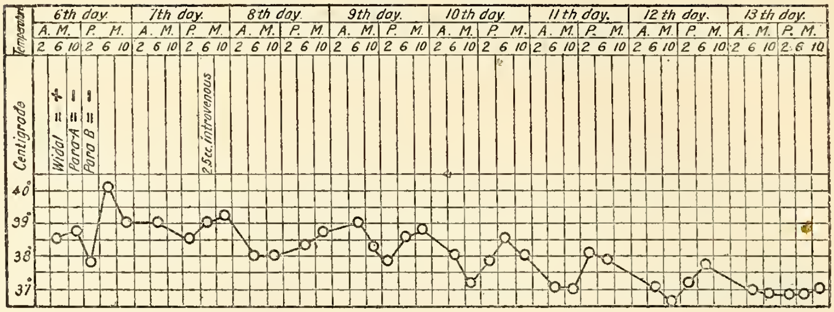

FIG. 10. Temperature chart of I. R. Showing benefited type of typhoid fever, treated with colloidal gold intravenously.

Symptomatology.—Letulle described the symptoms that appeared after the intravenous injection as consisting of a temporary rise in temperature preceded by chills, occurring from fifteen to forty minutes after injection, and followed by fall in temperature, sweats, general weakness, and alleviation of subjective symptoms. With my limited opportunities for observation, so far, I can only say that none of my cases developed chills. There is the possible exception of one patient who felt a slight sensation of chilliness, although his temperature showed a slight rise. Whether this difference of observation is due to racial insusceptibility of Filipino patients to the after effects of the treatment or whether the preparation on hand was defective are matters for future investigation.

Other symptoms observed were slight leucocytosis, temperature fall by lysis, remitting or intermitting temperature, and, rarely, fall by crisis. On the following day amelioration of the subjective symptoms may be marked.

Contraindications.—Letulle does not believe that delirium and high fever, tachycardia, small pulse, or albuminuria are contraindications for the intravenous injection. According to him the kidney continues to function well, for polyuria appears after injection. He observed neither intestinal hæmorrhage nor perforation.

It is not improbable that nephritis may be produced after a long-continued use of this preparation, because metals generally have an irritating effect upon the renal epithelium. This conception is supported by the experiment undertaken by Schöbl [1] in which he found marked nephritis in the kidneys of animals experimented upon with intravenous injection of colloidal silver preparation.

[1] Chief of the serum section of the Philippine Bureau of Science.

In conclusion, Letulle has stated that this preparation is antithermic, antitoxic, and without danger to the patient. He bases his conclusions on the disappearance of typhoid symptoms such as stupor, etc.

Complications.—The complications observed during the treatment are shown in Table XXII.

TABLE XXII.—*Complications before and during treatment.*

	Before treatment.	During treatment.
Lobar pneumonia	1	1
Intestinal hæmorrhage	0	[a] 2
Total	1	3

[a] One case developed two days after injection and the other six days after injection.

We see that there were three cases showing complications during the treatment, two of which were of intestinal hæmorrhage and one of lobar pneumonia. The fact that the cases of hæmorrhage did not appear early—that is, not until after two days following the injection—seems to show that the treatment did not induce this complication. The proportion of complications during the treatment of the series was found to be 20 per cent.

Mortality.—Out of fifteen cases in this series there were two deaths, a mortality rate of 13.3 per cent. Excluding one hopeless case, the mortality rate was 6.6 per cent. Autopsy findings of the two cases that were autopsied are shown as follows:

Autopsies (colloidal gold treatment).

File No. 2632: A. C.

Anatomic diagnosis: Lobar pneumonia; typhoid enteritis; parenchymatous degeneration of the viscera.

File No. 2603: H. G.

Anatomic diagnosis: Ulcerative enteritis, typhoid, healing; subacute splenitis; focal necrosis of the liver; chronic parenchymatous nephritis; chronic suppurative bronchitis; cloudy swelling of the liver and heart; trichuriasis; chronic pleurisy; emaciation.

Undoubtedly the two fatalities resulted from complications.

DISCUSSION

SPECIFICITY OF THE TREATMENT

Vaccine therapy has been studied extensively during recent years. The practical application of this biologic principle to the therapy of typhoid fever has its clue in the fundamental phenomena of Ehrlich's side-chain theory. The undoubted success of prophylactic vaccine seemingly has given rise to unrestrained enthusiasm on the part of early investigators and has lead them to advocate its use for therapeutic purposes. This treatment, therefore, is the outcome of conscientious study in immunology and it is not a surprise that its followers should approach the question from that point of view.

Early in the history of vaccine therapy, Jenner(16) discovered the efficacy of the treatment. Fraenkel(7) employed it therapeutically for typhoid fever with good results. Wright(50) has advocated and emphazied the specificity of its action. Waitzfelder(48) has advanced the view that the treatment is "logical, scientific, and exact. It measures up to and beyond the expectant plan of treatment, the one in present use, in that it reduces mortality and shortens the period of illness." Rodet(41) employed immune typhoid serum injected intravenously in typhoid cases with excellent results. Ichikawa(15) used the intravenous injection of living sensitized typhoid bacilli with excellent results. Gay(9) and Garbat(8) in using sensitized vaccine have upheld the specific theory.

Mechanism of cure.—To explain the exact mechanism of cure with this form of treatment is exceedingly difficult, if not impossible. However, the interpretation of the mechanism of the action of vaccine has been given most serious consideration by other investigators, who have advanced hypotheses which we may review.

Thus, Garbat(8) believes that the curative effect of vaccine is due to the production of antiendotoxins as the result of stimulation by endotoxins that had been liberated into the bloodstream after the complement in the blood had combined with the bacilli. Ichikawa,(15) on the other hand, is inclined to the supposition that in the case of intravenous injection followed by chill, rise of temperature, and then crisis, we have phenomena of anaphylaxis, followed by antianaphylaxis. Gay and Chickering(11) believe that the cure is due to specific hyperleucocytosis and increased formation of antibodies in the blood circulation. Koranyi(20) has observed increased opsonic index in the blood after vaccine injection.

NONSPECIFICITY OF THE TREATMENT

It is the tendency among workers along these lines to interpret the complex action of vaccine therapy through phases of immunology and the specificity of its action. The specific theory has been regarded by the dissenters as untenable.

Rumpf(43) observed very early the nonspecificity of the treatment. By injecting *Bacillus pyocyaneus* in typhoid he could procure results quite as favorable as those secured by Fraenkel after the injection of typhoid bacilli. Kraus(21) used colon vaccine intravenously in similar cases, and gained equally good results. On the other hand, Kraus(21) used typhoid vaccine in cases of puerperal infections with similarly beneficial results. Even Ichikawa(15) found that his paratyphoid patients were benefited by the injection of typhoid vaccine. Furthermore, I have observed that the use of intravenous injections of plain killed typhoid vaccine in any form of arthritis produced remarkable results in the majority of cases. This is in agreement with the observations of Miller(28) and Thomas.(47)

Ludke,(26) in accordance with his view that bacteria constitute nothing more than a foreign protein in the animal economy of the host, employed another kind of protein of nonbacterial origin. He used deutero-albumose in typhoid, also with good results. Miller and Lusk(29) used 1 to 2 cubic centimeters of a 4 per cent solution of proteose intravenously in typhoid and observed similarly good results; 20 per cent of their cases so injected recovered by crisis after a single injection. Nolf(36) noted beneficial results in the use of peptone solution, injected either intravenously or intramuscularly. Saxl(44) successfully treated typhoid patients by intramuscular injection of sterile milk. In this study both peptone solution and sterile milk have been used by me with success.

There is evidence, however, that foreign protein is not the only substance used successfully in combating the disease. Thus Letulle and Mage,(25) Gay,(10) and Labbe(23) employed colloidal-gold preparations with good results. In this investigation colloidal gold was also used, and satisfactory results were observed; as may be seen, 20 per cent of the cases in my series aborted. Mitlander(30) used salt solution intravenously in three hundred cases of typhoid fever, preceded intravenously by 1 cubic centimeter of 20 per cent caffein and 10 per cent camphor, and marked improvement followed.

Mechanism of cure.—Investigators in other fields have questioned the specificity of vaccine therapy, a claim which they declare to be without foundation. To attack a disease with its own weapon, so to speak, seems rather paradoxical. For, then, this question has been asked—and it still remains without a satisfactory answer: Are we justified, in acute infectious disease, in introducing in any manner into a host more of the same toxin from the effects of which he is already suffering? The view that there could be no possible stimulation of antibodies in a patient already suffering from acute infection with the typhoid organism has been given much thought in the effort to explain the mechanism of abortive cures, because it has been observed that there is no immediate change or increased concentration of antibodies in the patient after injection of vaccine.(18) In the case of pneumonia Cole,(4) at least, has not been able to produce immunity in animals rapidly enough to be of therapeutic value within six or seven days. The observations of other writers that there is a slight increase of Widal titer have been questioned on the ground that the Wright(28) opsonic index seems nowadays to be an unreliable guide, for the simple reason that the immunologist has no better method for determining immune body formation.

It has been observed in experimental work on animals that there is increased formation of nonspecific ferments, such as protease and lipase.(19) It is believed the protease has no action on bacteria, but that it hydrolyzes toxic protein into simpler and nontoxic substances, and that the lipase becomes lipoprotein against organisms in the final analysis. Whether the therapeutic application of other substances would mobilize the same nonspecific antiferments remains to be seen, although it is not improbable that such a thing may occur. That all improvements observed in bacteriotherapy might be wholly due to such specific action is, in my opinion, doubtful; because the frequent occurrence of relapses forms one of the objections to the belief that bacteriotherapy is specific.

Having set forth the two conflicting ideas in regard to the probable mechanism of cure, I am led to believe that the exact details of its mechanism are not fully known, and that in order to work out this problem a thorough coöperation between clinicians and laboratory workers is very necessary to allow justifiable interpretations of results.

Now, it might be asked, What form of therapy should be recommended in treating typhoid fever with the methods employed in this investigation? This is an exceedingly difficult, if not impossible, question to answer. It should be remembered that, in order to answer it satisfactorily, all the cases in each series should be placed under similar circumstances; that is, each series should consist of the same number of patients, who should be of the same sex and approximate age, and treatment should be administered simultaneously; the disease in each case should be of equal degree of severity and occur during the same period of epidemic, and the same season of the year. When a physician has the opportunity to handle a large number of cases at one time, and observe as closely as possible the factors enumerated above, then and only then will a definite statement seem warranted. When laboring as I have done, under unfavorable circumstances, in which many of the ideal and necessary factors could not be obtained, to recommend a particular treatment as being the best would be premature, and unfair both to the expounders of the several systems of therapy and to the treatment itself. There are, however, some clinical grounds for maintaining the view that any form of treatment will have beneficial effects, provided a moderate reaction can be produced.

Let me lay emphasis on the principle of the early application of the treatment. The patients respond better during the early stage of the disease. In advanced cases the treatment is seldom productive of good results.

SUMMARY AND CONCLUSIONS

For a period of seven months, extending from August, 1917, to February, 1918, ninety-eight cases of typhoid fever were admitted to the medical department in the Philippine General Hospital. Twenty additional cases were admitted during that period, but these were not included in the present paper, because they were already either convalescent or in a dying condition on admission. These ninety-eight cases were all Filipinos, sixty-five males and thirty-three females, ranging in age from 14 years up. The majority of the cases belonged to the working class and, as a rule, exhibited low powers of resistance, consequent on "their mode of life, under-development, and limited diet." The mortality rate in these ninety-eight cases is 19.38 per cent; but, excluding the hopeless cases, the death rate was 10.22 per cent.

These cases were classified according to their severity, the cases being grouped in series. Each series naturally comprised an unequal number of patients, was treated at different periods of the epidemic, and received different kinds of treatment.

The treatment of the cases has been carried under two general groups; namely, (*a*) treatment with foreign protein, which includes sensitized and nonsensitized vaccine, peptone, and milk; (*b*) treatment with colloidal preparation, such as colloidal gold.

Table XXIII shows graphically the comparative results of the different treatments.

TABLE XXIII.—*Comparative results of different treatments.*

Variety of treatment.	Mode of administration.	Patients.	Total average duration of disease.	Deaths.	
			Days.	*Number.*	*Per cent.*
Sensitized vaccine	Intramuscular	30	24.1	6	20
Classical	Control	21	27.7	5	23.8
Sensitized vaccine	Intramuscular	10	27.7	3	30
Nonsensitized vaccine	Intravenous	9	20.0	1	11.1
Peptone	Intramuscular	5	17.2	0	0
Milk	do	8	21.0	2	25
Colloidal gold	Intravenous	15	22.0	2	13.3
Total		98			

In the investigation here discussed I have employed some of the treatments that I believe are stamped with the march of progress. After conscientious deliberation of the observations gained, both from my limited personal experience and from the experiences of other investigators in this field, I am inclined to believe that the nonspecific theory with regard to the action of vaccine as used in this investigation seems plausible, but that the exact details of the mechanism of action of each kind of treatment administered is not yet fully understood. However, it has been observed that a moderate reaction, following the administration of any of the treatments discussed, produced beneficial effects.

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REFERENCES

1. BESREDKA. Cited by McWilliams (34).
2. CECIL, R. L. *Journ. Inf. Dis.* (1915), 16, 26.
3. CHAMBERLAIN, W. P. *Philip. Journ. Sci., Sec. B* (1911), 6, 317.
4. COLE, R. I. *Trans. Congr. Am. Phys. & Surg.* for 1916. The Tuttle, Morehouse and Taylor Co., New Haven, Conn. (1917), 10, 138.
5. CURSCHMANN, H. Nothnagel's Encyclopedia of Practical Medicine, edited with additions by W. Osler. W. B. Saunders Co., Philadelphia (1902), 383.
6. DITHORN and SCHULTZ. Cited by Jobling, Petersen and Eggstein (17).
7. FRAENKEL. Cited by Hektoen (13).
8. GARBAT, A. L. *Med. Rec.* (1916), 90, 1145.
9. GAY, F. P. *Journ. Lab. Clin. Med.* (1917), 2, 785.
10. IDEM. Cited by Gay (9).
11. GAY, F. P., and CHICKERING, H. T. *Arch. Int. Med.* (1916), 17, 303.
12. GUTIERREZ, P. *Philip. Journ. Sci., Sec. B* (1914), 9, 375.
13. HEKTOEN, L. *Trans. Congr. Am. Phys. & Surg.* for 1916, 10, 110.
14. HELMS, J. E. *Am. Med.* (1916), 22, 162.
15. ICHIKAWA. Cited by McWilliams (34).
16. JENNER. Cited by Helms (14).
17. JOBLING, J. W., PETERSEN, W., and EGGSTEIN, A. A. *Journ. Exp. Med.* (1915), 22, 603.
18. IDEM. *Journ. Am. Med. Assoc.* (1915), 65, 515.
19. IDEM. Ibid. (1916), 66, 1753.
20. KORANYI. Cited by Gay (9).
21. KRAUS. Cited by Jobling, Petersen and Eggstein (17).
22. KRUMBHAAR and RICHARDSON. Cited by Gay (9).
23. LABBE. Cited by Gay (9).
24. LEAKE, J. P. *Journ. Am. Med. Assoc.* (1917), 69, 631.
25. LETULLE, M. M., and MAGE, M. *Bull. Acad. Med.* (1914), 72, 42.
26. LUDKE. Cited by Miller (28).
27. METCHNIKOFF and BESREDKA. Cited by Gay and Chickering (11).
28. MILLER, J. L. *Journ. Am. Med. Assoc.* (1917), 69, 765.
29. MILLER, J. L., and LUSK, F. B. *Journ. Am. Med. Assoc.* (1916), 66, 1765.
30. MITLANDER. Abstracted in *Journ. Am. Med. Assoc.* (1916), 66, 1321.
31. MCCRAE, T. Osler's System of Medicine. Lea Brothers & Co., Philadelphia and New York (1907), 2, 207.
32. IDEM. Cited by Gay (9).
33. IDEM. Cited by Gay and Chickering (11).
34. MCWILLIAMS, H. I. Annual Report of the Health Officer of the Port of New York. Albany (1916), 98.
35. NICHOLS, H. J. *Journ. Exp. Med.* (1915), 22, 780.
36. NOLF, P. Abstracted in *Journ. Am. Med. Assoc.* (1917), 68, 1349.
37. OSLER, W. The Principles and Practice of Medicine. D. Appleton and Company, 8th ed. (1914), 38.
38. PETRUSCHY. Cited by Gay and Chickering (11).
39. QUADRONE. Cited by Gay and Chickering (11).

40. ROBERTSON, W. E. *N. Y. Med. Journ.* (1916), **103**, 777.
41. RODET, A., and LEGRIFFOUL. *Presse Medicale,* Paris (1910), **18**, 969.
42. ROGERS. Cited by Gutierrez (12).
43. RUMPF. Cited by Miller (28).
44. SAXL. Cited by Miller (28).
45. IDEM. Cited by Miller and Lusk (29).
46. SLADEK and KOTLOWSKY. Cited by Jobling, Petersen and Eggstein (17).
47. THOMAS, H. B. *Journ. Am. Med. Assoc.* (1917), **69**, 407.
48. WAITZFELDER, E. *N. Y. Med. Journ.* (1916), **103**, 407.
49. WHITTINGTON, T. H. *Lancet* (1916), **1**, 759.
50. WRIGHT. Cited by Jobling, Petersen and Eggstein (17).

ILLUSTRATIONS

TEXT FIGURES

THE VALIDITY OF THE NAME DISCOMYCES FOR THE GENUS OF FUNGI VARIOUSLY CALLED ACTINOMYCES, STREPTOTHRIX, AND NOCARDIA

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The nomenclature of the group of fungi the pathogenic members of which produce the various actinomycoses, so-called, has been the subject of a confusion that resulted from an unusual combination of circumstances. For some time it was a moot question whether the organisms were of bacterial or of fungous nature, in part because of erroneous conceptions of their morphology, which is complex and variable, and differs widely in different strains; even yet opinions differ as to whether or not the forms involved should be included in a single genus. One of the types, a saprophyte, *Streptothrix foersteri* Cohn, was for a time erroneously included in a genus of the higher bacteria, while the first pathogenic species described, *Actinomyces bovis* Harz, having been recognized as a fungus, was given a different generic name. The question was further complicated by the fact that both names had long before been employed for entirely different organisms. Since then some authors have held one invalid, some the other, and some have rejected both. Other names have been misapplied from time to time, while new ones have been proposed, the list now including a total of ten.

As is too frequently the case, the systematist and the pathologist have tended to ignore the work and the viewpoint of one another. Medical writers, who almost exclusively have been concerned with the study of these organisms and consequently the use of their names, have been very prone to choose these from the viewpoint of convenience and local custom rather than to recognize and adhere to the rules of nomenclature by which modern biologists are bound. On the other hand, botanists have overlooked or ignored—and they still do this—names and descriptions that have, in sincerity but without the formality customary with themselves, been published by medical writers. It is to consider the matter from both viewpoints in an effort to determine the actually correct designation that we have collaborated in a review of the vicissitudes of nomenclature that this group has undergone.

HISTORICAL

The phase of the confusion in which the characteristic of true branching in these organisms was not appreciated began in 1875, when Cohn (18) described, among others, two organisms that he made the types of new genera. One, which he named *Cladothrix dichotoma,* a colorless, filamentous plant found abundantly in water containing decomposing algæ, was characterized by a false branching that he compared to that of certain algæ; the other, which, apparently in ignorance of Corda's (19) previous use of the same generic name, he called *Streptothrix foersteri,* was a branching filamentous organism said to have been found first by Graefe and then by Foerster in concretions in the lachrymal canal of man and classified by Waldeyer as *Leptothrix buccalis.* Cohn did not accept this conclusion, the mode of branching suggesting the mycelium of fungi. It has been pointed out by Sauvageau and Radais (56) that the distinction between his *Cladothrix* and *Streptothrix* was so clear to Cohn that in the text he did not even compare them; furthermore, that his illustrations of them are quite distinct. They quote his diagnoses:

> *Cladothrix*—n. g. filamenta leptothricoidea tenerrima, achroa, non articulata, stricta vel subundulata, *pseudo-dichotoma.*
>
> *Streptothrix*—n. g. filamenta leptothricoidea tenerrima, achroa, non articulata vel anguste spiralia, *parce ramosa.*

In his summary, however, Cohn did not clearly differentiate them. According to Migula (44) he put them together among organisms showing false branching, although indicating uncertainty as to *Streptothrix* by an interrogation point:

> Zellfäden durch falsche Astbildung verzweigt.
> Fäden cylindrisch, farblos—*Cladothrix* Cohn.
> *Streptothrix?*

Cohn's later understanding of the morphology of the latter is evident from Israel's article cited below. However, it is hardly to be suspected from this arrangement that, as is now generally recognized, the dividing line between the higher bacteria and the lower fungi separates these two genera.

Bollinger, in 1876, demonstrated the fungous nature of the granules, or "drusen," from the lumpy jaw of cattle. Attempts at cultivation and inoculation had been without result. In the following year (10) he published a description in which he stated that Harz, to whom he had submitted fresh material, had concluded that the ray fungus (Strahlenpilz) belonged to the mold fungi and that it was related to *Botrytis, Monosporium,* and *Polyactis;* the name *Actinomyces bovis* was proposed for it.

Rivolta,(53) in 1878, changed the generic name to *Discomyces*. After amplifying the descriptions of the granules (corpuscoli discoidi) that he had made in 1868 and 1875, he said in part:

> E vero chi i corpuscoli discoidi compressi si risolvono in pennelli od in ventagli fatti di rami e ramoscelli, mar percio non si ponno dire *raggiati*. Questa parola in storia naturale ha un senso ben determinato. Il complesso dei dischi che ci rappresenta, se si voule, un micelio, non ha la forma raggiata, e per consequenza non si puo denominar raggiata o come venne detto *actinomyces*, e nemmeno si debbono indicare i danni o le lesioni che produce con la parola *actinomicosi*. Il solo nome conveniente, a mio avviso, sarebbe quello di *discomyces*[3] *bovis*, e con la parola *sarcomicosi* si potrebbero indicare le lesioni che produce vel corpo del bue.

Harz(28) then published a separate description of the fungus, rejecting Rivolta's change.

Israel,(29) in 1878, used *Actinomyces*, but called attention to the similarity between the organism found in lesions in man and Cohn's *Streptothrix foersteri*, a resemblance which, he said, Cohn himself had confirmed. Perroncito,(49) although himself employing *Actinomyces*, quoted a communication from Professor Garovaglio, director of the Cryptogamic Laboratories of the University of Padua, in which its previous use by Meyen(42) was noted.

Rivolta(54) later declared that he was willing to accept *Actinomyces bovis*, but added that one could, nevertheless, form a group of pathogenic discomycetes containing: (1) *Actinomyces bovis* Harz; (2) *Discomyces pleuriticus canis familiaris* Rivolta; and (3) *Discomyces equi* Rivolta and Micellone. The second is now *Cladothrix canis* Rabe. (1898), and the third is known as a *Micrococcus* (*M. botryogenes* Rabe., *M. ascoformans* Johne, etc.). The first is, therefore, the only one of these organisms remaining in Rivolta's genus, as thus amplified by him, and is the type of the genus, both as originally published and as later amplified.

During this period systematists, who placed these organisms among the bacteria, denied the generic validity of Cohn's *Streptothrix*. Winter,(61) Zopf,(63) Schröter,(58) and Baumgarten(5) considered it to be a synonym of *Cladothrix*. Schröter included, in the same family, the genus *Actinomyces*, this being apparently the first recognition of Harz's organism in systematic classification. Baumgarten concluded that the ray fungi belonged among the pleomorphic higher bacteria in the genus *Cladothrix*. MacFadyean(39) agreed that the organisms of actinomycosis probably belonged to the Schizomycetes; he held that the occurrence of clublike elements in the granules was not of specific value because inconstantly formed.

Macé(37) also confused the genera, but in a new fashion. In 1888 he erroneously described for *Cladothrix dichotoma* a process of true branching and adopted(38) this generic name for the ray-fungus group. Sauvageau and Radais hold that he had never had the true *Cladothrix* under observation.

Affanassiew(1) at first called the organism of actinomycosis *Bacterium actinocladothrix,* but in the following year, 1889, Affanassiew and Schulz(2) gave the term *Actinocladothrix* generic rank. The only evidence that we have encountered of the use of this name by anyone else is the mention, without reference, of *"Actinocladothrix nocardi,"* in an article by Haass.(27)

De Toni and Trevisan, in Saccardo's Sylloge Fungorum,(20) accepted these organisms as belonging to the Schizomycetaceæ. In the Cladothriceæ: "Sporae (arthrosporae) in filamentis normalibus obvenientes. Filamenta pseudo-ramosa" they included *Sphaerotilus, Cladothrix,* and a genus that they called *Nocardia* Trevisan: "Filamenta evaginata. Arthrosporae transformatione cocci singuli ortae." In this genus they included *Streptothrix* Cohn, non Corda; *Actinomyces* Harz, non Meyen; and *Discomyces* Rivolta, five species being defined. The description of these organisms as falsely branching was, of course, erroneous.

In 1890 Almquist(3) and Gasperini(23) described certain organisms that they identified as species of Cohn's *Streptothrix.* Kruse held that these species fell, with the organism of actinomycosis, into Zopf's *Cladothrix* group. Rossi-Doria (55) soon described six new species of *Streptothrix* from the air and classed *Actinomyces bovis* Harz, which he is said to have renamed *Streptothrix actinomyces,* with them. Kruse(31) later also employed *Streptothrix,* differentiating it from *Cladothrix.*

From cases of actinomycosis in man Bostroem(11) repeatedly cultivated an organism that differed distinctly from that cultivated by Israel. He concluded that it belonged to the *Cladothrix* group of the Schizomycetes and pointed out that it might be related to, or even identical with, *Streptothrix foersteri* Cohn.

Grüber,(26) in 1891, described as *Micromyces hofmanni* an organism that subsequent authors have included in the group under discussion.

Sauvageau and Radais's(56) discussion of the confusion of Cohn's *Cladothrix* and *Streptothrix* has been referred to. They believed that the two were distinct; that *Cladothrix,* the most differentiated of the Bacteriaceæ, was falsely branched; and that *Streptothrix,* a true though very low hyphomycetous fungus, to which the organism of actinomycosis belonged, showed true branching. They concluded that the latter really belonged to *Oospora* Wallroth (1831), but that, whether or not this was correct, it was necessary to discard *Streptothrix* Cohn because of Corda's use of this name in 1839. De Toni and Trevisan's description of *Nocardia* as falsely branching was incorrect, for although Nocard(47) had originally so described his "Bacille de farcin," Metchinkoff had found that it was a true-branching organism. Kanthack(30) accepted *Oospora* and created the name *Oospora indica* for the parasite of Madura disease, having demonstrated the identity of actinomycosis and of certain mycetomas. Lehmann and Neumann,(33) in 1896, introduced Mycobacterium as a family name for a group that they considered intermediate between the Hyphomycetes and the Schizomycetes, but rather more closely related to the former, and at first adopted *Oospora* as the generic name for the organisms under discussion.

Gasperini,(24) in 1894, proposed the use of *Actinomyces* to include the whole group, discarding *Streptothrix;* he listed eighteen species. Berestnew,(6) in 1897, accepted *Actinomyces* as valid and later(7) called attention to Gasperini's publication, which apparently had been overlooked. Lachner-Sandoval,(32) in 1898, pointed out the invalidity of *Oospora* in this connection and also adopted *Actinomyces.* Levy(34) reviewed the question, concluding that all the described types were generically related and that *Actinomyces* was the proper designation for them. He did not note Rivolta's original application of *Discomyces.* Lehmann and Neumann, in the second (1899) edition of their work, substituted the family name Actinomycetes Lachner-Sandoval for their own Mycobacterium, the pathogenic forms placed in the genus *Oospora* now becoming *Actinomyces.* This broader application of the term to the entire group is not now widely accepted, though Mallory,(40) after Gasperini, employed it tentatively, and Babes(4) and other German authors still use it.

Migula, in his earlier (1895) classification,(43) included these organisms among the higher bacteria, in his family Chlamydobacteriaceæ. He separated *Streptothrix* Cohn from *Cladothrix,* giving it a much modified diagnosis. In *Cladothrix* Cohn he included *C. bovis* (Harz) Migula (*Actinomyces bovis* Harz) and *C. foersteri* (Cohn) Schröter (*Streptothrix foersteri* Cohn), thus perpetuating the error of the earlier systematists. As already noted, Macé had adopted this generic name, although from a different viewpoint. Later(45) Migula modified this genus radically, removing those species that are now recognized to belong to the fungi.

Engler, in his Syllabus,(21) included Harz's organism in the genus *Sphaerotilus* as "*Sph. (Actinomyces) bovis,*" thus adding a new name to the list of synonyms. He had not revised this grouping in the fifth (1907) edition.

Discomyces Rivolta was shown to be the correct designation for the genus by Blanchard(9) who, stimulated by Levy's and Berestnew's articles, reviewed the question of nomenclature. In adopting this term he had changed his earlier opinion, for he had previously(8) employed *Nocardia.* His argument is based on accepted principles and should carry conviction. Previous to this the term had been practically ignored. It is true that Sheube(57) cites Nocard and then Blanchard as having advocated this term for *Discomyces (Streptothrix) indica,* but we have been unable to find any publication by Nocard in which it is used; on the other hand, in the third (1903) edition of Nocard and le Clainche's Maladies Microbiennes des Animaux,(48) *Actinomyces* is used in connection with actinomycosis and *Streptothrix* with "farcin du boeuf." Gedoelst(25) evidently accepted Blanchard's decision, for he designated the genus *Discomyces* Rivolta 1878, and the organism of actinomycosis *Discomyces bovis* (Harz 1877) Rivolta 1878. Stitt(59) is apparently the only American authority who has adopted this name. Brumpt(12) in a discussion of the mycetomas, used *Discomyces* and still subscribes to it, for in discussing organisms presented in 1913 by Pinoy(51) to the Société de Pathologie exotique (Paris) as *Nocardia* he used the former rather than the latter term. Manson,(41) in subscribing to Brumpt's classification of the mycetomas, also used the same nomenclature. Castellani and Chalmers(13) employed *Discomyces* in 1910, although they later discarded it.

A new name was introduced by Lignières and Spitz,(35) who called a subtype of this group *Actinobacillus.* In a later article(36) they acknowledged the strict propriety of Blanchard's argument in regard to the application of *Discomyces* to the general group, although they continued to use *Streptothrix.*

During this period certain German authors had adopted *Actinomyces* and *Streptothrix* as separate genera. This is exemplified by Petrusky's(50) classification in which they are placed in a family which he terms Trichomycetes. Wright(62) believed that *Actinomyces* should be retained for the organism of actinomycosis, which he emphatically maintained should be differentiated generically from other organisms of the group. He rejected de Toni and Trevisan's objection that Meyen had given the name to another organism as an unreasonably strict interpretation of the principles of botanical nomenclature. On the other hand, for the rest of the group he rejected *Streptothrix* and accepted *Nocardia*. This subdivision of the group has been adopted in several American bacteriological textbooks. However, Chester (16) adopted the first classification of Lehmann and Neumann, except that *Oospora* was replaced by *Streptothrix* Cohn. Clements (17) included these organisms among the Schizomycetes; he followed Migula's earlier classification, except that *Nocardia* was substituted for *Streptothrix* Cohn, emend. Mig.

Foulerton (22) argued that, since the other names that had been proposed had dropped out of use, only *Streptothrix* and *Actinomyces* remained to be considered. He chose the former because, although Corda had used it in 1834, it had become uncertain to what particular organism the term had been applied; further, a committee of the Pathological Society of London in 1899 had recommended the term "streptotricosis" as the appropriate clinical designation for the infection. Musgrave and Clegg (46) acknowledged that *Nocardia* was probably more strictly correct, but "chiefly because of usage, and therefore somewhat arbitrarily, tentatively accepted *Streptothrix* * * *." They suggested the possible advantage of substituting an entirely new name, *Carteria* (*Carterii*, sic!), evidently hoping that by this means further controversy might be eliminated.

Pinoy has divided the group into *Nocardia*, which is to include most of the species, and *Cohnistreptothrix*, said to be designed to replace Cohn's invalid *Streptothrix*. The article that contains his argument is probably one by Pinoy and Morax, (52) which is not available to us. According to Chalmers and Christopherson (15) the characteristics of this genus are preference for anaërobiosis, difficulty of cultivation, and nonproduction of arthrospores; in it they include Cohn's *Streptothrix foersteri* and Israel's *Actinomyces* from man (*Streptothrix israeli* Kruse, 1896).

Vuillemin, (60) as a result of the adoption by the 1910 meeting of the International Botanical Congress at Brussels of a program for the next congress that included the determination of the point of departure for the nomenclature of the Schizomycetes and the elaboration of lists of *nomina conservanda* for these organisms, has recently published a revised generic classification, which was intended to be submitted for consideration at the scheduled London (1915) meeting of the congress. In an appendix to this work he includes the family Microsiphones, composed of genera to certain of which organisms such as the "bacillus" of tuberculosis and the "bacillus" of diphtheria are assigned. For the genus under discussion he adopts *Nocardia* Trevisan, which he recommends for inclusion in the list of *nomina conservanda*. He says, in effect, that systematic botany need not concern itself with the "medical genus" *Discomyces*, in which Rivolta combined, without mycological significance, the parasites of actinomycosis, botryomycosis, and canine pleurisy, nor with the genus *Cohnistreptothrix*, founded by Pinoy upon bacteriological grounds, and that *Nocardia* remains the valid name for the genus. As the Congress did not meet in 1915, Vuillemin's recommendations have not yet been acted upon.

Castellani and Chalmers have substituted, without discussion, *Nocardia* for *Discomyces* in the second edition of their work.(14) They remark that there are many points in favor of Pinoy's subdivision of the genus, which probably would be soon generally accepted.

The most recent discussion of this question is in a study of actinomycotic mycetoma by Chalmers and Christopherson,(15) who enumerate sixty-three species of *Nocardia* and eleven of *Cohnistreptothrix*. They argue the validity of *Nocardia* on the grounds: (1) that it is the oldest name against which no objections can be raised; (2) that it has been formally adopted by the Botanical Section of the First International Congress of Pathology;[1] (3) that there are objections to the other names in use. They eliminate *Discomyces*, because:

> *Discomyces* was used by Rivolta in 1878 merely as a trivial name, and though it has not been applied to any other genus, still the word *Discomycetaceae* was introduced in 1836 by Fries for a large fungal group and has come into general use, and therefore has the double claim of priority and general use, and as its type genus should bear the name *Discomyces*, confusion is bound to arise if the same term is retained for the generic name of Bollinger's organism.

The value of these objections will not be discussed at this point.

SUMMARY

The source and present status of the various names that have been applied to the organisms of this group may be summarized as follows:

Cladothrix Cohn (1875). This name was used as generically

[1] This probably refers to the Congrès international de pathologie comparée, organized by the Société de pathologie comparée, the first and as yet only meeting of which was held at the Faculty of Medicine, University of Paris, in 1912.

valid over *Streptothrix* Cohn (1875) by Winter (1884) and other systematists, the distinction not being understood. The organism of actinomycosis was informally assigned to this genus by Bostroem, Baumgarten, and others, formally by Migula (1895). *Cladothrix* Cohn is a different type of organism and the name is, therefore, inapplicable.

Streptothrix Cohn (1875), non Corda (1839). This name was applied by Cohn to a true-branching organism but was placed in his classification as doubtfully synonymous with *Cladothrix*. The resemblance of the fungus of actinomycosis in man to it was noted by Israel (1878) ; the name was adopted in 1890 by Almquist and by Gasperini for nonpathogenic air organisms, and in 1891 it was adopted by Rossi-Doria for that of actinomycosis.

For a time this was probably the most widely used name for the group. At present it is frequently applied to the group minus the organism of actinomycosis. It is unquestionably invalid in either connection because previously applied by Corda (1839) to an organism distinct from those under consideration.

Actinomyces Harz (1877) non *Actinomyce* Meyen (1827). This name was applied by Harz to the fungus of "lumpy jaw" of cattle, by Gasperini (1894) to the entire group, replacing *Streptothrix*, and accepted in this application by Berestnew (1897), Lachner-Sandoval (1898), and others.

It is now used by many writers, particularly the German and the American, as a valid name for the organism of actinomycosis only; it is seldom used in the more general sense. As is shown below, this name is invalid because published in connection with an entirely different organism by Meyen (1827).

Bacterium Ehrenberg 1830. Affanassiew (1888) is said for a time to have called the organism of actinomycosis *Bacterium actinocladothrix*. This designation is manifestly inapplicable.

Actinocladothrix Affanassiew and Schultz (1889). This was proposed as a generic name by Affanassiew and Schultz in 1889 for the organism of actinomycosis. It did not receive the consideration to which, being of even date with the widely adopted *Nocardia*, it was certainly entitled.

Micromyces Grüber (1891). This name was applied by Grüber to an *Actinomyces*-like organism that he called *M. hofmanni*. This organism cannot be distinguished from the general group under consideration.

Oospora Wallroth (1833). This was adopted by Sauvageau and Radais (1892), who concluded that the group belonged to Wallroth's genus. Lehmann and Neumann (1896) adopted this view, but later abandoned it, Lachner and Sandoval (1898) having shown that *Oospora* Wallroth is an organism entirely different from those under discussion.

Sphaerotilus Kuetz. (1883). This name was adopted by Engler for the group including *Cladothrix (Streptothrix) foersteri* Cohn, with which he included *Actinomyces bovis* Harz. This disposition was undoubtedly due to the old misapprehension as to the distinction between *Cladothrix* and *Streptothrix.*

Actinobacillus Lignières and Spitz (1902). This name was applied by Lignières and Spitz to a supposed subtype of this group. The distinction has not been recognized, and by most authors the name is considered a synonym.

Carteria Musgrave and Clegg (1908). The adoption of this new name (as "Carterii") was tentatively suggested by Musgrave and Clegg as possibly advantageous for the purpose of avoiding further controversy, although they did not definitely advocate this highly informal procedure.

Nocardia Trevisan (1889). This name was adopted by de Toni and Trevisan to cover the entire group. Blanchard used it for a time in its original application and Wright (1894) adopted it for nonpathogenic strains only. As many other authors use it in one sense or another, of late it has gained much prestige. Vuillemin, and Chalmers and Christopherson have recently adopted it for the entire genus.

The validity of this name we deny on the grounds indicated in the discussion that follows.

Discomyces Rivolta (1878). This name was definitely substituted by Rivolta for *Actinomyces,* with the change of name of Bollinger's fungus to *Discomyces bovis.* It was practically ignored until Blanchard (1900) argued its priority over *Nocardia.* Subsequently Gedoelst, Brumpt, Manson, Stitt, and for a time Castellani and Chalmers, adopted it.

As indicated in the discussion this name is clearly valid over *Actinomyces* and all subsequent names.

DISCUSSION

Before considering the validity of *Discomyces* for this group over *Nocardia* and *Actinocladothrix,* it is necessary to emphasize the invalidity of two older terms that have gained general recognition.

Streptothrix Cohn (1875) is invalidated by *Streptothrix* Corda (1839). It has been argued that there is doubt as to what organism is referred to by Corda's name. This is apparently not the case for in recent years several new species have been described in Corda's genus. *Streptothrix* Corda is unquestionably a valid, recognized genus, and *Streptothrix* Cohn must fall.

Actinomyces was used by Harz with but a very limited knowledge of the organism to which he applied it, evidently without suspecting its possible relationship to Cohn's *Streptothrix foersteri* and probably without being aware of Meyen's use of the name. Whether or not this newer application is valid, as most writers seem at least tacitly to agree, depends on the validity of its preëmption by Meyen. That it is valid is evident from the following transcription from the original publication:

Actinomyce

Sporidochia, cellulis hyalinis simplicibus enormiter et multipliciter ramificantibus sporis impletis, substantiae uniformi gelatinosa hyalina induta.

Actinomyce Horkelii

R. forma irregulari sphaeroidea, gelatinosa duritie ad basin augente usque ad consistentiam cartilaginosam, colore hyalino-subcoeruleo. Hab. in pinguedine et pleuris animalium aquae submersis, autumno prope Coloniam Agrippinam.

Zum Schlusse wage ich noch, etwas über das beginnende Wachsthum dieses Pilzes zu sagen. Der Pilz ist nicht eine Krankheitsform eines Organismus, sondern er ist ein eigener Organismus, ein eigenes Leben unabhängig von seinem Mutterboden, aber dennoch von demselben beschränkt.

It is to be noted that Meyen used the name *Actinomyce*. While by some the use of this form might conceivably be argued not to invalidate *Actinomyces*, the derivation of the two is identical, and the argument cannot hold. *Actinomyce horkelii* Meyen is now an organism of uncertain status. Although it was described by Meyen as a fungus, the description apparently applies to one of the colonial Cyanophyceæ. The genus is not recognized in either mycological or algological literature. However, the description of both the genus and the species is indisputably valid, and in the present connection the question of its identity is unimportant. In being validly published, it invalidates the further use of the same name for another group of organisms in the plant kingdom.

From the foregoing it is evident that by the accepted principles of botanical nomenclature both of these names are preoccupied. To deny on this ground either of them and yet accept the other, as has been done, is inconsistent. Recommendation of "streptotricosis" by a committee of the Pathological Society of London cannot be accepted as competent to validate *Streptothrix*, nor can the adoption by the Botanical Section of the First International Congress of Pathology validate *Nocardia*. It is true that through formal adoption by the proper bodies *nomina conservanda* are validated; however, neither of the societies mentioned has authority to do this in botany.

There remains to be considered, then, the name next applied to this genus. This was published by Rivolta, in 1878, when he proposed, definitely and distinctly, to substitute *Discomyces* for *Actinomyces*.[2] The reason for which he did this is an invalid one; he believed that *Actinomyces* was not properly descriptive of the organism and, unhampered by rules of nomenclature, adopted *Discomyces* as preferable in this respect. He was undoubtedly not aware of the fact that the former had been used before, but it is on this ground rather than that on which he advanced his new name that *Discomyces* is valid.

Vuillemin, and more recently Chalmers and Christopherson, in advocating *Nocardia* as the valid generic name, hold that Rivolta's use of *Discomyces* was trivial and without botanical significance. We do not agree with this argument, which is clearly refuted by Rivolta's original paper. Here he distinctly proposes *Discomyces bovis* as the name for the organism called *Actinomyces bovis* by Harz in a manner that must be acknowledged as valid from the viewpoint of botany, even though it is not in conventional form and was advocated on irrelevant, inadequate grounds. Therefore, it is in no sense a "medical genus," as Vuillemin asserts. The fact that subsequently Rivolta erroneously referred other organisms to this genus has no bearing on the case. His original application of it was to the organism of Bollinger and Harz alone, which is, therefore, the type of the genus. Nor does the fact that, to propitiate Harz, Rivolta later agreed to accept *Actinomyces* affect the question. As Blanchard pointed out, a name once introduced

[2] The definite manner in which this substitution was made has been generally ignored, possibly because of the inaccessibility of the original paper, it having been published in an Italian veterinary journal. The rarity of this publication is exemplified by the difficulty that we have had in consulting it. The 1878 volume of Clinica Veterinaria was found to be missing from the set of this periodical in the Surgeon-General's library in Washington, whereupon Mr. P. L. Ricker, of the United States Department of Agriculture, to whom we had applied, requested it from Mr. B. B. Woodward, librarian of the British Museum. He, not finding the publication in that library, forwarded the request to Mr. F. Bullock, of the Royal College of Veterinary Surgeons, through whose kindness a separate of Rivolta's article was forwarded to Washington, where photostat reproductions were made, one of which Mr. Ricker forwarded to us. To these gentleman we express our appreciation.

is no longer the property of its originator to withdraw or modify at will.

Finally, to argue, as do Chalmers and Christopherson, that Discomycetaceæ, a group name, invalidates *Discomyces* as a generic name in the connection in which Rivolta used it, on the ground that the type genus of Fries's Discomycetaceæ, published in 1836, should bear the designation *Discomyces*, indicates an erroneous conception of the principles of nomenclature and priority in technical names; a family name such as Discomycetaceæ cannot invalidate the generic name *Discomyces* any more than a generic name can invalidate a similar specific name. This generic name was new with Rivolta, and there is no valid objection to its adoption in taxonomy.

Nocardia is no longer to be considered. Both it and *Actinocladothrix* of Affanassiew and Schultz, the publication of which seems to have been completely ignored, were proposed eleven years later and fall as synonyms of *Discomyces* Rivolta (1878), which genus is typified by *Discomyces bovis* (Harz) Rivolta.

The question of division of the group is a different matter. It is our conception that the group, exhibiting as it does wide differences among the species, should be subdivided. However, neither the characters upon which separation was advocated by earlier writers (granule formation in tissues, club-ended filaments in the granules), nor those advanced by Pinoy (difficulty of cultivation, anaërobiosis, absence of arthrospores), seem to be convincing for generic distinction. Granules may be formed in animal lesions by a variety of these organisms, and club formation is a variable feature even in typical actinomycosis. Anaërobiosis and difficulty of cultivation are not generically distinctive botanically, nor so considered for other groups of microörganisms from the bacteriological viewpoint. Furthermore, these features characterize both the strains described by Israel and those studied by Wright. Should it appear desirable to divide the genus, this will probably be done on the basis of morphologic rather than metabolic differences.

REFERENCES

(1) AFFANASSIEW. *St. Petersb. med. Wochenschr.* (1888), **13**, 76 and 83. Cited by Blanchard (1910).

(2) AFFANASSIEW and SCHULTZ. Third Congress of Russian Physicians, St. Petersburg, Subsection for Bacteriology. Ref.: *Centralbl. f. Bakt.*, etc., 1. Abt. (1889), **5**, 683; also *Baumgarten's Jahresber.* (1889), **5**, 398.

(3) ALMQUIST, E. *Zeitschr. f. Hyg.* (1890), **8**, 189.

(4) BABES. In Kolle and Wassermann's Handbuch der pathogenen Mikroorganismen. 2d ed. Jena (1913), **5**, 365.
(5) BAUMGARTEN, P. Lehrbuch der pathogenischen Mykologie. Braunschweig (1886–1890), **2**, 869.
(6) BERESTNEW. Aktinomykose und ihre Erreger. (Diss.) Moskau (1897). Ref.: *Centralbl. f. Bakt.*, etc., 1. Abt. (1898), **24**, 706.
(7) IDEM. *Centralbl. f. Bakt.*, etc., 1. Abt. (1899), **26**, 390.
(8) BLANCHARD, R. In Bouchard's Traité de Pathologie générale (1895), **2**, 649–932. Cited by Brumpt.
(9) IDEM. *Arch. parasit.* (1900), **3**, 193.
(10) BOLLINGER, O. *Centralbl. f. d. med. Wiss.* (1877), **15**, 481; and *Deutsche Zeitschr. f. Thiermed. u. vergl. Path.* (1877), **3**, 334.
(11) BOSTROEM. *Beit. z. path. Anat. u. z. allg. Path.* (1891), **9**, 1.
(12) BRUMPT, E. *Arch. parasit.* (1906), **10**, 489.
(13) CASTELLANI, A., and CHALMERS, A. J. Manual of Tropical Medicine. London (1910), 615.
(14) IDEM. Ibid., 2d ed. (1913), 812.
(15) CHALMERS, A. J., and CHRISTOPHERSON, J. B. *Ann. Trop. Med. & Parasit.* (1916), **10**, 223.
(16) CHESTER, F. D. A Manual of Determinative Bacteriology. New York (1901), 360.
(17) CLEMENTS, F. E. The Genera of Fungi. Minneapolis (1909), 7.
(18) COHN, F. Untersuchungen über Bakterien, II, Beit. z. Biol. d. Pflanzen, Bd. I. Breslau (1875). Quoted by Migula and others.
(19) CORDA, A. C. J. Pracht-Flora europaeischer Schimmelbildungen. Leipzig and Dresden (1839), 23. Cited by Saccardo, Sylloge Fungorum (1886), **4**, 282, and others.
(20) DE TONI, J. B., and TREVISAN, V. In Saccardo, P. A., Sylloge Fungorum (1889), **8**, 927.
(21) ENGLER, A. Syllabus der Pflanzenfamilien. 3d ed. Berlin (1903), 5.
(22) FOULERTON, A. G. R. In Allbutt and Rolleston's System of Medicine (1906), **2**, pt. 1, 302.
(23) GASPERINI, G. *Ann. de microgr.* (1890), **2**, 449. Ref.: *Centralbl. f. Bakt.*, etc., 1. Abt. (1891), **9**, 59.
(24) IDEM. Proc. Eleventh Internat. Cong. of Med. Rome. Ref.: *Centralbl. f. Bakt.*, etc., 1. Abt. (1894), **15**, 683.
(25) GEDOELST, W. Les Champignons Parasites de l'Homme et des Animaux Domestiques. Lierre and Bruxelles (1902), 155.
(26) GRÜBER, M. Trans. VIIth Internat. Cong. of Hyg. and Demog. London (1891); Section II, Bacteriology (1892), **2**, 65. Also Ref.: *Münch. med. Wochenschr.* (1891), **37**, 653.
(27) HAASS, E. *Centralbl. f. Bakt.*, etc., 1. Abt. (1906), **40**, 180.
(28) HARZ, O. C. *Jahresber. d. k. Centr.-Thierarzneischule z. München* (1879), 125. Ref.: *Jahresber. d. gesam. med.* (1879), **1**, 627.
(29) ISRAEL, J. *Virch. Arch.* (1878), **74**, 15.
(30) KANTHACK, A. A. *Journ. Path. & Bact.* (1893), **1**, 140.
(31) KRUSE, W. In Flugge's Mikroorganismen. 3d ed. (1896), 48.
(32) LACHNER-SANDOVAL. Ueber Strahlenpilze. Eine bacteriologische-botanische Untersuchung. (Diss.) Strasbourg (1898). Cited by Blanchard (1900), and others.

(33) LEHMANN, K. B., and NEUMANN, R. O. Atlas und Grundriss der Bakteriologie und Lehrbuch der speciellen bacteriologischen Diagnostik. München, 1. Auf. (1896), Teil II.

(34) LEVY, E. *Centralbl. f. Bakt.*, etc., 1. Abt. (1899), 26, 1.

(35) LIGNIÈRES, J., and SPITZ, G. *Bull. Soc. centr. Méd. veter.* (1902), 487. Ref.: *Centralbl. f. Bakt.*, etc. Ref. (1902), 32, 781.

(36) IDEM. *Centralbl. f. Bakt.*, etc. Orig. (1904), 35, 294, and 452.

(37) MACÉ, E. *Compt. rend. Acad. Sci.* (1888), 106, 1622.

(38) IDEM. Traité pratique de Bactériologie. Paris (1889). Cited by Sauvageau and Radais.

(39) MACFADYEAN, J. *Brit. Med. Journ.* (1889), 1, 1339.

(40) MALLORY, F. B. *Bost. Med. & Surg. Journ.* (1895), 132, 296.

(41) MANSON, P. Tropical Diseases. 4th ed. New York (1907), 759.

(42) MEYEN, J. Linnaea (1827), 2, 441.

(43) MIGULA, W. In Engler and Prantl, Die natürlichen Pflanzenfamilien. Leipzig, Teil I, Abt. 1a, (1895), 1.

(44) IDEM. System der Bakterien. Jena (1896), 1, 21 et seq.

(45) IDEM. Ibid. (1900), 2, 1033.

(46) MUSGRAVE, W. E., and CLEGG, M. T. *Philip. Journ. Sci., Sec. B* (1908), 3, 470.

(47) NOCARD, E. *Ann. Inst. Past.* (1888), 2, 293.

(48) NOCARD, E., and LE CLAINCHE, E. Les Maladies microbiennes des Animaux. 3d ed. Paris (1903), 2.

(49) PERRONCITO, E. *Deutsche Zeitschr. f. Thiermed. u. vergl. Path.* (1879), 5, 33.

(50) PETRUSKY. In Kolle and Wassermann's Handbuch der pathogenen Mikroorganismen. Jena (1903), 2, 832; and ibid., 2d ed. (1913), 5, 267.

(51) PINOY, E. *Bull. Inst. Past.* (1913), 11, 927 and 977.

(52) PINOY and MORAX. *Bull. Soc. Ophthalmol. Paris* (1911), No. 3. Cited by Pinoy (1913).

(53) RIVOLTA, S. *Clinica Veterinaria* (1878), 204 (Nos. 7, 8, and 9). Also abstracted and discussed by Bollinger in *Deutsche Zeitschr. f. Thiermed. u. vergl. Path.* (1879), 5, 110. Also quoted by Blanchard (1900).

(54) IDEM. *Giornale Anat. Fisiol. e Patol.* (1884), 16. Cited by Blanchard (1900).

(55) ROSSI-DORIA, T. *Ann. R. Univ. Roma* (1891), 1, 399. Ref.: *Baumgarten's Jahresb.* (1891), 7, 348.

(56) SAUVAGEAU, C., and RADAIS, M. *Ann. Inst. Past.* (1892), 6, 242.

(57) SCHEUBE, B. Die Krankheiten der warmen Länder. Jena (1900), 625.

(58) SCHRÖTER. Die Pilze, Bd. III. In Kryptogamenflora von Schlesien. Bakterien (1886). Quoted by Migula (1896), 1, 30.

(59) STITT, E. R. Practical Bacteriology, Blood Work and Animal Parasitology. 4th ed. Philadelphia (1918), 158.

(60) VUILLEMIN, P. *Ann. Mycolog.* (1913), 11, 512.

(61) WINTER, G. In Rabenhort's Kryptogamen-Flora von Deutschland, etc., Die Pilze. Leipzig (1884), 1, 1 Abt., 38.

(62) WRIGHT, J. H. *Journ. Med. Res.* (1904), 13, 349.

(63) ZOPF. Die Bakterien. 1. Aufl. (1884); 2. Aufl. (1885). Quoted by Migula (1896), 1, 26.

IONTHA IDA, A NEW PHILIPPINE NOCTUID

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ONE PLATE

LEPIDOPTERA: HETEROCERA

NOCTUIDÆ

QUADRIFINÆ[2]

Genus IONTHA Doubleday[2]

Iontha ida sp. nov.

Male.—Head dark brown; eyes nearly black; apical segment of palpus ringed with ochraceous scales at middle, antennæ reddish; body and wings dorsad and ventrad a faded, dark, yellowish brown, the wings above darker apicad and highly bronze-iridescent; a darker reniform, median, subcostal spot on fore wing circumscribed by a very few heliotrope scales and punctured centrad by one or two ochraceous scales; a faint brown zigzag line connects it with caudal margin, at which point is a very tiny patch of heliotrope scales; a dark brown dot, similarly circumscribed, five-eighths of the distance from base of wing to reniform spot; a submarginal row of six dark brown dots from apex to anal angle on outer margin. Each of these dots lies within an area of diffused heliotrope scales forming more or less of a circle around the individual spot but all running together to form an indistinct marginal band; ectad of this a thin, dark brown wavy line; marginal cilia alternately white and brown, the white being subjacent to the respective submarginal dots. Hind wings with a similar pale heliotrope band containing about five distinct, dark brown dots, almost obsolete at outer angle but growing more marked toward anal angle, which is much produced and lobed laterad and somewhat recurved (See Plate I, fig. 1). Fore wings ventrad uniformly brown, irrorated with heliotrope on apical area and with a

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[2] *The Entomologist* (1842), 298, 1 figure.

subcostal, ill-defined, darker brown, transverse spot beyond median area; marginal cilia as on dorsal surface. Hind wings ventrad slightly darker iridescent brown, strongly irrorated with heliotrope scales over costal and outer areas and with a row of linear, heliotrope dots extending from costa obliquely across the cephalic two-thirds of wing to a line from base to anal lobe. Of these dots the costal is most prominent and almost white. These dots have faint counterparts on the dorsal surface but the latter extend farther toward inner margin, which is heavily fringed with pale brown cilia; the basal, median, and inner areas of the hind wing and the basal area of the fore wing on their dorsal surfaces are heavily clothed with long hair of a golden brown hue. Tegulæ concolorous with wings.

Ventral surface of thorax and abdomen whitish ochraceous, growing darker toward apex of abdomen, so that sixth abdominal sternite has a diffused, longitudinal, brown, median stripe, and seventh is nearly all brown, with sublateral suffusions of heliotrope. Anal tuft nearly as long as abdomen, very dark iridescent brown, the iridescence more marked ventrad. Fore and mid legs with femora and tibiæ brown ectad, creamy white entad; tarsi brown with creamy white at articulations. Hind legs uniformly brown, very hirsute, the tibiæ and tarsi having very dark brown hairs, lying in the same plane, lengthening toward apex of tibia and growing shorter toward apex of tarsus.

Total length (including palpi and anal tuft), 48 millimeters; width of head, 5.25; length from front of head to apex of abdomen, 30; length of anal tuft, 18. Expanse of wings, 60 millimeters; length of fore wing, 28; length of hind wing, 23; length of antenna, 20; length of hind leg, 23; hind tibiotarsal length, 17; tibial fringe, 4.

LUZON, Laguna, Los Baños, P. I.; July 8, 1915 (*Charles S. Banks*). A single specimen flew into my house at night and, rapidly half crawling, half flying, around on the table, was captured without injury.

Type, No. 18468, male, in the entomological collection, College of Agriculture, Los Baños, P. I.

This species is closely related to *Iontha umbrina* Doubleday,[3] from which it differs most strikingly in having the anal angle of the hind wing lobed and much reflexed ectad; in having the heliotrope submarginal band extended to anal angle on hind wings and equally as well marked as on the fore wings, and in the alternately pale and dark brown fringe of the fore wings.

[3] *The Entomologist* (1842), 298, 1 figure.

Its very striking appearance differentiates it at once from all other noctuids that I have seen, and its graceful actions are not easily forgotten when once they have been witnessed.

I dedicate this beautiful insect, the first and only one of its genus ever taken in the Philippines, to my mother, Ida Randolph Banks.

Its closest ally, *Iontha umbrina* Doubleday, is recorded from Sylhet, in northern India, by all authors and from Singapore by Swinhoe. Hampson[4] gives Borneo in addition but, as he cites no collector, this may be an error.

[4] Fauna of British India, Moths (1894), 2, 541, fig. 301.

ILLUSTRATION

PLATE I

Iontha ida sp. nov., natural size. *a*, dorsal aspect; *b*, ventral aspect; *c*, lateral aspect.

PLATE I. IONTHA IOA SP. NOV., NATURAL SIZE.

THE SOCIAL BEES OF THE PHILIPPINE ISLANDS

By T. D. A. Cockerell

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The social bees of the Philippines are included in three families, easily distinguished as follows:

Anterior wings with reduced venation; small, stingless bees.... **Meliponidæ.**
Anterior wings with three submarginal cells; larger bees, with sting in females and workers........ 1.
1. Eyes hairy; marginal cell long (honey bees)........ **Apidæ.**
Eyes naked; large hairy bees (humble bees)........ **Bombidæ.**

MELIPONIDÆ

A large family of social bees, abundant in the tropics of both hemispheres, but absent from the temperate parts of the northern hemisphere, though extending south of the tropics in Australia. The only Philippine genus is the following:

Genus **TRIGONA** Jurine

The record of *T. læviceps* Smith is probably erroneous. The following species are known to occur:

Base of abdomen bright ferruginous, the following segments intense black, abruptly contrasting .... palavanica Cockerell.
Abdomen not thus bicolored........ 1.
1. Larger, the worker 6.5 to 7 millimeters long; abdomen ferruginous. luteiventris Friese.
Smaller, worker about 3.75 millimeters long; abdomen dark. biroi Friese.

Trigona palavanica Cockerell.

Trigona palavanica Cockerell, Ann. & Mag. Nat. Hist. (1915), VIII, 16, 2.

Palawan, Puerto Princesa (from *Baker*).

Trigona luteiventris Friese.

Trigona luteiventris Friese, Résult. L'Expéd. Sci. Néerlandaise à la Nouvelle-Guinée. Leiden (1900), 5, Zoologie, 358.

Palawan; also Perak.

Trigona biroi Friese.

Trigona biroi Friese, Termés. Füzetek (1898), 21, 429.

Philippines and New Guinea, according to Friese. Philippine Islands (*C. R. Jones*).

LUZON, Los Baños (*Baker*): Bataan, Lamao (*P. J. Wester*), at flowers of *Nipa fruticans*, February 26, 1916.

I take the opportunity to make known some species obtained by Professor Baker in Penang and Singapore:

Trigona ambusta sp. nov.

Worker.—Length, 8.5 millimeters; anterior wing, 8 millimeters. Head large, shining black, the clypeus ferruginous, broadly suffused with dusky above and at sides; antennæ dark, except basal third of scape, which is bright ferruginous; mandibles simple; front with fine brown pruinose tomentum; a band of stiff black hair behind ocelli; mesothorax and scutellum ferruginous, the latter with two dark marks and the mesothorax with dusky lines anteriorly; surface of mesothorax with very short thin rich fulvous tomentum, and anteriorly with black hairs; scutellum with short stiff black hairs; metathorax hairy at sides, but the broad central portion polished, shining black; pleura black in middle, reddish around sides, and red below; tegulæ castaneous; wings fuliginous, with the apical field broadly reddish hyaline; stigma and nervure dusky reddish; legs black, the coxæ and trochanters red; abdomen black (extreme base of first segment red), narrow, compressed, shining, with dark hair at apex.

SINGAPORE (*Baker 9067*). Allied to *T. lacteifasciata* Cameron, from Borneo, but with black femora, basal part of wings dark, and other differences. It is also related to *T. thoracica* Smith, differing in the color of the wings, which Smith describes as flavo-hyaline in his species.

Trigona atripes Smith, a variety differing a little in the color of the legs, comes from Penang Island (*Baker 9068*). The following species with black head and thorax were obtained by Baker on Penang or at Singapore:

Mesothorax dull, bordered with fulvous hair (Penang). fulvomarginata sp. nov. (9073).
Mesothorax not thus bordered .... 1.
1. Small species, with red scape .... 2.
   Larger species; scape black, at most red at extreme base .... 3.
2. Tegulæ ferruginous (Singapore) .... valdezi sp. nov. (9074).
   Tegulæ black (Penang) .... penangensis sp. nov. (9075).
3. Larger; transverse-cubital nervures barely indicated (Singapore). busara sp. nov. (9072).
   Smaller; transverse-cubital nervures distinct .... 4.
4. Scutellum bare (Penang) .... bakeri sp. nov. (9069).
   Scutellum conspicuously hairy (Singapore). itama sp. nov. (9071=type; 9070).

Trigona fulvomarginata is very close to *T. ventralis* Smith and has the abdomen whitish at base and beneath as in *ventralis.* It differs by the dusky wings and the bright fulvous hair bordering mesothorax and scutellum. The scape is pale at the extreme base, and the face has short grayish white hair.

Trigona valdezi and *penangensis* belong to the *iridipennis* and *biroi* series. They differ at once from *iridipennis* by the dusky wings. The wings of *penangensis* are less produced apically than those of *iridipennis,* and the abdomen is pure black. *Trigona biroi* is larger than *penangensis* and has darker wings. *Trigona valdezi* is 5 millimeters long, but *penangensis* is not over 4. The abdomen of *valdezi* is brown, palest basally; that of *penangensis* is pure black. *Trigona valdezi* is also close to *T. læviceps* Smith, but differs by the black femora, tibiæ, and middle and hind basitarsi.

Trigona busara is about 7 millimeters long, robust, with dusky wings; stigma and nervures dilute sepia; face and front covered with cinereous pile; scutellum with much black hair; pleura with mouse-colored tomentum above, grading into cinereous below; legs black.

Trigona bakeri and *T. itama* are much alike, about 6 millimeters long, with dilute fuliginous wings, noticeably darker than those of *T. busara.* The front mesothorax and abdomen are shining, but in *bakeri* the mesothorax is extremely smooth and polished, in *itama* distinctly dullish. The legs are black in both. *Trigona busara, bakeri,* and *itama* all have the abdomen shining black.

The following, described by Smith from Singapore, are not represented in the collection: *Trigona fimbriata, T. læviceps,* and *T. thoracica.* Smith described four others from Mount Ophir; one of them (*T. atripes*) was found on Penang. It is a fulvous insect, quite unlike the others here described.

APIDÆ

I recognize only a single genus, though the segregates proposed by Ashmead may be considered subgenera.

Genus APIS Linnæus

Large species, workers about 16 to 18 millimeters, with eyes somewhat converging above; second recurrent nervure joining third submarginal cell very near its apex.................................... Subgenus Megapis Ashmead.

Medium-sized species, typified by the common honey bee; second recurrent nervure not going so near end of third submarginal cell. Subgenus Apis Linnæus.

Small species, workers about 8 millimeters......... Subgenus Micrapis Ashmead.

Subgenus Megapis Ashmead

Basal half of abdomen clear ferruginous........................... dorsata Fabricius.
Abdomen black, with a band of white tomentum at base of second segment. binghami Cockerell.

Subgenus Apis Linnæus

Length of worker, 10 to 13 millimeters; labrum black...... mellifera Linnæus.
Length of worker, 9 to 11 milimeters; labrum and more or less of clypeus pale reddish.. indica Fabricius.

Subgenus Micrapis Ashmead

One species; labrum and clypeus dark.................................... florea Fabricius.

Apis dorsata Fabricius.

Apis dorsata FABRICIUS, Ent. Syst. (1793), 2, 328.

Listed by Ashmead.

Apis binghami Cockerell.

Apis binghami COCKERELL, Canad. Entom. (1906), 166 (*zonata* Smith, preoccupied).

LUZON, Mount Banahao (*Baker*); Bacoor (*P. L. Stangl*); reported by Ashmead.

Apis mellifera Linnæus.

Apis mellifera LINNÆUS, Syst. Nat. (1758), 10, 576 (later called *mellifica* by Linnæus).

Presumably occurs only as a domesticated insect.

Apis indica Fabricius.

Apis indica FABRICIUS, Ent. Syst. Suppl. (1798), 274.

LUZON, Los Baños. MINDANAO, Dapitan (from *Baker*). The Philippine specimens seen by me have the abdomen banded conspicuously with black, and belong to the race *nigrocincta* Smith. The form *unicolor* Latreille, with black abdomen, has been reported by Ashmead from Cagayan and Alcala. Ashmead reports *nigrocincta* from Manila (*Stanton*).

Apis florea Fabricius.

Apis florea FABRICIUS, Mant. Ins. (1787), 1, 305.

Said to occur in the Philippines. I have none from the Islands.

BOMBIDÆ

Genus BOMBUS Latreille

Body covered with pale hair, some black intermixed on abdomen; wings hyaline .... mearnsi Ashmead.

Hair of head nearly all black, of thorax above black, but on pleura fulvous; abdomen with first two segments yellow-haired, the others with black; wings fuliginous.. irisanensis Cockerell.

Bombus mearnsi Ashmead.

Bombus mearnsi ASHMEAD, Proc. U. S. Nat. Mus. (1905), 28, 959; COCKERELL, Ann. & Mag. Nat. Hist. (1905), VII, 16, 393.

MINDANAO, Mount Apo, 6,000 feet (*E. A. Mearns*). Type in United States National Museum.

Bombus irisanensis Cockerell.

Bombus irisanensis COCKERELL, Ann. & Mag. Nat. Hist. (1910), VIII, 5, 416.

LUZON, Benguet, Irisan (collector unknown). Type in British Museum. Structurally resembles *B. sumatrensis* Ckll., from Sumatra, but the colors are quite different. *Bombus* is known from Java (*B. rufipes* Lep.), Sumatra (*B. senex* Snell., *B. rufipes melanopoda* Ckll., and *B. sumatrensis* Ckll.), and the Philippines; but not yet from Borneo.

THE PHILIPPINE BEES OF THE FAMILY NOMADIDÆ

By T. D. A. Cockerell

(*University of Colorado*)

The Nomadidæ are represented in the Philippine Islands by species of *Nomada* Scopoli, a genus very widely spread over both hemispheres. The Philippine species are all small and look like small wasps. They are parasitic, presumably in the nests of the various species of *Halictus*. Those so far recognized may be separated thus:

Genus NOMADA Scopoli

Anterior wings with two submarginal cells........ 1.
Anterior wings with three submarginal cells........ 4.
1. Mesothorax of female black........ pervasor sp. nov.
   Mesothorax of female red, at least at sides........ 2.
2. Front black, except along orbits........ attrita sp. nov.
   Front red........ 3.
3. With a yellow spot at each side of second abdominal segment. makilingensis Cockerell.
   Without such yellow spots........ palavanica sp. nov.
4. Males........ 5.
   Females........ 6.
5. Third antennal joint short, little longer than broad.* banahaonis Cockerell.
   Third antennal joint long, much longer than broad. mindanaonis Cockerell.
6. With a conspicuous yellow spot at each side of second abdominal segment. exheredans sp. nov.
   Without such spots........ 7.
7. Mesothorax black, at most with a little red at sides........ 8.
   Mesothorax red, with at most a blackish discal shade........ 9.
8. First abdominal segment with a broad red band; hind tibiæ red. concessa sp. nov.
   First abdominal segment black, with small red spots; hind tibiæ black, with the ends red........ bakeri Cockerell.
9. Hind margins of abdominal segments suffused with dusky; flagellum dull red beneath........ lusca Smith.
   Abdomen usually clear red; flagellum black........ mindanaonis Cockerell.

* The second joint is very small and partly hidden in the apex of the first, so it is possible to mistake the third for the second.

Nomada pervasor sp. nov.

Male (*type*).—Length, about 6 millimeters; black, with the following chrome-yellow markings: Basal part of mandibles (which have no inner tooth), labrum, lower margin of clypeus, small triangular areas at lower corners of face, claviform streak above eyes, scape in front except at base (but suffused with reddish), tubercles, tegulæ (except a dark spot), scutellum (which is bilobed), apical part of femora (especially in front), tibiæ (except a dusky mark, and on hind tibiæ the middle half dark, except a stripe behind), anterior tarsi and middle basitarsi, large spots on each side of second and third abdominal segments, smaller (paler) marks on fourth, a briefly interrupted band on fifth, and a broad complete band on sixth. Middle of face and a transverse mark on pleura reddish; apical plate of abdomen pale ferruginous, very deeply notched; flagellum long, black; third antennal joint a little longer than fourth; mesothorax very densely and coarsely punctured; wings with only two submarginal cells, the second transverse-cubital nervure lacking; apical part of wings strongly infuscated; basal nervure going far basad of transverse median; abdomen polished and shining, first segment entirely black.

Female.—Similar to the male in most respects; a large, quadrate, subapical yellow patch (more or less emarginate anteriorly) on abdomen.

LUZON, Benguet, Baguio (*Baker*), 1 male, 3 females.

Nomada attrita sp. nov.

Female.—Length, a little over 4 millimeters; differing from *N. makilingensis* thus: Smaller; front black, with a red band along each orbit; mesothorax with middle third or rather more black, lateral parts dusky red; abdomen beyond first segment suffusedly blackened.

MINDANAO, Butuan (*Baker* collection).

Nomada makilingensis Cockerell.

Nomada makilingensis COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 15, 263.

LUZON, Laguna, Mount Maquiling (*Baker*).

Nomada palavanica sp. nov.

Nomada mindanaonis, variety, COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 15, 4.

Female.—Length, about 5.5 millimeters; differing from *N. makilingensis* by the absence of yellow spots on second abdominal segment, the black flagellum, and the dusky hind legs.

PALAWAN, Puerto Princesa (*Baker* collection). I was evidently in error in regarding this as a variety of *N. mindanaonis;* the first recurrent nervure joins the second submarginal cell much nearer the base than in that species.

Nomada banahaonis Cockerell.

Nomada banahaonis COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 15, 264.

LUZON, Mount Banahao (*Baker*). The male varies in size; length, 4.5 to 6 millimeters.

Nomada mindanaonis Cockerell.

Nomada mindanaonis COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 15, 265.

MINDANAO, Dapitan (type locality); Davao. PALAWAN, Puerto Princesa. All from Baker. The tegulæ of the male vary to red. The females vary, Davao specimens showing more or less dusky shades on the abdomen. It becomes difficult to separate females of this species from *N. lusca,* but I have no male of *lusca* from Luzon. It is quite possible that *N. mindanaonis* is only a local race of *lusca,* differing in average rather than absolute characters. The type is a male.

Nomada exheredans sp. nov.

Female.—Length, about 5.5 millimeters; red with blackish markings, the second abdominal segment with a large round yellow spot on each side; mandibles simple; front, occiput, and cheeks black, but a red band along orbits; scape long, red, with a dusky spot at apex behind; flagellum very long, reddish black, the basal half red beneath; third antennal joint about as long as fourth; mesothorax dusky red, with a broad median black stripe and obscure sublateral ones; white hair patches on mesothorax dense and bright; tegulæ clear red; wings dusky at apex; basal nervure going a short distance basad of transverse median; second submarginal cell large; legs clear ferruginous, only the hind tarsi dusky; abdomen with broad dusky bands; venter clear red.

LEYTE, Tacloban (*Baker* collection).

Nomada concessa sp. nov.

Female.—Length, about 6 millimeters; black, marked with yellow and red; closely related to *N. bakeri,* but differing thus: Mesothorax very distinctly shining between the punctures, its lateral margins reddish; first abdominal segment broader, and with a broad band; hind tibiæ red.

MINDANAO, Dapitan (*Baker* collection).

Nomada bakeri Cockerell.

Nomada bakeri COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 15, 263.

LUZON, Mount Maquiling (*Baker*).

Nomada lusca Smith.

Nomada lusca SMITH, Cat. Hymenop. Insects British Museum, pt. 2 (1854), 243; BINGHAM, Fauna British India, Hymenoptera (1897), 1, 465; COCKERELL, Trans. Amer. Ent. Soc. (1905), 31, 313; COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 15, 263.

LUZON, Los Baños; Benguet, Baguio (*Baker*). This species was briefly described by F. Smith from the Philippine Islands, the particular island not stated. I have examined Smith's type in the British Museum. Bingham recorded the species from "Sikhim; Tenasserim; Ceylon; Philippines;" remarking however that the variety he described appeared to be intermediate between the Philippine *N. lusca* and the Indian *N. adusta*. I have little doubt that true *N. lusca* is confined to the Philippines, the Indian specimens belonging to one or more distinct species. Bingham was inclined to lump species in *Nomada;* thus he placed *N. subpetiolata* Smith as a synonym of *N. adusta* Smith, but Meade-Waldo later reëstablished it as a valid species.

THE OSTEOLOGY OF THE GIANT GALLINULE OF THE PHILIPPINES, PORPHYRIO PULVERULENTUS TEMMINCK

WITH NOTES ON THE OSTEOLOGY OF TACHYBAPTUS PHILIPPENSIS (BONNATERRE) AND HYDROPHASIANUS CHIRURGUS (SCOPOLI)

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FIVE PLATES

Before describing the skeleton of this big paludicoline bird, it will be as well to present a brief history of what we know of its habits, distribution, taxonomy, and other matters of interest. For this history I am indebted to Mr. Richard C. McGregor, ornithologist of the Bureau of Science at Manila, who has kindly furnished me with the following notes:

Porphyrio pulverulentus Temminck.

Porphyrio pulverulentus TEMMINCK, Pl. Col. (1826), 5, Pl. 405; SHARPE, Cat. Bds. Brit. Mus. (1894), 23, 207; Hand-list (1899), 1, 109; MCGREGOR, Man. Phil. Bds. (1909), 81.

Distribution.—Philippine Islands.

At the time that Sharpe wrote volume 23 of the Catalogue of Birds, the British Museum possessed only two specimens of the Philippine blue gallinule; these are listed as follows:

a.	Ad. sk.	Manila, Luzon.	Hugh Cuming, Esq. [C.].
b.	Juv. sk.	Manila.	Gould Coll.

It is very unlikely that either of these was collected in the vicinity of Manila. That they came from Laguna de Bay is probable, for the species can be found at many points along the shores of that lake, but it is nowhere as abundant as the moorhen (*Gallinula chloropus*).

Since the Catalogue of Birds was written, this gallinule has been collected in Bohol, Mindanao, and Mindoro, as well as in Luzon. It is probable that it occurs on all of the larger islands where there are suitable lakes with shallow reed-filled water near the shores.

The food of *Porphyrio,* as indicated by the stomach contents of specimens collected at Paete, Laguna, Luzon, consists of fresh-water snails, small insects, seeds, and vegetable matter that could not be determined. When startled or surprised this gallinule stands erect, as if at attention. From this and its conspicuous red bill the Spaniards called it "artillero."

The most conspicuous external features of this bird are the heavy bill and long, heavy feet. It has a striking resemblance to the pictures of *Notornis,* next to which the genus is placed in Sharpe's Hand-list. See the text figure of *Notornis* in Knowlton, Birds of the World, page 325, and in Newton, Dictionary of Birds, page 592. You will notice that the frontal shield in the specimens of *P. pulverulentus* extends much farther backward than is represented by Newton for either *Notornis* or for *Porphyrio*. If you happen to have a copy of Egyptian Birds, by Charles Whymper, London, Adam and Charles Black, 1909, you will find, facing page 168, some nice studies of *Porphyrio madagascariensis* that might pass for the Philippine *Porphyrio* if done in black and white.

In times past, in various journals here and in Europe, I have published complete accounts of the skeletons of all the American Gruidæ, or cranes; a full description of the skeleton of *Aramus vociferans;* and the same of the majority of our Rallidæ, or rails, gallinules, and coots. These papers and monographs are now so well known to ornithotomists and to many ornithologists, that it will not be necessary to cite them by title in the present connection. This also applies to such descriptions as I have published on the osteology of paludicoline birds of the Old World and elsewhere.

At the present writing I have been unable to obtain the skeleton of an American gallinule; so I shall compare the bones of the Philippine giant gallinule with the corresponding ones in the skeleton of a coot (*Fulica americana*). Such material has kindly been loaned me by the Division of Birds of the United States National Museum. (No. 19710, adult male?)

There are but few marked differences to be discovered when we come to compare the skeletons of the soras, the cranes, the short-billed rails, the gallinules, and the coots, or other closely allied forms in the same group. Still there are some interesting points to be noticed along such lines, and they are of generic as well as specific significance. Most of them, it would seem, pertain to the skull rather than to any other part of the skeleton.

OSTEOLOGY OF PORPHYRIO PULVERULENTUS

The skull.—As compared with *Fulica*, there is a general lack of pneumaticity in the entire skeleton of this big gallinule, which is corroborative evidence that the demand for its being a good flier is considerably less; moreover, it points to the fact that its relation to *Notornis* is much nearer than any of its congeners of the allied groups of the Rallidæ. This reduction of the amount of air gaining access to the inner recesses of the bones is well exemplified in the skull, as compared with that part of the skeleton in the coot; consequently we find it to be, in the gallinule, thicker, denser, darker, and proportionately heavier in comparison—a condition which is largely extended to other parts of the skeleton, as will be seen further on in this description.

Viewed upon its superior aspect, the skull of *Porphyrio* will be seen to be very broad in its interorbital area, generally convex, with almost complete reduction of the superorbital glandular fossæ, and, posteriorly, faintly differentiated from the parietal area of the cranium. The craniofacial line is not as strongly marked as it is in *Fulica*, though on both the naso-premaxillary sutures are distinctly in evidence on this superior view of the skull.

When we come to regard the cranium of this gallinule laterally, we find a number of very striking differences, as compared with what obtains in our coot. In the former, the superior mandible is proportionately far more massive, broader, and deeper from above downward. Furthermore, its decurvature is more pronounced, and it is carried more abruptly to a sharper apex. The osseous roof of the mouth is not as open as it is in the coot, while the external narial apertures in this *Porphyrio* are relatively, as well as actually, very much smaller and of an elliptical outline (Plate II, fig. 10).

A lacrymal bone in our subject differs very considerably from that element of the cranium in *Fulica;* for in the first-mentioned bird its superior portion is curved and elongate, making close articulation with the external margins of the frontal and nasal. It is pneumatic, while the foramen is usually in the lower portion. This latter is rather broad, thin, curved, and pointed below; a small, free ossicle brings it in articulation with the infero-external angle of the thin, oblong, though thoroughly ossified pars plana of the same side. In the coot the lacrymal is triangular for its lower portion—triangular and very thin—being produced as a spiculalike point below. It is separated by a wide interval from the pars plana, or ethmoidal wing. The latter is a thin lamina of bone presenting several peculiarities. Its superoexternal angle is produced forward as a slender process in contact with the under surface of the frontal, while internally, immediately below this same surface, an extensive elliptical foramen is formed for the passage of the nerve to the rhinal chamber.

In both the *Porphyrio* and the coot the interorbital septum is almost entirely lacking in bone, which also applies to the anterior cranial wall above and behind it. Both birds have the foramen rotundum circular and complete.

Porphyrio pulverulentus has the zygomatic bar very straight, rather broad, and transversely much compressed, rendering its upper and lower edges sharp.

On the side of the cranium the crotaphyte fossa is well defined (Plate II, fig. 10), which is not the case in *Fulica*.

Both species have a pronounced postfrontal process, which points directly downward in either species; while in *Fulica* the squamosal process is spiculiform. In the Philippine gallinule it is broad and transversely flattened, constituting a conspicuous character of the side of the skull.

These birds have the osseous meatus of the ear very open, which admits, in the dried skull, of a complete view of the interior parts, the nature of the articulation of the head of the quadrate, the Eustachian passage, and other characters. This is also true of the coot; but in that bird the posterior wall of the osseous meatus is not nearly as much thickened, either relatively or actually, as it is in the big gallinule of the Philippines. Posteriorly, in either species, the supra-occipital prominence is conspicuously developed, and is not pierced by twin foramina as it is in many birds. A well-defined occipital ridge is present and very distinctly marked as a bounding line to this region. Above, on either side, the bounding line of the crotaphyte fossa runs into it; the points where the two lines meet it are 13 millimeters apart.

The external surface of the cranial vault is flatter than it is in the coot and presents a pair of parietal eminences placed side by side. Beyond this the frontal region, superiorly, is smooth and convex from before backward, merging gradually with the nasal on either side, but terminating abruptly and mesially in a transverse line over the premaxillaries; the latter are thoroughly united, with all sutural traces absorbed.

A quadrate has a large, inturned, blunt orbital process, with an extensive articulation for the mandible, it being triangular in form, with an articular, convex facet at each angle.

A pterygoid is short and not much twisted upon itself; it is broadened anteriorly, and the two bones meet in the median line, when normally articulated as they are in life.

The palatines are very intimately in contact in the median line, below the rostrum of the sphenoid, as far forward as the union with the bifurcation of the vomer, which latter fuses with them. The hinder part of either palatine below has an inner and an outer crest running forward and parallel with each other. Above, the broad orbital surface, however, is smooth and flat. Beyond this either bone mounds up in a peculiar way to meet the lower part of the ethmoidal wing and lacrymal bone of the same side. Still more anteriorly a palatine fuses with the maxillopalatine; the latter is separated from the fellow of the opposite side by quite an interval. The vomer is keeled inferiorly; it is slightly spreading above and is pointed at its free anterior apex.

Fulica has all of these bones far more delicately constructed and slenderer. In this species the prepalatines are extremely slender rods, the postpalatine parts being short, and far removed, on either side, from the pars plana. Moreover, a maxillopalatine is a shell-like bone, distinct from its fellow, being attached at the point of union of the zygoma, the nasal, the prepalatine, and the dentary part of the premaxillary. It is elliptical in outline, with its major axis parallel to the slender prepalatine, while its outer surface is concave, and the mesial correspondingly convex.

The external narial openings in the coot are very large and elongate, which is not the case in *Porphyrio* (Plate II, fig. 10).

As in many birds, the mandible is a V-shaped bone, with deep, thin rami and extensive symphysis in this species. There are no postarticular processes present; in fact, the hinder aspects of the articular ends of this mandible are substantially flat surfaces, only slightly concaved and lying in planes perpendicular to the long axis of the bone. The free margins, both above and below, are moderately rounded, while the dentary ones above are cultrate, terminating in a subacute apex anteriorly.

There are two foramina in either ramal part; that is, the usual splenial one, which is elliptical in outline, and another, smaller one, posterior to it, halfway between the first and the articular extremity, which is circular in outline.

Posteriorly, the ramal portion of the bone is thin, it being considerably heavier for its anterior portion. Most of the former moiety exhibits some pneumaticity, and this condition is present in a good part of the cranium and associated bones of the palatal region and face; it is also true of the ossa quadrata.

The ear bones have been lost.

In *Fulica* we also find a V-shaped mandible, with a number of its general characters agreeing with the corresponding ones in *Porphyrio*. The former, however, has the bone more elongate, narrower, and with a shorter symphysis. Finally, its ramal sides are not nearly so deep nor so thin. Then, too, in *Fulica* there is a special character not found in *Porphyrio*, which is well worthy of notice. It consists of little semicircular plates of bone attached, one on either side, just above the splenial foramen on the superointernal margin of the ramus. These platelets are directed horizontally and toward the median line. My impression is that each is covered with the horny theca of the lower jaw and is capable, in life, of being moved up and down in the vertical direction. They are not present in *Porphyrio;* and what their special function is in life is difficult to conjecture. (Specimen No. 19710, collection United States National Museum bird skeletons.)

The hyoid bones (Plate I, fig. 4) are extremely slender and elongate, and the glossohyal remains in cartilage throughout life, while the very minute urohyal is prolonged by a short, threadlike extension. This part of the skeleton of the coot at hand has been lost, so no comparisons can be made. It is fair to presume, however, that the skeletal parts of the tongue in these two birds are very similar.

The trunk skeleton.—There are thirteen vertebræ in the cervical division of the spinal column of *Porphyrio* wherein the pleurapophyses are not free; in the fourteenth they are small, and are found to articulate freely with the vertebra, while in the fifteenth each rib of the pair is long and as slender as a needle. They do not reach the sternum, nor are epipleural appendages present upon them. The fourteenth vertebra has some of the characters of a leading dorsal, and these are still more pronounced in the fifteenth vertebra (Plate III, fig. 11).

The cervical vertebræ in *Fulica* are far more delicately fashioned than they are in the big gallinule of the Philippines. Proportionately, they are more elongate, with the pleurapophyses of the fourth to the eighth, inclusive, needlelike and long; in *Porphyrio*, relatively as well as actually, they are shorter and blunter. Only the second, third, and fourth have low, blunt, neural spines upon them, while in the fourteenth and fifteenth these processes are conspicuous and resemble the dorsal neural spines, only they are not so broad anteroposteriorly. Hæmapophyses are present on the atlas and on the next two vertebræ behind it; they then disappear, to be seen again on the eleventh, twelfth, thirteenth, and fourteenth, where they are thin laminæ of bone in the median line and transversely compressed.

The carotid canal is open for its entire length; while the vertebral canal, on either side, is completely surrounded by bone in the third to thirteenth cervicals, inclusive.

In both *Porphyrio* and *Fulica* the first two dorsal vertebræ possess hæmal spines resembling those of the cervical vertebræ; they are short and transversely compressed. On the other hand, all of the vertebræ in this division of the spinal column possess very large, thin, quadrilateral neural spines, which increase in size from first to last as we proceed in the anteroposterior direction. Their free superior margins are slightly thickened; and from the second to the eighth dorsal vertebra—the latter the last of the series—they are in contact at all of their superior angles, each vertebra with the one next behind it. The anterior and posterior margins of these neural spines are concave in outline and sharp. This, in the articulated skeleton, leaves elliptical vacuities among them (Plate III, fig. 11). There are linking metapophyses on the superior outer extremities of the transverse processes of all these dorsal vertebræ; while in *Fulica* the neural spines above are lashed together through the ossification of the tendons of the muscles of the back.

As will be noted from Plate III, fig. 11, of the present article, the dorsal ribs of *Porphyrio* are long and slender, as in the case of all true coots and gallinules, with costal ribs, or hæmapophyses, to correspond with them. The leading five support epipleural appendages—six in *Fulica*. There is always a pair of slender pelvic ribs; but the costal ribs of this pair do not articulate with the sternum.[1]

The pelvis.—*Porphyrio* has a pelvis that is shorter and broader than it is in *Fulica* and in the gallinules—relatively with respect to the latter and actually with respect to the former. This increased breadth is especially marked in the postacetabular portion of the bone; it is also of denser and heavier build in the big gallinule of the Philippines than in the other forms mentioned.

The preacetabular portion is elongate, narrower, and markedly concaved on the external iliac surfaces, which in *Porphyrio* fuse with the superior margin of the presacral vertebræ for its full length, completely closing up the iliac-neural posteriorly. Curiously enough, in the coots and gallinules the inner margin of the middle third of the preacetabular part of either ilium is concave and sharp, thus sweeping below the superior margin of the sacral crista, between the anterior third of the crest and the posterior, which latter is opposite the acetabulæ. At this interval the inner margins of the ilia are not in contact with

[1] When the present paper had been finished up to this point, there came to hand a "complete" disarticulated skeleton of a *Gallinula* (No. 18889, United States National Museum). It is from an adult individual collected by Dr. W. L. Abbott on Ile St. Louis, of the Seychelles. The skull, hyoid arches, vertebræ, and ribs in this species of gallinule resemble those parts of the skeleton in *Fulica* more than they resemble the corresponding bones in the skeleton of *Porphyrio*. It is to be noted, however, that the curious processes on the mandible found in *Fulica* are not present in this *Gallinula;* while the cranium, on the other hand, agrees in all respects with that of *Fulica*, and consequently exhibits the same differences when we come to compare it with the cranium of *Porphyrio*.

the sacral crest, a little open slit being present as a consequence; this is also the arrangement in *Gallinula*. In most respects, the postacetabular portion of the pelvis in this *Gallinula* agrees in its characters with the corresponding ones as we find them in *Porphyrio*. There are two striking characters, however, which agree, upon comparison, in *Fulica* and *Gallinula* and depart from the corresponding ones in *Porphyrio;* they are these: The posterior-inferior angle of the ischium in the coot and in the gallinule is drawn downward and outward as a conspicuous process; this angle is truncate in *Porphyrio*. Again, the distal free extremity of the postpubic rod in *Fulica* and in *Gallinula* is bent downward at an angle with the rest of this rod, the bending taking place at a point opposite the posterior-inferior angle of the ischium of the same side. Turning to the skeleton of *Porphyrio*, we note that this angle of the ischium on either side is truncated, and that the postpubic rod is not bent at any part of its length (Plate III, fig. 11).

In all the species of this coot-gallinule group of birds there is a very remarkable character on the inferior side, or ventral aspect, of the hinder part of the pelvis; it consists of a deep, pocketlike recess, or concavity, apparently formed by the extension, on either side, of the ischium. Mesiad, it thoroughly coössifies with the last three vertebræ of the pelvic sacrum, and its anterior free margin beneath is sharp and concave in outline. The completed osseous pockets thus formed are deep and capacious, occupying very nearly one-half of the postacetabular concavity of the pelvic basin. Each extends as far forward as the posterior margin of the rather large subcircular ischiadic foramen on either side.

There are seven small free caudal vertebræ in *Porphyrio* to eight in *Fulica*. In addition to these in each bird there is a more or less inconspicuous quadrilateral pygostyle. When duly articulated, these vertebræ form an arc, which is concave along its superior line (Plate III, fig. 11).

The shoulder girdle and sternum.—There is a great similarity in the characters with respect to all the bones of this part of the skeleton in the bird forms referred to in the present paper.

In *Porphyrio* a scapula, in the articulated skeleton, reaches almost as far back as the pelvis; it is narrow, flat, pointed, and markedly curved, being convex along its inner border and correspondingly concave along its outer one. In *Fulica* this is much narrower, longer, and less curved and does not seem to articulate with the os furcula, whereas it does so, extensively, in *Porphyrio*.

A coracoid in our present subject is a stout, straight bone, much expanded for its sternal moiety, which part is concave posteriorly and nearly flat anteriorly. As in *Fulica* and *Gallinula* it develops a sharp process at the outer inferior angle of its shaft, and the two bones in none of these genera meet in the coracoidal groove of the sternum in the articulated skeleton. All three bones of the arch assist in forming, superiorly, the "tendinal foramen." The very delicately formed "fourchette" is a U-shaped bone in all of these paludicoline birds (Plate III, fig. 11), and lacks anything like a hypocleidium. At the median point of the arch below, however, there is usually developed a minute process on the upper side, directed upward.

None of the bones of the pectoral arch in any of these genera is pneumatic, which is also true of the sternum; in fact there is little or no pneumaticity of any part of the skeleton, as we find it among the various genera of the marsh birds. Indeed, this is what we would expect in the case of fowls that make so little use of such powers of flight as they possess.

There is no mistaking the sternum of any species of this interesting group, and the characters of the bone are much the same throughout. The anterior border of the keel in *Porphyrio* slopes away posteriorly, more than it does in *Gallinula* and the coots; but beyond this the differences are barely of generic rank (Plate III, fig. 11).

The sternal body is narrow and much concaved on its dorsal aspect. Markedly prominent, the quadrilateral "costal processes" are flaring and truncated superiorly. A very small manubrium is present, and the costal grooves are practically continuous with a median notch above them on the superior border.

The "carina" is well developed, being concave on its anterior border and convex on its inferior, the "carinal angle" being acute. There are six articular facets upon either costal border in *Porphyrio* and *Fulica*, but apparently only four or five in the *Gallinula* from the Seychelles Islands.

The midxiphoidal process, with the carina running the entire length of it on its ventral aspect, is bluntly pointed posteriorly, and an isosceles triangle in outline, the somewhat blunt angle being acute.

This xiphoidal portion of the bone is profoundly one-notched upon either side; the notch being triangular, with the angle pointing anteriorly. This gives rise to a long, lateral xiphoidal process on either side; each process is narrow, of uniform width, and somewhat expanded at its free extremity. Plate II, fig. 7, gives some idea of the ossifications that take place in trachea; they are quite ordinary, which is likewise true of such ossifications as are met with in the larynx.

The pectoral limb.—All the bones of either limb in *Porphyrio* are entirely nonpneumatic, and this is apparently the case in *Fulica, Gallinula,* and their near congeners in various parts of the world. In *Gallinula,* when the skeleton is carefully cleaned and bleached, the humeri—as is the case in all the bones—are extremely light and creamy white; but they present no pneumatic foramina at the sites where, when present, they occur in the vast majority of birds. All the bones of the limbs in *Porphyrio,* even when carefully prepared, are dark and greasy—at least this is the case with those before me, and they were prepared at the United States National Museum.[2]

In their morphology the pectoral limb bones in *Porphyrio* and *Fulica americana* are wonderfully similar, the several bones being somewhat shorter and correspondingly slenderer in the latter species. The humeral shaft in the coot is a shade stouter. In *Porphyrio* the bone has an extreme length of 7.8 centimeters; in *Fulica,* 7.5 centimeters. Were these two bones found fossil, they would never be described by any competent avian palæontologist as having belonged to representatives of different genera. In the humerus of the coot the pneumatic fossa is deeper and somewhat more circumscribed; and this, apart from the difference in length, is the only distinguishing character of any consequence.

The form of the humerus in *Porphyrio* is well shown in Plate I, figs. 1 and 6. It will be noted that the radial crest is very low (fig. 6); and the notch, or valley, between the humeral head and the thickened proximal portion of the ulnar crest overarching the pneumatic fossa is notably deep and characteristically conspicuous.

Radius is nearly straight and inclined to be slender, while the ulna exhibits considerable curvature, thus insuring, in the articulated skeleton, a rather broad "interosseous space."

Radiale and ulnara of the carpus present the usual ornithic characters and articulations. The shafts of the carpometacarpus are long and slender (fig. 1), and the pollex phalanx supports a free claw at its distal end; but no such claw occurs on the terminal phalanx of the index digit.

The general characters of the pelvic limb may be well seen in Plate II, fig. 8.

[2] I am inclined to believe that Mr. Scollick made no attempt to degrease or bleach this skeleton.

The head of the femur is very small in proportion to the size of the remainder of the bone; and the pit for the ligamentum teres is extensive and rather deep. Rising somewhat above the summit of the bone, the trochanter major is very broad across its outer aspect. While bowed to the front, the shaft of the bone has a curious though very slight turn in it about its middle (fig. 8). Distally, the condyles are large, and the fibular notch in the outer one is notably deep. As a matter of fact, the skeleton of the pelvic limb of *Porphyrio* is not only big-boned for the size of the bird; but the individual bones are long, with conspicuous characters at their extremities. No patella is to be seen in this limb, and this is also true of the coots and gallinules.

Porphyrio has a very long tibiotarsus as well as tarsometatarsus, and this is also true of the joints of pes (Plate II, fig. 8). In the first-named segment of the skeleton of the leg, the cnemial process is rather conspicuously developed, it being confined to the upper part of the shaft. The "ectocnemial projection" terminates in a little hook at its lower angle. *Fulica* has the entocnemial process wonderfully developed; it not only rises well above the summit of the shaft of the bone, but also projects far forward and to some extent downward. Often the fascia attached to its inferior border ossifies to some considerable extent, especially the outer margin of it, running into the antero-inner surface of the shaft at a point below the "fibular ridge" on the other side. The "ridge" referred to is well developed in all of these paludicoline birds, distinctly so in *Porphyrio*, while in it, as in all of them, the fibula is very weak, and partly ligamentous below its articulation with this projection. At the distal end of the tibiotarsus, on the anterior aspect, we may note above the condyles the usual ossified tendinal bridge crossing the longitudinal groove in that locality.

Taking the unusual development of the proximal extremity of this bone into consideration, it is worthy of note that the condylar end is, relatively speaking, not so markedly enlarged; that is, the condyles, though of good size, are not strikingly bulky. As is usually the case, the outer one is the larger and the rounder in outline, and, anteriorly, the thicker in its transverse diameter. To some extent they project beyond the surface of the shaft, posteriorly, thus continuing the intercondylar valley in that locality.

Hypotarsus of the tarsometatarsus is well developed, but in *Porphyrio* appears to be neither grooved nor pierced for the passage of tendons. It is both once-grooved and once-pierced in *Fulica* and in *Gallinula,* though feebly so in either case. *Porphyrio* has simply a shallow, central depression there to guide the passage of the tendons of the muscles coming down from the leg.

Our big gallinule has the shaft of the long tarsometatarsus somewhat flattened on its anterior and posterior aspects, and these surfaces are strongly grooved for their entire lengths, particularly on the hinder aspect, where the tendinal gutter runs the entire length of the straight shaft of this element of the pelvic limb.

A large accessory metatarsal is present, being hinged to the shaft by strong ligament at its usual site in ordinary birds; it supports the big phalanx and claw of hallux. All the other phalangeal joints of the three anterior toes of pes are lengthy and of considerable caliber, as will be seen by referring to Plate II, fig. 8.

This brief review of the osteology of *Porphyrio* shows it to be a form possessing many of the characters of the typical paludicoline fowls; at the same time it exhibits not a few others that are distinctly generic in kind, especially those that have been described above as pertaining to the skull and to the pelvis.

NOTES ON THE OSTEOLOGY OF TACHYBAPTUS PHILIPPENSIS (BONNATERRE)

Early in August, 1917, when Mr. McGregor sent me the skeletons of *Porphyrio pulverulentus,* he also sent for my examination rough skeletons of *Tachybaptus philippensis* (Bonnaterre) and *Hydrophasianus chirurgus* (Scopoli); one each of these two species has been cleaned for me by Mr. Scollick, of the United States National Museum, an assistance for which I have to thank Dr. James E. Benedict, chief of exhibits of that institution. When Mr. McGregor sent me these skeletons, he also included brief life histories of *Tachybaptus* and *Hydrophasianus,* which I may some day use in another connection; the present brief notes refer, as their title indicates, simply to their osteology.

The specimen of *Tachybaptus philippensis,* an adult male from Paete, Laguna, Luzon, P. I.; March 26, 1917 (*McGregor*), is No. 226033, United States National Museum. The entire skeleton of this bird presents the characters of those found in that part of the anatomy of any small average grebe. Indeed, they are quite typical, as I find to be the case upon comparing the various bones with the corresponding ones in the skeleton of *Podilymbus podiceps* (No. 17272, United States National

Museum) and those of *Colymbus cornutus* (No. 17873, United States National Museum).

Taken as a whole, the skull of *Tachybaptus* agrees much better with the skull of *Colymbus* than it does with that of *Podilymbus*—a fact due principally to the shortening and broadening of the superior mandible and jaw in the latter form. The space between the superior peripheries of the orbits in the frontal region is quite as broad in the Philippine grebe as in the dabchick, while in the horned grebe it is much narrower.

Tachybaptus presents a peculiar character in the pterygoids not to be found in the skulls of the two species with which it is here being compared; this consists in their being, in the case of either pterygoid, gradually broadened out by thin laminæ that pass from the quadrate end to the palatine of the same side, the broadest part being the distal third. In *Colymbus* these bones are very slender rods, with scarcely a trace of laminar expansion.

The hyoid arches seem to have been lost in these skeletons except in *Tachybaptus*, where they have been preserved with the trachea. The glossohyal is rather short and broad, the urohyal being very slender. The hypobranchials are long, and the ceratobranchials very short, while the two together are reduced almost to hairlike proportions, so exceedingly slender are they in caliber.

Throughout its length the trachea is simple in structure, and the numerous rings are entire and thoroughly ossified from first to last.

The true grebes seem to possess eighteen cervical vertebræ in the spinal column to seventeen of *Podilymbus;* possibly one may have been lost in the skeleton of the latter bird at hand, but I am inclined to think not.

Tachybaptus has the first pair of ribs on the nineteenth vertebra; they are without costal ribs, though the epipleural appendages are well developed and long. These do not ankylose with their ribs anywhere in the series, and they are found upon the next following four pairs of ribs, all of which latter have true costal ribs. There are two pairs of pelvic ribs; the first pair reaches the sternum through costal ribs, while the second does not. Behind these a very delicate pair of floating hæmapophyses is seen. None of these possess unciform appendages.

We find the same arrangement in *Podilymbus podiceps,* while in *Colymbus cornutus* there are nine pairs of ribs, the leading seven pairs having unciform processes. The first two pairs do not possess costal ribs; and the last two pairs, which are pelvic ribs, are without appendages. Only the first pair of these pelvic ribs has costal ribs, while an aborted floating hæmapophysis, long and slender, completes the series.

Morphologically, the grebe's pelvis is well known—comparatively speaking as well as actually; it is shorter in *Tachybaptus* than in either *Colymbus* or *Podilymbus;* in the latter genus it is extremely long and strikingly narrow. Nothing of particular note marks the small caudal vertebræ in this little grebe of the Philippines.

In regard to its shoulder girdle, or pectoral arch, it comes nearer *Podilymbus* than it does to *Colymbus*, especially in the matter of the U-shaped furcula; for there is no hypocleidium present except in the case of *Colymbus cornutus*, where it is a well-developed peg of bone directed backward.

The sternum presents all the usual characters as we find them in the grebes generally; it is nonpneumatic, and the mid-xiphoidal notch is notably shallower than in the dabchick and most other American grebes. This is also true of the lateral sternal notches, while the lateral xiphoidal processes are stouter and shorter than we find them among the birds last mentioned.

As among the Colymbidæ generally, the long bones of the arm and hand in *Tachybaptus* are completely nonpneumatic, while in form they are long and slender. While the usual "sigmoid curve" is to be seen in the humerus, it is not nearly as well marked as we find it in many other groups of birds. Then, too, the general characters of the proximal extremity of the bone are more or less feebly developed—a fact that causes no surprise, in as much as these birds are feeble fliers as compared with many other aquatic species. There are no claws on the phalangeal joints, and the carpometacarpus is long and slender.

Judging from appearances in the prepared skeleton, it would seem that the femur and the superior halves of the bones of the leg might be to some extent pneumatic, which is not the case in the grebes found in North America. Otherwise, the morphology of this part of the skeleton in *Tachybaptus* is entirely in agreement with that of any small grebe; this especially applies to the patella and other features of the knee joint. As in other grebes the inner trochlea of the tarsometatarsus is situated posteriorly on the shaft of the bone, and the accessory metatarsal, with its joint and claw (hallux), is found well up the shaft above it. The ungual joint of the midanterior toe is much expanded and shell-like, while in the case of those of the other two toes, though thin and flattened, they are no wider than the joint next behind them in the case of either toe; this is also characteristic of the American grebes.

NOTE ON THE SKELETON OF HYDROPHASIANUS CHIRURGUS (SCOPOLI)

Hydrophasianus possesses no special osteological characters not found in any typical jacana; as, for example, in *Jacana spinosa* (Linnæus), the Mexican jacana. This is what we would look for, in as much as it is but a good average representative of the Jacanidæ of the world's avifauna.

Its skull is to some considerable extent pneumatic, including the mandible, while no other part of the skeleton enjoys that condition. There is an unusual resemblance in its skull to some of the sandpipers, and, to a slighter degree, this is likewise to be observed in the remainder of the skeleton; though this does not apply, to be sure, to the greatly lengthened digits of pes.

The sternum is somewhat narrow and elongate, being profoundly once-notched on either side, which gives rise to long, slender xiphoidal processes, and a rather broadish midxiphoidal part with slightly projecting outer angles.

As the skeleton of this species has probably not been heretofore figured—and certainly not from a photograph made direct from the dried skeleton—I am here giving such a plate, which I personally prepared from the skeleton forwarded me by Mr. Richard C. McGregor, and which now forms a part of the collection of bird skeletons in the United States National Museum.

ILLUSTRATIONS

[All of the figures of the plates are of natural size and are reproduced from the author's photographs made direct from the specimens.]

PLATE I

FIG. 1. Left pectoral limb of *Porphyrio pulverulentus* Temminck, seen upon palmar aspect. The bones figured on Plates I to III illustrating this paper are all from the same individual. Adult male, No. 226035, collection of the United States National Museum. Paete, Laguna, Luzon, P. I.

2. The mandible of *Porphyrio pulverulentus,* dorsal view.
3. The skull of *Porphyrio pulverulentus,* superior aspect. See Plate II, fig. 10.
4. The hyoid arches seen from above; the cartilaginous parts of the glossohyal have been allowed to remain by the osteologist who prepared the skeleton at the United States National Museum.
5. The first eight cervical vertebræ of *Porphyrio pulverulentus,* normally articulated and seen from above.
6. The right humerus seen upon anconal aspect.

PLATE II

Fig. 7. Right lateral view of the trachea of *Porphyrio pulverulentus,* with the bronchial extremity and a few rings above it removed.

8. Left pelvic limb of *Porphyrio pulverulentus* seen upon outer aspect. The patella does not exist in this species, its place being taken by a strong fibrous ligament.
9. The leading eight cervical vertebræ of *Porphyrio pulverulentus* seen from below; they are normally articulated as in life, and the upper view of them is shown in Plate I, fig. 5.
10. Right lateral view of the skull of *Porphyrio pulverulentus,* with mandible dissociated. See Plate I, figs. 2 and 3.

PLATE III

Left lateral view of the trunk skeleton of *Porphyrio pulverulentus,* with all its bones normally articulated. This gives a side view of the remainder of the cervical vertebræ, the anterior ones being shown in Plate I, fig. 5, and Plate II, fig. 9.

PLATE IV

FIG. 1. Right lateral view of the skull of *Hydrophasianus chirurgus* (Scopoli); adult female, natural size. Mandible detached. Paete, Laguna, Luzon, P. I. Collection of the United States National Museum.

2. Hyoid arches of the specimen shown in fig. 1.
3. Trachea of the specimen shown in fig. 1.
4. Right pectoral limb of the same individual, seen upon palmar aspect.
5. Right lateral view of the trunk skeleton of the same specimen as in the other figures.

PLATE V

Outer aspect of the skeleton of the left pelvic limb of *Hydrophasianus chirurgus*. From the same specimen as shown in Plate IV. The patella is extremely small and is here shown in its tendon, occupying the extreme upper apex.

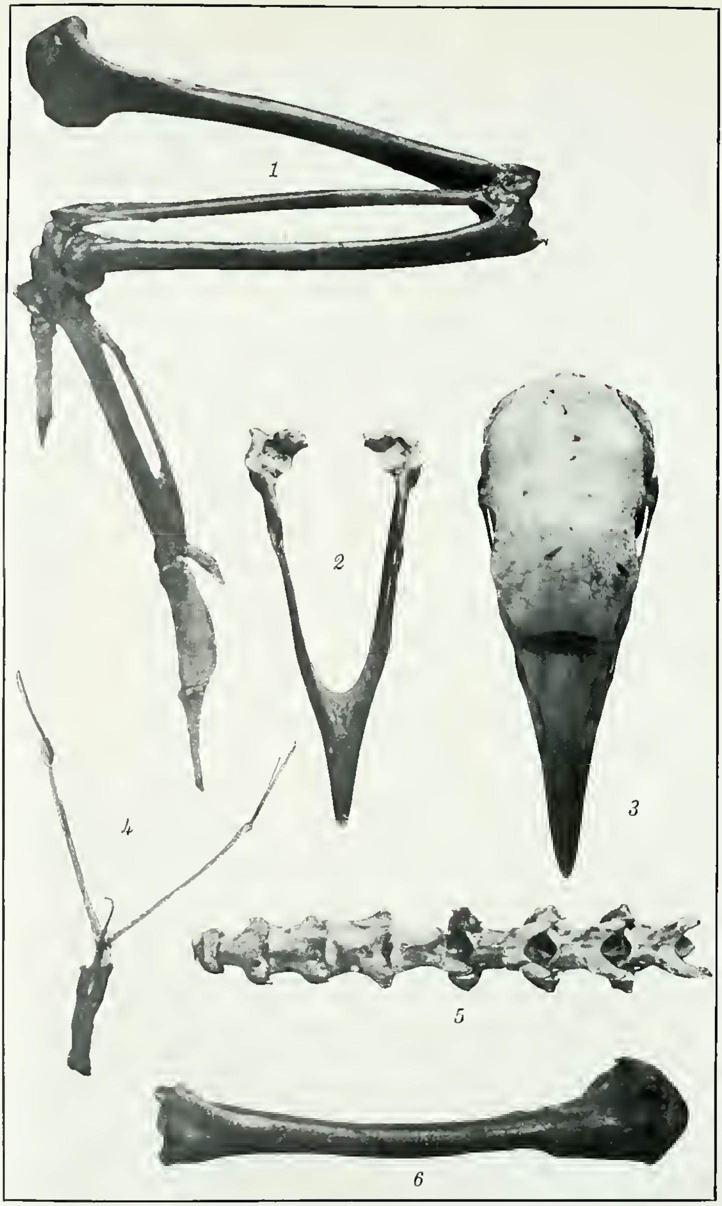

PLATE I. PORPHYRIO PULVERULENTUS TEMMINCK.

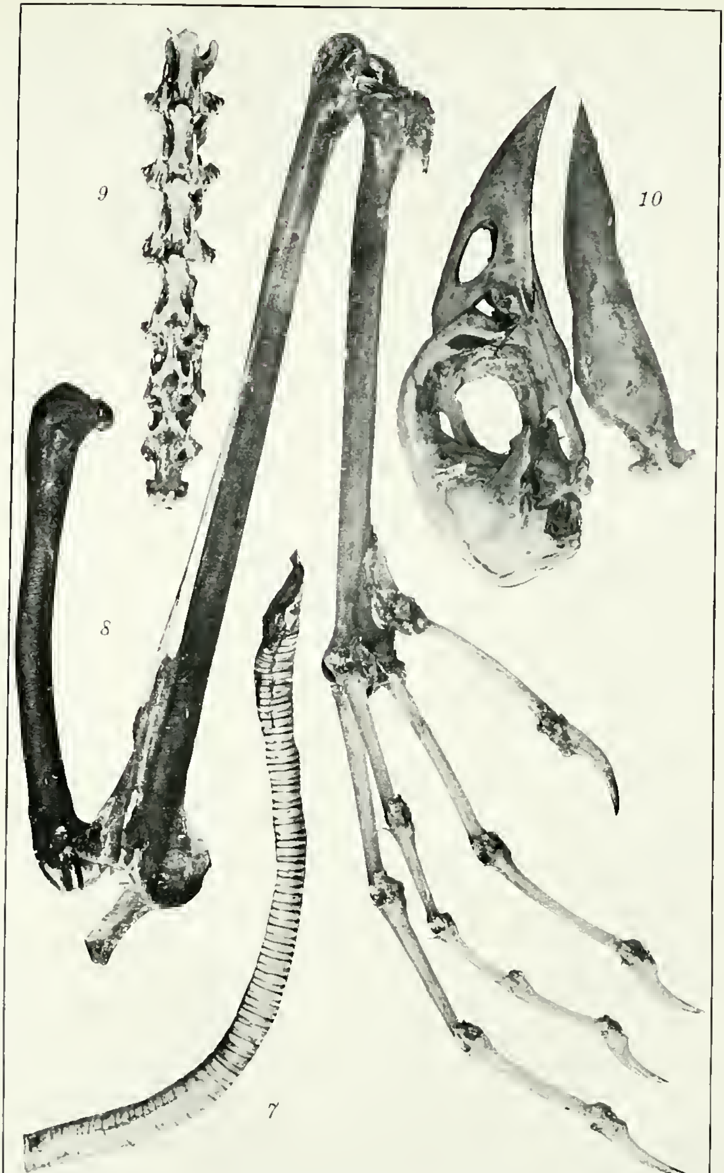

PLATE II. PORPHYRIO PULVERULENTUS TEMMINCK.

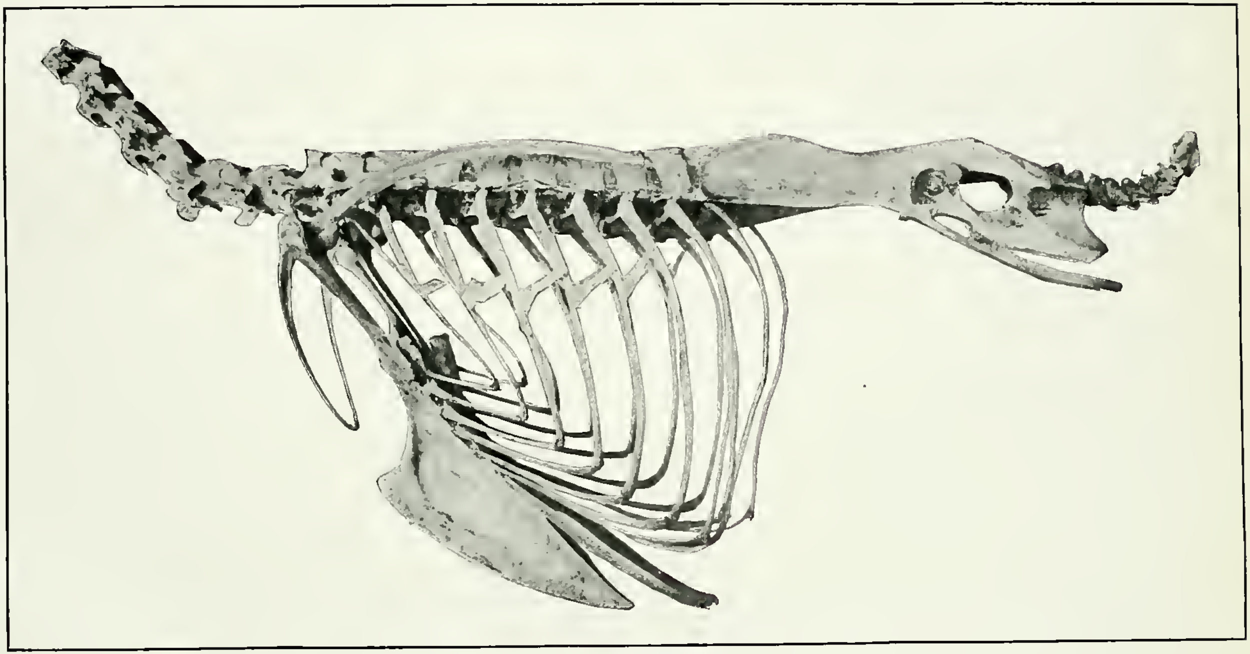

PLATE III. PORPHYRIO PULVERULENTUS TEMMINCK.

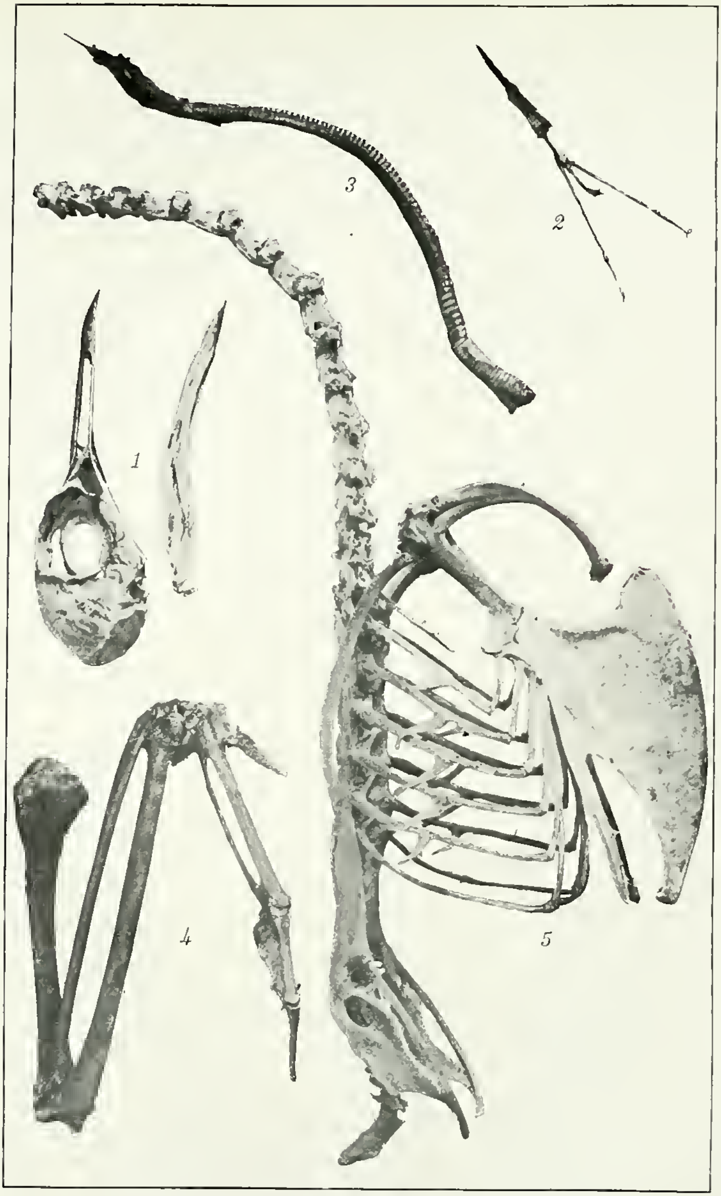

PLATE IV. HYDROPHASIANUS CHIRURGUS (SCOPOLI).

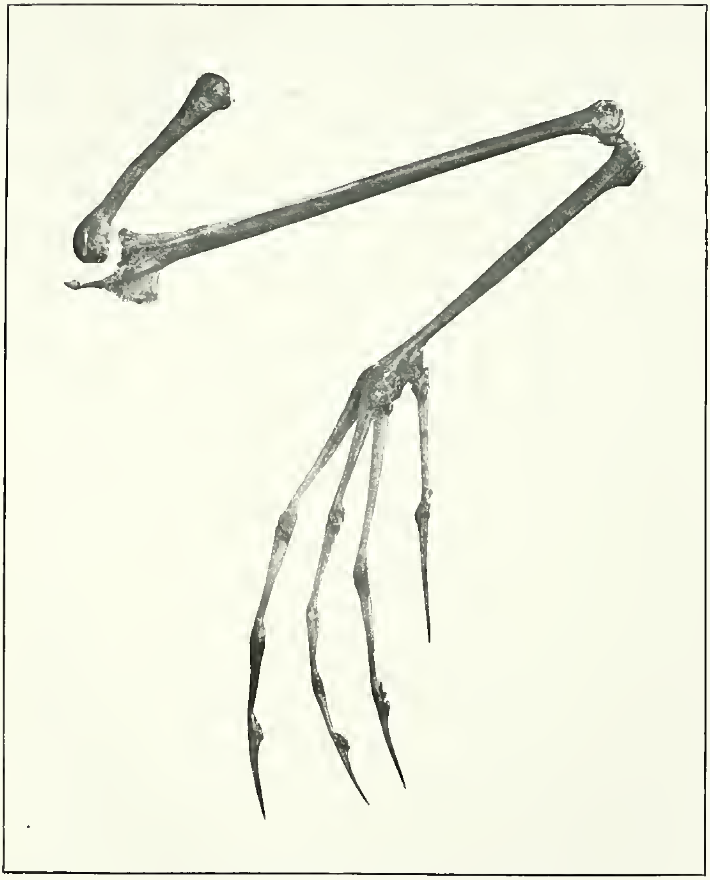

PLATE V. HYDROPHASIANUS CHIRURGUS (SCOPOLI).

NEW OR RARE PHILIPPINE REPTILES

By Edward H. Taylor

(From the Section of Ichthyology, Biological Laboratory, Bureau of Science, Manila)

TWO PLATES AND FOUR TEXT FIGURES

In this paper I am describing five new species of snakes and five new lizards from the Philippine Islands. One species is founded on specimens in the Bureau of Science collections, two on specimens in the Santo Tomas Museum of Manila, and the remainder on specimens in my own collections.

The species described and their respective type localities are as follows:

SNAKES

Typhlops luzonensis. Mount Maquiling, Laguna, Luzon.
Typhlops manilæ. "Philippines."
Typhlops longicauda. Bunawan, Agusan, Mindanao.
Typhlops rugosa. Bunawan, Agusan, Mindanao.
Trimeresurus mcgregori. Batan Island, Batan Islands.

LIZARDS

Lepidodactylus naujanensis. Naujan Lake, Mindoro.
Gekko mindorensis. Pocanil, Mindoro.
Siaphos kempi. Naujan Lake, Mindoro.
Sphenomorphus lednickyi. Aroroy, Masbate.
Sphenomorphus llanosi. "Philippines."

SNAKES

Typhlops luzonensis sp. nov.

Type.—No. 109, E. H. Taylor collection; collected on Mount Maquiling, Laguna, Luzon, May 12, 1915, by E. H. Taylor.

Description of type.—Head rather flat, broader than neck, the lower jaw not or scarcely visible in lateral profile; snout rounded, projecting, rather truncate, the end only slightly less deep than head on a level with eyes; portion of rostral visible above much longer and a little wider than the part below, failing to reach the level of the eyes by a minute distance, and minutely less than one-half the width of head; prefrontal forming a suture with rostral little less than one-third its width, larger than frontal, its longest sutures with the supraoculars; frontal, the smallest upper head scale, forming equal sutures with interparietal and prefrontal; supraocular about the same size as parietal, its lower point barely reaching eye; parietals somewhat narrowed on their lower end; nasal completely divided; nasal suture arises from second labial and after passing nostril reaches rostral in a line horizontal to upper edge of nostril; nasals not in contact behind rostral; preocular reaching above level of eyes, about as broad as ocular, in contact with two labials below; its edge crosses over middle of eye; two postoculars only slightly differentiated from body scales; first labial very small, in contact with anterior nasal only; second labial nearly three time as large as first, touching both nasals and preocular; third labial more than twice as large as second, and a little larger than fourth; lower jaw narrow, about five scales on lower jaw between fourth upper labials; eye a visible black spot, very small, with no pupil evident; about 338 scales from head to vent, 10 subcaudally; tail ending in a small spine.

Color in life.—Above reddish olive brown; below yellowish brown. Each scale with a darker yellowish brown area, giving body a checkered appearance on close examination; rostral, nasal, and labials on underside of snout yellowish white.

Measurements of Typhlops luzonensis sp. nov.

Total length (mm.)	260
Tail (mm.)	4
Width of body (mm.)	4.5
Width of head (mm.)	4.5
Width of tail (mm.)	4
Width of body in total length (times)	58
Width of tail in tail length (times)	1

Remarks.—Only the type specimen is known. The species is obviously related to the group of the genus represented by *T. ruficauda*, *T. ruber*, and *T. kraalii*, the first two of which are members of the Philippine fauna. From *T. ruficauda* it differs in having four less rows of scales about the body. From *T. ruber* it differs in having the preocular in contact with two labials, the nasal completely divided, and the length greater in proportion to the width of body. (Here the width of body is contained in the total length 58 times, while in *T. ruber*, it is contained 36 times.) From *T. kraalii* it differs in having the rostral much more than one-third the width of the head, and the preocular in contact with two labials; the color is also somewhat different.

Typhlops manilæ sp. nov.

Type.—Specimen in Santo Tomas Museum, unnumbered; labeled "Filipinas;" locality and collector unknown.

Description of type.—Snout rounded in front, projecting; a distinct depression crossing head in region of eyes. Rostral narrowed at a point on snout between nostrils, distinctly longer than wide below; rostral little more than one-third the width of head; nasals not in contact behind rostral; rostral reaching level of eyes; prefrontal rather large, narrowly in contact with frontal; supraoculars large, their lower end not touching eye; frontal slightly smaller than prefrontal, about the same shape; parietals rounding, a little broader than deep, smaller than the supraoculars; interparietal enlarged; nasal not completely divided; the suture issues from the second labial, then makes a backward deflection, widening the anterior part of nasal; preocular narrowed above, reaching above level of eye, but scarcely reaching below level of nostril, abruptly widened below eye, its posterior suture not crossing eye; nasal is much wider than either preocular or ocular; a small subocular scale in contact with second and third labials; preocular touches second labial behind this intercalated scale; ocular widens abruptly on a level with eye; it extends higher than preocular; first labial elongate; second higher and shorter, of nearly the same bulk; third very large, three or four times as large as second, reaching to near the top level of nostril, larger and higher than fourth labial (third labial on one side is fused with subocular); three scales border ocular behind; eyes very small but distinct; nostril comparatively large; lower jaw very narrow, in its middle scarcely two-fifths the width of head. Tail ends in a blunt spine; twelve scales under tail in longitudinal line; snout projecting 2 millimeters.

Color in alcohol.—Reddish brown, darker on posterior two-thirds of body; anterior part rather grayish brown. Head distinctly marked with darker and lighter areas; snout yellowish. Below lighter yellowish, each scale with a slightly darker area.

Measurements of Typhlops manilæ sp. nov.

Total length (mm.)	280
Tail (mm.)	5
Width of tail (mm.)	5.2
Width of body (mm.)	5
Width of head (mm.)	5.5
Scale rows	28

Remarks.—This unique specimen was found in the collection of the Santo Tomas University, Manila. The container was labeled "Filipinas" with no indication as to the locality from which it came. This species has no close affinities among other species of the genus in the Philippines as characterized by the presence of a subocular. It belongs to the division of the genus of which *T. ater* and *T. inornatus* are members, but differs from all in the very much larger number of scale rows.

Typhlops longicauda sp. nov. Plate I, fig. 1.

Type.—No. R 99, E. H. Taylor collection; collected at Bunawan, Agusan, Mindanao, July 15, 1913, by E. H. Taylor.

Description of type.—Head rather broader than neck, broadly oval in outline; snout with a sharp horizontal cutting edge, moderately projecting, not or but scarcely hooked in profile; rostral not as wide below as above, somewhat narrowed between nostrils, and failing to reach level of eye by more than one-half the depth of prefrontal; the latter wider than deep, larger than frontal, the suture formed with it larger than that with rostral which is only about one-fifth its width; frontal about as wide as deep, equal to the parietals which are about the size of the body scales and scarcely differentiated from them; interparietal somewhat larger than frontal; the supraocular diagonal, the lower point reaching the anterior level of eye, but failing to reach the horizontal level by a distance equal to its distance from nasal; two nasals, the anterior very small, the suture dividing them arises from first interlabial suture; preocular narrower and much shorter than ocular, in contact with two labials below; ocular large, with a slight, rounded prominence over eye; eye and pupil distinct; four postoculars between parietal and fourth labial; four labials, first and second smallest, subequal in size; third more than twice as large as second and about one-half of fourth; scales in 26 rows; about 430 scales in a longitudinal line to above vent; 40 scales in a row on underside of tail.

Color in life.—Above light yellowish brown, gradually becoming lighter below. Head lighter; laterally a distinct, broadly rectangular, lighter spot, including the eye and reaching the mouth. Each ventral scale has a regular darker brown area.

Measurements of Typhlops longicauda sp. nov.

Total length (mm.)	340
Tail (mm.)	34.5
Width of head (mm.)	5.5
Width of body (mm.)	6
Width of tail (mm.)	4.75
Body width in length (times)	56.6
Tail width in tail length (times)	7.2

Remarks.—This species has a very marked, apparently normal, enlargement of the pelvic region, which suggests a greater development of the pelvic bones or the rudimentary leg bones. The tail in this species is believed to be comparatively longer than in any other of the extremely numerous species of this genus.

The type specimen was obtained from the trunk of a small tree, which was bored full of tunnels by large black ants. It probably feeds on the larvæ of ants. There are eleven specimens in my collection.

Typhlops rugosa sp. nov.

Type.—No. R 97, E. H. Taylor collection; collected at Bunawan, Agusan, Mindanao, July 14, 1913, by E. H. Taylor.

Description of type.—Head rough, the anterior outline broken by depressions between scales along the sutures. Rostral a little longer than wide above, not reaching to level of eyes, more than one-third the width of head; below the enlarged part about as deep as wide, forming a slightly curved hook on snout; rostral dimly granular; prefrontal a little wider and somewhat smaller than frontal, its posterior point reaching a little beyond level of eyes; frontal as broad as long, the distance from oculars equal to distance between nasals, larger than interparietal; supraoculars larger than frontal, wider than deep; parietals much larger than frontal, separated by an interparietal, which is smaller than frontal; parietal not twice as wide as long; nasal with a swollen prominence about and above nostril, which gives the anterior head outline a roughened appearance; nostrils latero-inferior, not visible from above; nasal cleft issues from first labial and barely passes beyond nostril, not wholly dividing the scale; preocular not as wide as, and much shorter than, nasal, in contact with two labials; eyes dim, barely outlined; two postoculars, the inferior largest, in contact with fourth labial; four upper labials, fourth largest, first and second smallest, subequal in size; scales in 26 rows; tail ending in a sharp spine; 479 scales in a dorsal longitudinal line.

Color in life.—Above brownish to golden yellow, slightly lighter beneath. Very little distinction between the two colors as they merge gradually on the sides.

Measurements of Typhlops rugosa sp. nov.

Total length (mm.)	395
Tail (mm.)	23
Width of head (mm.)	7.5
Width of body (mm.)	8
Width of tail (mm.)	6.5
Body width in length (times)	50
Tail width in tail length (times)	3.54

Remarks.—Two other specimens besides the type were taken, an adult and a young. These two specimens were forwarded to Dr. Lawrence E. Griffin at the University of Pittsburg. They have not been at hand for comparison. All were taken in masses of fern roots growing in high forest trees. This species has no close affinities among the Philippine species unless *T. mindanensis* be regarded as such. From this it differs in the size of the frontal, which is larger than the prefrontal in *T. mindanensis*. One has two, the other three, labials touching the nasal. In one the head is very rough; in the other, comparatively smooth. Many other differences are obvious on a comparison of the two descriptions. The roughness of the head is not unlike that in *T. rossii* and *T. reginæ*, but here the resemblance ceases.

Trimeresurus mcgregori sp. nov. Fig. 1.

Type.—No. 748, Bureau of Science collection; collected on Batan Island, Batanes group (lying between Luzon and Formosa), June 12, 1907, by Richard C. McGregor.

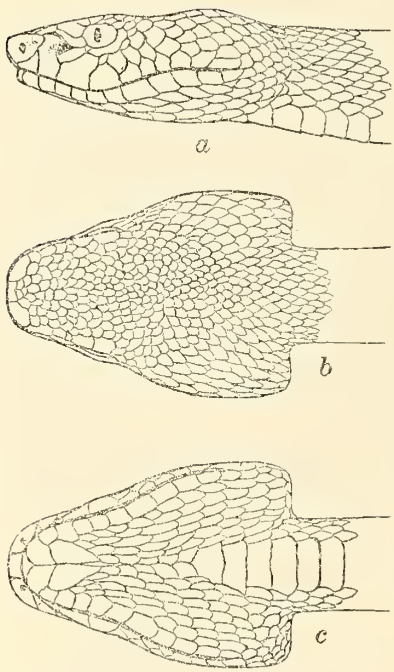

FIG. 1. *Trimeresurus mcgregori* sp. nov., from the type, × 1. *a*, head, lateral view; *b*, head, dorsal view; *c*, chin.

Description of type.—Rostral a little wider than high, slightly narrower at top, visible above as a narrow line, bordered behind by a rectangular scale, distinctly enlarged, which separates the two much enlarged supranasals; latter not or barely in contact with rostral, separated from anterior supraocular by three (four on right side) scales; two enlarged supraoculars followed by one or two small scales above eye; nasal single, large, triangular, visible above as a narrow line, the nostril, which is vertically oval, pierced near the lower border; canthus rostralis sharp, formed by the edge of nasal, the narrow elongate loreal following nasal, and superior preocular; facial pit surrounded by second labial, which forms anterior border of pit, and middle and lower preoculars, which are much elongated; three preoculars; a narrow elongate subocular, as long as orbit; two or three postoculars; ten supralabials, first small, triangular, narrowly in contact with rostral; second high, reaching almost to canthus rostralis; third much the largest, broadly in contact with subocular; fourth and fifth scales separated from subocular, each by a single scale; temporal scales distinctly enlarged, larger than, or as large as, posterior labials; mental broadly triangular, wider than rostral; eleven lower labials, first, seventh, and eighth largest; a pair of large chin shields, much longer than wide, broadly in contact, bordered by three labials; 5 pairs of scales between chin shields and first ventral; 28 scales from angles of mouth across occiput; 13 scales between supraoculars; 29 scale rows on neck (at seventh ventral); 21 on body; ventrals, 175; 56 subcaudals; anal single; temporal scales perfectly smooth, body scales slightly keeled on the eight or ten median rows. Head rather angular, flattened above and depressed in supraocular region. Tail prehensile.

Color in life.—Above bright yellow with a darker yellow lateral streak; tail with a few small reddish brown spots near tip (in alcohol entire snake almost paper white with practically no trace of marking).

Measurements of type and cotype of Trimeresurus mcgregori sp. nov.

	Type. mm.	Cotype. mm.
Total length	865	702
Tail	120	100
Head width	25	25
Head length	36	33
Eye to end of snout	12	92
Eye to mouth	6	5
Supraocular width	16	14
Length of eye	4.5	4
Width of eye	3.2	2.8

Variation.—A second specimen from the same locality shows a certain amount of variation. The scale counts are as follows: Ventrals, 179; subcaudals, 59; scale rows on neck (at seventh ventral), 29; body, 21 rows; scales between eyes, 13; upper labials, 11–10; lower labials, 12; three scales behind supranasals bordering the rostral. On the right side the third labial does not touch the subocular; the lateral stripe covers one whole and a half scale rows.

Remarks.—This species belongs to the *T. gramineus* Shaw group, which includes *T. flavomaculatus* and *T. halieus,* of the

Philippines. It is differentiated from that group, however,[1] by the striking color with no dark markings, a larger number of scales on snout and supraocular region, and larger unkeeled temporals; the supranasals are larger and more clearly differentiated. Mr. McGregor, its discoverer and for whom I take pleasure in naming it, states that it is not rare on Batan Island. In a memorandum dated June 12, 1907, he says:

Our party went to the summit of the mountain. On the return a large yellow snake was found resting at about 2 meters from the ground coiled on some leaves that had lodged among the thick stems of a kind of large grass.

The snake was struck with an alpen-stock and fell to the ground. In attempting to put a string on its neck I was scratched by the fangs, between the last two joints of my thumb. Mr. H. G. Ferguson immediately made several cuts across the wound with a pocket knife and tied a string around the thumb. My hand and forearm were swollen by evening. The swelling subsided within a couple of days. There was very little pain, and no further trouble was experienced.

LIZARDS

Hemidactylus luzonensis Taylor. Plate I, fig. 2, *b* and *c*.

Hemidactylus luzonensis TAYLOR, Philip. Journ. Sci., Sec. D (1915), 10, 93.

This species was first described from a single mutilated female specimen. I have since examined several other specimens of this rare lizard. Four were presented to me by Dr. Edward S. Ruth, of the University of the Philippines. Several other specimens have been collected for the Bureau of Science collection.

Description of species.—(Adult male, No. 1620, E. H. Taylor collection; collected at Manila in 1916, by Edward S. Ruth.) Head flattened; snout rather oviform, more than twice as wide as deep, elongate, little less than twice the diameter of eye, one and one-half times the distance of eye from auricular opening; latter distinctly oblique on one side, rather vertical on the other; rostral squarish, upright, with a median notch and a cleft nearly half the depth of the scale; nostril pierced between rostral, first labial, two postnasals, and a supranasal; supranasals separated by two scales; ten upper labials, the last two very small; nine lower labials; mental triangular followed by two pairs of chin shields, first pair touching one labial and forming a long median suture; second pair in contact with first pair and two labials, but separated from each other by three scales; scales

[1] Compared with Stejneger's description of a Formosan specimen.

bordering upper and lower labials somewhat enlarged; scales on chin and throat small, those on abdomen imbricate and larger; snout covered with uniform granules, larger than those on occiput or body; occiput with scattered tubercular granules, rather conical; body with about sixteen irregular rows of trihedral tubercles; latter present on limbs; tail but slightly depressed, with whorls of sharply keeled spines marking annulations, about eight spines in transverse rows at base of tail; below enlarged, broadened, imbricate scales; regenerated part of tail without spines; limbs moderate, with digits all clawed, without any trace of webs, the distal phalanx rising from near end of toe; latter long, compressed, much deepened near end; nine divided lamellæ under longest toe, seven under longest finger; a distinct lateral fold from axilla to groin; a short series of femoral pores, five on one side, six on other side.

Color in alcohol.—The specimen is light yellow-brown with no evidence of marking save a dark spot on the snout.

Measurements of Hemidactylus luzonensis Taylor.

	mm.
Total length (tail regenerated)	123
Width of head	10.5
Length of head	18
Snout to vent	58
Foreleg	22.5
Hind leg	29.5

Variation.—The variation noted among specimens is largely in the markings. The live specimens examined usually exhibited a series of large dim dark blotches on the back, alternating with lighter markings. In most specimens the spiny tubercles on the back were white (see Plate I, fig. 2, *b* and *c*). The skin above the auricular opening forms an indistinct flap or fold (scarcely noticeable in preserved specimens), which is usually held distended in living or freshly killed specimens; this character is very evident and is shown in Plate I, fig. 2, *b* and *c*. The fold of skin on sides of body is prominent in living specimens and is shown clearly in the figure mentioned.

Remarks.—Evidently a rare form; most closely allied to *H. depressus* but easily distinguished by the longer snout, the character of the tail and the preanal pores, and the absence of webs on the feet. Known only from the Philippines.

Lepidodactylus naujanensis sp. nov.

Type.—No. 2006, E. H. Taylor collection; collected April 25, 1916, at Naujan Lake, Mindoro, by E. H. Taylor.

Description of type.—Rostral low, more than twice as broad as high, not entering nostril; the latter surrounded by first labial and five nasal scales, forming a rounded prominence; postnasal bordering second labial, largest of the five; supranasals separated from each other by two series of three scales, all about the same size as nasal scales; a rather distinct groove on front end of snout; 13–14 upper labials, 13 lower labials; angle of mouth extends scarcely behind posterior vertical of eye; mental scarcely larger than adjacent scales, chin covered with a large number of somewhat enlarged scales, about 35, which fill all the space in front of a line drawn across jaw between the fifth lower labials, those bordering labials largest; granules on snout larger than those on body; back and sides covered with minute granular scales with scattered, slightly larger, spinelike scales, which are yellow; these also occur on the back part of head and neck; tail rather cylindrical, with a distinct lateral denticulated fringe, the annulations marked by an enlarged spinelike scale in the lateral fringe; scales on upper surface of tail distinctly larger than those on body, those on underside still larger; scales on belly imbricate, much smaller than those under tail; a long series of 25 preanal and femoral pores forming a median sharp angle; pores elongate in shape; limbs well developed, the adpressed hind leg reaches the wrist of the adpressed foreleg; web between toes and fingers very rudimentary; 14 lamellæ under longest toe; toes much wider at end than at base, the basal lamellæ rather scalelike; inner digits on limbs well developed, without claws; eye nearer ear than end of snout; ear slightly nearer eye than foreleg.

Color in life.—Reddish brown above with dim, zigzag, darker marking of brown across back; lighter at base of tail; a dark line between eyes and another on nose; sides dark with minute yellow spots; a more or less distinct row of yellow dots borders belly ventrolaterally; belly canary mixed with brown scales; underside of tail yellow at base, grayish at tip; lower part of eye dark.

Measurements of Lepidodactylus naujanensis sp. nov.

	mm.
Length	74
Snout to vent	34
Snout to foreleg	12
Tail	40
Axilla to groin	16
Foreleg	10
Hind leg	13.5
Width of head	5.1
Length of head	9.3

Variation.—Two other adult specimens were taken in the type locality. The following variations are in evidence. One specimen, a female, has 14–13 upper labials; 12 lower labials; the internasal scales are arranged with one large median scute, with a pair of smaller scales on each side; the angle of mouth fails distinctly to reach the posterior vertical of eye; no preanal pores, but a series of 12 enlarged scales on each side, angular medially, representing the pore scales; a series of distinct black spots on each side of tail just above the lateral fringe. The other specimen, also a female, has the internasal scales similar to those of the type save that the second row has 4 instead of 3 scales; upper labials, 13–14; lower labials, 12; calcareous deposits are present on the sides of neck.

On the opposite side of Mindoro, near Sablayan, another adult male specimen was taken. It agrees remarkably well with the type. The row of scales bordering the lower labials are distinctly larger than other chin scales. Preanal pores 12–11 in broad angular series; the body is gray with bronze-brown, irregular, zigzag markings.

Young.—Six pairs of small eggs were found attached to various trees under bark. These were brought to Manila, and with no special care ten young were hatched. These were very lively, but owing to my inability to obtain suitable food all died soon or were preserved. A male and female emerged from each pair of eggs; they were a uniform grayish brown; the largest measured 32.5 millimeters in length, the smallest, 29 millimeters.

The eggs are smooth, white, flattened on the two sides where they were attached to each other and to the trees. A great many of these eggs were found, but most of them were destroyed in removing them from their resting places.

Remarks.—This species is related to *L. christiani* Taylor, as shown by the arrangement of the nasals and the separation of the nostril from the rostral. It differs, however, in the development of the web between the toes; there is no skin fold on the femur, and the tail is essentially different.

The type and cotype, from Naujan Lake, Mindoro, were found under leaves of small climbing vines on trees. Other specimens observed escaped. The habitat is especially similar to that of the small *Siaphos kempi*, described from the same locality. On two occasions the two species were observed on the same tree. This species is probably common in the type locality.

Gekko mindorensis sp. nov. Fig. 2.

Type.—No. 499, E. H. Taylor collection; collected at Pocanil Point, Mindoro, May 4, 1916, by E. H. Taylor.

Description of type.—Head moderately large, rather oviform; distance from eye to snout somewhat longer than distance from eye to auricular opening; latter at least one-half diameter of eye, oval, distinctly oblique; rostral large, wider than deep, with a suture above, medially; nostril large, obliquely oval, surrounded by rostral, first labial, two subequal supranasals, and a postnasal; rostral forming the longest side of nostril; a single scale inserted between the two anterior supranasals; twelve upper labials; ten lower labials; the line of mouth makes

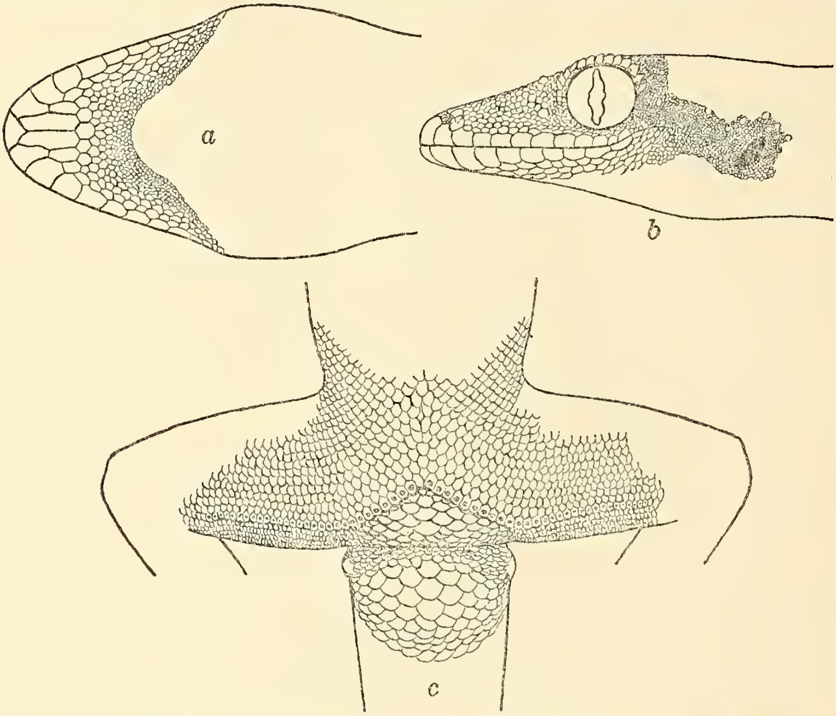

FIG. 2. *Gekko mindorensis* sp. nov., × 2. *a*, chin; *b*, head, side view; *c*, anal region.

a sharp angle upward immediately below eye; loreal regions covered with rather enlarged granules, largest immediately in front of eye; a row of enlarged granules bordering upper labials above; interorbital region and medial area on snout depressed, covered with much smaller granular scales; occipital region covered with minute granules interpersed with indistinct larger granules; mental triangular, followed by two elongate chin shields nearly three times as long as wide; a few enlarged pentagonal scales behind and at sides of chin shields; throat covered with equal-sized granules, larger than those on dorsal surface. Body rather slender, covered above with minute granules, intermixed with numerous rounding granules; an indistinct lateral fold; about 30 longitudinal rows of scales between the folds; preanal and femoral pores continuous, 27–28 on each side, slightly separated medially, a total of 55 pores. Tail regenerated wholly; above covered with fine granules, with no trace of annulations, below with irregular large broad scales; two enlarged tubercles at base of tail. Extremities moderate; toes not greatly dilated, about 16 lamellæ under longest toe; no rudiment of web evident.

Color in life.—Above almost uniform olive brown with but very little variation delineating the lighter and darker areas. No markings evident; below yellowish white.

Measurments of Gekko mindorensis sp. nov.

	mm.
Total length	162
Tail, regenerated	80
Snout to foreleg	34.5
Snout to vent	82
Snout to ear opening	22
Foreleg	30
Hind leg	40

Variation.—Eight other specimens have been studied, taken by myself about Naujan Lake, Mindoro. These specimens are all young; they are darker than the type, with blackish stripes across the backs and on the tails. Two males in the lot have 62 and 64 pores, respectively.

Remarks.—This species is related to *Gekko monarchus,* from which it differs as shown in the table of measurements. Several specimens of that species are at hand for comparison.

Comparative measurements of Gekko mindorensis and G. monarchus.

	G. mindorensis.	*G. monarchus.*
Snout to vent (mm.)	82	85
Foreleg (mm.)	26	29
Hind leg (mm.)	35	40
Width of body (mm.)	16	18
Width of head (mm.)	18	20
Diameter of eye (mm.)	6.5	5
Diameter of auricular opening (mm.)	3.3	2
Interorbital measurement (mm.)	6.75	8
Preanal and femoral pores	54	33
Scale rows across belly	30	45

Two males of equal size are compared. The ear-opening of *G. mindorensis* is larger, equaling half the eye. The eye itself is much larger than that of *G. monarchus;* the interorbital distance is less; there is a much larger number of preanal and femoral pores, the number of scale rows across the belly is about fifteen less; the tubercles are fewer and much less prominent and the very characteristic markings of *G. monarchus* are wanting.

The type specimen was captured with the assistance of Mr. Clark Burks, of Sumagui, Mindoro; two eggs were found at the same time.

Oshima [2] has described *Gekko kikuchii* from Botel Tobago, Formosa, which seems to vary from *Gekko monarchus* in much the same way as does the present species. Although no specimens of the species are at hand for comparison the following differences are evident: *Gekko mindorensis* has many more femoral pores, 55 to 64, while 48 are recorded in *G. kikuchii;* the limbs are longer in the present species, and the basal web is wanting on the feet in both sexes.

Siaphos kempi sp. nov. Fig. 3.

Type.—No. 2016, E. H. Taylor collection; collected April 23, 1916, at Naujan Lake, Mindoro, by E. H. Taylor.

Description of type.—Head short, snout blunt, not especially depressed; rostral covering tip of snout, the part visible above much less than the depth of snout at the posterior border of rostral; no supranasals; frontonasal large, the suture with rostral equal to, or smaller than, that with nasal, and slightly larger than that with frontal; prefrontals much reduced, separated, not in contact with first supraocular; frontal moderate, about equal to frontoparietal in length, as long as its distance from end of snout, in contact with two supraoculars and first superciliary; frontoparietals fused in a single scale a little broader than long; interparietal triangular, a little wider than frontal, but shorter; parietals forming a suture behind interparietal; four pairs of nuchals; nasal pierced medially by nostril, touching a single labial; two frenals, both higher than wide; four supraoculars, last longest, second widest; eight superciliaries; several much enlarged temporals; seven upper labials, fifth below center of eye; five or six lower labials; mental larger than rostral; ear opening obliquely oval, moderately large; eye nearer tip of snout than ear opening; limbs small, barely touching when adpressed; digits not or but slightly compressed; 20 lamellæ under fourth toe; two enlarged preanals; median row of scales under tail slightly widened; 22 scale rows around body; scales smooth, the median dorsal rows widest.

[2] *Philip. Journ. Sci., Sec. D* (1912) 7, 241.

Color in life.—Above silvery olive to brown, somewhat lighter on tail; laterally a broad dark stripe from eye to near end of tail, becoming somewhat lighter on tail, bordered above and below with a narrow greenish silver line; head uniform dark brown; belly dirty greenish white with a few small specks of dark color under chin; underpart of tail creamy white; limbs mottled brown and yellowish.

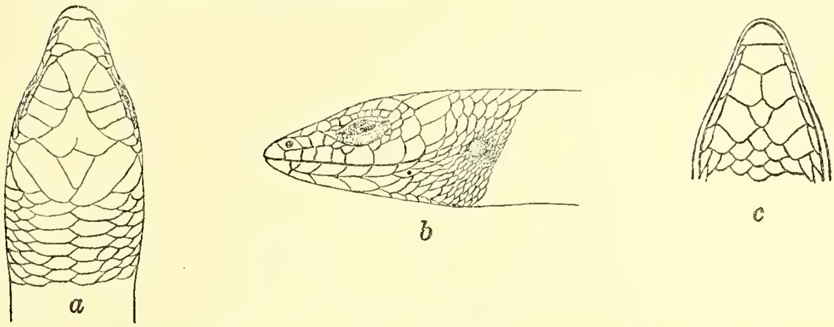

FIG. 3. *Siaphos kempi* sp. nov., from the type, × 4. *a*, head, dorsal view; *b*, head, lateral view; *c*, chin.

Measurements of Siaphos kempi sp. nov.

	mm.
Total length	93
Tail	53
Axilla to groin	21
Snout to vent	40
Snout to foreleg	14.5
Foreleg	9
Hind leg	14

Variations.—Two other specimens were taken in the same locality; both agree with the type in markings save that both are lighter above; they are practically identical in scalation.

Remarks.—This species appears to be intermediate between *Leiolepisma* and *Siaphos*. I have referred it to the latter rather than to the former genus because of its closer superficial resemblance to the other Philippine members of that genus and the fewer prefrontals and shorter limbs; the ear opening, however, is large and distinct. The known Philippine species of *Leiolepisma* have the divided frontoparietal; the three known species of *Siaphos* have the frontoparietal single.

The species is named for Ollie C. Kemp, Mangyan agent in Mindoro, who accompanied me on the collecting trip to Naujan Lake and assisted in making collections.

The species was found living under the leaves of small, close-clinging vines on trees. When these vines were loosened at the base of the tree and torn down, the lizards were revealed on the sides of the trees at some distance from the ground and they immediately took refuge much higher up the tree; thus many specimens escaped. Only three specimens, brought down with the vines, were captured.

This species differs markedly from the two small species *Siaphos infralineolatum* Peters and *Siaphos quadrivitatum* Peters in size, markings, and the presence of an auricular opening. From the recently described *Siaphos auriculatum* Taylor, which it resembles greatly in markings, it differs in the presence of small prefrontals, and it probably does not grow so large. Many other differences are obvious on a comparison of descriptions and figures. Known only from the type locality.

Sphenomorphus lednickyi sp. nov. Fig. 4.

Type.—No. R 1992, E. H. Taylor collection; collected in June, 1917, on Masbate Island, by Victor E. Lednicky.

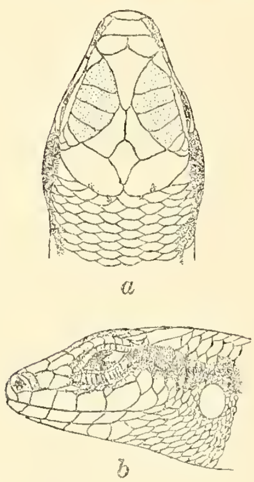

FIG. 4. *Sphenomorphus lednickyi* sp. nov., No. 291, E. H. T. collection, × 3. *a*, head, dorsal view; *b*, head, lateral view.

Description of type.—Rostral only slightly visible from above, forming a broad, rather curved suture with frontonasal; latter much broader than deep, broader behind than in front, in contact with anterior frenal; prefrontals large, broadly in contact, touching both frenals laterally, not in contact with first supraocular; frontal as wide as, or slightly less than, the supraocular region, in contact with first superciliary and two supraoculars, narrowed behind; frontoparietals distinct, rather elongate, broadly in contact; interparietal much longer than wide, with a distinct eyespot; parietals forming a suture behind interparietals; no nuchals present; five supraoculars, last very small, first deepest, second widest; nostril pierced in a single nasal; no supranasals; anterior frenal not as high as nasal, much higher than wide; second frenal wider at top than bottom, lower than anterior; three preoculars superimposed, between first superciliary and third labial; six upper labials, fourth and fifth under eye, but separated from orbit by several scales; third labial smaller than second; five lower labials; mental small, followed by a very wide postmental; three pairs of chin shields, only first pair in contact; four enlarged temporals, that bordering parietal largest; auricular opening very large; tympanum very superficial; 40 rows of scales around belly; scales on sides in longitudinal rows, all rows subequal in size; preanal scales distinctly enlarged; limbs well developed, the adpressed hind leg reaching wrist of foreleg; latter brought forward reaches middle of eye; 22 lamellæ under longest toe; scales below tail scarcely broadened; eye a little nearer end of snout than ear; latter nearer foreleg than end of snout.

Color.—Head and body variegated brown above with dark areas over supraocular region and a median row of irregular black dots, extending somewhat on tail; a heavy black stripe begins behind eye and continues as a broken series of irregular spots along side of body and tail above legs; legs brown, with black variegations and a light spot on knee; toes barred with black; throat and labials muddy white; belly light cream; tail below with dark flecks; a few cream yellow spots above and below the black stripe on neck.

Measurements of Sphenomorphus lednickyi sp. nov.

	Type. mm.	Cotype. mm.
Total length	106	114
Snout to vent	46	50
Snout to foreleg	18	18.5
Tail	60	64
Axilla to groin	27	28
Width of head	7	8
Length of head	8.6	8.5
Foreleg	15	14
Hind leg	21	22.5

Variation.—A second specimen from the same locality agrees in scalation, but the head is broader, and the broad black stripe is almost wanting along the body. The regenerated tail has broad scales above and below.

Remarks.—The two specimens were collected in Masbate, near the Aroroy gold mines, by Mr. Victor E. Lednicky. He states that they appear to be plentiful in that locality. Superficially this species resembles *Sphenomorphus curtirostris*, but the latter has the frontoparietal single, fourteen lamellæ under longest toe, more upper labials, and the nasal followed by superimposed frenals. It is a larger species. I take pleasure in naming the species for its discoverer.

Sphenomorphus llanosi sp. nov. Plate II.

Type.—Santo Tomas Museum, Manila, specimen unnumbered, collector unknown. Probably from Luzon.

Description of type.—Habit lacertiform; snout narrower and longer than in *Sphenomorphus jagori;* rostral much wider than high, much narrowed laterally in front of first labial below nasal; frontonasal little broader than deep, forming a straight suture with rostral, laterally in contact with upper anterior frenal, posteriorly in contact with frontal; prefrontals rectangular, separated in the middle, in contact laterally with upper anterior and posterior frenals, and a single superciliary; frontal much elongate, narrowed behind and in front; distance between supraocular regions about one-third the width of the region above one eye; frontal little shorter than frontoparietal and interparietal length, in contact with two supraoculars; frontoparietals slender, pointed in front, forming a common suture much more than half their length; interparietal nearly as broad as frontal, but not nearly as long, as large as frontoparietals; parietals large, in contact behind interparietals, touching last supraocular and two small postoculars; no nuchals; nasal quite large, the scale placed diagonally, touching only one labial; two anterior frenals superimposed, the two not as high as nasal, but higher than the very large frenal following, which is much wider at top than bottom, touching two labials; two preoculars, the lower largest, followed by two moderately large scales below eye, the second partly wedged between fifth and sixth labials; ten superciliaries; five large supraoculars followed by two paired scales, the first supraocular more than a third of the length of the supraocular region, second widest; nine upper labials, sixth below orbit, sixth and seventh largest; five distinctly enlarged temporals, the largest bordering parietal; eight or nine lower labials; one unpaired postmental; two paired chin shields, first pair in contact, second separated by one scale; anals enlarged; 23 lamellæ under longest toe; ear opening moderate, vertically oval; 42 scale rows around middle of body. Adpressed hind leg reaches beyond elbow of adpressed foreleg; adpressed foreleg reaches anterior corner of eye.

Color in alcohol.—Above rich, reddish brown traversed by about thirteen indistinct bands of light, black-edged dots on back, and continuing on tail; behind eye to above foreleg is a large, broad, dark brown stripe bordered below by a white stripe, which begins on second labial and continues back to ear, then widens and takes a backward and downward course to foreleg; below this there is a rather irregular mottled area of brown; lower labial flecked with brown; limbs above mottled with elongate light spots; sides somewhat lighter, flecked with brown; a brown area above hind limb; below yellowish; there is a very dim row of brown spots along upper lateral region.

Measurements of Sphenomorphus llanosi sp. nov.

	mm.
Total length	148
Tail (end regenerated)	60
Foreleg	16
Hind leg	26
Axilla to groin	27.5
Snout to foreleg	21.5
Snout to eye	5
Eye to ear	5.2
Ear to foreleg	8.5
Width of head	9

Remarks.—Closely related to *S. jagori*, but differs in the following points: The first frenal is divided and the scales superimposed; the second frenal is proportionally much larger; there are five instead of four large supraoculars; the frontoparietals are slenderer and extend farther forward; the coloration is also distinctive; there are more rows of scales about the body.

Unfortunately the collections in the Santo Tomas Museum are unnumbered, and for the most part are without authentic localities. It is highly probable that this species is from Luzon, and perhaps the northern part of the island. Only a single specimen, the type, is present in the collection. I take pleasure in naming this species in honor of Father Florencio Llanos, director of the University of Santo Tomas, who has generously permitted me to study the collections in the museum of the university and to describe the new species.

ILUSTRATIONS

Plate I

FIG. 1. *Typhlops longicauda* sp. nov., from the type, × 5. *a*, lateral view; *b*, dorsal view; *c*, ventral view.

2. *a*, *Hemidactylus frenatus* Duméril and Bibron; *b* and *c*, *Hemidactylus luzonensis* Taylor.

Plate II

Sphenomorphus llanosi sp. nov., from the type, about × 1.5.

TEXT FIGURES

FIG. 1. *Trimeresurus mcgregori* sp. nov., from the type, × 1. *a*, head, lateral view; *b*, head, dorsal view; *c*, chin.

2. *Gekko mindorensis* sp. nov., × 2. *a*, chin; *b*, head, lateral view; *c*, anal region.

3. *Siaphos kempi* sp. nov., from the type, × 4. *a*, head, dorsal view; *b*, head, lateral view; *c*, chin.

4. *Sphenomorphus lednickyi* sp. nov., × 3. *a*, head, dorsal view; *b*, head, lateral view.

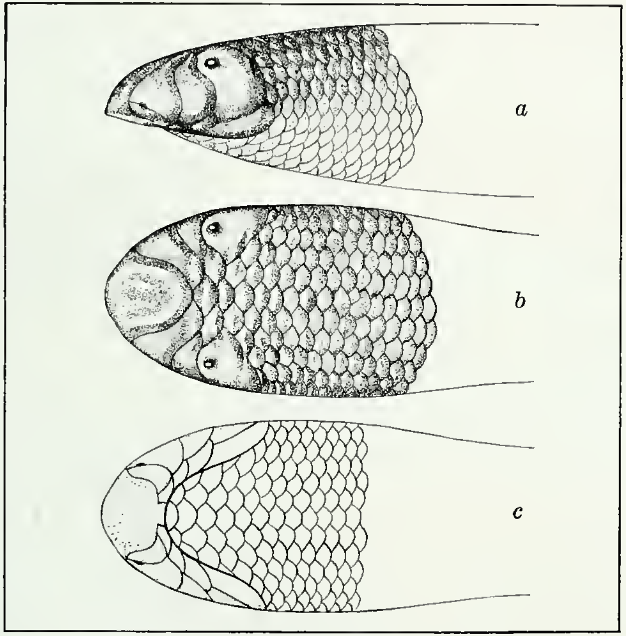

Fig. 1. Typhlops longicauda sp. nov., from the type, × 5.

Fig. 2. *a*, Hemidactylus frenatus Duméril and Bibron; *b* and *c*, Hemidactylus luzonensis Taylor.

PLATE I.

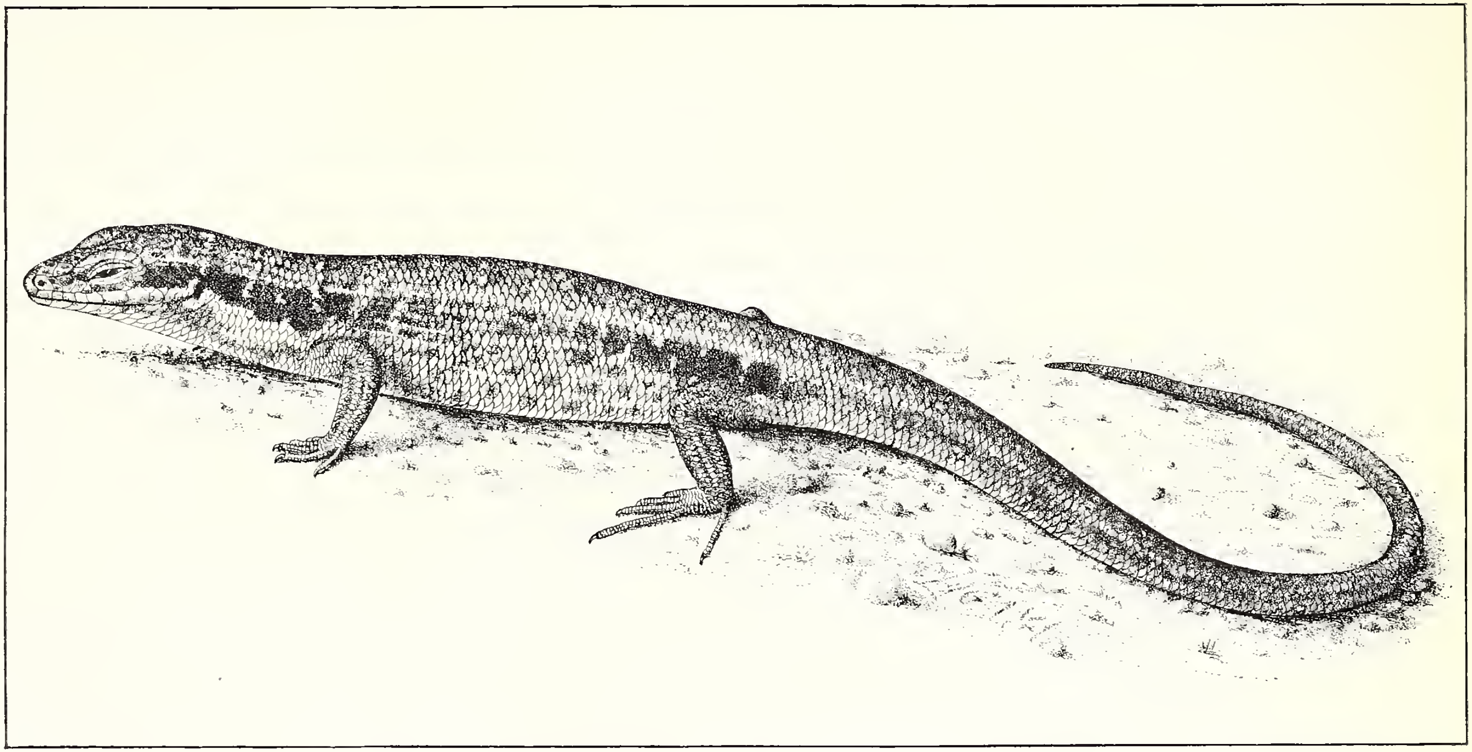

PLATE II. SPHENOMORPHUS LLANOSI SP. NOV., FROM THE TYPE, ABOUT × 1.5.

IPON FISHERIES OF ABRA RIVER

By EDWARD H. TAYLOR

(From the Section of Ichthyology, Biological Laboratory, Bureau of Science, Manila)

On the western coast of Luzon as well as in numerous other parts of the Philippines there are several annual runs of the young of a small fish of the family Gobiidæ, known to the Ilocanos as *ipon* or *hipon*.[1] At stated seasons they appear along the shore and attempt the ascent of the rivers, where they attain adult size. The adults reach a length of from 8 to 10 centimeters; the young when taken are usually less than 2 centimeters in length. In spite of the very small size of these fishes the catch in the Philippines is so large that the industry is of marked economic importance.

The ipon fisheries of Abra River, which are typical of the ipon fisheries of other places along the Luzon coast, are probably the best illustration of this important industry.

Abra River rises in the highlands dividing Kalinga Subprovince, Mountain Province, from Abra Subprovince, Ilocos Sur. It is fed by several fairly large streams, which carry much water during the rainy season. It emerges from the mountainous plateau of Abra through a narrow gap in the coast range about 12 kilometers from the sea. Here on the coastal plain it spreads out in fan shape, to lakelike dimensions, entering the sea through several mouths. In its upper reaches it probably attains considerable depths, since several soundings of more than 10 meters' depth were made. However, it frequently descends over long stretches of gravel and small bowlders, with a depth of from 1 to 2 meters. During the dry season the depth at the various mouths is slight, probably averaging about a meter. The provincial road crosses the river very near the mountain gap. Here the river is about 0.4 kilometer wide, and the depth does not exceed 2.5 meters during December.

The ipon of Abra River that were taken during November were the young of a small goby which when full grown does not attain a length of more than 10 centimeters. During the greater

[1] In many of the Filipino dialects the names *ipon* and *hipon* are applied to small shrimps or prawns, species of which are found in both fresh and salt water.

part of the year it is found in the fresh water of lakes and rivers. At certain seasons it descends to the sea to spawn, probably about the month of June, for the young ipon make their first appearance along the coast during September, rarely in August.

According to substantiated report the young arrive near the coast nine days after the first full moon in each month from September until February. Fishing begins along the coast as soon as the fish are sighted, in water from 2 to 10 meters deep. The sea catch is of superior quality and brings the highest prices. However, shore fishing is profitable for only three days, because during these three days the fish have entered the river and may be caught by nets and traps. The river fishing lasts several days after the shore fishing has ceased to be profitable. The value of the fresh-water catch quickly diminishes. The fresh water has a tendency to turn the living fish dark, and as the flesh darkens it acquires a somewhat bitter taste. The fish when full grown has a fair flavor and when fried crisp is quite palatable. After a few days the river catch has lost entirely its commercial value, and the fishermen await the next monthly run. The number of adults captured for food is negligible.

The two most important methods of taking the fish are by means of a special net, known as *daclis de ipon,* and a small trap, known locally as *sarep.* The former is the more important. It is a large affair, averaging 60 to 100 meters in length and 8 to 12 meters in depth. It is composed of many pieces of abacá or maguey cloth sewn together lengthwise and resembles a huge piece of patchwork, varying in shade from yellow to brown. Brails are attached at the ends; the tops are well corked; the bottoms are leaded heavily, and the leads are concealed by several long ropes running lengthwise and securely fastened together. These ropes seem to prevent the bottom of the net from becoming readily entangled with objects on the sea bottom. The net is used near the river mouth in water as deep as 12 or 14 meters. During a run of the ipon, a good haul will often bring in as many as 10 cavans; [2] the usual haul is less.

From January 1 to November 1, 1916, the town of Caoayan lying at the mouth of the river, licensed one hundred thirty-six of these nets, daclis de ipon (or *chinchorros para ipon,* as designated on the tax ordinance). Each net of this type is taxed annually 10 pesos,[3] thereby bringing to the tax income of the

[2] One cavan equals 75 liters.

[3] One peso Philippine currency equals 50 cents United States currency.

town 1,360 pesos per annum. Each net over 60 meters in length has a marketable value of 300 pesos or more; thus the nets represent a property value of at least 40,800 pesos.

The sarep is a small cylindrical trap made of finely woven bamboo and is about 1 meter long by 25 centimeters in diameter; at one end it tapers to a narrow cylindrical mouth stopped by a cork about 5 centimeters in diameter. The other end is furnished with a funnel-shaped mouth, which extends within for about one-third of the length. These traps are set in the river near the various mouths where the water is shallow or where there are riffles, as many as two hundred being placed side by side in certain designated places. The places where sarep may be used are fixed and classified by the municipal councils. These places are designated as "first class" and "second class." For a first-class location the minimum tax is 12 pesos per annum; but these places are usually sold at auction, the best localities bringing as much as 40 pesos each. The minimum for the second-class locations is 6 pesos per annum.

The auctioning of locations is frequently the occasion of much dissension among the fishermen, at times resulting in fights.

The catch for the most part is made into the popular fish food, known as *bagoon̄g*.[4] To make bagoon̄g the fish are laid in layers in large earthen jars called *tinajas*, a layer of salt between two layers of fish. This mixture is then stored away and allowed to ferment into an evil-smelling substance, which is greatly relished by many Filipinos. The liquid portion obtained from the mixture is used for a sauce and is usually eaten with rice, while the more solid part of the ferment is heated or fried and eaten as ordinary fish. The proportion of salt and fish varies; according to Seale[5] the proportion is two parts of fish to three parts of salt for certain varieties of bagoon̄g. This is certainly a much higher percentage of salt than is used or required for the bagoon̄g made of ipon.

The fisheries at the mouth of the river are in the hands of the two municipalities of Santa and Caoayan. In the two towns the taxes on the fishing industry alone amounted to 3,224.39 pesos for 1915, and the collections for 1916 up to December 1 amounted to 3,220.15 pesos. Not all of this represents tax on the ipon fishery, but certainly a large part of it does, since

[4] Bagoon̄g is a generic term applied to a number of preparations made from small fish or shrimp. It is usually known as *guinamos* in Visayan dialects.

[5] Seale, Alvin, *Philip. Journ. Sci., Sec. D* (1914), 9, 4.

according to a previous paragraph the taxes on the daclis de ipon in the town of Caoayan alone, not including the sarep localities, amounted to at least 1,360 pesos.

A conservative estimate of the value of the ipon fisheries of Abra River based on the average of the catches of individual fishermen, on the estimates of various officials and traders, and on the taxes for the nets and traps for catching ipon, amounts to well over 350,000 pesos annually. Various estimates made by the municipal treasurers and secretaries were invariably between 400,000 and 500,000 pesos. These last estimates are too large, save during exceptional years, as the size of the catch varies from year to year.

To use this fish for canning would be feasible. Without doubt such a canned product would find a ready sale in interior towns. Possibly it might take the form of a paste such as the anchovy paste now found in European and American markets, or the ipon might be preserved in a piquant sauce and used as a relish with curry or preserved in oil and used the same as salmon and other fish products.

Appended is a statement obtained from the Provincial Treasurer of Ilocos Sur of tax receipts for towns along Abra River.

TABLE I.—*Statement of collections on fisheries of the municipalities along Abra River.*

Municipality.	1914	1915	1916	1916 up to—
	Pesos.	*Pesos.*	*Pesos.*	
Bangued, Abra	21.55	21.75	17.05	Nov. 30.
Bucay, Abra	62.56	70.20	43.00	Oct. 31.
Caoayan, Ilocos Sur	1,903.90	2,037.16	2,333.31	Nov. 30.
Dolores, Abra	5.91	14.88	7.13	Sept. 30.
Piotiojan, Abra	10.00	10.00	11.00	Oct. 31.
Pilar, Abra	33.60	14.60	----------	Sept. 30.
Santa, Ilocos Sur	1,048.49	1,187.23	986.04	Nov. 30.
Tayum, Abra	44.00	62.00	53.00	Nov. 30.
Two towns of Ilocos Sur at mouth of river	2,957.39	3,224.39	3,220.15	[a] 9,396.93
Six towns on upper river in Abra	177.62	193.13	131.18	[a] 501.93

[a] Total for three years.

PHYTOPHTHORA FABERI MAUBL.: THE CAUSE OF COCONUT BUD ROT IN THE PHILIPPINES

By Otto A. Reinking

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THREE PLATES

The cause, and the method of spread, of coconut bud rot, which produces severe losses in all parts of the tropics where coconuts are cultivated have been subjects of investigation. Various organisms have been considered responsible for the disease. Because of this diversity of opinion, extensive work has been done by the writer to determine, if possible, the organism responsible for the disease in the Philippine Islands. Although these studies are still in progress, sufficient evidence has been obtained to make it seem advisable to present in a preliminary paper the most important conclusions that have been reached. Before adequate control measures can be devised to reduce the damage done by this disease, it is of the utmost importance that the causal organism and its methods of dissemination be definitely known. The work already done has been sufficient to establish the identity of the organism responsible for the disease in the Philippine Islands.

HISTORY OF THE DISEASE IN THE PHILIPPINES

In March, 1908, the first authentic and reliable investigations into the bud-rot situation in the Philippines were conducted by Copeland.(5) The disease was reported as prevalent in the coconut sections of Laguna and Tayabas Provinces, being especially severe in the regions surrounding Lilio and Nagcarlan; and some cases were observed on the mountain slopes near the town of Tayabas. In the vicinity of Nagcarlan, it had been reported as being serious for a period of ten years preceding these studies. Due to these investigations ordinances were enacted in Laguna Province whereby all the infected trees were to be cut down and burned, in order to check the advance. In the latter part of the same year Byars,(3) of the Philippine Bureau of Agriculture, visited the affected regions for "the inspection of these provinces with a view to eradicating the bacterial disease known as 'bud-rot of the coconut'." On this trip Byars found the disease to be most prevalent around the base of Mount Banahao in the municipalities of Nagcarlan, Lilio, and San Pablo. It was reported that more than two thousand trees had been destroyed in one of the barrios of Nagcarlan. In March, 1911, Roxas(11) in a report on the cultivation of coconut mentions the bud rot as being probably due to bacteria. Cevallos,(4) in 1911, discussed control measures for the bud rot that had been observed some years ago. In 1912 Barrett(1) wrote of the infection as being by far the most serious of all the fungus or bacterial diseases that trouble the coconut planter. In 1916 the first extensive means for combating the bud rot were inaugurated by the Bureau of Agriculture under the direction of Mackie.(8) The work "was designed to furnish information as to the spread and the prevalence of disease and, if possible, to ascertain the pathogenic agent, and the means of distribution." The inspections were confined largely to the coconut belt in central Luzon, in Laguna and Tayabas Provinces. New ordinances were passed, and the Bureau of Agriculture was charged with inspection and destruction of infected trees. Little was learned, however, concerning the cause and manner of its spread. A bacterium was reported to have been isolated from affected trees, and from palm weevils that attack the trees, and an attempt was made to prove that the insects carried the organism and spread the disease. No inoculation studies were performed. Wester,(12) in a paper on coconuts, cited Reinking, of the College of Agriculture, as having isolated a bacterium which produced disease when inoculated into healthy trees. The latter, in a report on Philippine economic-plant diseases,(9) under the discussion of bud rot, stated that a diseased condition could be produced by a specific bacterium.

From this resumé of the literature in the Philippine Islands it may be seen that very little work has been reported on the causal organism, and that the general opinion has been that a bacterium was the cause of the disease.

Johnston,(7) after an extensive piece of work on coconut bud rot, arrived at the conclusion that the disease in the West Indies was caused by a bacterium similar in most respects to *Bacillus coli* (Escherich) Migula. Butler(2) has presented evidence to prove that the disease on palms in India was produced by *Pythium palmivorum* Butler. In other sections of the world various fungi have been associated with the disease.

For the past two years the writer has made a study of the rot with the aim of determining the causal organism. Until the present investigations were started, no accurate and definite study was made of the organism which causes the coconut bud rot in the Philippines. The report as here presented is only a preliminary one; a complete work on the bacterial and fungus phases will be prepared at a later date. Preliminary tests indicated that the disease might be due entirely to bacteria; but more extensive studies proved that bacteria could not account for the severity of the disease observed under field conditions. On March 11, 1919, from a diseased tree kindly sent in by the Bureau of Agriculture, a fungus was isolated which was proved to produce disease in all seedlings inoculated. This work, taken in connection with inoculation studies with *Phytophthora faberi* Maubl. isolated from cacao pods, appears to the writer to furnish conclusive evidence that the primary agent in the production of the infection is a fungus; and that bacteria, while always associated with severe cases of the disease, are to be regarded as secondary agents.

DISTRIBUTION OF THE DISEASE

In the Philippines, according to the Bureau of Agriculture reports for 1916 by Mackie,(8) the disease was found in Laguna, Tayabas, Batangas, Pangasinan, Tarlac, Albay, and Ambos Camarines Provinces; and it was reported as occurring in Misamis, Capiz, Samar, and Bohol. The report of the Bureau of Agriculture for the year 1917–18, submitted by Mr. G. Merino, states that the disease is also prevalent in Zamboanga. The infection is most severe and widespread in those sections of the Islands in which the climatic conditions afford a very moist atmosphere. Thus coconut bud rot is very abundant in the upper belt of the coconut country about Mount Banahao. The studies made by the writer were concerned principally with this section.

An extensive discussion of the rot as it occurs in other parts of the world has been given by Copeland(6) and by Johnston.(7)

NATURE OF THE DISEASE

General diagnosis.—The first symptom is a withering of the youngest unfolded leaf, followed by the leaf turning brown. Gradually the next younger leaves wither and turn brown, until the entire central group is affected. At this stage the central leaves may be easily pulled out. Frequently, in advanced cases, they fall over (Plate I, figs. 1, 2, and 3). About this diseased central portion is a fringe of older leaves, which are perfectly healthy and remain upon the tree for months after infection.

It appears that trees are most commonly infected when they first come into bearing. The young nuts on a bearing tree attacked remain small and fall off prematurely.

Internal symptoms are very characteristic. The fungus apparently gains entrance into the soft tissue, usually called the "cabbage," through the youngest leaves. In the early stages a longitudinal section of the bud shows that the disease may start in young leaves, at a point where they begin to unfold (Plate II, fig. 1). At this point a spotting of the leaf is first noticed; then the organism works downward, causing a soft rot and browning of the group of unfolded leaves. The upper exposed portions of these die and turn brown, due to the rotting beneath. The rot advances downward to the growing point and then spreads into the soft tissue below. From here it invades the woody parts, usually not penetrating farther than from 5 to 10 centimeters. In the early stages no discoloration is produced in the growing point and "cabbage," but a dark red to brownish line always marks the limits of the advance in the woody parts (Plate II, fig. 4). The organism does not penetrate readily into the old leaf sheaths surrounding the young, tender, developing portions (Plate III, figs. 1, 2, and 3). The rot is commonly checked when it reaches the firmer tissues of the trunk though, in advanced cases, it may penetrate about 20 centimeters (Plate III, figs. 1 and 2). The affected portion in the trunk may become greatly softened; this is shown by the fact that the finger can be pushed into the diseased part. There is present a putrid, somewhat sour odor. The most advanced stages are characterized by the change of the white "cabbage" into an ill-smelling, semiliquid mass. A portion of the trunk below becomes a softened group of fibers.

Spread and loss.—The disease spreads very rapidly from tree to tree, but the manner in which this is accomplished has not been thoroughly investigated. Wind and insects are probably the most important agencies. In one barrio under observation, fifty-eight new infections appeared within one year after an inspection in which all attacked trees found had been cut down and burned. The disease may have started from trees unobserved during the first examination. The trees were located in the upper extremities of the coconut region on the slopes of Mount Banahao, where the atmosphere is very moist and where thick planting is practiced. Both conditions are favorable for the development and spread of the organism.

Up to September 30, 1918, according to reports of the Bureau of Agriculture furnished the writer by Mr. José Sanvictores, 12,813 coconut trees had been found affected in Laguna, Tayabas, Pangasinan, and Zamboanga Provinces. The largest number was found in the first two provinces. Since each tree is valued at not less than 10 pesos, the entire loss, not including early losses and the cost of inspection and burning of affected coconut trees, has been 128,130 pesos. The number of trees destroyed will undoubtedly be lessened by a thorough system of inspection and eradication of diseased trees. Future examinations ought to show a lower proportion of infection.

INVESTIGATION OF THE DISEASE

FIELD STUDIES

Careful study has been made of more than thirty typical cases in the field. These diseased trees were cut down and the buds opened for observation. Judging from macroscopic examination the infection appeared to be due to bacteria. Portions of infected trees were collected and placed in sterile vials for transporting to the laboratory. In addition to these studies, work was done with diseased specimens sent to the College of Agriculture by the Bureau of Agriculture.

LABORATORY STUDIES

Bacterial.—During the first part of the investigation microscopic examinations, in the majority of cases, failed to reveal the presence of mycelia. Bacteria, however, were always present in abundance. Diseased pieces, which had been collected under sterile conditions in the field and placed immediately in sterile vials, usually developed no fungi; but they were completely overgrown with bacteria. Later studies have indicated that, in these cases, the bacteria multiplied rapidly and destroyed the slower-growing fungus that probably was present. The only fungi observed in the earlier studies were saprophytic forms.

Cultures were obtained by cutting and plating small pieces from all parts of infected trees, specimens being taken from the tip of the unfolded infected leaves down to the growing point and the woody tissue below. A mixed culture of bacteria was present in the majority of these cases. In very young stages of infection, and in tissues into which infection has advanced farthest, only one kind of bacterium may be present. Such cases were usually not obtained, probably because saprophytic bacteria are soon washed down into the infected parts and there find a favorable place for development. Since no specific fungus was isolated in the first studies, and bacteria were always present, inoculation experiments were conducted with them in order to test their virulence.

The inoculations were made chiefly with seedling coconuts from 60 to 180 centimeters in height. They were prepared by stripping off the outermost leaves. Then the outside of the portion to be inoculated was washed with mercuric chloride, 1 to 1,000, and after ten minutes was rinsed with sterilized water. With a sterile scalpel a stab was made into the growing point, and a pure culture of the bacterium introduced with a platinum needle. The injured portion was then covered with melted paraffin. Controls were prepared in the same manner except that sterile water was used in place of the bacteria. About three hundred inoculations have been made in this manner, and in a number of instances cases of bud rot were produced (Plate II, figs. 5 and 6). Employing this method, saprophytic bacteria were eliminated, because of their failure to produce disease. After the elimination of these saprophytic forms, there remained one distinct kind of bacterium that would produce disease under certain favorable conditions, such as severe injury of the growing point, and excessive dampness. Inoculations were not repeatedly successful, but when the exact requirements were met a number of positive infections could be obtained. Bacteriological tests have shown that the organism thus isolated and used for inoculations was similar to *Bacillus coli* (Escherich) Mig., and apparently is identical with that considered by Johnston(7) to be the cause of coconut bud rot.

Authenticated cultures of *Bacillus coli* (Escherich) Mig. were obtained from Dr. L. R. Jones, of the University of Wisconsin, and also from Dr. O. Schöbl, of the Philippine Bureau of Science. The cultures from the United States were isolated from man, and those secured in the Philippines, from man and horse. Under extremely favorable conditions a bud rot could be produced with each of these cultures. The infections produced from the first inoculations were very slight; but the organism, after it was reisolated and then used for reinoculation, appeared to produce a more rapid and severe case of rot. This may indicate that the bacteria increase somewhat in virulence after passing through a weakened tissue.

Cytological studies also have shown the presence of bacteria in the tissues of the coconut. Sections of a typical case were made from parts of the young leaves near the growing point, from portions of the growing point, and from the woody tissue. These sections show that the organism is present not only in the parenchymatous tissue, but also in the vascular system.

The bacteria are present in the xylem tubes of the young leaves, and of all the parts down to the woody tissue. This probably accounts for the rapid spread of the bacteria.

Thus bacterial studies have proved that under certain very favorable conditions *Bacillus coli* (Escherich) Mig., and a similar organism isolated from coconut trees, may produce disease. A summary of the entire bacterial investigations has indicated that, although the bacteria are always present and account for the destruction of a portion of the weakened tissues, they can not explain the prevalence and rapid spread of the disease. Further researches have been conducted in order to ascertain whether or not a fungus is present and is the primary agent in the production of the disease.

Phytophthora faberi Maubl. studies.—While the investigations of coconut bud rot were in progress, studies were also being conducted with *Phytophthora faberi* Maubl. isolated from cacao. The latter organism proved not only to cause the black rot of cacao pods, the rot of papaya fruit, and the canker of cacao and Hevea rubber, but also to produce an infection in a number of other hosts as well. Table I gives a summary of these inoculations.

TABLE I.—*Infection experiments with Phytophthora faberi Maubl. isolated from the black rot of cacao pods.*

Seedlings killed by the organism:
- *Annona muricata* L. Guanabano; soursop.
- *Hevea brasiliensis* (H. B. K.) Muell. et Arg. Para rubber.
- *Spondias lutea* L.
- *Theobroma cacao* L. Cacao.

Infection confined to wounds:
- *Annona glabra* L.
- *Ariocarpus odoratissima* Blanco. Marang.
- *Artocarpus integra* (Raderm.) Merr. Jack fruit.
- *Averrhoa bilimbi* L. Camias.
- *Eugenia jambolana* Lam. Duhat; lumboy.
- *Lansium domesticum* Jack. Lansones.

Fruit rot produced:
- *Carica papaya* L. Papaya.
- *Theobroma cacao* L. Cacao.

Because of the omnivorous habit of this fungus, and since various countries in the East, notably India, have reported that coconut bud rot has been produced by a Phycomycete, *Pythium palmivorum* Butler,(2) it was deemed advisable to try inoculations with *Phytophthora faberi* Maubl. isolated from cacao pods. As is shown by the inoculation experiments presented in Table II, a large percentage of the trees became diseased.

TABLE II.—*Coconut inoculation experiments with Phytophthora faberi Maubl. from cacao.*

Tree.	Date.	Character of inoculation.	Observations.		Reisolation.
			Severe rot.	No rot.	
	1918.		1918.	1918.	
1	Oct. 4	Stab; damp chamber		Oct. 15	
2	do	do	Oct. 15		+
3	do	do	do		+
4	do	do		Oct. 15	
5	Nov. 11	do	Nov. 21		+
[a]6	Aug. 16	Stab; outside in shade		Oct. 15	
7	Aug. 26	do	Sept. 20		+
8	Nov. 18	do	Dec. 4		+
9	Dec. 10	do	Dec. 16		+
10	do	do	do		+
[a]11	Nov. 18	do		Dec. 16	
	1919.		1919.		
12	Jan. 13	do	Jan. 26		+
13	do	do	do		+
				1919.	
[a]14	do	do		Jan. 16	
	1918.		1918.		
15	Nov. 20	do	Nov. 26		+
16	do	do	do		+
				1918.	
[a]17	do	do		Nov. 26	
18	Nov. 22	do	Dec. 10		
19	do	do	Dec. 7		+
20	do	do	Dec. 10		
[a]21	do	do		Dec. 10	
	1919.		1919.		
22	Jan. 21	do	Jan. 29		+
23	do	do	do		
				1919.	
[a]24	do	do		Jan. 29	
25	Jan. 8	do	Jan. 16		+
26	do	do		Jan. 16	
[a]27	do	do		do	
28	Jan. 13	Uninjured; outside in shade		Jan. 26	
	1918.		1918.		
29	Nov. 20	do	Nov. 26		+
				1918.	
30	Dec. 13	do		Dec. 30	
31	do	do		do	
32	do	do		do	
[a]33	do	do		do	
	1919.			1919.	
34	Jan. 8	do		Jan. 16	
			1919.		
35	Feb. 3	do	Feb. 18		+
36	do	do		Feb. 18	
[a]37	do	do		do	
38	Feb. 20	Stab; mature tree outside	Apr. 7		+
39	do	do	(b)		
[a]40	do	do	Apr. 7		

[a] Control. [b] Not as yet examined.

The infection was extremely rapid; when the seedlings were placed in a damp chamber, severe disease occurred a few days after inoculation. The same method of inoculation was used as that described under bacterial studies. Of five cases infected by the stab method and placed in the damp chamber, three developed severe cases of bud rot. Of fifteen seedlings inoculated in the same manner, but placed outside in the shade, fourteen developed the disease. Eight seedlings were inoculated by merely placing the fungus between the young unfolded leaves near their tips; these seedlings were placed in the shade and two developed the infection. Trees 38, 39, and 40 were large, mature trees in a coconut grove. They were prepared in the same manner as the seedlings, except that an auger was used to make an opening, into which the fungus could be inserted. Tree 38 developed a typical case of bud rot. The other inoculated tree, No. 39, is still under observation. In every case the controls remained perfectly healthy. The fungus was reisolated from all diseased seedlings except from Nos. 18, 20, and 23. These experiments prove that *Phytophthora faberi* Maubl. from cacao may produce disease by invading directly the young uninjured leaves, but that infection takes place more readily through injuries.

The fungus spread in all directions, above and below the wound; it was not confined to the tender young leaves, but penetrated older leaf sheaths, and the woody portion below the growing point as well. At first the affected bud turned brown; later, due to fungus and bacterial action, rotting occurred, and a foul odor was produced. A distinct reddish or brown line was usually formed at the extremities of the disease in the older leaf sheaths, and in the woody tissue below the growing point. In advanced stages of infection the entire bud was killed and the tree died.

These symptoms produced with *Phytophthora faberi* Maubl. from cacao were identical with those observed in coconuts, on inspection trips in the field, thus indicating that a fungus was overlooked in the former isolation experiments. In order to ascertain whether a fungus was actually present in field cases, a typical specimen was secured from inspectors in the Bureau of Agriculture. Detailed microscopic examination of this diseased bud showed the presence of the mycelium of one of the Phycomycetes in the affected tissues, and of chlamydospores in the upper parts of the unfolded diseased leaves. Cultures were then conducted from various sections of the diseased tree with a view to isolating any fungi that might be present.

PHYTOPHTHORA FABERI MAUBL.: THE CAUSE OF BUD ROT

ISOLATION

On March 11, 1919, isolations were made from the typical case of bud rot sent to the writer by the Bureau of Agriculture. The tree was about 4 years old and was approximately 3 meters tall. Infection had apparently started from the tip of the young unfolded leaves, and had advanced downward into the young tender tissue of the growing point and into the woody parts below. The bud rot was a typical case, such as has been described in the section on general diagnosis. The tree was split lengthwise. The diseased portion was 2 meters in length extending from the tip of the young leaves to 20 centimeters below the growing point. Microscopic examination of the infected parts of the leaves, 60 centimeters above the growing point, showed the presence of mycelia and chlamydospores. Portions were cut from the affected parts with a sterile scalpel and placed on prepared corn meal plates. A *Phytophthora* was isolated from the woody tissue below the growing point, from the parts adjacent to the growing point, and from the leaf sheath 90 centimeters above. A microscopic examination of the fungus indicated that it was apparently the same as *Phytophthora faberi* Maubl. from cacao.

INFECTION STUDIES

With coconuts.—Infection studies were immediately carried out with this *Phytophthora*. For the first experiments seedling coconuts, from 75 centimeters to 2.5 meters in height, were used. The stab method of inoculation, described under bacterial work, was employed. Because of the extremely dry weather, all inoculated seedlings were placed in a damp chamber. Table III gives the results of the inoculations.

TABLE III.—*Inoculations with Phytophthora faberi Maubl. obtained from coconut bud rot.*

No. of plant.	Date.	Condition of plant.	Observations.			Reisolation.
			Date.	Character.	Extent.	
					cm.	
1	March 21, 1919	Seedling, 75 cm. tall	April 1, 1919	Severe rot	4	+
2	do	do	do	do	9	+
3	do	do	do	do	10	+
4	do	do	do	do	4	+
5	do	do	do	do	5	+
6	do	do	do	do	9	+
7	do	do	do	do	7	+
8	do	do	do	do	5	+
9	do	do	do	do	6	+
[a]10	do	do	do			
11	March 24, 1919	Seedling, 2.5 m. tall	do	Severe rot		+
12	do	do	do	do		+
13	do	do	do	do		+
14	do	do	do	do		+
[a]15	do	do	do			

[a] Control.

The tests showed that the thirteen inoculated seedlings were severely infected, while the two controls remained healthy. Thus all plants inoculated developed the disease. Evidence of infection could be observed one day after inoculation, because of a blackening of the tissues about the points of insertion. The controls, which were injured in the same way, and into which sterile water was introduced, remained perfectly healthy. The rapidity with which the organism attacks the tissues is shown by the fact that it advanced 10 centimeters in a period of ten days. Microscopic examination of the diseased portion showed in all cases the presence of the large, thin-walled, irregular, nonseptate, granular mycelium, characteristic of *Phytophthora faberi* Maubl. No bacteria had gained entrance at this early stage. Only a slight odor was evident, showing that the stench in older cases is produced by putrefying bacteria that follow the attacks of the fungus. In all cases reisolations were positive.

With other hosts.—In order to find out whether the fungus was omnivorous in its habits, and to determine whether it was similar, in this respect, to *Phytophthora faberi* Maubl. isolated from cacao, inoculations were made in fruits of cacao and papaya, and in seedlings of *Hevea* rubber. The cacao fruits were upon trees in the field, while those from papaya were placed under bell jars in the laboratory. Table IV gives a summary of the inoculations.

TABLE IV.—*Inoculations on various hosts with Phytophthora faberi Maubl. isolated from coconut bud rot.*

CACAO-FRUIT INOCULATIONS.

No.	Date.	Character.	Observation.	
			Date.	Character.
1	April 2, 1919	Injury; on tree	April 7, 1919	Slight infection.
2	do	do	do	Medium infection.
3	do	do	do	Slight infection.
4	do	do	do	Do.
[a]5	do	do	do	No infection.
		PAPAYA-FRUIT INOCULATIONS.		
1	April 2, 1919	Injury, damp chamber	April 7, 1919	Severe rot.
[a]2	do	do	do	None.
		HEVEA RUBBER. SEEDLING INOCULATIONS.		
1	April 3, 1919	Injury, damp chamber	April 7, 1919	Severe infection.
2	do	do	do	Do.
3	do	do	do	Do.
4	do	do	do	Slight infection.
[a]5	do	do	do	No infection.

[a] Control.

The inoculations clearly show that the fungus will cause a rot of cacao and papaya fruit, and a severe infection and the death of *Hevea* rubber seedlings. Since the same hosts are attacked by the strain of *Phytophthora faberi* Maubl. isolated from cacao fruits it can be stated, from the evidence furnished by cultural studies, that the organism from cacao is identical in this respect with the strain of *Phytophthora* isolated from coconut bud rot.

MORPHOLOGY OF PHYTOPHTHORA FABERI MAUBL. ISOLATED FROM COCONUT

GROWTH ON VARIOUS MEDIA

The fungus grows well on potato agar, oat meal agar, corn meal, and macerated young corn. A dense white, more or less felty growth, is produced on each. In the small number of tests thus far conducted the spore formation appeared to be slightly different on each medium. Chlamydospores are produced in abundance by young cultures on oat meal agar, and conidia are only sparingly formed. In older cultures more conidia are produced. On corn meal the reverse was true in the preliminary tests. These tests also indicated that on potato agar and on macerated corn the chlamydospores appeared before the conidia.

MYCELIUM

The mycelium is white, producing a dense mass in pure culture. In young cultures it is nonseptate and granular. In older ones septa may be produced. Protoplasmic streaming is common. The submerged mycelium is more or less gnarled, while the aërial is straight. Branching is abundant. The width varies from about 3 to about 8 microns.

CONIDIOPHORES

Conodiophores are produced in great abundance in pure culture, especially on corn meal. Special culture methods must be employed in order to show them in their best condition. Material showing excellent conidiophore production may be obtained in sterilized Van Tieghem cells, by placing a few spores on a film of agar that has been put on the flamed cover slip. Each conidiophore may bear from one to fifteen or more conidia. A conidium is produced at the tip of a conidiophore; the latter then continues its growth by pushing the conidium to one side, and produces another conidium at its tip. By a continuation of this process a bunch of spores is finally formed. The conidiophores vary in size, ranging approximately from 180 to 645 microns in length and from 3 to 6 microns in width.

CONIDIA

The conidia are produced terminally as described above. They are elliptic to ovate, and possess very prominent raised terminal papillæ. These spores are pale yellow to colorless, and densely granular, usually having a large vacuole. Older conidia possess more granules that are in groups.

Measurements of conidia.—The measurements conform with those of *Phytophthora faberi* Maubl. as determined by Rosenbaum.(10) Measurements were made from two-day-old cultures on corn meal. The lengths and widths of two hundred spores were measured. The results are presented in Table V, which gives the class in microns and the number of conidia out of two hundred, both for length and width, that falls into each class.

TABLE V.—*Summary of measurements of conidia of Phytophthora faberi Maubl. from coconuts.*

[Corn meal cultures; age 2 days.]

Class.	Conidia in each class.	
	Length.	Width.
μ.		
19.5 to 21.49	0	0
21.5 to 23.49	0	1
23.5 to 25.49	0	11
25.5 to 27.49	0	2
27.5 to 29.49	2	29
29.5 to 31.49	1	23
31.5 to 33.49	5	68
33.5 to 35.49	0	27
35.5 to 37.49	8	32
37.5 to 39.49	4	4
39.5 to 41.49	23	3
41.5 to 43.49	14	0
43.5 to 45.49	25	0
45.5 to 47.49	11	0
47.5 to 49.49	21	0
49.5 to 51.49	6	0
51.5 to 53.49	26	0
53.5 to 55.49	5	0
55.5 to 57.49	19	0
57.5 to 59.49	4	0
59.5 to 61.49	11	0
61.5 to 63.49	4	0
63.5 to 65.49	4	0
65.5 to 67.49	5	0
67.5 to 69.49	2	0
69.5 to 71.49	0	0
Total	200	200

From Table V it can be readily seen that the conidia vary in length from 27.5 to 69.49 microns, and in width from 21.5 to 41.49 microns. In length the majority of the spores falls into the classes between 39.5 and 53.49 microns, the largest number falling in classes between 43.5 and 53.49 microns. In width the majority falls into classes between 27.5 and 37.49 microns, the largest number being in class 31.5 to 33.49 microns.

Table VI presents the arrangement in classes of the ratios of the length to the width of the conidia.

TABLE VI.—*Arrangement in classes of the ratio of the length to the width of the conidia, showing the limits of variation.*

[Corn meal cultures; age 2 days.]

Class.	Spores in each class.
85 to 0.94	0
95 to 1.04	1
1.05 to 1.14	6
1.15 to 1.24	11
1.25 to 1.34	36
1.35 to 1.44	40
1.45 to 1.54	28
1.55 to 1.64	24
1.65 to 1.74	23
1.75 to 1.84	11
1.85 to 1.94	13
1.95 to 2.04	5
2.05 to 2.14	1
2.15 to 2.24	0
2.25 to 2.34	1
2.35 to 2.44	0
Total	200

The class of ratio values into which the greatest number of conidia fell was 1.35 to 1.44. The mean ratio of length to width would thus have an approximate value of 1.4. These figures correspond closely with those obtained for *Phytophthora faberi* Maubl. by Rosenbaum.(10)

Germination of the conidia.—Germination takes place by the production of either germ tubes or swarm spores. Every conidium is potentially a sporangium; its method of germination is influenced greatly by its environment. Germination by germ tubes is by far the commoner method under cultural conditions. From one to five germ tubes may be produced; these apparently may develop from any part of the surface of the conidium. Up to the present time, no swarm-spore formation has been observed in the cultures obtained from coconut; but in those isolated from cacao germination by this method was frequently produced. During the first trials it was found impossible to obtain germination by swarm spores. In the months of February and March, at which time the nights are cool, swarm spores were produced abundantly in old cultures on macerated corn. Swarm spores were readily obtained in Van Tieghem cells by growing the organism on very dilute agar or in hanging drops of water placed on sterile cover slips. Just before formation, there appears a rearrangement of the protoplasmic granules. The swarm spores are then produced within the sporangium. The papilla finally breaks off, and the spores escape. No vesicle formation has been observed. The spores near the opening escape one by one. Each rests for the period of a moment on the outside, and then swims off rapidly. As soon as a few spores have escaped, those remaining swim about actively within the sporangium and escape one at a time. The swarm spores are kidney-shaped. They swim about for a time by means of two flagella and then come to rest. At this stage they become spherical and may germinate after a few hours by the production of a germ tube.

CHLAMYDOSPORES

Chlamydospores are produced directly from the mycelium, usually terminally, but sometimes intercalarily. They are spherical, granular like the conidia, but with a slightly deeper yellow shade. In pure cultures they are produced in great abundance on oat meal or potato agar.

Measurements of chlamydospores.—The size of the chlamydospores is one of the criteria by which the species are separated. Two hundred measurements were made of the spores from cultures 3 to 10 days old on oat meal agar, and one hundred measurements of spores from cultures 6 and 7 days old on macerated corn. A summary of these measurements, grouped in classes, appears in Table VII.

The chlamydospores vary in diameter from 15.5 to 57.49 microns, the largest number falling in class 39.5 to 41.49 microns. The mean diameter is, therefore, more than 35 microns, being approximately 39 microns. These measurements correspond closely with those for *Phytophthora faberi* Maubl., found in the classification prepared by Rosenbaum.(10) There was little or no difference in size between the chlamydospores produced by the fungus growing on oat meal agar and those produced on macerated corn.

Germination of chlamydospores.—In Van Tieghem cells prepared with hanging drops of distilled water, corn meal extract, pure agar, or potato agar, direct germination will take place within twenty-four hours. From one to twelve germ tubes may arise from one spore.

TABLE VII.—*Summary of measurements of chlamydospores of Phytophthora faberi Maubl. from coconut bud rot.*

Class.	Chlamydospores in each class.	
	Oat meal culture; 3 to 10 days old.	Macerated corn culture; 6 to 7 days old.
μ.		
13.5 to 15.49	0	0
15.5 to 17.49	0	1
17.5 to 19.49	0	2
19.5 to 21.49	1	2
21.5 to 23.49	0	1
23.5 to 25.49	1	3
25.5 to 27.49	0	2
27.5 to 29.49	3	0
29.5 to 31.49	2	3
31.5 to 33.49	12	5
33.5 to 35.49	2	8
35.5 to 37.49	20	15
37.5 to 39.49	15	9
39.5 to 41.49	52	24
41.5 to 43.49	15	15
43.5 to 45.49	41	10
45.5 to 47.49	13	2
47.5 to 49.49	18	2
49.5 to 51.49	1	0
51.5 to 53.49	1	0
53.5 to 55.49	1	0
55.5 to 57.49	2	1
57.5 to 59.49	0	0
Total	200	105

SEXUAL BODIES

No sexual bodies have been observed in diseased portions of coconuts or in pure cultures. The absence of antheridia places the fungus at once in the *faberi* group, according to the classification of Rosenbaum.(10)

TAXONOMY

In determining the species isolated from coconut bud rot, the methods employed by Rosenbaum(10) have been followed. According to his key, which is given below, the fungus is included in the *faberi* group and is the species *Phytophthora faberi* Maubl.

AAA. Faberi group.—Antheridium entirely unknown or its relation to the oogonium not yet determined, chlamydospores absent or present. *P. faberi*, *P. jatrophae*.

B. Chlamydospores large, mean diameter more than 35 μ.

C. Mean diameter of chlamydospores 38.98 μ, mean ratio of length to width of conidia 1.47........10. *P. faberi.*

BB. Chlamydospores small, mean diameter less than 35 μ.

C. Mean diameter of chlamydospores 32.89 μ, mean ratio of length to width of conidia 1.28....11. *P. jatrophae.*

SUMMARY

1. Enormous losses, amounting to thousands of pesos each year, are produced by coconut bud rot. As shown by the Bureau of Agriculture reports, the disease is most prevalent in Laguna, Tayabas, Pangasinan, and Zamboanga Provinces. It is most abundant in very humid sections and in thickly planted groves, both of which conditions are found on the slopes of Mount Banahao. Field studies show that the spread may be extremely rapid during favorable weather.

2. An organism similar to *Bacillus coli* (Escherich) Mig., and other saprophytic bacteria are associated with the disease. Under certain conditions, such as a host weakened by severe injury, the former organism and *Bacillus coli* (Escherich) Mig. isolated from man or horse, may in inoculation experiments produce disease.

3. A summary of the entire bacteriological work done by the present writer, including approximately three hundred inoculations, has indicated that, while the bacteria are always present and are a factor in destroying the weakened tissues, they cannot account for the initiation of the disease or its prevalence and rapid spread.

4. *Phytophthora faberi* Maubl. isolated from cacao produces a typical bud rot of coconut seedlings and of mature coconut trees.

5. A fungus isolated from a typical field case of coconut bud rot was found to be identical with the *Phytophthora faberi* Maubl. isolated from cacao.

6. *Phytophthora faberi* Maubl. isolated from the field case of coconut bud rot produced in all inoculated seedlings a typical infection.

7. *Phytophthora faberi* Maubl. isolated from the field case of coconut bud rot produced disease in coconut seedlings, cacao fruit, *Hevea* rubber seedlings, and papaya fruit. The same species of fungus isolated from cacao fruit produced disease in coconut seedlings and mature trees, cacao fruit and stem, *Hevea* rubber seedlings and mature trees, and papaya fruit.

8. A morphologic and taxonomic study of the organism isolated from coconut has proved that it is *Phytophthora faberi* Maubl., as described by Rosenbaum.(10)

9. From these researches it can be stated with certainty that *Phytophthora faberi* Maubl. causes coconut bud rot; bacteria are apparently, in the majority of cases, always secondary, but are concerned with destroying the weakened tissues.

10. By proving that the fungus causing coconut bud rot is identical with the organism which produces black rot of cacao pods, canker of cacao, fruit rot and canker of *Hevea* rubber, and rot of papaya fruit, it becomes evident an entirely new series of controls will have to be devised. *Phytophthora faberi* Maubl. may grow readily, under favorable conditions, as a saprophyte also, on dead portions of coconut, cacao, and papaya.

RECOMMENDATIONS

1. Trees when once severely infected never recover. The mode of growth of the palms and the nature of the disease make it impossible to cure trees already badly affected.

2. Systematic inspection, condemning and burning of all diseased coconut trees, as carried on by the Bureau of Agriculture, should be continued.

3. All parts of diseased trees must be burned; otherwise the organism will live as a saprophyte on dead matter, and then spread to healthy trees.

4. Clean cultivation ought to be practiced in all groves.

5. Under no circumstances should coconuts be interplanted with cacao or papayas.

6. If coconuts are planted near diseased *Hevea* rubber, precautions should be taken to avoid the spread of the disease.

7. Trees in new groves must be planted 10 meters apart each way. This spacing is one of the most satisfactory means of control against bud rot, and at the same time tends to give the highest production of nuts.

BIBLIOGRAPHY

(1) Barrett, O. W. Diseases of the coconut. *Philip. Agr. Rev.* 5 (1912) 262–263.

(2) Butler, E. J. The bud rot of palms in India. *Memoirs of the Department of Agrieulture in India* 3 (1910) 221–280.

(3) Byars, A. F. Coconuts in Laguna and Tayabas Provinces. *Philip. Agr. Rev.* 1 (1908) 516–520.

(4) Cevallos, Felipe O. Control of diseases and pests by cultural methods. *Philip. Agriculturist and Forester* 1 (1911) 86–88.

(5) Copeland, Edwin Bingham. Bud rot of the coconut. *Philip. Agr. Rev.* 1 (1908) 210–220.

(6) Idem. The coco-nut. London, Macmillan and Co. (1914) 43–63.

(7) Johnston, John R. The history and cause of the coconut bud rot. U. S. Dept. Agr. Bur. Plant Industry Bull. 228 (1912) 1–175.

(8) MACKIE, D. B. A summary of the work of the pest control section for the year 1916. *Philip. Agr. Rev.* **10** (1917) 128–145.

(9) REINKING, OTTO A. Philippine economic-plant diseases. *Philip. Journ. Sci., Sec. A,* **13** (1918) 192–196.

(10) ROSENBAUM, J. Studies of the genus Phytophthora. *Journ. Agr. Research* **8** (1917) 233–276.

(11) ROXAS, MANUEL L. The cultivation of coconut. *Philip. Agriculturist and Forester* **1** (1911) 57–60.

(12) WESTER, P. J. The coconut, its culture and uses. *Philip. Agr. Rev.* **11** (1918) 5–57.

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ILLUSTRATIONS

[The plates are from a publication prepared by the writer on Philippine economic-plant diseases in the Philippine Journal of Science, Sec. A, 13 (1918) 192–274.]

PLATE I

FIG. 1. Coconut bud rot. Old infection. Entire central group of leaves killed and some fallen over.
2. Coconut bud rot. Central leaves killed and some fallen over. Outer older leaves healthy.
3. Coconut bud rot. Diseased central bud fallen over.

PLATE II

FIG. 1. Coconut bud rot. Young infection, showing unfolded tips of leaves newly diseased. From this point the disease advances downward into the growing point and more woody portion.
2. Coconut bud rot. Old infection. Entire "cabbage" and growing point softened.
3. Coconut bud rot. Old infection. Rotted portion just above growing point.
4. Coconut bud rot. Old infection. Characteristic brownish stripe, showing limits of infection in the wood.
5. Coconut bud rot. Disease produced in an injured seedling with a pure culture of bacteria similar to *Bacillus coli* (Escherich) Mig.
6. Coconut bud rot. Disease produced in an injured seedling with a pure culture of bacteria similar to *Bacillus coli* (Escherich) Mig.

PLATE III

Fig. 1. Coconut bud rot. Young infection. The fungus entered in young leaves at top. Note brownish line of demarcation at the limits of the advance in the woody parts.
2. Coconut bud rot. Young infection starting in at young unfolded leaves at top.
3. Coconut bud rot. Portion just below growing point in "cabbage" and young wood. Young infection.

Fig. 1.

Fig. 2.

Fig. 3.

PLATE I. COCONUT BUD ROT.

PLATE II. COCONUT BUD ROT.

Fig. 1.

Fig. 2.

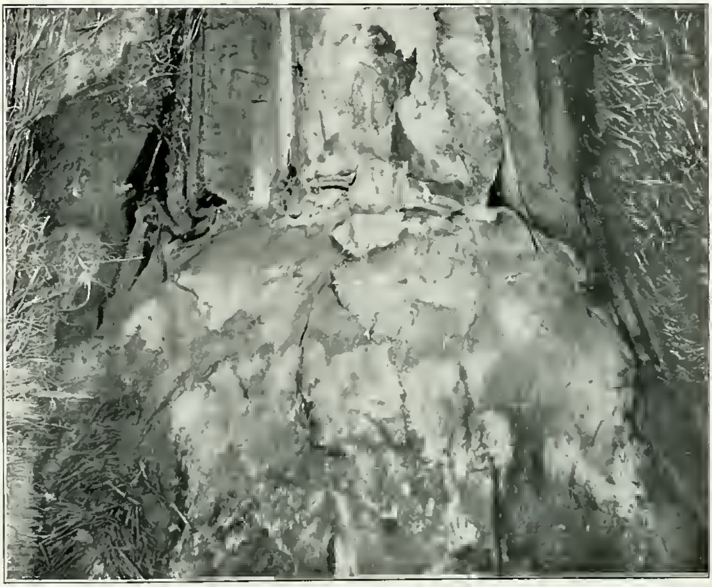

Fig. 3

PLATE III. COCONUT BUD ROT.

REVIEWS

Concerning some | Headaches and Eye Disorders | of Nasal Origin | by | Greenfield Sluder, M. D. | Clinical professor and director of the department of laryngology and rhinology, Washington University Medical School, | St. Louis. | St. Louis | C. V. Mosby Company | 1918. 272 pages, with 115 illustrations and index.

Impotence and Sterility | with | Aberrations of the Sexual Function | and | Sex-gland Implantation | By | G. Frank Lydston, M. D., D. C. L. | [3 lines of titles] | The Riverton Press | Chicago | 1917. 333 pages, illustrated. Cloth, $4.

Naval Hygiene | by | James Chambers Pryor, A. M., M. D. | medical inspector, United States Navy; master of arts in hygiene | Johns Hopkins University; head of department of hygiene, | U. S. Naval Medical School; professor of preventive | medicine, George Washington University | published with approval of the Surgeon General, U. S. Navy | and | by permission of the Navy Department | Philadelphia | P. Blakiston's Son & Co. | 1012 Walnut Street. Cloth, 507 pages, with 153 illustrations and index, $3 net.

Modern Chemistry and | Chemical Industry of | Starch and Cellulose | (with reference to India) | by | Tarini Charan Chaudhuri, M. A. | professor of chemistry, Krisnath College, Berhampore (Bengal); formerly | Government Research Scholar in chemistry; author of "Sir William | Ramsay as a Scientist and Man," etc. | Calcutta: Butterworth & Co. (India), Ltd., 6 Hastings St. | Winnipeg: Butterworth & Co. (Canada), Ltd. | Sydney: Butterworth & Co. (Australia), Ltd. | London: Butterworth & Co., Bell Yard, Temple Bar. | Medical Publishers | 1918 | All rights reserved. Pp. i–viii + 1–156, including index. Price, Rs. 3/12/-net.

Abstracts | of | Surgery | An abstract of the war literature of general | surgery that has been published since | the declaration of war in 1914 | prepared by the Division of Surgery, Surgeon- | General's Office | St. Louis | C. V. Mosby Company | 1918 | 434 pages. Cloth, $4.

As shown by the Preface, the "preparation of these abstracts, in common with many of the other early war activities, was an emergency war measure * * *. The volume must of necessity be regarded merely as a condensed text for ready reference. Most of the abstracts have been used through the courtesy of *Surgery, Gynecology* and *Obstetrics,* the *Journal of the American Medical Association,* the *Medical Record,* the *Military Surgeon,* and the *New York Medical Journal.* Some articles in the *British Medical Journal* and in *Surgery, Gynecology* and *Obstetrics* were so fundamental that they were abstracted with a minimal amount of paraphrase."

Genitourinary Diseases | and Syphilis | by | Henry H. Morton, M. D., F. A. C. S. | [10 lines of titles] | fourth edition, revised and enlarged | with 330 illustrations and 36 full-page colored plates | St. Louis | C. V. Mosby Company | 1918. Price, $7.

Issued with THE PHILIPPINE JOURNAL OF SCIENCE,
Vol. XIV, No. 1, January, 1919.

PROCEEDINGS OF THE MANILA MEDICAL SOCIETY

REGULAR MONTHLY MEETING, OCTOBER 7, 1918

MINUTES OF THE MANILA MEDICAL SOCIETY

The meeting was called to order at 8.40 p. m. in the Philippine General Hospital by President F. W. Vincent.

Twenty members were present. The minutes of the previous meeting were read and approved. Dr. Miguela Gemil was elected an active member of the society.

The following resolution, presented by Dr. R. B. Gibson, was adopted:

Whereas the National Guard of the Philippine Islands is urgently in need of medical officers at the present time.

Therefore, be it resolved that the Philippine Islands Medical Association and its component organization, the Manila Medical Society, in joint session, urge those available individual members thereof, who have not yet offered their services to the Guard, to at once apply for service with the Guard as a patriotic duty and for the honor of the medical profession of these Islands, and to use what personal influence they may command to persuade other medical men to this end.

The following papers from the surgical department of the College of Medicine and Surgery were read and freely discussed:

1. A Study of a Series of Cases of Splenectomy, by Dr. Potenciano Guázon.

2. Report of a Case of Schistosoma in the Appendix, by Dr. Potenciano Guázon.

3. Ureteral Obstruction, by Dr. José Eduque.

4. Demonstration of Some Important Cases of Fractures, by Dr. Ricardo Fernández.

There being no further business, the meeting adjourned.

D. DE LA PAZ,
Secretary-Treasurer,
Manila Medical Society.

SCIENTIFIC PROGRAM

A STUDY OF A SERIES OF CASES OF SPLENECTOMY

By DR. POTENCIANO GUÁZON

Several cases on whom splenectomy was performed by the department of surgery were described. The technic and special precautions to be observed were given in detail, and the postoperative treatment and prognosis were discussed.

A CASE OF SCHISTOSOMA IN THE APPENDIX

By Dr. Potenciano Guázon

Structures, seemingly schistosoma ova, were found in a section of an appendix. The possibility of the schistosoma as a causative factor in appendicitis is suggested.

URETERAL OBSTRUCTION

By Dr. José Eduque

Several cases of ureteral obstruction were reported. The diagnosis was made by Roentgen-ray photographs. Recoveries followed operation. The occurrence of this condition is commoner than may be supposed, and is characterized by acute attacks of pain which may be relieved when the patient is kept in bed for a few hours. Skiagrams illustrating the cases were exhibited by Dr. Ricardo Fernández.

A DEMONSTRATION OF SOME IMPORTANT CASES OF FRACTURES

By Dr. Ricardo Fernández

A demonstration of skiagrams of some complex cases of fractures was given.

R. B. Gibson,
Editor of the Proceedings,
Manila Medical Society.

Issued with THE PHILIPPINE JOURNAL OF SCIENCE,
Vol. XIV, No. 1, January, 1919.

PROCEEDINGS OF THE MANILA MEDICAL SOCIETY

REGULAR MONTHLY MEETING, NOVEMBER 4, 1918

MINUTES OF THE MANILA MEDICAL SOCIETY

The meeting was called to order at the Philippine General Hospital at 8.45 p. m. by Doctor Gibson, in the absence of the officers and councillors.

On motion, duly seconded and carried, Doctor Schöbl took the chair. Doctor Gibson acted as Secretary pro tempore. Twelve members and six guests were present. The minutes of the preceding meeting were not read.

The following scientific program was presented, and the papers were read, with the exception of that of Doctor Gonzalez who was not present:

1. Clinical Observations on 178 Cases of Dysentery, by Drs. J. Albert and J. Tirona. Discussion by Dr. H. W. Wade.
2. A Case of the Pseudomeningitic Form of Infantile Beriberi, by Dr. T. C. Arvisú.
3. A Case of Subcutaneous Emphysema Complicating Acute Bronchopneumonia, by Dr. Alberto Tupas.
4. Coöperation between Hospital Ward, Dispensary, and Social Service Department, by Dr. J. Gonzalez. Discussion by Dr. J. Fabella.
5. Demonstration of Skiagrams of Beriberi Heart in Children, by Dr. R. Fernández.

The meeting was adjourned at 10.55.

R. B. GIBSON,
Secretary pro tempore,
Manila Medical Society.

SCIENTIFIC PROGRAM

CLINICAL OBSERVATION ON 178 CASES OF DYSENTERY

By DRS. JOSÉ ALBERT and J. TIRONA

The records of the department of pediatrics for the last two years show a mortality of 54 per cent in the dysentery cases entered, thus making it the most serious type of cases which the pediatrics staff encounters. The incidence and virulence of the infections is increased during the rainy season. The largest number of cases occurred in children under 2 years of age, and the next highest in those under 5 years; of seventy-three cases under 2 years of age, twenty-four were infants less than a year old (one case only 6 days old). Almost 50 per cent of the children of 5 years or younger died with pulmonary complications. The usual period of the disease is from three weeks to two months. Five cases had a history of previous or existing cases of dysentery in the family. Bacteriological examinations of the stools for *B. dysenteriæ* were rather unsatisfactory, negative reports being received for many cases clinically dysenteric. Five cases were positive for *Entamœba histolytica.* Twenty-eight cases were heavily infected with ascaris, ten had trichuriasis, and eight had a double infection with these parasites. There was one case each of anchylostomiasis, oxyuriasis, and blastomycosis, and two having trichomonas. Four cases were complicated with paratyphoid, and one was positive for both paratyphoid and typhoid infections as shown by blood cultures. Treatment is partly symptomatic; purgatives and saline colonic irrigations are given also when acute toxæmia is present, and intramuscular or intravenous injections of antidysenteric serum are administered, when available, to the severe cases.

A CASE OF THE PSEUDOMENINGITIC FORM OF INFANTILE BERIBERI

By Dr. T. C. Arvisú

Pseudomeningitic cases of beriberi in infants have recently been reported to this society by Doctor Albert. Another case, 6 months old, is presented. Symptoms were slight fever, drowsiness, vomiting, cyanosis, convulsions, no crying, and ptosis. Skiagrams showed an enlarged right heart. Improvement and recovery followed treatment with vitamine preparations (tikitiki extract), which is confirmatory of the diagnosis.

DEMONSTRATIONS OF SKIAGRAMS OF BERIBERI HEART IN CHILDREN

By Dr. Ricardo Fernández

The method of determining the size of the heart from skiagrams was described. Plates exhibited demonstrated the hypertrophy in beriberi cases.

R. B. Gibson,
Editor of the Proceedings,
Manila Medical Society.

Issued with The Philippine Journal of Science,
Vol. XIV, No. 1, January, 1919.

PROCEEDINGS OF THE MANILA MEDICAL SOCIETY

REGULAR MONTHLY MEETING, DECEMBER 2, 1918

MINUTES OF THE MANILA MEDICAL SOCIETY

The meeting was called to order at 8.40 p. m. in the Philippine General Hospital.

President F. W. Vincent and nine members were present.

The minutes of the October and November meetings were read and approved. Drs. Pedro T. Lantin and Alva D. Cook were elected active members in the society. The society approved a plan to hold a symposium on the present epidemic of influenza at the coming annual meeting.

The following program was presented, and the papers were read and discussed:

1. Cataract Cases and Operations, by Dr. A. R. Ubaldo.
2. Unusual Complication after Grattage of the Lids for Trachoma, by Dr. A. R. Ubaldo.
3. Mastoid Operations, by Dr. H. E. Velarde.
4. Cases of Tonsillitis in the Dispensary of the Philippine General Hospital, by Dr. F. Nicolas.
5. Teratoma of the Maxillary Antrum, by Dr. H. E. Velarde.
6. Skiagrams of Cases from the Department of Eye, Ear, Nose, and Throat, by Dr. R. Fernández.

The meeting was adjourned at 10.50 p. m.

D. de la Paz,
Secretary-Treasurer,
Manila Medical Society.

CATARACT CASES AND OPERATIONS

By Dr. A. R. Ubaldo

Fifty operations for cataract included twelve cases of double cataract, one congenital, one with a dislocated lens, and three traumatic. The ages of the patients varied from 4 to 90 years. The methods employed, including the advantages of a preliminary iridectomy, combined removal of the iris and lens, or extraction of the lens alone, were presented. In one case of double cataract, one eye was operated with iridectomy, the other subsequently without; vision after the recovery was 20/80 and 20/40, respectively. The author favors the upper corneal section. Postoperative treatment, complications, and accidents were generally discussed; prolapse of the iris with iritis was the most frequent postoperative complication in the series of cases.

AN UNUSUAL COMPLICATION AFTER GRATTAGE OF THE LIDS FOR TRACHOMA

By Dr. A. R. Ubaldo

A female patient, 26 years old, had trachoma for three years. Three weeks before operation the condition became more acute. Examination showed the upper fornix of the right eye covered with granulations. Three hours after operation (with local anæsthesia, using cocaine powder) the patient complained of severe pain in both eyes. Treatment consisted of ice compresses, morphine, bromides, and aspirin. The following day the patient had severe pain in the right eye; the lids were swollen and were opened with a retractor. An unusual keratitis with peculiar striations was observed. Both eyes were affected. There was no ciliary injection and no tension of the eyeball. On the third day pain continued in the right eye. Atropine dilated the left iris only. An œdematous condition of the nimbus (sclero-corneal union) with beginning suppuration was observed. The condition lasted from two to three weeks. The right eye became entirely blind.

MASTOID OPERATIONS

By Dr. H. E. Velarde

The writer reviewed the common operative procedures and postoperative treatment. Of eighty-five cases considered, sixty recovered, eleven improved, four did not improve, five died, and five were discharged, results comparing favorably with statistics from other hospitals.

TONSILLITIS

By Dr. F. Nicolas

The etiology, character, treatment, and complications were discussed for the acute and chronic cases. The commonest forms of tonsillitis treated were the acute catarrhal and follicular types. The condition is most common in males, in patients from 14 to 25 years of age, and it occurs most frequently in July and August.

TERATOMA OF THE MAXILLARY ANTRUM

By Dr. H. E. Velarde

The case described was that of a 14-year-old girl. The condition was of several years' standing, there being an increasing prominence of the right face. The right maxilla in the region of the antrum of Highmore was found to be prominent and bulging, extending to the side of the nose. There was no inflammation nor was there tenderness on pressure. A skiagram showed the presence of a tooth in the antrum. A radical operation was performed, the antrum being opened by a blow on a chisel, the membranous sac (containing fluid) was incised, and the sac and the single rooted tooth buried in the roof of the antrum and floor of the orbit were removed. An opening into the nose was left for drainage. The pathological examination indicated that the tumor mass was of the nature of an enamel organ or adamantinoma. The location is unusual.

SKIAGRAMS OF CASES FROM THE DEPARTMENT OF EYE, EAR, NOSE, AND THROAT

By Dr. Ricardo Fernández

An instructive series of plates was presented showing the locations of coins in the œsophagus and lower tract, seeds (coated with bismuth subnitrate) in the intestine, an automobile (cracker) in the œsophagus, three cases of foreign bodies in the eye which were located by double exposures with the eyes directed first to the right and then to the left, a shot in the orbit, and sinus and mastoid infections.

R. B. Gibson,
Editor of the Proceedings,
Manila Medical Society.

CONTENTS

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THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. XIV FEBRUARY, 1919 No. 2

PHLEBOTOMUS NICNIC, A NEW SPECIES, THE FIRST PHILIPPINE RECORD FOR THIS GENUS

By CHARLES S. BANKS [1]

(From the College of Agriculture, University of the Philippines, Los Baños)

ONE PLATE

Although the genus *Phlebotomus* has been recorded from India and Ceylon [2] no species of this genus has ever been noted as from the Philippines; in fact, casual collecting during a period of many years has resulted in the amassing of a considerable number of species of the Psychodidæ, none of which has been determined or described and among which there are sure to be found several new species in this very interesting group of the Diptera.

The present paper is written especially to bring to scientific attention a new species of the genus as a serious factor in human existence in this part of the world and as a not improbable agent in disease transmission.

For a number of years I have had accounts of a tiny fly which bites at night but which is "too small to be seen," and it was only after experiencing the bite of this pest in the summer of 1915 that I was able definitely to assign to a given fly the term "nicnic" which is the Tagalog name of a "tiny fly too small to be seen." I have therefore decided to give the vulgar name permanence as well as definiteness, by using it to designate a new species of *Phlebotomus* which was particularly abundant at the College of Agriculture campus about the middle of July in 1915 and which has been awaiting description since that time.

[1] Professor of entomology and chief of the department of entomology, University of the Philippines.

[2] Brunetti, E., Fauna Br. Ind., Dipt. Mem. (1912), 202.

Phlebotomus nicnic sp. nov.

Male and female.—Grayish ochraceous to brownish buff, with slight silvery reflections at ends of some of the squamose hairs which so abundantly cover the body. Seen by transmitted light head and thorax are honey yellow, abdomen and legs are buff.

Head.—Long ellipsoidal to end of clypeus which is slightly concave basad, and inflated apicad, with numerous conical tubercles on its apical third. Proboscis one-half length of entire head. Palpi with first and second segments subequal, the former curved basad; third slightly longer and thinner, fourth and fifth subequal and nearly filiform, the latter bulbous basad. Antennæ with first segment cyathiform, second spherical, third three times length of fourth. Segments 3 to 10 slightly fusiform, segments 11 to 15 cylindrical, segment 16 obovoid fusiform. Each segment bears a subbasal regular whorl of curved hairs and other scattered groups most of which are three-fourths the length of the segment or longer than it. Eyes dark brown to black, nearly circular in outline and seven-eighths the occipitogular diameter. Hairs on head and thorax erect and of a length equaling the head diameter.

Thorax.—Pronotum a tiny squamose sclerite slightly proflexed over base of head. Distance, in profile, from mesonotal dorsimeson to apex of coxæ equal to length of abdomen. Length over mesonotum slightly less than this. Scutellum well rounded in profile, metanotum nearly plane. Upright hairs abundant.

Abdomen.—Cylindrical in male, slightly obovoid in female, with semierect hairs as long as the segments and evenly scattered over the tergites and sternites.

Legs.—Long, slender, coxæ and femora sparsely covered with long coarse hairs, femora, in addition, and remaining segments with a thickset covering of very fine recumbent downy hairs. Ungues rectangulate at their basal fifth, thence straight or scimitar-shaped apicad.

Wings.—Linear ovate or subspatulate, twice length of abdomen, their greatest width one-third their length in both sexes, very hairy on all veins, especially costa, sixth vein, and anal margin. Auxiliary vein ends midway between costa and first longitudinal, touching neither, but causing a decided curvature in latter. Petiole of first fork of second longitudinal equals anterior branch of fork. Fourth longitudinal forks at middle of wing. All veins except third longitudinal enter wing margin nearly perpendicularly, angulating before entrance. All veins about equidistant over wing surface. Both anterior and posterior cross veins very evident, the former being at origin of third longitudinal and the latter at that of fifth. Seventh longitudinal not present or, if so, confused with fold in base of anal margin. Halteres very stout, with large, dark knob and paler stem.

Genitalia.—Hypopygium of male twice length of last abdominal segment, ventral styles fleshy, straight, or slightly curved, setose along sides and at rounded apex. Harpes asymmetrically spatulate and with four stout, curved spines along apex. Penis slender, constricted before apex which is obconical. Ovipositor of female with ventral lobes broadly ovoid and setose, dorsal lobes minute, setose.

Length.—Owing to the humpbacked attitude of this insect the measurements are taken from cephalic end of mesonotum to caudal end of abdomen and from tip of proboscis to dorsum of mesonotum.

Male: Thorax–abdomen, 1.083 millimeters; proboscis–thorax, 0.59; total, 1.673.

Female: Thorax–abdomen, 1.317 millimeters; proboscis–thorax, 0.85; total, 2.167.

Male: Length of wing, 1.44 millimeters; female, length of wing, 1.74.

LUZON, Laguna, Los Baños (*Charles S. Banks*).

Type.—Male and female, No. 18492 in entomological collection, College of Agriculture, Los Baños, P. I. Several additional specimens collected at the same time and place are labeled as paratypes.

The habits of this insect, which is a very vicious biter, are described in another paper dealing with the bloodsucking insects of the Philippines.

It is believed that the nicnic breeds in the kitchen drains of this vicinity, and as soon as time will permit an endeavor will be made to rear it.

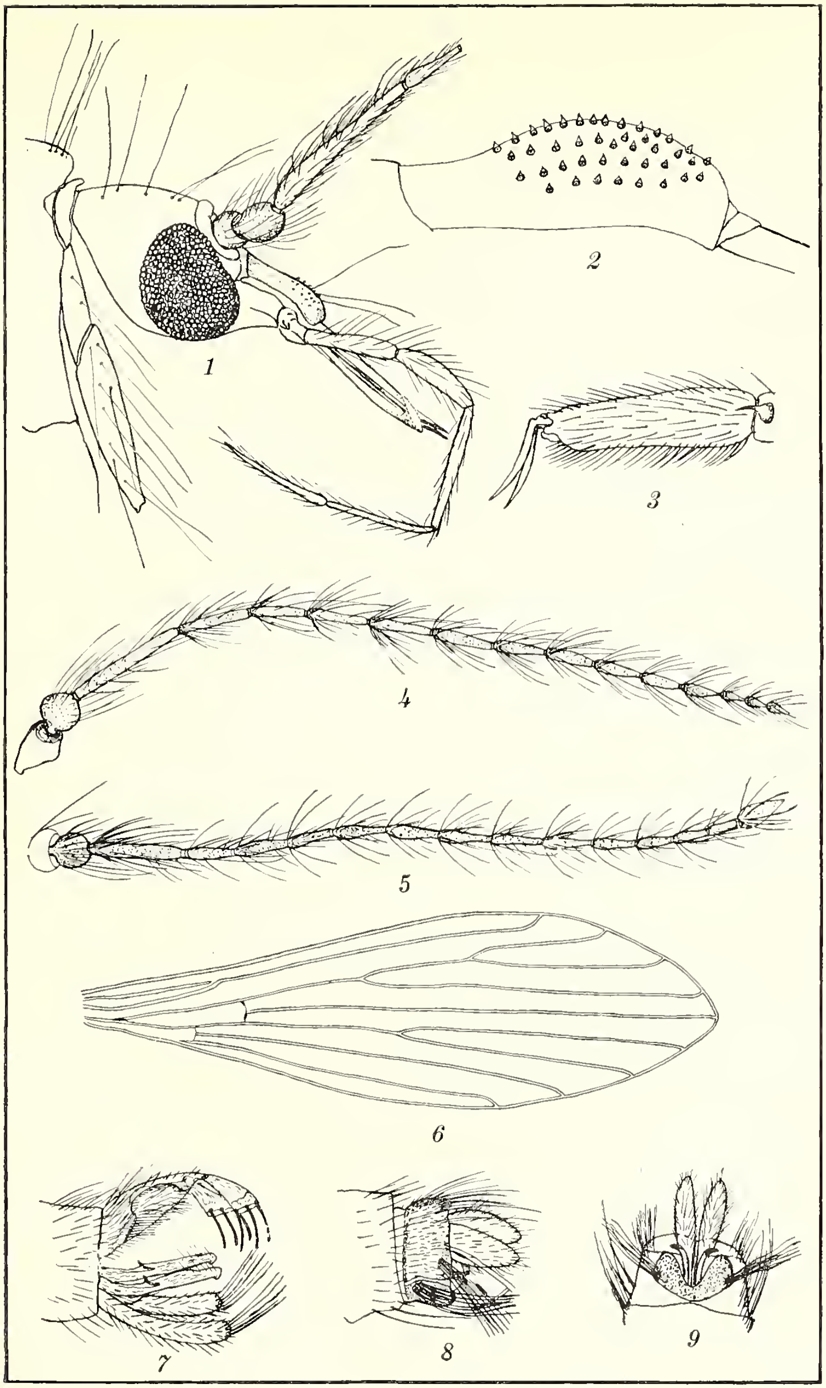

PLATE I. PHLEBOTOMUS NICNIC BANKS SP. NOV.

ILLUSTRATION

PLATE I. PHLEBOTOMUS NICNIC BANKS SP. NOV.

FIG. 1. Head of female, showing peculiar clypeus, first segments of antennæ, and form of palpus.
2. Profile of clypeus, showing conical portions of hairs which have been left when main part has been broken off.
3. Apical segment of fore tarsus of female, showing rectangular ungues.
4. Antenna of male, showing three obconical distal segments.
5. Antenna of female, showing single obconical distal segment, much larger than that of male.
6. Wing denuded, showing peculiarities of venation.
7. Genitalia of male, profile.
8. Genitalia of female, profile.
9. Genitalia of female, ventral aspect, showing peculiar form of sternite of last abdominal segment.

THE BLOODSUCKING INSECTS OF THE PHILIPPINES [1]

By CHARLES S. BANKS [2]

(*From the College of Agriculture, University of the Philippines, Los Baños*)

Insects and other arthropods that obtain all or a part of their sustenance from other animals during the whole or at some specific period of their lives are called parasites. Such parasites may be either facultative (that is, living for a part of their life upon other animals) or obligatory (requiring a continued existence on the host as a sine qua non of their own existence and propagation).

Confining this definition solely to insects, it may be stated that parasitism is not a faculty of any particular order or family of these organisms, but finds representatives among several orders that are only remotely related, so far as phylogeny is concerned.

The geological history of the Insecta plainly demonstrates that they were originally plant feeders, and that the habit of obtaining nutriment from animals, whether of their own class or of widely different phyla, is one that has been acquired during long ages of more or less intimate association among them, and between them and other animals.

Parasitism and predatoriness, especially the former, have been looked upon by some students as necessarily involving a condition tending toward, if not actually predisposing to, morphological degeneration of the parasite. But a casual glance at the various modifications of mouth parts, legs, wings, and even of the body itself will suffice to show that each of these modifications has tended toward a better adaptation of the insect to its special environment with the least amount of discomfort to its host and, therefore, with the greatest degree of security to itself.

BEDBUGS

The bedbug (*Cimex lectularius* L.), a universal companion of man though a very unwillingly accepted one, has its body

[1] Read at the twelfth annual meeting of the Asamblea Médico-Farmacéutica de Filipinas, February 9, 1918.

[2] Professor of entomology and chief of the department of entomology, University of the Philippines.

well adapted to living in the crevices of beds and of rooms, by being depressed almost to the thinness of paper in the unfed and nongravid conditions. Its prehensile proboscis, which it carries folded along the median line of the ventrum when at rest, can be easily thrust forward for tapping its prey without the insect itself being obliged to come near enough to risk accidental crushing by the sleeping victim.

All species of lice quickly succumb—in the tropics, at least—when removed from the warm environment of the host's body; but the bedbug, not being dependent upon the temperature factor, can endure long periods of isolation from the host, this being particularly true of the newly hatched nymphs before they have had a meal of blood. In the North Temperate Zone both nymphs and adults [3] have been kept in closed vials for as long as a year without apparent injury.

LICE

Body lice, head lice, and crab lice, living upon animals (man) whose hair is more or less recumbent, or who are provided with artificial covering in the form of clothing, have their bodies very markedly depressed, to enable them to glide readily from part to part of the host's body and still maintain a position favorable to the easy obtaining of food in the form of blood. All these insects have legs specially adapted to hair-clinging, the tarsal claws being reflexed upon the tarsi and provided with well-developed adductor muscles. The latter adaptation accounts for the necessity of "stroking" a head louse the length of the hair before it can be removed from its victim. A louse travels upon a single hair by means of the three legs on one side of its body. It will be observed that these legs are of the same length and almost identical in structure.

Two or more carabao lice, when placed on a hair suspended by its extremities, will be seen to travel from end to end of the hair, passing and repassing each other interminably with the greatest ease, without losing their hold.

The crab louse (*Phthirus pubis* L.), living among hairs that are stiffer and more nearly erect than those of the head, has a different morphological adaptation to its special needs. By means of the claws of the tarsi of its mid and hind legs it is enabled to grasp somewhat widely distant hairs on the body of the host. Pulling them toward each other, while it lies flat on the skin between them, it digs the claws of the tarsi of its

[3] *Insect Life* (1889–1890), 2, 105.

forelegs into the flesh. These two operations undoubtedly cause an irritation, which serves to bring more blood to the spot, decidedly to the advantage of the louse.

The manner of egg laying among the Pediculidæ is particularly well adapted to the life of absolute parasitism which they lead. Each egg, when laid, is fastened at its lower end to a hair by means of a band of glue, which completely encircles the hair and makes it impossible to remove the egg without first "stroking" it to the end of the hair. The young insect upon hatching grasps the hair and is ready to begin its existence. In the case of the body louse (*Pediculus corporis* de Geer), with which very fortunately the Philippines has not been infested during recent years, the eggs are fastened to the threads and seams of garments. The insects can only survive where woolen underclothing is worn and not changed with sufficient frequency to conform to the laws of hygiene. The best development of this insect has been manifested in the war camps of Europe and especially among the troops and other inhabitants of Servia, where it was shown to be the vector of typhus fever. An instructive account of the insect is given by Felt in his paper on household and camp insects.[4] The article gives the life history, habits, and means of control of this dangerous bloodsucking pest and contains an excellent bibliography of recent work done on it.

In addition to the lice found upon man in the Philippines, several animals harbor their respective species. The carabao louse (*Hæmatopinus tuberculatus* Nitzsch)[5] is too well known to need detailed description. It is sometimes found on carabaos in such great numbers as seriously to affect their general well-being. We are by no means certain that they do not serve as a means of transmission of the dread rinderpest. Young carabao calves, having longer hair than adult animals, frequently become infested by these lice to such a degree as to make shaving the hair necessary in order to alleviate their suffering. Submergence by the carabao has little or no permanent effect upon the insects, as the egg, the nymph, and the adult appear to be able to withstand a considerable stay under water. On the adult carabao they congregate upon the jowl, the neck, the shoulders, and other parts not easily affected by rubbing processes, while on the calves they are much more generally distributed.

[4] *Bull. N. Y. State Mus.* (1917), No. 194, 40 et seq.

[5] Insecta Epizoa (1875), 46.

The cattle louse (*Hæmatopinus eurysternus* Nitzsch),[6] though present, can scarcely be said to be abundant in the Philippines. Its habits are practically the same as those of the carabao louse, which it resembles. It may be distinguished from the former by the more strongly scalloped outline of its abdomen, the greater width of its thorax, and the longer tarsal claws.

Closely related to the above-mentioned species is the hog louse (*Hæmatopinus urius* Nitzsch) found throughout these Islands. It may be distinguished by its long slender legs with acutely curved tarsal claws mottled with dark brown, and by the black, strongly chitinous, lobed, lateral margins of the abdominal segments, the last of which is truncated and double-notched. The hog louse is slightly smaller than the cattle louse and more glabrous and transparent than either it or the carabao louse.

The goat louse (*Hæmatopinus stenopsis* Burm.) is fairly common on goats wherever they are found and was undoubtedly introduced with these animals just as the other species of the genus were brought in with their respective hosts. It is less than half as long as the cattle louse and very slender and is usually found gorged with blood.

Related to the goat louse is the rat louse (*Hæmatopinus spinulosus* Denny), which is common on these rodents when they are congregated in considerable numbers in bodegas and elsewhere. This insect is much smaller than the goat louse, of a uniform pale straw yellow, except when full of blood, and has a very much rounded face, with projects little beyond the antennæ.

Kellogg[7] has set forth the view, in discussing the biting lice (Mallophaga), that the same species of these parasites occurring on different species of birds argues the existence of a common ancestor for the latter. With equal reason we might assume that in other parasites, as the sucking lice, the closeness of their relationship might be further proof of the common ancestry of species now as widely separated as *Homo sapiens* L. and the other members of the Primates.

The monkey louse (*Pedicinus eurygaster* Gerv.), which is found on all monkeys in these Islands, bears a very close resemblance to the species of the genus *Pediculus;* in fact, the former differs only in having eight abdominal segments and five-segmented antennæ, while the latter has nine abdominal segments

[6] Op. cit., p. 45.

[7] American Insects. New York (1908), 117.

and three-segmented antennæ; *Pediculus,* according to Giebel,[8] having the apical segment composed of three ankylosed segments. The average monkey kept as a pet in the Philippines is rarely infested with this parasite. It is only when large numbers of the animals are confined together and when new wild ones are added from time to time that the colony becomes lousy. The habit of apparent depediculizing, often seen in individual monkeys, is therefore more reflex or instinctive than remedial.

FOREST FLIES

Another group of apparently obligatory bloodsucking parasites is composed of the so-called forest flies. These insects, belonging to the family Hippoboscidæ, of the Diptera, are extremely anomalous in their appearance. They are flat, leathery, louselike insects, with peculiarly shaped wings or none, and with tarsal claws well adapted to holding on to the wool, the hair, or the feathers of the mammals or the birds that they infest. The winged forms fly readily from one host to another, and it is stated that when a suitable host is found the flies, both male and female, dealate themselves,[9] presumably for greater convenience of motion through the pelage or plumage of the host.

Little is known of their life history, but it has been shown that the females of many species retain the single larva in the oviduct until it is fully grown and ready to transform to a pupa, when they deposit it.[10] At least five species are recorded from the Philippines, and there are some undescribed species in the Government collection.

BAT FLIES

Closely related to the forest flies, at least in general habits, are the bat flies, even more anomalous in their form than the Hippoboscidæ. There is no vestige of wings, the head is borne reflexed upon the dorsum of the thorax, and the long spiny legs and the body armature of spines, setæ, and hairs enable the insects to cling with great tenacity to the smooth hair of bats. Their life history is very similar to that of the forest flies according to Osten Sacken.[11] That they are obligatory parasites,

[8] Insecta Epizoa (1874), 32.

[9] *Trans. Ent. Soc. London* (1881), 360.

[10] Leuckart, *Abh. Ges. Halle* (1858), 4, 145; Pratt, *Arch. Naturges.* (1893), 59 (1) 151.

[11] Leuckart, *Abh. Ges. Halle* (1858), 4, 145.

their form and habits amply prove. Some undescribed species are in the Government collection.

Next in importance to the obligatory parasites among blood-sucking insects comes that class, the species of which obtain the blood of vertebrates in the adult stage, and whose larvæ find nutriment in decomposing vegetable or animal matter or among the minute plants of the waters where they breed. Chief among these are the mosquitoes (Culicidæ), the horseflies (Tabanidæ), the moth flies (Psychodidæ), the true flies (Muscidæ), the black flies (Simuliidæ), the midges (Chironomidæ), and the fleas (Pulicidæ), the last named breeding in dry rubbish in houses.

MOSQUITOES

Mosquitoes are so well known in the Philippines that much that might be said concerning their habits would be superfluous at this time; yet despite the wide distribution of these insects very few persons distinguish the many species as to place of breeding, time of appearance, manner of attack, and danger from their bite.

Five subfamilies of Culicidæ; namely, Anophelinæ, Megarhininæ, Culicinæ, Sabethinæ, and Chaoborinæ, are recognized by Bezzi [12] as being found in the Philippines, and he gives thirty-three genera including one hundred nine species. The species most commonly encountered are *Culex fatigans* Wied., the night mosquito; *C. microannulatus* Theob. and *C. ludlowi* Blanch., the salt-water mosquitoes; *Stegomyia persistans* Banks, the common tiger mosquito; *S. scutellaris* Walk., the white-lined tiger mosquito; *Myzomyia rossi* Giles, the common salt- and fresh-water malaria mosquito; and *M. febrifera* Banks,[13] the fresh-water malaria mosquito, found in running streams in the provinces, particularly those south of Manila. The last species was described since Bezzi's list was prepared. He does not include the grass-field mosquito, *Skusea diurna* Theob.,[14] which is abundant in Manila and its vicinity.

Other species, which at certain periods of the year may be veritable pests in the provinces, especially at Los Baños, are *Mansonioides uniformis* Theob.; *M. annulifera* Theob., the small woolly mosquito; *Theobaldiomyia gelida* Theob., the white-capped mosquito; and *Hulecœteomyia pseudotæniata* Giles, the rock

[12] *Philip. Journ. Sci., Sec. D* (1913), 8, 306.
[13] *Philip. Journ. Sci., Sec. D* (1914), 9, 405.
[14] *Entomologist* (1903), 36, 259.

mosquito, so-called from its habit of breeding in depressions in the bowlders of rocky streams where rain water collects.

One mosquito, though formidable in appearance, is beneficial in habit; this is the elephant mosquito, *Worcesteria grata* Banks,[15] which feeds only on fruit juices in the adult stage and, as a larva, destroys large numbers of the larvæ of noxious species.

HORSEFLIES

The horseflies are known wherever domestic or wild horses and cattle occur. They are fairly abundant in the Philippines and are of numerous species. At least one species, *Tabanus striatus* L., is abundant. Its life history is fully discussed by Mitzmain,[16] who also gives an excellent account of the bloodsucking habits of the adult.

These flies not only annoy domestic and wild animals, but they also attack human beings, especially children who may be asleep in the vicinity of cattle or horses. The species of the genus *Chrysops*, commonly known as deer flies, are annoying in the open forests of these Islands, and *Tabanus striatus* L. has been definitely proved to be a transmitter of surra.[17] Four genera and ten species are recorded from the Philippines.

MOTH FLIES

The moth flies (Psychodidæ) are extremely minute, woolly insects having the general appearance of tiny moths, due to the hairy covering of their wings, which are held out from the body at an angle of about 30 degrees. Few of these insects measure more than 2 millimeters in length and the average is about 1.5 millimeters. Most of the species found in the Philippine Islands belong to the genus *Psychoda*, the members of which do not suck blood, but at least one is a species of the genus *Phlebotomus*. The common Filipino name for this fly is *nicnic*, and I have used this as the specific name for the species, which is described in the preceding paper.

The nicnic is a very slender insect and does not exceed 2.2 millimeters in length. Its head is bent downward, giving it the humpbacked appearance common in this and related flies. Its gray, shaggy aspect causes it to blend perfectly with the color of the skin. Even when the pain produced indicates that a nicnic is biting the hand or the arm, it is extremely difficult

[15] *Philip. Journ. Sci., Sec. A* (1908), 3, 435.
[16] *Philip. Journ. Sci., Sec. B* (1913), 8, 197, Pls. I to VII.
[17] Ibid., 223.

to locate until it has become engorged with blood, an operation that takes from nine to fifteen minutes. At present nothing is known of its biology, though its larvæ have been sought for since it was first noticed in July, 1915, at the College of Agriculture, Los Baños, where it occurred in such large numbers as to be an annoyance to the entire community. It is so very small that it can easily crawl through the finest mosquito netting; and at the time of its great abundance, two and a half years ago, blood-filled specimens could be found in the upper corners of nets examined in the morning. Its time of first attack is from 7 to 8.30 o'clock in the evening, but it may be noted at almost any time that the sleeper awakes during the night. It is readily attracted to light, and hundreds of specimens were found crawling on lamp shades and bamboo walls near the electric lights.

This insect has been collected at no other place in the Philippines during sixteen years of entomological work, although the name "nicnic" has been heard frequently in connection with "a small, invisible insect that bites in the evening." Its bite is extremely severe, even more painful than that of most mosquitoes, and the wheal remains itchy for a day or more. If not satisfied with the first puncture, this fly will repeat the act four or five times within an area of a few square millimeters, and the bites are all equally painful. Each bite causes a distinct wheal, and sometimes the wheals overlap when fully formed. It is not definitely known whether or not both sexes bite; but, as their mouth parts are identical in structure, it is strongly suspected that they do.

That these insects might prove a factor in the spread of some disease is highly probable, on account of their great abundance at times and of their persistent manner of attack.

TRUE FLIES

The true flies (Muscidæ), as bloodsuckers, number at least five species in three genera in the Philippines. The genus *Stomoxys* contains two species, *S. calcitrans* L. and *S. nigra* Macq. The former, commonly called the stable fly or biting house fly, is by far the commonest bloodsucking fly found in these Islands. It is a cosmopolitan species and so closely resembles the common house fly (*Musca domestica* L.) that the latter is very frequently supposed to be a bloodsucking species.[18]

The larvæ of this fly feed on a great variety of decom-

[18] *Bull. N. Y. State Mus.* (1917), 194, 20.

posing animal and vegetable substances; Mitzmain,[19] who has worked out their life history in the Philippines, says that ordinary wet filter paper served as food for them.

The bite of the adults is very painful, but its effects soon pass. Clothing such as is worn in the tropics is no impediment to their attacks. They frequently bite through stockings or through a shirt and undershirt. Bare-legged children, especially when sleeping, are common victims of their attacks, as are also cattle and horses which they annoy very greatly, especially in the city of Manila, where they are exceedingly abundant. They do not restrict their feeding to these animals but will also bite monkeys, carabaos, goats, sheep, guinea pigs, cats, deer, dogs, rabbits, chickens, bats, rats, and lizards, at least under experimental conditions.[20]

The cattle fly (*Lyperosia exigua* de Meij.) is a common pest of bovine animals throughout the Islands. It congregates in hundreds upon every part of the body of work cattle and causes them an endless amount of annoyance. The swarms on one side of an animal simply transfer to the other side at the approach of an observer, but they do this with no special hurry, particularly when partially filled with blood. The coat of a cow will frequently be found to be matted with dried blood, which in some cases has exuded after the withdrawal of the insect's proboscis; in others it is the bloody fæcal matter voided by these little gluttons in the act of almost continuous feeding for an hour at a time. The insects remain upon the host when not feeding, simply resting upon the extremities of the hairs; but, when about to suck blood, they of necessity bury themselves deeply into the hairy coat, and nothing remains visible except the tips of their wings. The fact that they breed in cow and carabao dung, laying their eggs within a few minutes of the time it is voided, makes combatting them extremely difficult here.

Both of these genera are somewhat closely related to the deadly tsetse fly (*Glossina* spp.), of Africa, and might well play a rôle similar to that of the latter.

Two other species of bloodsucking flies, belonging to the genus *Philaematomyia*, namely *P. crassirostris* Stein and *P. inferior* Stein, are closely related to the genus *Musca*, and are reported from the Philippines as attacking cattle. They are related to *P. insignis* recorded from tropical Africa and the Oriental Region, a valuable account of the mouth parts of which

[19] *Philip. Journ. Sci., Sec. B* (1913), 8, 29.

[20] Mitzmain, *Philip. Journ. Sci., Sec. B* (1913), 8, 41.

has been given by Cragg,[21] who also describes [22] the mouth parts of *Lyperosia minuta* Bezzi, which is related to our species.

BUFFALO GNATS

The black flies (Simuliidæ) are represented in the Philippines only in the mountains, where they are extremely annoying to travelers, getting into their eyes, nostrils, and ears, and severely biting any exposed portions of their bodies. They are sometimes called buffalo gnats, from their former abundance on the plains of the United States where the buffalo, or bison (*Bison americanus*), once roamed. A few specimens of the genus *Simulium* in the Government collection were taken on one of the peaks of Canlaon Volcano, Occidental Negros, in 1906. This genus seems to be of world-wide distribution, and its ill favor in Europe and America is well warranted by the damage it does.[23]

MIDGES

The midges (Chironomidæ) are abundant in the Philippines, where the genus *Culicoides*, represented by *C. judicandus* Bezzi, is one of the commonest and most annoying pests in provincial regions. It is very persistent at certain times of the year, especially in Los Baños, where the mountain streams undoubtedly supply its breeding places. According to de Meijere,[24] Jacobson in Java found that its bite does not disturb sleeping persons or cause a subsequent itching, but certainly this is not the case in these Islands. He further states that these insects are to be found in chicken houses at night, where they cause great unrest among the fowls. A white hen was noticed with the feathers covered with drops of blood drawn by these midges. It was further observed that at Samarang, Java, they were most abundant during the times of heaviest rainfall. This coincides with observations made in the Philippines; the year 1917 was unusually rainy, and these little pests were extremely abundant at that time. Their small size and mottled wings serve as a protection when they alight on the bare arm or leg of a person, and they readily enter mosquito nets where, like the nicnic, they congregate in the upper

[21] *Sci. Mem. Off. Med. & San. Corps*, Govt. of India (1912), No. 54 (N. S.).

[22] Ibid. (1913), No. 59 (N. S.).

[23] Williston, S. W., North American Diptera, 2d ed. New Haven (1908), 146.

[24] *Tijdsch. voor Ent.* (1909), 52, 195.

corners when replete with the blood of their victims. Their bite is as painful as that of the nicnic, but the effects last longer and the redness of a bitten spot will remain for two or three days, while the slightest irritation will cause it to begin itching again.

FLEAS

Fleas (Siphonaptera) have been considered by some authors as a suborder of the Diptera.[25] Their metamorphoses would tend to indicate this and their wingless condition has its counterpart in certain Diptera, for example, the Phoridæ.

Fleas, living upon animals whose hair is more or less semi-erect, are very strongly compressed, so that they can easily travel through the mass of hairs and still maintain an attitude in which their suctorial mouth parts are at right angles to the skin that they puncture. Their bodies and legs are extremely smooth and are armed with strong spines, or setæ, pointing caudad and distad, so that the slightest effort causes a forward movement and gives an excellent chance for escape even when caught between the teeth or the fingers of their permanent or temporary hosts. Their well-developed, saltatory hind legs make it easy for them to spring from the ground to their hosts or from host to host. Their hard chitinous integument protects them from being crushed, while their specially developed claws, or ungues, enable them to hold on to the hairs or the skin of the host.

The adult flea lives habitually upon warm-blooded animals. The female drops her eggs to the floor, where they are brushed into crevices and where the grublike larvæ feed upon dust, dried blood particles, fæcal matter, and other filth, and among which they spin their cocoons for transformation to pupa and adult. The newly emerged adults then hop upon the mammalian host to begin their period of parasitism.

The Philippines proves no exception to the rule that wherever man is found, with his congested habitations and his variety of domestic animals, there will be found an abundant supply of these annoying and dangerous pests. The superabundance of dogs and cats in all parts of the Archipelago accounts for the great numbers of dog and cat fleas (*Ctenocephalus felis* Bouché), while the many warehouses, old dwellings, and ill-designed newer ones in Manila and other large cities furnish harbors for hundreds of thousands of rats upon which the

[25] Folsom, J. W., Entomology with Special Reference to its Biological and Economic Aspects, 2d rev. ed. P. Blakiston's Son & Co., Philadelphia (1913), 19.

dangerous plague flea (*Læmopsylla cheopis* Rothsch.) prefers to live. That the plague flea does not confine itself to this host, the terrible outbreaks of human plague in this and other countries too well have testified, since it is the only known medium for the transmission of this deadly malady from the rat to man.

The so-called human flea (*Pulex irritans* L.) is rarely met with in the Philippines, and as specimens have been taken only in Manila and Iloilo it is presumed that they are brought here by steamers.

It will be seen that all the insects discussed in this section, including flies and fleas, are semiobligatory parasites that in the adult stage require the blood of vertebrates but live apart from the host as larvæ.

Another interesting insect is the red-banded cone-nose (*Conorhinus rubrofasciatus* de Geer), which has been recorded from the Oriental Region, Africa, and America, and is closely related to insects of similar habit in the United States and Brazil. One of its common names in the United States is bedbug hunter, as it is known to suck the blood which these pests have taken from the human host. From this habit has naturally resulted the taking of blood directly from the sleeping host, and at least one case is known of a student in Manila who was bitten by these insects. In June, 1914, an adult and a half-grown larva were sent to my office by the Director of Health; the specimens were full of human blood, and one had been crushed by the person bitten.

It is stated by Herrick [26] that a person bitten by the American species (*Conorhinus sanguisugus* Le Conte) did not recover for more than a year.

These insects are so large and conspicuous, measuring from 18 to 20 millimeters in length, that it is strange they are not reported more frequently; but they escape detection undoubtedly because they are very quick fliers and are nocturnal in their habits. They cannot of course penetrate a well-kept mosquito net, but could easily crawl under one that is torn or carelessly adjusted.

A close relative in Brazil (*Conorhinus megistus* Burm.) is the transmitter of a deadly human trypanosome (*Schizotrypanum cruzi* Chagas); [27] an admirable account of its life history and habits has been given by Neiva.[28] The Philippine species should be looked upon with suspicion so far as disease transmission

[26] Household Insects. New York (1914), 422.

[27] *Mem. do Inst. Osw. Cruz* (1909), 1, 159–218, 4 pls.

[28] In Chagas, loc. cit.

is concerned, and living material should be studied from a protozoölogical standpoint.

The list of occasional bloodsucking insects includes those species in diverse orders and families which, while normally either plant feeders or predatory on other insects, will under exceptional conditions attack vertebrates, either piercing them severely or sucking their blood. Among these are the assassin bugs (Reduviidæ), represented by many genera and species and comprising some of the insects most beneficial to agriculture because of their habits of feeding on injurious insects.

The assassin bug most commonly met with in houses is *Ectomocoris atrox* Stål, which is attracted to light in considerable numbers and which inflicts a bite like the puncture of a red-hot needle with its sharp, horny proboscis, if disturbed when crawling over the body. Very little swelling accompanies the bite, but the pain lasts several hours or even days; and not infrequently suppuration, due to infection at the time or subsequently, causes a sore similar to a boil. The resulting scar has the appearance of a smallpox pit, even to the whiteness. As some of these insects are known to suck the juice of carrion, it is highly probable that infection may be caused by deleterious matter injected mechanically when they bite.

Two other species of this genus, *Ectomocoris flavomaculatus* Stål and *E. biguttulus* Stål, are occasionally met with; but neither of them has been known to attack man unprovokedly. Among other dangerous or unpleasant members of this family may be mentioned *Sycanus ståli* Dohrn, *Eulyes illustris* Stål, and *Sphodronyttus erythropterus* Burm., which are merely representative of a large class with similar habits, not naturally aggressive to higher animals, but always ready to assert their rights when molested or even occasionally to intrude upon the rights of others. The red-banded cone-nose described above is one member of this family that appears to have departed entirely to the side of parasitic aggressors.

Somewhat remotely related to the Reduviidæ is a group of insects of the same order, but of a different suborder, and known as leaf hoppers. They are primarily and preëminently plant feeders, but occasionally the tiny green *Nephotettix apicalis* Motsch or *N. bipunctatus* F. will alight upon, and suck blood from, the bare hand or arm of the observer at night when large numbers of these insects are attracted to light. They are most abundant at the end of the rainy season, and as many as two liters have been collected at a light in Manila on a single damp night.

WATER BUGS

At least five species of water bugs merit our attention here because of the more or less severe bite that they can inflict. In the order of their size and importance, these are: *Belostoma indica* St. F. et Serv., the giant water bug, sometimes called the electric-light bug; *Laccotrephes robustus* Stål and *Ranatra parmata* Mayr, the water scorpions; *Sphaerodema rusticum* Fab., the diver; and *Micronecta quadristrigata* Bredd., the small back-swimmer. The first of these kills small fishes and then sucks their blood. It can cause great pain, if handled so carelessly as to permit it to pierce the finger with its sharp beak. The next three are only harmful when carelessly handled, and they feed principally on insects. The fifth is attracted to light and will, like *Nephotettix*, bite a person that may be near the light.

ROBBER FLIES

Of the same character as the foregoing as to habits might be mentioned the robber flies, belonging to the families Mydaidæ and Asilidæ. Their species are numerous in the Philippine Islands, and individuals are abundant on every sunny roadside. They are the most extensively predaceous of any flies, and while the largest Philippine species rarely exceed 30 millimeters in length, they do not hesitate to capture and suck the fluids from other flies, bees, wasps, beetles, and even moths and butterflies. They are only known to bite man when captured and carelessly handled, but the bite is painful in the extreme and they might well develop a marked bloodsucking tendency.

THRIPS

The thrips, small fringe-winged insects (Thysanoptera), often are almost microscopic, and the largest rarely exceed 7 or 8 millimeters in length; they feed habitually upon the juices of plants, the leaves of which they cause to curl at the edges, thus forming a retreat for their young. One species of this order has a decided predilection for human blood, and a sharp bite on the hand during the middle of a hot, sunny afternoon can almost always be attributed to these minute insects, especially if one be resting near a tree in an open field. The bite of these insects causes no further inconvenience than the momentary pain, which vanishes almost with the culprit, no swelling or itching being produced.

TICKS

It would hardly be proper to close this paper without reference to a class of arthropod animals which, while it cannot be included among the insects strictly speaking, contains species most of which are highly important from an economic as well as a morphologic and biologic standpoint. This class includes the mites and ticks and is closely related to the spiders. All of the ticks and many of the mites are bloodsucking arthropods, and they infest both man and the lower animals in these Islands.

The most important is the cattle tick, *Margaropus australis* Fuller (synonym, *Boophilus*), an account of which was given by me several years ago.[29] That its effect upon the health and general welfare of our cattle is deleterious can hardly be gainsaid, and its habits are such as to make its eradication difficult. The eggs are laid on the ground by females that have dropped from the host for this purpose. The young, when hatched, crawl to the tops of plants and gain easy access to passing animals upon which they fasten themselves for engorgement.

The dog tick (*Dermacentor variabilis* Say) will attack not only dogs but also cattle, horses, rabbits, and man. Children who are allowed to play on the floors where dogs lie, or with these animals, are sure to get the ticks between their toes and fingers and elsewhere upon their bodies.

The males when fully grown are seldom over 2.5 millimeters in length, while the females, like those of the cattle tick, attain a length of 10 to 12 millimeters and are shaped almost exactly like the seed of the castor plant (*Ricinus communis* L.); so much so that some authors have called the order Ricini instead of Acarina.

Excellent accounts of ticks, as well as mites, are given by N. Banks,[30] who describes in a very enlightening manner many species from all parts of the world.

In the Philippines, as in several other parts of the world, man is infested by a small, red mite, known in many portions of this country as *tuñgao*. This mite affects the axilla, groin, and other portions of the body where the skin folds upon itself, and causes extreme annoyance by its burrowing mouth parts. The Philippine species is undoubtedly a *Trombidium*, but if it be closely related to the Japanese river-fever, or kedani, mite [*Leptus akamushi* (Brumpt)], which in Japan causes a rather severe fever among rice harvesters and those who work in river lands, is not known, owing to lack of sufficient material from both countries.

[29] *Bur. (Philip.) Govt. Laboratories* (1904) No. 14, 13.
[30] *Rep. U. S. Dept. Agr., Off. Secy.* (1915), No. 108.

The foregoing does not include every species of bloodsucking insect of these Islands, and new facts are coming to light daily with reference to our rich insect fauna. Work in this line can be greatly aided by coöperation on the part of medical practitioners and those connected with sanitation, who have opportunities for collecting useful data and specimens known to have, or suspected of having, the habits set forth above.

LIST OF BLOODSUCKING INSECTS OF THE PHILIPPINES, ACCORDING TO THEIR NATURAL ARRANGEMENT

ARACHNIDA

ACARINA

IXODOIDEA

IXODIDÆ

Margaropus australis Fuller. C. S. Banks, P. I. Bur. Govt. Laboratories (1904), No. 14, 13.

Dermacentor variabilis Say. N. Banks, Report U. S. Dept. Agr., Off. Secy. (1915), No. 108, 67.

TROMBIDIODEA

TROMBIDIIDÆ

Trombidium spp. N. Banks, Report U. S. Dept. Agr., Off. Secy. (1915), No. 108, 42.

INSECTA

HEMIPTERA-APTERA

PEDICULIDÆ

Pediculus humanus Linn., 1758. Giebel, Insecta Epizoa (1874), 30.

Pedicinus eurygaster Gerv. Giebel, Insecta Epizoa (1874), 32.

Phthirus pubis Linn., 1758. Giebel, Insecta Epizoa (1874), 23.

Hæmatopinus eurygaster Nitzsch. Giebel, Insecta Epizoa (1874), 41.

Hæmatopinus stenopsis Nitzsch. Giebel, Insecta Epizoa (1874), 44.

Hæmatopinus spinulosus Nitzsch. Giebel, Insecta Epizoa (1874), 38.

Hæmatopinus tuberculatus Nitzsch. Giebel, Insecta Epizoa (1874), 46.

Hæmatopinus urius Nitzsch. Giebel, Insecta Epizoa (1874), 45.

HEMIPTERA-HETEROPTERA

CIMICIDÆ

Cimex lectularius Linn. Herrick, Household Insects (1914), 122, for bibliography.

REDUVIIDÆ

Conorhinus rubrofasciatus de Geer. Stål, Oefv. Vet. Akad. Forh. (1870), 693.

Ectomocoris atrox Stål, Oefv. Vet. Akad. Forh. (1870), 692.

Ectomocoris biguttulus Stål, Oefv. Vet. Akad. Forh. (1870), 692.

Ectomocoris flavomaculatus Stål, Oefv. Vet. Akad. Forh. (1870), 692.

Eulyes illustris Stål, Oefv. Vet. Akad. Forh. (1870), 681.

Sycanus fulvicornis Dohrn, 1866. Stål, Oefv. Vet. Akad. Forh. (1870), 681.

Sycanus ståli Dohrn, 1866. Stål, Oefv. Vet. Akad. Forh. (1870), 681.
Sphodronyttus erythropterus Burm., 1834. Stål, Oefv. Vet. Akad. Forh. (1870), 684.

HEMIPTERA-HOMOPTERA

BELOSTOMIDÆ

Sphærodema rustica Fabr. Stål, Oefv. Vet. Akad. Forh. (1870), 706.
Belostoma indica St. F. et Serv. Stål, Oefv. Vet. Akad. Forth. (1870), 706.

NEPIDÆ

Laccotrephes robustus Stål, Oefv. Vet. Akad. Forh. (1870), 706.
Ranatra parmata Mayr, 1866. Stål, Oefv. Vet. Akad. Forh. (1870), 707.

NOTONECTIDÆ

Micronecta quadristrigata Bredd.

SIPHONAPTERA

PULICIDÆ

PULICINÆ

Læmopsylla cheopis Rothsch. Herrick, Household Insects (1914), 161. For bibliography of fleas, see Rothschild, Ent. Mo. Mag. II, (1903), 14, 85.
Pulex irritans Linn. Baker, Proc. U. S. Nat. Mus. (1905), 29, 142.
Ctenocephalus canis Curtis. Baker, Proc. U. S. Nat. Mus. (1905), 29, 131, 145.
Ctenocephalus felis Bouché=*C. canis*, q. v.

DIPTERA

PUPIPARA

Hippobosca equina Linn., 1758. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 59.
Hippobosca maculata Leach, 1917. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 59.
Olfersia nigrita Speis., 1905 Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 311.
Ormittroctona nigricans Leach. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 311.

BRACHYCERA

TABANIDÆ

Tabanus spp. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 308.
Tabanus rubidus Wied., 1821. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 312.
Tabanus striatus Fabr. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 312; Mitzmain, Philip. Journ. Sci., Sec. B (1913), 8, 197 (life history and disease transmission).
Chrysops signifer Walk., 1861. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 312.
Ommatius chinensis Fabr., 1794. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 313.
Laphria dimidiata Macq., 1846. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 313.

MUSCIDÆ

Philæmatomyia crassirostris Stein, 1903. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 29.

Philæmatomyia inferior Stein, 1909. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 29.

STOMOXINÆ

Lyperosia exigua de Meij., 1903. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 30.

Stomoxys calcitrans Linn., 1758. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 315; Mitzmain, Philip. Journ. Sci., Sec. B (1913), 8, 29 (life history).

Stomoxys nigra Macq., 1851. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 30.

ASILIDÆ

Twenty-four species enumerated in 10 genera. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 308.

Philodicus longipes Schiner, 1868. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 313.

Mydas fruhstoferi v. d. Wulp, 1896. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 21.

Leptogaster princeps O. S., 1882. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 21.

Saropogon rubricosus Bezzi, Philip. Bur. Sci. Pub. (1916), No. 10, 21.

Saropogon specularis Bezzi, Philip. Bur. Sci. Pub. (1916), No. 10, 22.

Xenomyza vitripennis O. S., 1882. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 23.

Damalina semperi O. S., 1882. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 23.

Orthogonis scapularis Wied., 1828. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 24.

Anisosis phalaris O. S., 1882. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 24.

Pogonosoma cyanogaster Bezzi, Philip. Bur. Sci. Pub. (1916), No. 10, 24.

Smeringolaphria alternans Wied., 1828. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 24.

Epholchiolaphria aurifascies Macq., 1848. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 24.

Epholchiolaphria leucoprocta Wied., 1828. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 24.

Epholchiolaphria partialis Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 24.

Epholchiolaphria vulcanus Wied., 1828. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 23.

Promachus bifasciatus Macq., 1838. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 26.

Promachus forcipatus Schiner, 1868. Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 26.

Myiophthiria reduvioides Rond., 1878. Bezzi, Philip. Journ. Sci., Sec. D (1913), 8, 311.

CHIRONOMIDÆ

Culicoides judicandus Bezzi, P. I. Bur. Sci. Pub. (1916), No. 10, 8.

PSYCHODIDÆ

Phlebotomus nicnic Banks. Antea, 164.

CULICIDÆ

For species of Culicidæ of the Philippines, see bibliography under C. S. Banks and C. S. Ludlow.

PARTIAL BIBLIOGRAPHY OF BLOODSUCKING INSECTS

[Fuller bibliographies will be found in the volumes that are marked by an asterisk.]

BANKS, C. S. The Australian tick (Boophilus australis Fuller) in the Philippine Islands. *P. I. Bur. Govt. Laboratories* (1904), No. 14.

* IDEM. A List of Philippine Culicidæ, with descriptions of some new species. *Philip. Journ. Sci.* (1906), 1, 997.

IDEM. Problems in economic entomology in the Philippine Islands. *Philip. Journ. Sci.* (1906), 1, 1067.

IDEM. Biology of Philippine Culicidæ. *Philip. Journ. Sci., Sec. A* (1908), 3, 235.

IDEM. A mosquito which breeds in salt and fresh water. *Philip. Journ. Sci., Sec. B* (1908), 3, 335.

IDEM. Experiments in malarial transmission by means of Myzomyia ludlowii Theob. *Philip. Journ. Sci., Sec. B* (1908), 2, 513.

IDEM. Four new Culicidæ from the Philippine Islands. *Philip. Journ. Sci., Sec. A* (1910), 4, 545.

IDEM. Mosquitoes and other insects: medical survey of the town of Taytay. *Philip. Journ. Sci., Sec. B* (1909), 4, 233.

IDEM. The mosquito survey in and near San José. *Philip. Journ. Sci., Sec. B* (1914), 9, 163.

IDEM. A new Philippine malaria mosquito. *Philip. Journ. Sci., Sec. B* (1914), 9, 405.

* BANKS, N. A revision of the Ixodoidea or ticks of the United States. *Tech. Bull. U. S. Dept. Agr., Bur. Ent.* (1908), No. 15.

* IDEM. The Acarina or mites. A review of the group for the use of economic entomologists. *Rep. U. S. Dept. Agr., Off. Secy.* (1915), No. 108, 153, fig. 294.

BEZZI, M. Studies in Philippine Diptera, I. *Philip. Journ. Sci., Sec. D* (1913), 8, 305.

BISHOPP, F. C. The distribution of the Rocky Mountain spotted-fever tick. *Circular U. S. Dept. Agr., Bur. Ent.* (1911), No. 136.

BLANCHARD, R. Les Moustiques, histoire naturelle et medical (1905), 673 pp.

* BRAUN, MAX. The Animal Parasites of Man (1906), 351.

CHAGAS, CARLOS. Nova Tripanozomiaze humana. *Mem. do Inst. Osw. Cruz* (1909), 159, pl. 9.

CONRADI, A. F. Black-fly studies. *Bull. U. S. Dept. Agr., Bur. Ent.* (1905), No. 52, 100.

DE MEIJERE, J. C. H. Blutsaugende Micro-Dipteren. *Tijdschrift voor Ent.* (1909), 52, 191.

* DOANE, R. W. Insects and Disease. H. Holt & Co., New York (1910). (For general bibliography.)

FELT, E. P. Household and camp insects. *Bull. N. Y. State Mus.* (1917), No. 194.

* GIEBEL, C. G. Insecta Epizoa. Halle (1874).

* GIRAULT, A. A. The bedbug; literature, pathogenic relations, etc. *Psyche* (1906), 13, 42.

HAMILTON, J. The red bug. *Ent. News* (1896), 7, 2.

* HERRICK, G. W. Insects Injurious to the Household and Annoying to Man. Rural Science Series. New York (1914), XVII + 470 pp.

Howard, L. O. The principal household insects of the United States. *Bull. U. S. Dept. Agr., Bur. Ent.* (1896), No. 4.

Idem. The insects to which the name "kissing-bug" became applied during the summer of 1899. *Bull. U. S. Dept. Agr., Bur. Ent.* (1900), No. 22, 24–30.

Idem. Economic loss to the people of the United States through insects that carry disease. *Bull. U. S. Dept. Agr., Bur. Ent.* (1909), No. 78, 40.

Kellogg, V. L. American Insects. American Nature Series, 2d ed., New York (1908), XIV + 694 pp.

Lefroy, M. A preliminary account of the biting flies of India. *Bull. Agr., Research Inst.* (1907), No. 7.

Ludlow, C. S. Two Philippine mosquitoes. *Journ. N. Y. Ent. Soc.* (1902), 10, 127.

Idem. Concerning some Philippine mosquitoes. *Canad. Ent.* (1904), 36, 69.

Idem. Mosquito notes, No. 3. *Canad. Ent.* (1905), 37, 129.

Idem. Mosquito notes, No. 5. *Canad. Ent.* (1906), 38, 367.

Idem. Mosquito notes, No. 6. *Canad. Ent.* (1908), 40, 32, 50, 331.

Idem. Mosquito comment. *Canad. Ent.* (1909), 41, 22.

Idem. New Philippine mosquitoes. *Canad. Ent.* (1909), 41, 97.

Marlatt. The blood-sucking cone-nose. *Bull. U. S. Dept. Agr., Bur. Ent., n. s.* (1896), No. 4, 38.

Mitzmain, M. B. The rôle of Stomoxys calcitrans in the transmission of Trypanosoma evansi. *Philip. Journ. Sci., Sec. B* (1912), 7, 475.

Idem. The bionomics of Stomoxys calcitrans Linnæus; a preliminary account. *Philip. Journ. Sci., Sec. B* (1913), 8, 29.

Idem. The mechanical transmission of surra by Tabanus striatus Fabricius. *Philip. Journ. Sci., Sec. B* (1913), 8, 223.

* Miyajima, M., and Okumura, T. On the life cycle of the "akamushi." *Kitasato Arch. Exp. Med.* (1917), 1, 1. (With synonymy and bibliography.)

Neiva, Arthur. Informações sobre a biolojia do Conorhinus megistus Burm. *Mem. do Inst. Osw. Cruz* (1910), 2, 206.

Nuttall, G. H. F. On the rôle of insects, arachnids, and myriapods as carriers of disease. *Johns Hopkins Hosp. Rep.* (1899), 8, 14, 17, 49, 119, 133.

* Osborn, H. Poisonous insects. Reference Handbook of Medical Science (1902), 5, 158–169.

Idem. Insects affecting domestic animals. *Bull. U. S. Dept. Agr., Bur. Ent., n. s.* (1896), No. 5.

Idem. Harvest mites; chiggers. *Bull., U. S. Dept. Agr., Bur. Ent., n. s.* (1896), No. 5, 251.

Pratt, F. C. Notes on "punkies." *Bull. U. S. Dept. Agr., Bur. Ent.* (1907), No. 64, Part III.

Riley, C. V. Buffalo gnats. *Rep. U. S. Comm. Agr. for 1886* (1887), 492.

Idem. Some insect pests of the household. *Insect Life* (1889–90), 2, 104.

Schamberg, J. F. An epidemic of a peculiar and unfamiliar disease of the skin. *Phila. Med. Journ.* (1901).

Simmons, W. J. The metamorphoses of the dog-flea. *Am. Month. Micros. Journ.* (1888), 227.

THEOBALD, F. W. A Monograph of the Culicidæ of the World. British Museum (Natural History) (1901–1910), Vols. I–V, Volume of plates.

IDEM. Flies and ticks as agents in the distribution of disease. *Proc. Assn. Econ. Biol.* (1905), 1.

VERJBITSKI, D. T. The part played by insects in the epidemiology of plague. *Journ. Hyg.* (1908), 8, 162–208.

WALKER, E. L., and BARBER, M. A. Malaria in the Philippine Islands, I. Experiments in the transmission of malaria with Anopheles. *Philip. Journ. Sci., Sec. B* (1913), 9, 381.

WALLACE, A. R. The Malay Archipelago. New York and London (1869), 2, 250. (On Culicoides sp.)

WASHBURN, F. L. The irritating harvest mites or "jigger." *Rep. State Ent. Minn.* (1908), 12, 156.

WILLISTON, S. W. North American Diptera. James T. Hathaway, New Haven, 2d ed. (1908), 405 pp.

THE PROSOPIDÆ, OR OBTUSE-TONGUED BEES, OF THE PHILIPPINE ISLANDS

By T. D. A. Cockerell

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The Prosopidæ, represented by the genus *Prosopis* Fabricius, are easily recognized among the Philippine bees by their small size, short emarginate tongue, and scanty development of hair on the body. The wings have a large stigma and only two submarginal cells. The only Philippine bees that can be confused with them are the species of *Allodape*, which are long-tongued. In *Allodape* the face marks are unlike those of *Prosopis*, the broad light mark down the middle of the face being especially characteristic. The *Prosopis philippinensis* of Ashmead is an *Allodape*.

The Philippine species of *Prosopis*, so far as known, may be separated thus:

Abdomen steel blue .... worcesteri sp. nov.
Abdomen black .... 1.

1. Clypeus entirely yellow in male; small slender species, with the tarsi and greater part of the tibiæ yellow; lateral face marks not going above level of antennæ .... taclobana Cockerell.
   Clypeus entirely black in female; lateral face marks cuneiform, truncate above; tubercles broadly edged with white; stigma piceous; abdomen strongly shining; both recurrent nervures meeting transverse-cubitals. tagala Ashmead.
   Clypeus black with a light patch or spot .... 2.
2. Lateral face marks cuneiform, not extending along orbital margins above level of antennæ .... 3.
   Lateral face marks extending above level of antennæ .... 4.
3. Mesothorax coarsely punctured, shining between the punctures. cuneifera sp. nov.
   Mesothorax entirely dull and very finely and densely punctured; scutellum with large punctures .... opacissima sp. nov.
4. Scape with a light mark in front; light area on clypeus triangular, pointed above .... 5.
   Scape entirely black; light area on clypeus not pointed above .... 6.
5. Hind tibiæ entirely black in male .... palavanica Cockerell.
   Hind tibiæ broadly yellow at base in male .... mindanensis Cockerell.
6. Clypeal mark shaped like a tall hat; upward extension of lateral face marks cuneiform, not extending far above antennæ. benguetensis sp. nov.
   Clypeal mark a spot near lower margin; upward extension of lateral face marks narrow .... 7.

7. Mesothorax finely punctured .... contradicta sp. nov.
Mesothorax coarsely punctured; female with face broad, area of clypeus above yellow mark about as broad as long; male with face narrow, area of clypeus above yellow mark much longer than broad.
luzonica Cockerell.

Prosopis worcesteri sp. nov.

Male (*type*).—Length, nearly 6 millimeters; dark blue, the cheeks and sides of thorax green; mandibles black, reddish apically; labrum black; clypeus white, with the lateral and inferior margins black; white lateral face marks filling space between clypeus and eye, and extending nearly halfway up front, ending obtusely but narrowly; scape black with a reddish spot at extreme base; flagellum short for a male, ferruginous beneath; mesothorax finely and closely punctured; tubercles with a pale spot, but prothorax otherwise dark; base of metathorax shining, area not distinctly defined; tegulæ black, wings dusky, stigma piceous; recurrent nervures joining second submarginal cell about equally distant from base and apex; basitarsi white or whitish except apically; hind tibiæ white at base.

Female.—Face dark green, without light markings; tubercles without light spot; hind tibiæ white at base, but their basitarsi entirely dark.

LUZON, Laguna, Los Baños, male (*Baker*, type); Mount Maquiling, females (*Baker*). Allied to *P. jacobsoni* Friese, from Java, but distinguished by the longer lateral face marks and dark clypeal margin. I have ventured to associate this pretty little species with the name of one who will be always remembered for his varied labors in the Philippine Islands.

Prosopis taclobana Cockerell.

Prosopis taclobana COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 16, 2.

LEYTE, Tacloban (from *Baker*).

Prosopis tagala Ashmead.

Prosopis tagala ASHMEAD, Proc. U. S. Nat. Mus. (1905), 28, 959.

LUZON, Manila (*C. S. Banks*). I have examined Ashmead's type.

Prosopis cuneifera sp. nov.

Female.—Length, 6 millimeters or over (abdomen of type strongly retracted); very robust, black; light marks of face consisting of cuneiform lateral marks, obliquely truncate above at level of antennæ, and a broad median band (not twice as long as broad) on clypeus, not extending above the middle third;

antennæ black; mesothorax and scutellum very coarsely punctured, scutellum and disk of mesothorax shining between the punctures; area of metathorax triangular, transversely plicate basally; tubercles with a large yellow spot, and a very widely interrupted yellow marginal band on prothorax; tegulæ piceous, with a yellow spot; wings rather dusky, stigma piceous, first recurrent nervure joining second submarginal cell a short distance from base; legs black, anterior tibiæ with a broad yellow stripe on more than basal half, middle tibiæ with a light spot at extreme base; hind tibiæ broadly light at base; abdomen broad, polished, without evident punctures.

LUZON, Mount Banahao (*Baker*). Somewhat related to *P. feai* Vachal, from Burma.

Prosopis opacissima sp. nov.

Female.—Length, 5.5 to 6 millimeters; black, with the mesothorax dull and excessively densely punctured, the scutellum with much larger and more widely separated punctures; mandibles black, red at apex; orbits strongly converging below; yellow face marks consisting of cuneiform lateral marks, truncate above at level of antennæ, and a broad band on clypeus, not reaching upper margin, its length at least twice its breadth, and its upper end rounded; scape black, flagellum very obscurely brown beneath; thick upper border of prothorax interrupted in middle, tubercles and spot on tegulæ yellow; base of metathorax dull and rugose; wings hyaline, stigma brown; first recurrent nervure meeting first transverse cubital; basitarsi, basal two-thirds of anterior tibiæ in front, middle tibiæ at base, and nearly basal half of hind tibiæ yellow; abdomen moderately shining, with extremely fine punctures.

MINDANAO, Davao (from *Baker*, type locality). LUZON, Laguna, Mount Maquiling (from *Baker*). Related to *P. scutula* Vachal, from Burma.

Prosopis palavanica Cockerell.

Prosopis palavanica COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 16, 1.

PALAWAN, Puerto Princesa (from *Baker*).

Prosopis mindanensis Cockerell.

Prosopis mindanensis COCKERELL, Ann. & Mag. Nat. Hist. (1915), VIII, 16, 486.

MINDANAO, Dapitan (from *Baker*).

Prosopis benguetensis sp. nov.

Male.—Length, about 6.5 millimeters; black, with rather slender abdomen; labrum and mandibles black; pale lemon yellow lateral and clypeal marks, the former extending a short distance above level of antennæ, acutely angulate above and below, the upper inner side shorter than the lower inner; clypeal mark a very broad band, truncate submarginate above, and with a small projection at each side of base; scape black, rather robust; flagellum long, coffee brown beneath; head very finely punctured; mesothorax finely and closely punctured, punctures of scutellum larger, but dense; base of metathorax polished and shining; end of tubercles and two marks on upper margin of prothorax yellow; ventral surface of thorax with white hair; tegulæ piceous, with no light spot; wings somewhat dusky, the apical region decidedly brown; stigma dark reddish brown; first recurrent nervure meeting first transverse cubital, but second recurrent going beyond end of second submarginal cell; anterior tibiæ yellow in front, but legs otherwise dark, except that hind basitarsi are a little pallid at base; abdomen shining, with very fine punctures on second and following segments; lateral hind margins of segments with poorly developed white hair bands.

LUZON, Benguet, Baguio (*Baker*). Easily distinguished from *Prosopis contradicta* and *P. mindanensis* by the shining base of metathorax.

Prosopis contradicta sp. nov.

Male.—Length, about 6 millimeters; black, with yellow markings as follows: Small mark above apical margin of clypeus, narrow lateral face marks (shining on inner side) narrowly continued up orbital margin some distance above antennæ, rather narrowly interrupted band on prothorax, spots on tubercles and tegulæ, and anterior tibiæ in front. Scape short; flagellum long, dark coffee brown beneath; sides of front with rather large punctures; mesothorax and scutellum distinctly shining, finely but very distinctly punctured; area of metathorax elongated, dull and rough, but the oblique lateral margins shining; abdomen reddish black; segments (including first) with very minute sparse punctures.

NEGROS, Cuernos Mountains (from *Baker*). Somewhat related to *P. mustela* Vachal, from Burma.

Prosopis luzonica Cockerell.

Prosopis luzonica COCKERELL, Ann. & Mag. Nat. Hist. (1914), VIII, 14, 364 (♀); (1915), 16, 486 (♂).

LUZON, Mount Maquiling and Mount Banahao (*Baker*).

THE PHILIPPINE BEES OF THE FAMILIES ANTHOPHORIDÆ AND MELECTIDÆ

By T. D. A. Cockerell

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The two families now discussed include the most highly ornamented Philippine bees, remarkable for their blue or green markings, due to appressed scalelike hairs. They are long-tongued; the Anthophoridæ make nests, in which the Melectidæ are parasitic. The latter are represented by the genus *Crocisa*, which is easily known by the expanded emarginate scutellum, with the margin W-like or -like, according to the species. The species of *Anthophora* are swift and powerful fliers.

Genus **ANTHOPHORA** Fabricius

Abdomen with narrow white hair bands; a large robust species. luzonica Cockerell.
Abdomen with lilac or purple bands.............................. whiteheadi Cockerell.
Abdomen with shining green or bluish green bands .... korotonensis Cockerell.

Anthophora luzonica Cockerell.

Anthophora luzonica Cockerell, Ann. & Mag. Nat. Hist. (1914), VIII, 14, 12.

Luzon, Laguna, Mount Maquiling (*Baker*).

Anthophora whiteheadi Cockerell.

Anthophora zonata whiteheadi Cockerell, Ann. & Mag. Nat. Hist. (1910), VIII, 5, 412; Proc. U. S. Nat. Mus. (1911), 40, 259.

Luzon, Cagayan, Cape Engaño (*Whitehead*). It is probably this insect that has been erroneously listed from the Philippines as *A. cingulata* Fabricius.

Anthophora korotonensis Cockerell.

Anthophora korotonensis Cockerell, Ann. & Mag. Nat. Hist. (May, 1911), VIII, 7, 491.

Anthophora zonata stantoni Cockerell, Entomologist (July, 1911), 44, 233; Ann. & Mag. Nat. Hist. (1915), VIII, 16, 4.

This is the species reported from the Philippine Islands as *A. zonata* Linnæus. I described it as *A. korotonensis* from a single male taken at Koroton, Formosa. The name *stantoni* was based on a female from Manila. A series of males from the Philippine Islands shows that both names refer to a single species. The females vary in the color of the bands on the abdomen, as follows:

Variety *a*, (*stantoni* proper), first two bands green, second two blue. Manila and Los Baños.

Variety *b*, first band emerald green, the other three pearly blue with a greenish tint. Los Baños.

Variety *c*, all the bands alike, extremely brilliant blue-green. Los Baños.

Variety *d*, bands very pale pearly green. Davao.

LUZON, Manila (*W. A. Stanton*): Laguna, Los Baños and Mount Maquiling (*Baker*): Benguet, Baguio (*Baker*). MINDANAO, Davao (*Valdez*), Dapitan (*Valdez*).

Genus CROCISA Jurine

The records of *C. emarginata* Lepeletier, *C. nitidula* Fabricius, and *C. lamprosoma* Boisduval from the Philippines are undoubtedly erroneous. The following four species are known to occur:

Abdominal bands brilliant blue .... 1.
Abdominal bands pallid blue or grayish .... 2.
1. Abdominal bands shining, no inclosed black area on first segment, but a transverse posterior incision .... cælestina sp. nov.
   Abdominal bands shining, that on first segment interrupted by a longitudinal band in middle .... crucifera sp. nov.
   Abdominal bands very bright blue but not shining, first segment with a large black area surrounded by blue .... luzonensis Cockerell.
2. [First abdominal segment with a very broad continuous basal hair band; abdominal bands gray with some lilac scales; wings very dark (Celebes) .... kalidupana sp. nov.]
   First abdominal segment with about the middle third dark; abdominal bands pale blue; wings only moderately dark .... irisana Cockerell.

Crocisa luzonensis Cockerell.

Crocisa luzonensis COCKERELL, Ann. & Mag. Nat. Hist. (1910), VIII, 5, 419.

LUZON, Benguet, Irisan (collector unknown): Nueva Vizcaya, Imugan (*Baker*).

Crocisa irisana Cockerell.

Crocisa irisana COCKERELL, Entomologist (Aug. 1910), 219.

LUZON, Benguet, Irisan (collector unknown). Type in British Museum.

Crocisa cælestina sp. nov.

Female.—Length, about 11 millimeters; very robust, black, with the tegument of the abdomen more or less purplish; blue markings exceedingly brilliant and shining, as follows: Upper half of face, supraclypeal region (which is very strongly keeled), sides of front broadly, small patches next to ocelli, band on cheeks, very large transverse patch on pleura, small spot on lowest part of pleura, transverse spots partly on mesothorax and partly on prothorax, longitudinal band on anterior part of mesothorax, large spot on each side of disk, line over tegulæ, spot in front of each axilla, very broad band across first abdominal segment (the posterior margin broadly incised in middle, the lateral corners of the incised area pointed), broad bands (narrowly interrupted in middle) on second to fifth segments; spot on hind coxæ, outer side of middle and anterior tibiæ, but only basal half of hind tibiæ, and a few blue scales on anterior tarsi. Middle and hind tarsi and the W-like scutellum without blue; wings dark fuliginous; clypeus finely and closely punctured; flagellum obscurely reddish beneath.

LUZON, Laguna, Los Baños (*Baker*). A beautiful species, distinguished from *C. rostrata* Friese by the immaculate scutellum and dark basitarsi. It is very closely related to *C. nitidula* Fabricius from Amboina, but is larger, with somewhat different scutellum, and the markings clear cobalt blue, not greenish blue. The name *nitidula* has been applied to various forms, but I have seen a specimen from Amboina, the original locality.[1] It is possible that the Philippine and Amboina insects may be found to represent only races of one species, but they are more likely to be distinct, without intergrading forms.

The following species from Celebes is described, as it was sent by Professor Baker with the Philippine collection:

Crocisa kalidupana sp. nov.

Male.—Length, about 9 millimeters; black, the tegument of abdomen slightly purplish; light markings pale gray, with lilac scales sparsely intermixed on prothorax, pleura, sides of abdomen, and legs; light patches and spots as follows: Face and sides of front, band on cheeks, interrupted band on prothorax (slightly invading mesothorax), large rounded patch on pleura, five spots on mesothorax (the anterior median one short and those before axillæ small), very broad band on first abdominal segments, very broadly incised in middle, the corners of the incision pointed, broadly interrupted bands on the other segment, outer side of anterior tibiæ, and large spots on basal half of middle and hind tibiæ. Scutellum (which is -like) and tarsi without light marks; wings dark fuliginous; anterior femora very small, reddish; hind femora with a sharp thornlike tooth beneath.

CELEBES, Kalidupa (*H. Kühn*). Related to *C. quartinæ* Gribodo, but easily separated by the color of the markings. The

[1] See *Bull. Am. Mus. Nat. Hist.* (1907), 233, where for "scutellum without dark marks" read "without *light* marks."

type of marking on the first abdominal segment is the same as that in *C. cælestina*, but in *C. cæruleifrons* Kirby the basal band is interrupted in the middle, though the posterior incised or excavated area is of the same character.

Crocisa crucifera sp. nov.

Male and female.—This is the species that Friese determined for Professor Baker as *C. quartinæ* Gribodo (type locality, Celebes), but he included in *quartinæ* a variety of species, even the shining blue-spotted one of Australia. *Crocisa crucifera* differs from the description of *C. quartinæ* by the two conspicuous blue spots on the scutellum; it also has the scutellum W-like, though the incision is very wide and relatively shallow. The first abdominal segment is blue, except the hind margin and a longitudinal median band, and the longitudinal band extends down the other segments, producing a black cross on a blue ground. The male has the hind femora toothed beneath.

LUZON, Laguna, Los Baños (*Baker 306*).

The somewhat related Australian form, which has also passed as *quartinæ*, requires a name:

Crocisa omissa sp. nov.

Crocisa quartinæ COCKERELL (not Gribodo), Proc. Linn. Soc. N. S. W., 1912 (1913), 595.

Crocisa cæruleifrons COCKERELL (not Kirby), Entomological News (1907), 46.

The scutellum is -like and without blue spots; the pattern of the first abdominal segment is similar to that of *C. cæruleifrons*, except that the incision is broader.

I have seen the type of *cæruleifrons* Kirby; it is certainly distinct. The type of *C. omissa* is from Mackay, Queensland (*Turner 302*), the species extends south to New South Wales.

The following new species of *Crocisa* have been lately obtained by Prof. C. F. Baker in the Malay Peninsula:

Crocisa callura sp. nov.

Female.—Length, 15 millimeters; very robust, black, with turquoise-blue markings, not shining; wings very dark fuliginous, even the usual pale spots dusky; scutellum without blue spots, its margin -like. Allied to *C. decora* Smith, but larger, and with the following special characters: Median blue mark on mesothorax a band extending over halfway from anterior margin toward posterior end; spots on each side of disk large, oval; posterior spots large; axillæ with small spots; scutellum longitudinally grooved and well punctured; tubercles with black fringe; upper end of mesopleura covered with pale blue hair, and a blue spot on lower part, the interval black; white hair projecting beneath scutellar notch; anterior and middle tibiæ blue on outer side, hind tibiæ with only basal half blue; all the basitarsi with blue hair on outer side; first abdominal segment with basal band having a linear interruption, and the transverse black discal area with its basal edge straight, its lateral corners pointed, and the apical blue band widely interrupted; the other abdominal segments have rather widely interrupted bands; apical segment without blue.

PENANG ISLAND (*Baker 9077*). *Crocisa ridleyi* Cockerell, from Penang, is smaller, with W-like scutellum, anterior margin of pleura entirely covered with light hair, markings much paler, and other differences.

Crocisa reducta sp. nov.

Female.—Length, about 11 millimeters; black, with turquoise-blue markings, not shining; anterior wings fuliginous, with the usual pale spots and areas well marked; scutellum without blue spots, its margin ⌐—^—¬-like. Allied to *C. callura*, but smaller, and differing thus: Third antennal joint shorter than fourth (longer than fourth in *callura*); median mark on mesothorax short, not longer than the transverse diameter of anterior marginal marks, not closely approaching anterior margin; spots on each side of disk small; spots on axillæ larger; scutellum polished and punctured, the punctures more or less in transverse rows; first abdominal segment with basal band continuous, but apical band extremely widely interrupted, and the lateral lobes of the black area very broadly obliquely truncate at end, the upper (basal) margin of the black area also concave; pygidial plate broader at end.

SINGAPORE (*Baker 9076*). A specimen of *C. decora* Smith, also from Singapore, is very similar, but has much larger spots on each side of disk of mesothorax, and the scutellum with very minute punctures, those of *reducta* being strong and very distinct.

THE ABSENCE OF BOTH HIND LEGS BELOW THE FEMUR IN A FULL-TERM PIG

By Marciano Carreon

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ONE PLATE

Recently I had the opportunity to observe a pig in the act of parturition. The third pig that was born attracted my attention, in as much as it could not stand like the first two. When all were born—seven in the litter—I picked up the third one and found its two hind legs missing. The pig appeared normal in every other way, breathing regularly, but it was somewhat weak and exhausted. The specimen was immediately taken to the laboratory, where it died two hours later. Efforts were made to sustain life, but these were all in vain.

All of the pigs in the litter were measured. The average crown–rump length—that is, the distance from the vertex of the head to the buttocks—was 160 millimeters. The pig without the hind legs was a female with a crown–rump length of 151 millimeters. Some of the normally developed pigs were of about the same length as the specimen. When compared with some of the smaller members of the litter, it was quite apparent that this pig was not underdeveloped.

The external features of the pig were carefully studied, various measurements were taken, and a careful dissection was made to determine if any other abnormalities were present. The length of the femur was 31 millimeters, which was 5 millimeters longer than the humerus. The length of the femur in the specimen and in the normal pigs was found to be almost identical, so it was apparent that the femur was normally developed. Attached to the skin overlying the distal ends of the femur were two minute appendages forming a whorllike arrangement. Each mass was less than a millimeter in its dimensions, and was composed of dried tissue, apparently the remains of the atrophied portion of the extremities, growth evidently having ceased very early in the development of the limb buds.

A dissection of the right hind thigh was carried out to determine the arrangement of muscles and their attachments (Plate

I, fig. 3). The muscles of the thigh were all normally arranged, but the muscles having their insertion at the proximal end of the tibia and the fibula were attached to the end of the femur by fibrous connective tissue. At the distal end, and lying slightly anteriorly and laterally, a single cartilaginous mass was found—apparently the patella. The patella was attached to the end of the femur by fibrous connective-tissue bands.

On careful examination I also discovered that the pig had a cleft palate. This extended from the posterior part of the alveolar process throughout the entire soft and hard palate (see Plate I, fig. 2). The length of the cleft was 27 millimeters; its width was 3 millimeters anteriorly and 7.5 millimeters posteriorly. The nasal septum and various parts of the roof of the nasal cavity can be easily made out. The tongue appears normal in size, but on the median line is a ridge which fits into the cleft palate. This ridge serves as a palate for inspiration and expiration.

In this interesting specimen two abnormalities were found; namely, the missing legs and the cleft palate. It is reasonable to assume that the underlying cause producing the pathological conditions was identical for both anomalies. Both show an interrupted growth very early in the development of the pig. What the influence was that inhibited the growth of the legs and the palate is not definitely known, though everything points toward a physicochemical interference with growth. Mall [1] discusses this question in great detail and in part says:

> It would have been quite simple to conclude that the poison produced by an inflamed uterus should be viewed as the sole cause, but when it is recalled that the pathological ova occur far more commonly in tubal than in uterine pregnancy, such a theory becomes untenable. Moreover, monsters are frequently observed in swine and other animals without any indication of an inflammatory environment. For this reason I have sought the primary factor in a condition buried in the non-committal term faulty implantation. It would seem to be apparent that lesions occurring in the chorion as the result of faulty implantation, can and must be reflected in the embryo.

He further states:

> It is perfectly clear that monsters are not due to germinal and hereditary causes, but are produced from normal embryos by influences which are to be sought in their environment. Consequently, if these influences are carried to the embryo by means of fluids which reach it either before or after the circulation has become established, it would not be very far amiss to attribute these conditions to alterations in the nutrition of the embryo.

[1] On the frequency of localized anomalies in human embryos and infants at birth, *Am. Journ. Anat.* (1917), 22, 69.

In as much as all of the other pigs in the litter were normally developed, we can at once exclude the probability that uterine inflammation may have interfered with the normal process of development. It seems probable on the other hand that a faulty implantation might produce a pathological condition such as we found in this specimen. The cause in this case may have been primarily a mechanical one that was reflected on the embryo, thus producing the malformation. The presence of the appendages attached to the skin overlying the distal end of the femur seems to indicate that the extremities were more developed at some previous time. However, when the factor that produced the malformation appeared, the further development of the palate and the hind legs ceased.

In making this report I am indebted to Prof. Edward S. Ruth and the members of the anatomical staff for valuable criticisms and suggestions; for all of which I wish to express my appreciation.

ILLUSTRATION

[Drawings by Vicente Santos.]

PLATE I

FIG. 1. An abnormal pig, showing the right lateral side with the hind limbs missing. On the distal end of the femur may be seen the small appendage that is mentioned in the text. Two-thirds actual size.

2. Front view of the head of the pig specimen, showing the cleft palate with the ridge on the tongue. Actual size.

3. Dissection of the muscles of the thigh of the pig specimen. Actual size. *bf*, biceps femoris; *smb*, semimembranosus; *std*, semitendinosus; *tfl*, tensor facia lata.

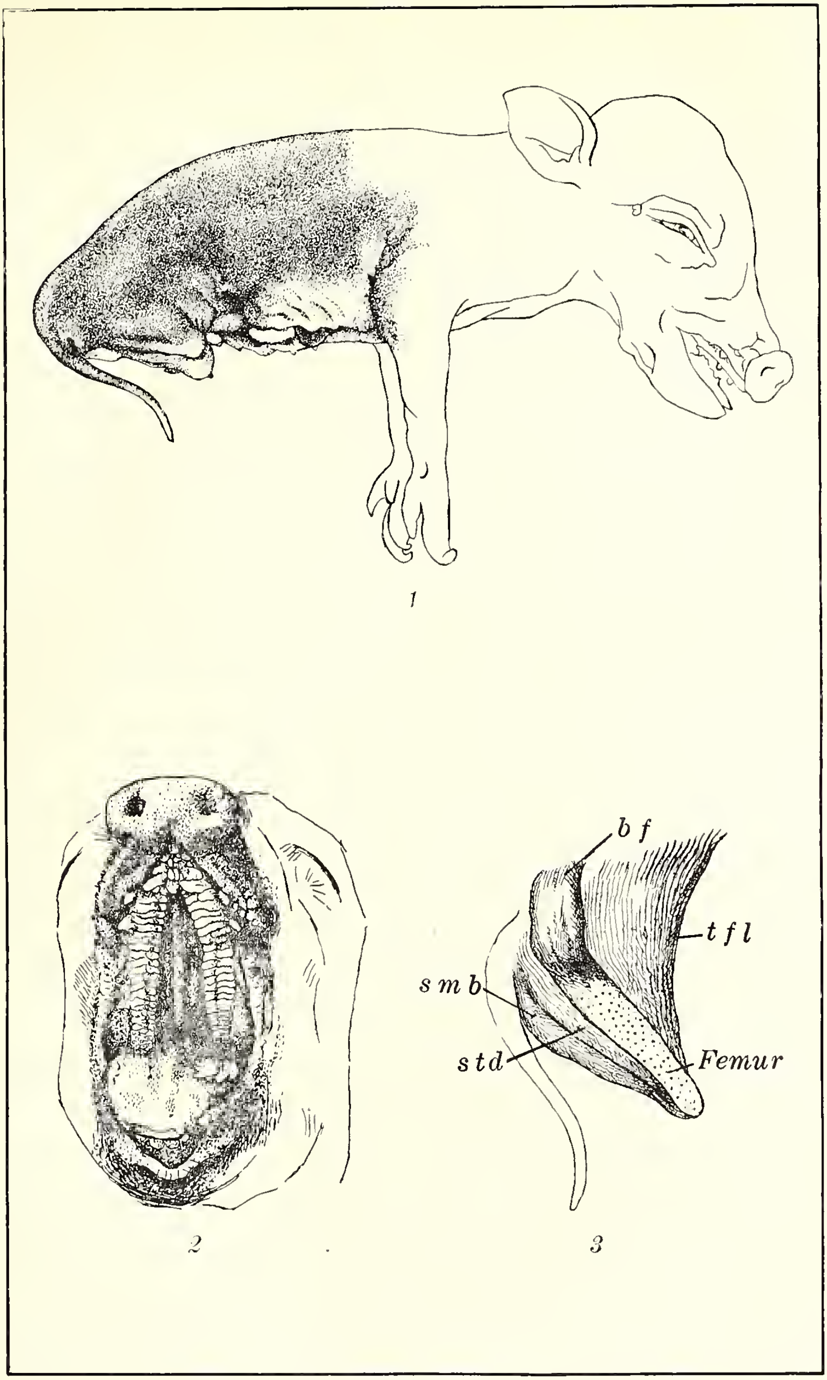

PLATE I. AN ABNORMAL FULL-TERM PIG.

ON THE INGESTION OF ERYTHROCYTES BY PENTATRICHOMONAS SP., FOUND IN A CASE OF DYSENTERY

By Frank G. Haughwout[1] and Walfrido de Leon[2]

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ONE PLATE

On March 9, 1919, there was admitted to the pediatrics ward in the Philippine General Hospital, on the service of Dr. José Albert, "S. de G.," Filipina, female, 6 years old, for treatment of a condition described as acute dysentery.

The child had been passing frequent bloody and mucoid bowel movements for seven days prior to admission, the stools averaging about twenty in number in the twenty-four hours. Each movement was accompanied by painful tenesmus. Four days after the onset of the disease the stools became black and gave off a pronounced fishy odor.

On admission to the hospital the child had slight fever. The pulse was of fair volume. She was weak and looked sick, and her eyes were slightly sunken. At the time, however, her lungs were clear, and the heart was in good condition; in short, the general condition of the patient was good. A day or two later she developed a mild bronchopneumonia. The parents stated that the child had suffered from dysentery when she was 3 years old. The attack had lasted three days, during which time she had passed numerous bloody and mucoid stools, and ceased following the administration of a purgative. The patient had also suffered from epileptiform attacks from time to time. There was no other intestinal infection of a similar nature in the house, but the parents said the child sometimes drank the city water, sometimes artesian-well water, but very frequently water that was literally filthy.

Examination of the child's stool in the hospital laboratory disclosed the presence of numerous flagellates and moderately heavy infections with *Ascaris lumbricoides* and *Trichuris trichiura*. No entamœbæ were found. The stool contained mucus,

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leucocytes of various types, pus, and enormous numbers of erythrocytes. Bacteriological examination for *Bacillus dysenteriæ* was negative, but it should be noted that the bacteriologist did not receive a fresh stool.

During the stay of the patient in the hospital the temperature was intermittent in type. There was a daily rise toward evening, and a fall to the lowest point in the morning. The variations in temperature ranged between 36.5° C., and 38.25° C.

The pulse varied between 100 and 125, and the respirations, between 30 and 40 to the minute. The bowel movements recorded were as follows: March 9, four; March 10, four; March 11, seven; March 12, seven.

The treatment given consisted of intramuscular injections of antidysenteric serum, purgatives, and stimulants.

The patient failed to improve, but on the contrary grew steadily worse, and with the development of the pneumonic symptoms her condition became very serious. Notwithstanding this the parents, who were of the poorer class of Filipinos, insisted on taking the patient home. Against the strongly expressed advice of the physicians in charge of the case they took the girl home on the morning of March 13, at which time she was virtually in a dying condition. It was learned through the social service department of the hospital that the child died a day or two later. Whether she succumbed to pneumonia or dysentery we cannot say.

A specimen of the stool was sent to the department of pathology of the hospital on March 12. There it was examined by one of us (W. de L.) and found to contain swarms of flagellates of the trichomonad group.[3] The stool was liquid and contained considerable blood. A slight amount of mucus was found sticking to the bottom of the container. This is the type of stool quite characteristic of heavy flagellate infections we have seen, and has led us to suspect the presence of *Trichomonas* on occasions other than this. Microscopically, however, considerable detritus was found, such as leucocytes, and epithelial cells in various stages of disintegration which, of course, suggested the possibility of the presence of bacillary dysentery. We believe, nevertheless, that such evidence of inflammatory reaction oc-

[3] We apply the term trichomonad as a common name for polymastigote flagellates having an undulating membrane, axostyle, and parabasal as *Trichomonas*, *Tetratrichomonas* and *Pentatrichomonas*. We employ it in the same sense as the properly employed term ameba as used by Schaeffer, but not as unhappily used as a generic name by some of the medical journals.

curring in cases of protozoal infection may, in some instances, be due to secondary invasion of the tissue by bacteria other than the dysentery bacilli.

It was quickly seen by the examiner that the flagellates in many instances contained erythrocytes. The finding was immediately communicated to the senior author and the stool specimen sent to the laboratory of parasitology.

The observation was quickly confirmed by the senior author who, in the course of the examination of several preparations, noted 103 flagellates that had ingested one or more erythrocytes, some of which presented evidence of having undergone partial digestion—an appearance frequently seen in *Entamœba histolytica* containing ingested erythrocytes. More than this, the actual process of ingestion was observed in one individual found in the act of taking in a corpuscle and whose progress was followed under the microscope for nearly an hour. During that time the parasite ingested no less than three corpuscles. The individual that went through this performance was actively swimming about in the fæcal débris and when first seen had applied its anterior extremity to an erythrocyte that was being drawn in through the cytostome, as shown in Plate I, fig. 3. The operation of ingestion consumed about fifteen seconds, during which time the organism maintained its active movements. The act was one of literal deglutition. The corpuscle entered the cytoplasm as if drawn in by suction, though it was probably accomplished by the action of myonemes or similar structures entering into the formation of the cytopharynx. Its progress may be traced by inspection of Plate I, figs. 3 to 8, which show the deformation of the corpuscle as it passed through the narrow orifice of the cytostome. In time, the corpuscle came to lie free in the cytoplasm toward the posterior end of the animal, where it produced a slight bulge in the body. The formation of a digestive vacuole around the erythrocyte was not observed; nor could any vacuoles of that nature be discovered in any of the other individuals seen that had taken in corpuscles. The erythrocytes simply seemed to lie free in the cytoplasm where they were carried about in the cellular cyclosis. No individual was seen that contained bacteria, so far as could be made out, which leads us to the belief that this particular species is not a bacteria eater, but possibly derives its nourishment from erythrocytes and other tissue elements. This, of course, presupposes an adaptation to parasitism of a more complete type than we have evidence of in the other intestinal flagellates infesting man.

The other two corpuscles that were taken in by this individual were ingested in substantially the same manner, but the parasite was lost from the field in the sudden shifting of fluid due to evaporation and could not again be found. In no instance did we observe the expulsion of a corpuscle that had been ingested.

The presence of the projecting axostyle and the marginal undulating membrane placed the parasite in the trichomonad group, but it was not until specimens were stained that the five anterior flagella were discovered that enabled us to place the organism definitely in the genus *Pentatrichomonas*. Unfortunately, only two slides were prepared from this stool for staining, for it was assumed that the case would remain in the hospital and that an abundance of material could be procured for study. It was felt that the case was one of unusual interest, and efforts would have been made to secure an autopsy had the patient died in the hospital.

At the time we made this observation, we believed that the ingestion of erythrocytes by an intestinal flagellate had not been reported previously; but subsequently we were able to obtain Chatterjee's original paper on *Pentatrichomonas*(3) in which he says: "In several a full sized red corpuscle was found inside the body; no vacuole is seen." We have been unable to find any development of this observation in the literature accessible to us.

STUDY OF THE STAINED PREPARATIONS

The films were fixed in Bouin's picro-aceto-formol solution and stained by the alcoholic iron-hæmatein method of Dobell. The slides were carefully searched with the aid of the mechanical stage, and we failed to find *Entamœba histolytica* or any other protozoön in either the trophozoite or encysted stage. So far as concerns the parasite in question the results were rather disappointing, as is apt to be the case with preparations of the intestinal flagellates. These parasites show a tendency to conceal themselves in the thicker parts of the film, and they only swim out into the open after the lapse of time. Relatively few were found. Fig. 1 shows an individual, found near the margin of one film, that had unfortunately undergone some distortion through almost complete drying before the preparation was fixed. It was drawn because it contained a deeply stained disklike body that was, in all probability, an erythrocyte. Fig. 2 shows a fairly perfect individual, in which most of the parts are demonstrated. In no case did we succeed in demonstrating the mouth parts. Special methods such as are used in the demonstration of the neuromotor apparatus of ciliates and flagellates, such as

Mallory's connective-tissue stain, would probably yield better results. Indeed, we are inclined to believe, from the exceedingly coördinated nature of the process of deglutition and the accompanying phenomena, that the animal may be found to possess a well-developed neuromotor apparatus, such as has been described by Sharp(12) and Boeck(2) in the case of certain ciliated and flagellated endoparasitic protozoa.

A fairly complete picture of the organism was secured from a study of the individual shown in fig. 2. The structures did not all stand out with the sharpness shown in the figure, but we are quite convinced of the presence of the parabasal body and the undulating membrane, neither of which could be seen with any distinctness in the individual shown in fig. 1. A puzzling feature shown in fig. 2 is the row of chromatinic granules of graduated size, that appear to lie free in the cytoplasm between the parabasal and the axostyle. These were rather deeply staining, and we believed at first inspection that they marked the line of the axostyle and represented the axostylar chromatinic granules seen so frequently in the trichomonads. But later, we discovered the axostyle lying in the position shown in the figure and convinced ourselves of its identity. Therefore, the question arises as to the nature of these large, prominent granules; for their extreme regularity in position and their size gradation belie the supposition that they are erythrocytes in various stages of digestion.

Ordinarily, the axostyle and the "axostylar chromidia" are demonstrated with some difficulty, after careful staining and extraction and under exceptionally good illumination. The axostyle in both stained individuals figured was quite clear and distinct; the granules shown in fig. 2 took the stain as intensely as the nucleus. The conformation in which they lay suggested an axostylar relation, and if the granules seen in the axostyles of other trichomonads are intra-axostylar, as many workers believe, the questions arise as to whether the granules shown in our preparation are identical with the axostylar granules of other species and, if they are, what they are doing free in the cytoplasm. The axostyle itself was perfectly clear throughout its length. Its posterior extremity had been drawn into the cytoplasm, and throughout its entire length it showed no trace of the presence of "axostylar chromidia." In fig. 2 it will be seen that the axostyle is apparently carried anteriorly to the point where its anterior extremity seems to underlie the nucleus. The nucleus was of the karyosome type with a fairly large karyosome, and more or less abundant peripheral chromatin lying within a nuclear membrane. However, we do not consider that the material available to us in this case has been either sufficiently abundant or suitable for making the cytological study of the parasite that these remarks suggest. Now that we know of the presence of *Pentatrichomonas* in the Philippine Islands we shall watch for further infections with it, with a view to confirming these observations and working out some of the details.

A sufficient number of individuals was not forthcoming on our slides to enable us to make measurements that would justify us in giving the mean size of this species. Those we measured varied in length from 14 μ to 18 μ and in width from 10 μ to 13 μ. The anterior flagella measured from 8 μ to 10 μ, and were approximately of equal length.

This is the first time that *Pentatrichomonas* has been reported from the Philippine Islands, but as Chatterjee(4) has reported it as commonly occurring in India, we think it likely that when sought here it will be found to be of as frequent occurrence. Because of the lack of proper material for study we deem it unwise, for the present, to give specific designation to the form observed by us. Derrieu and Raynaud, who described a similar parasite from Algiers in 1914 under the name *Hexamastix ardindelteili,*(5) gave measurements of from 10 μ to 15 μ in length and from 9 μ to 13 μ in width. The flagella, they stated, varied in length from 10 μ to 17 μ. Chatterjee's *Pentatrichomonas bengalensis*, described by him in 1915, was said to vary in length from 8 μ to 10 μ, and in width from 5 μ to 6 μ, with a flagellar length of from 8 μ to 10 μ. The few measurements made by us seem to fall fairly well between the two, but Mesnil(11) has already suggested a duality of species between Derrieu and Raynaud's parasite (now included in the genus *Pentatrichomonas*) and Chatterjee's *Pentatrichomonas bengalensis*. Fantham has concurred in this. In view of this, we refrain from bestowing a specific name on this parasite until we have had the opportunity to check our observations on other cases and to make a more thorough study of the organism.

DISCUSSION

Notwithstanding the extreme limitations that were placed on our study of this single case, we regard the observation as an important one. We feel that it lends support to the contention of Chatterjee that *Pentatrichomonas* is pathogenic and may produce dysentery in the general acceptance of that term.

A few months ago one of us (F. G. H.) published a paper on the tissue-invasive powers of the flagellated and ciliated intestinal Protozoa(8) and, although certain of the views therein expressed by the author have been modified by him in the light of more recent publications—particularly those of Wenyon and O'Connor and other British protozoölogists—it seems apropos to quote the following paragraph from the paper (p. 255):

> Next in order appears to be the desirability of attempting to explain the conflicting opinions expressed by different authors regarding the pathogenicity of the intestinal flagellates. It has been shown that some workers regard these forms as harmless or capable, at the most, of giving rise to nothing worse than diarrhœa, while others frankly express the belief that they may produce dysentery—actual lesions of the bowel. Is it possible that we have here different strains of the same organism, some showing and others not showing tissue-invasive powers—a condition somewhat resembling the relation between *Entamœba histolytica* and *Entamœba coli?*

At least one other observer, Barlow,(1) has suggested that it "is not impossible" that there may be different strains, or even species, of *Trichomonas* and that some of them may at times be more or less pathogenic.

In connection with this particular case, these facts must be carried in mind in the attempt to interpret our observation: (1) The patient, according to the assertion of her relatives, had suffered from an attack of dysentery of short duration some three years previous to this attack. (2) On admission to the hospital she showed characteristic clinical symptoms of dysentery, the stools passed were of dysenteric character, not merely diarrhœal, and contained large numbers of *Pentatrichomonas.* (3) Careful search by three observers failed to detect the presence of *Entamœba histolytica;* the findings of three microscopists agreed in all other essential details. (4) The microscopic picture of the stool, though it was similar to that presented by many cases of flagellate infection we have seen, yet suggested the possibility of bacillary dysentery.

The fact that the bacteriological examination for *Bacillus dysenteriæ* was negative carries no weight with us, for our experience is that negative findings in such cases are worthless, especially if the stool has not reached the bacteriologist immediately after its passage. So, in short, we are left in doubt as to whether the dysenteric symptoms were due to a protozoal, a bacterial, or a mixed infection. This is aside from the statement of Chatterjee that he recognizes flagellate dysentery as a distinct entity and incriminates *Pentatrichomonas* as one genus that may be an etiologic factor.

To our minds the most important feature lies in the observation of a trichomonad that ingests red blood corpuscles. Only second in importance to this is the question as to whether they are digested by the parasite or are only fortuitously taken up to be later expelled like non-nutritious matter or unaccustomed food taken in by many of the free-living species of protozoa. The faculty of food selection is a striking feature of the life activities of many protozoa, both free-living and parasitic. Calkins, speaking in a rather happy vein of certain predatory forms says that they "seem to select their food with all the care of a gourmand." With many forms "all is grist that comes to the mill" and then the process of selection may take place within the cytopharynx or possibly within the cytoplasm, the non-nutritious matter or the nutritious matter to which the animal is not adapted being rejected and cast back into the environment. Many species are known to thrive best on some particular species of bacteria to the exclusion of others; some will prey upon smaller protozoa of one species alone to the exclusion of all others, as in the case of *Didinium nasutum* which derives its sole nourishment from *Paramœcium caudatum,* and the same principle probably applies to a certain extent in the parasitic species, and is expressed to a degree in the predilection of certain species for certain organs or tissues where they find the food to which they have become adapted. Others may nourish themselves by one method under certain physical conditions, and by another when these conditions change. From this viewpoint, therefore, the problem becomes one of the bionomics of this particular trichomonad; and, having in mind the not infrequent occurrence of mixed bacillary and protozoal dysentery, we are inclined to cast the dysenteric symptoms out of this discussion until we can make further observations.

Erythrocytes may be said to constitute a fairly specialized diet, one that in the natural order of events might be expected to be indulged in only by an organism that is, to a certain extent, adapted to life in the tissues. The lumen-dwelling intestinal parasites are, for the most part, vegetarians. Those which can be shown to make a meal from blood corpuscles and to derive nourishment therefrom have become carnivores and immediately fall under suspicion of being likely to cause destruction of tissues. The case has been pretty well proved against *Entamœba histolytica* almost in this count alone to the extent that the presence of erythrocytes in the cytoplasm is of great diagnostic significance and now the burden of suspicion falls heavily on *Pentatrichomonas.*

In the material we were able to study we saw no individual in which we could detect bacteria such as one may find in the general run of lumen-dwelling forms. If we had encountered merely one or two individuals containing erythrocytes, we should have been inclined to place less weight on the observation, because trichomonads will frequently take in rather large bodies. (Kofoid and Swezy(9) figure *Trichomonas prowazeki* from the gut of *Diemyctylus torosus* with an engulfed "Blastocystis enterocola" fully half the size of its own body.) But here the senior author counted 103 individuals containing erythrocytes and observed many more, while the junior author likewise saw a large number. There was every apparent evidence that the ingestion of the corpuscles was not fortuitous, but was "purposeful" to the extent that the parasites literally seemed to "go after" the corpuscles; and, furthermore, the variation in size of the corpuscles contained in the bodies of the parasites suggested, on the analogy of *Entamœba histolytica*, that they were being digested and assimilated. It should be noted, further, that the cytoplasm of the organisms bore a distinct greenish tint such as is seen very frequently in *Entamœba histolytica* and is thought to be due to the breaking down of hæmoglobin. To be sure, this greenish tint is occasionally seen in *Entamœba coli*, according to some authors.

This seems to us to open a new line of attack on the general problem of the pathogenicity of the trichomonad flagellates found in the intestine of man. This group comprises three genera: *Trichomonas* (sensu stricto), with three anterior flagella; *Tetratrichomonas*, with four anterior flagella; and *Pentatrichomonas*, with five anterior flagella. All are equipped with an axostyle and an undulating membrane bearing a marginal flagellum which is continued beyond the posterior end of the body as a free lash.[5]

On the basis of our present knowledge, *Trichomonas* and *Tetratrichomonas* seem to be lumen-dwelling forms subsisting solely on bacterial life. But now *Pentatrichomonas* appears as a form adapted to the rather specialized diet of erythrocytes and, so far as we can see in this instance, gives no evidence of being

[5] As the proof on this paper is being read we have discovered a trichomonad and an associated spirochaete in the exudate removed by aspiration from the pleural cavity of a Chinaman in the Philippine General Hospital a few hours before death. We are unable at this time to offer an explanation as to how the flagellate gained entrance to the pleural cavity; but, the case having gone to autopsy, we shall report in detail on it in the near future.

a bacteria eater. It must be remembered that we are dealing only with the forms seen by us. Chatterjee, in his original paper(3) describing *Pentatrichomonas bengalensis,* makes only incidental mention of the ingestion of blood corpuscles, and we do not know whether or not his species feeds on bacteria. Derrieu and Raynaud do not discuss the nutrition of the species seen by them.

As a basis for future work looking to the clarification of the problem, it is suggested that *Trichomonas* and *Tetratrichomonas* might, for the present, be looked upon as feeding upon bacteria in the lumen of the bowel, and as occupying a position similar to that of *Entamœba coli;* while the species of *Pentatrichomonas* observed by us, and also probably by Chatterjee, may be regarded as a form subsisting on erythrocytes and possibly other tissue elements, and perhaps bearing the same relation to its host as does *Entamœba histolytica.* That these differences may exist within the genus is, of course, to be taken into consideration; that is to say, certain species of *Pentatrichomonas* may, like their cousins *Trichomonas* and *Tetratrichomonas,* subsist on bacteria solely, while others derive their nourishment from tissue elements alone, or may even adopt either method of nutrition under certain physical and chemical conditions obtaining in the particular environment in which they happen to find themselves at the time, or at some definite period in the life cycle. These are things that are to be determined by future investigation.

It is scarcely possible to go into the matter of tissue invasion on the basis of these observations, for that is purely conjectural. An autopsy on our case might or might not have developed interesting information on this point. Hadley, in his excellent studies on trichomoniasis in turkeys(7) has described in detail the mode of invasion of the intestinal wall through the goblet cells, and also the method by which the parasites later reënter the lumen of the intestine to complete their developmental cycle. We can, for the present, only surmise that such a thing might happen in man; but only histological study of the tissues in a case similar to ours can clear up that point. From his papers and from the study of preparations kindly sent to the senior author, we believe that Hadley has built up a strong case for *Trichomonas* in the intestine of the turkey. So far, the opportunity has been lacking to make the study of the liver sections sent by Doctor Hadley that they deserve, but we regard his work as forming a good basis of attack on the problem in man when favorable material becomes available. The fact that the phenomena observed by us occurred in a child may have some significance in view of the well-known virulence of protozoal infections in children and in young animals. Mello-Leitao(10) lays particular stress on the virulence of flagellate infections in children and states his belief that the most frequently occurring type of dysentery in infants is of flagellate origin.

In the cases reported by Derrieu and Raynaud, and by Chatterjee, the bowel movements were dysenteric in character, as in our case. Derrieu and Raynaud also reported 14 per cent mononuclear leucocytes on the differential blood count. The mononuclear count is almost always of interest in protozoal infections, but unfortunately they say nothing in connection with their case as to the possibility of a concurrent malaria.

It has occurred to us that *Pentatrichomonas* may be the etiologic factor responsible for the outbreaks of so-called "epidemic flagellate dysentery" reported by so many workers in the tropics and elsewhere. On this point, Derrieu and Raynaud in their paper say:

> Nous devons signaler le caractère épidémique de cette variété de dysenterie. Notre malade nous a affirmé que les cas de diarrhée dysentériforme étaient nombreux dans la contrée qu'il habitait: certains de ses compagnons avaient gardé cette diarrhée pendant plusieurs mois, mais aucun n'avait été aussi gravement attreint que lui. Il nous a été impossible de faire une enquête sur place, à cette époque; elle aurait donné lieu trè probablement à de curieuses constatations.

We also have in mind a supposed epidemic of flagellate dysentery at Parañaque, near Manila, in 1914, and mentioned by one of us,(8) in which many deaths occurred and for which no other cause except a trichomonad infection could be found.

We do not see the necessity for discussing at length the treatment of trichomonad infections. Suffice it to say that Derrieu and Raynaud claim to have cured their case by the administration of turpentine, by mouth and by enema. This is a form of treatment advocated in 1913 by Escomel, who later(6) used the same treatment in vaginal infections and introduced another treatment with iodine solution, either of which he claims will cure all cases. Derrieu and Raynaud noted the inefficacy of ipecac, collargol, neosalvarsan, urotropin, and sodium sulphate in their cases. Castellani has reported encouraging results, in some instances, in the treatment of flagellate infections with methylene blue.

Chatterjee seems to have met with poor success in the emetine treatment of his cases of dysentery associated with *Pentatrichomonas* infection. Only one of those he cites seems to have responded at all to the drug. Chatterjee points out that there is danger of confusing these cases of flagellate dysentery with sprue, tuberculous diarrhœa, chronic amœbic dysentery, and the like. This point, we think, is well taken, and might with profit be borne in mind by practitioners unfamiliar with the perplexing manifestations in infections with the intestinal protozoa.

In conclusion we desire to thank Dr. José Albert, chief of the department of pediatrics for giving us access to the case, and Dr. Alberto Tupas, of the same department, who kindly furnished us the clinical data and coöperated with us in other ways.

REFERENCES

(1) BARLOW, NATHAN. Studies on Trichomonas. *New Orl. Med. & Surg. Journ.* (1916), **69**, 299.

(2) BOECK, WILLIAM C. Mitosis in Giardia microti. *Univ. of Calif. Pub. in Zool.* (1917), **18**, No. 1, 1.

(3) CHATTERJEE, G. C. On a five flagellate Trichomonas parasitic in man. *Indian Med. Gaz.* (1915), **50**, 5.

(4) IDEM. Note on flagellate dysentery. *Indian Journ. Med. Res.* (1917), **4**, 393.

(5) DERRIEU et RAYNAUD. Dysenterie chronique a flagelle nouveau. *Bull. Soc. path. exot.* (1914), **7**, 571.

(6) ESCOMEL, E. Quelques remarques a propos des Trichomoniases intestinale et vaginale. *Bull. Soc. path. exot.* (1917), **10**, 553.

(7) HADLEY, PHILIP B. The role of the flagellated Protozoa in infective processes of the intestines and liver. Bull. 166, Agr. Exp. Station, Rhode Island State College, Kingston, R. I. (1916). The avenue and development of tissue-infection in intestinal trichomoniasis. Bull. 168, Agr. Exp. Station, Rhode Island State College, Kingston, R. I. (1916). The part played by the goblet cells in protozoan infections of the intestinal tract. *Journ. Med. Res.* (1917), **36**, 79.

(8) HAUGHWOUT, F. G. The tissue-invasive powers of the flagellated and ciliated Protozoa with especial reference to Trichomonas intestinalis. A critical review. *Philip. Journ. Sci., Sec. B* (1918), **13**, 217.

(9) KOFOID, C. A., and SWEZY, OLIVE. Mitosis and multiple fission in trichomonad flagellates. *Proc. Am. Acad. Arts & Sci.* (1915), **51**, 296.

(10) MELLO-LEITAO. Cited by Fantham, Stephens and Theobald. The animal parasites of man. John Bale Sons & Danielsson, Ltd., London (1916), 624.

(11) MESNIL, F. Apropos du flagelle nouveau decrit par MM. Derrieu et Raynaud (Pentatrichomonas-Hexamastix D. et R., nec Alexeieff). *Bull. Soc. path. exot.* (1915), **8**, 574.

(12) SHARP, ROBERT G. Diplodinium ecaudatum with an account of its neuromotor apparatus. *Univ. of Calif. Pub. in Zool.* (1914), **13**, No. 4, 43.

ILLUSTRATION

Plate I

[Figs. 1 and 2 were redrawn from camera lucida drawings of specimens fixed in Bouin's picro-aceto-formol solution, and stained with Dobell's alcoholic iron-hæmatein. Figs. 3 to 8 were redrawn from sketches made of the living organism during the process of feeding. Drawings by Haughwout.]

Fig. 1. Partially macerated individual showing disklike body, presumably an erythrocyte, lying in the cytoplasm.

2. Preparation showing further morphological details. Note the line of chromatinic granules lying in the cytoplasm between the axostyle and the parabasal.

Figs. 3 to 7. Successive stages in the ingestion of an erythrocyte by a living specimen of *Pentatrichomonas*.

Fig. 8. Ingested erythrocyte lying in the cytoplasm at the posterior extremity of the parasite, and forming a bulge on the external surface of the body.

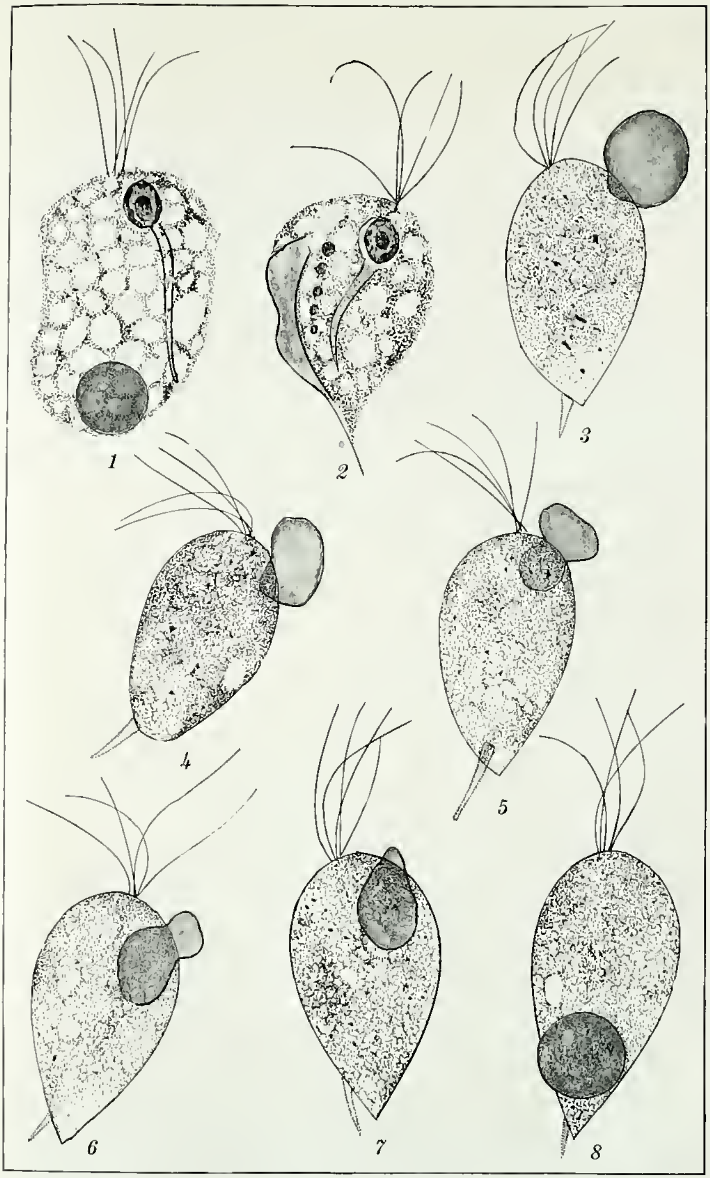

PLATE I. PENTATRICHOMONAS SP.

THE EFFECT OF CALCIUM SULPHATE ON CEMENT

SECOND PAPER

By J. C. Witt

(From the Chemical Laboratory, Bureau of Science, Manila)

TWO TEXT FIGURES

The first paper of this series [1] was a report of an investigation made at the Bureau of Science, Manila, to determine the effect of various amounts of calcium sulphate on a number of cements manufactured in the Orient. It was desired to learn the sensitiveness of these cements to calcium sulphate, the amount of this substance that could be present without harmful effects, and either to confirm or to refute some of the established principles of previous investigations. All the samples were prepared in the laboratory. Either finished cement or clinker was obtained, a calculated amount of gypsum or of some other form of calcium sulphate added, and then the two were placed in a small ball mill where they were ground and thoroughly mixed. The mixture was removed, analyzed for sulphuric anhydride (SO_3), and subjected to the usual physical tests.

In conformity with previous work it was found that in general the time required for the initial set was directly proportional to the amount of sulphuric anhydride present [2] until a certain point was reached, but further additions quickened the set.[3] This maximum point corresponded to from 1.5 to 2 per cent sulphuric anhydride. With more than 2 per cent sulphuric anhydride the tensile strength was likely to decrease, and with more than 3 per cent considerable expansion in sea water was likely to result. The soundness was independent of the sulphuric anhydride content.

After the first paper was completed, some phases of the investigation were continued. It developed that one of the cements was very irregular in setting time. Several series of samples were prepared, and sulphuric anhydride–setting time

[1] *Philip. Journ. Sci., Sec. A* (1917), 12, 133.

[2] Many other electrolytes have this effect. See *Philip. Journ. Sci., Sec. A* (1916), 11, 273; (1918), 13, 29.

[3] Several references to the influence of substances on cement and concrete are given in the papers referred to in footnotes 1 and 2 and are not repeated here.

curves were plotted, but no two of these curves resembled each other. At the plant where this cement was manufactured similar irregularity was also noted, and considerable difficulty was experienced in controlling the addition of gypsum. Some samples taken from the conveyors, having a low sulphuric anhydride content, were normal [4] in set, while others, with much higher content, had a flash set. In such cases the other physical tests showed no essential differences; nor were there sufficient differences in chemical analyses to account for the irregularity. It developed further that samples prepared in the laboratory by crushing the clinker and grinding it in a small ball mill did not have the same behavior as the cement which had been ground in a large mill at the plant.[5]

Most of the work reported in the present paper was carried out to solve the problem of satisfactory gypsum control for the cement in a single plant and with no intention of publishing the results. To obtain the number of results necessary to accomplish the desired purpose it was necessary to work with one cement alone, even though an investigation of several simultaneously would have contributed more to the general subject.

All physical tests have been made in accordance with United States Government specifications for Portland cement,[6] except that the ball method for normal consistency has been used, and no effort has been made to control room temperature (usually 25° to 35° centigrade). The setting time as determined by the Gillmore needles is given to the nearest ten minutes, and any value less than five has been called zero. As a rule the final set has been omitted in the tables, because most of the irregularity has been noted with the initial set. The normal consistency is given only when it shows some characteristic of interest. Most of the samples have been analyzed individually, but a few of the values were calculated from the sulphuric anhydride content of the clinker and of the gypsum. In Table I the samples shown as containing no sulphuric anhydride were not analyzed. No gypsum was added, but the clinker contained a trace. The tests were made at different times and by different operators, so that some slight variation may be due to personal equation. Samples that gave the most erratic results have purposely been

[4] In this paper, "normal set" means a satisfactory initial set—usually two to four hours.

[5] For simplicity, samples ground from clinker in a laboratory mill will be called "laboratory samples" while those taken from the conveyors in the plant will be called "plant samples."

[6] No. 59 C1a, January 1, 1917.

included. In Table I are shown some tests on laboratory samples which have been made from time to time. For convenience in comparison, they have been arranged in the order of their sulphuric anhydride content.

Commercial cements clinkered in rotary kilns require the addition of some substance subsequent to burning. I have never found a cement either in the United States or in the East that did not contain calcium sulphate, though of course the amount varies greatly with conditions. This cement, however, is an exception, when ground in a laboratory mill. Only one of several samples ground without the addition of gypsum was quick setting, and that one required only a small addition of gypsum to give a normal set. Further, the addition of gypsum has little effect on the setting time. The results obtained with laboratory samples are irregular when considered individually, but if those for each half per cent sulphuric anhydride are averaged (omitting the samples having a flash set, and calculating to round numbers) we have the following, which show that the average setting time is apparently independent of the sulphuric anhydride content:

Sulphuric anhydride. Per cent.	Time of set. Minutes.
0.50 to 1.00	200
1.01 to 1.50	250
1.51 to 2.00	220
2.01 to 2.50	230
Above 2.50	240

Table II shows some of the results obtained with plant samples, likewise arranged with reference to their sulphuric anhydride content. Averaging these results, we have

Sulphuric anhydride. Per cent.	Time of set. Minutes.
Less than 1.80	33
1.80 to 2.00	161
Above 2.00	171

Many plant samples below 1.80 per cent sulphuric anhydride are quick setting. With percentages greater than 1.80, the average sample has a normal set, though the period is not so long as for the laboratory sample containing no retarder. The samples shown in Table II were taken from the conveyors at the plant in the course of control work extending over several months. Samples were taken regularly every half hour, and when one was found to be quick setting, it was put aside for analysis and further examination.

The data given in the first two tables may be readily understood by reference to fig. 1. The setting time of each sample is plotted against the sulphuric anhydride content. The plant samples are designated by ○ and the laboratory samples by +. The line representing sixty minutes, the minimum initial set allowable under Government specifications when Gillmore needles are used, and the lines representing 1.80 per cent and 2.10 per cent sulphuric anhydride, respectively, are made heavy for the sake of comparison. The last named is the upper limit of sulphuric anhydride content allowable under Government specifications.

SPECIAL PLANT TEST

By referring to fig. 1 it will be noted that only four plant samples below 1.50 per cent were included. Cement had not been regularly manufactured below this amount, and no such

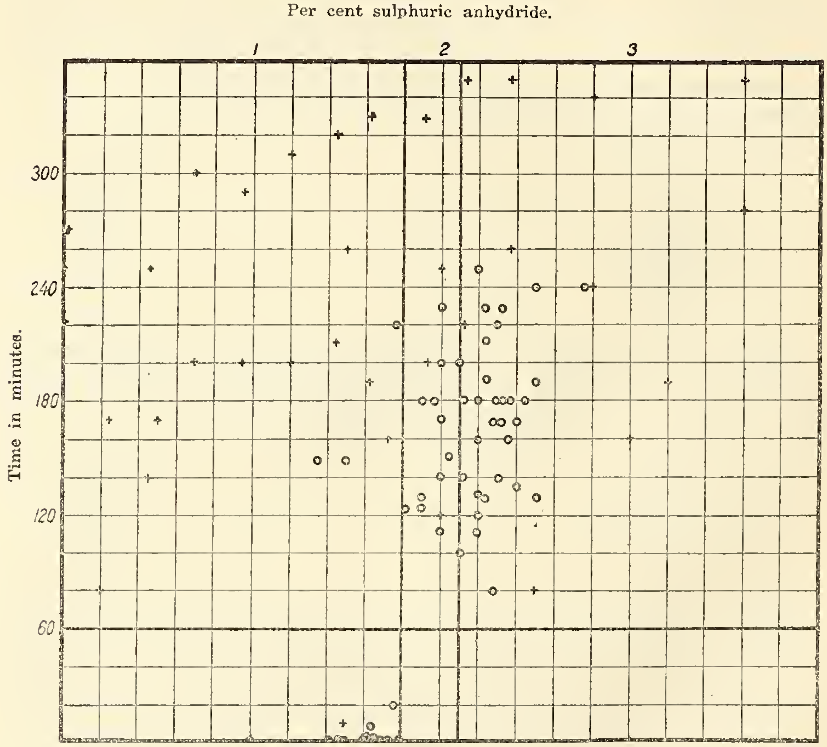

FIG. 1. Showing the relation of initial set to sulphuric anhydride content.

plant samples were available. The first cement was made with 1.50 per cent sulphuric anhydride but was found unsatisfactory, and since then the calculated amount had been gradually raised to bring the setting time within the required limits. A number of laboratory samples low in sulphuric anhydride had been studied, but no conclusions concerning the regular product could be drawn. It often has been found that when an electrolyte is mixed with a cement there is a maximum point in the setting-time curve. When a given amount of the electrolyte is present, the cement will have the slowest set—either less or more of the substance causing a quicker set. The peculiar behavior of the plant samples in requiring so much calcium sulphate to produce a normal set and the results obtained with laboratory samples containing little or none of the retarder suggested the possibility that the optimum sulphuric anhydride content was at some point below 1.50 per cent. In that event, the difficulty in the manufacture was that the sulphuric anhydride was always above the optimum point.

Arrangements were made by which the output of a tube mill for a number of hours was taken for the experiment. A quantity of clinker recently made and known to be very uniform was selected. Sufficient gypsum was mixed, sampled, and analyzed. At 6 o'clock in the morning the mill was started; it was run twelve hours in the usual manner, keeping the sulphuric anhydride at approximately 2 per cent. The cement was tested repeatedly during the day and was found to be normal in every respect. At 6 in the afternoon all additions of gypsum were stopped and clinker alone was fed to the mill until 9 o'clock, after which gypsum was added as before. From 6 p. m. until 1 a. m. samples of 4 or 5 kilograms each were taken every half hour, and at times every fifteen minutes. Physical tests were started at once, and the following day each sample was analyzed for sulphuric anhydride. The results are shown in Table III. Samples 1 to 4 and 15 to 18 gave satisfactory tests for soundness. The others could not be tested because they were quick setting. The normal consistency of all samples tested was the same. The fineness did not vary greatly during the run. The lowest point reached in sulphuric anhydride content was 0.62 per cent. It would have been difficult to obtain a lower result than this unless the tests had continued a long time, because the cement was run through an air separator, and the cement returning to the mill always carried considerable sulphate. The test demonstrated that satisfactory cement could not be made with a small amount of the retarder, because only one sample having less than 1.50 per cent sulphuric anhydride had a normal set.

The construction of fig. 2 is based on the results in Tables I, II, and III, and several hundred other analyses and physical tests. The figure is a diagram showing in general the relation of sulphuric anhydride content, from 0 to 2.50 per cent, to the setting time, in both plant and laboratory samples. Because of the considerable variation areas have been substituted for the usual graphs. The shaded areas represent plant sam-

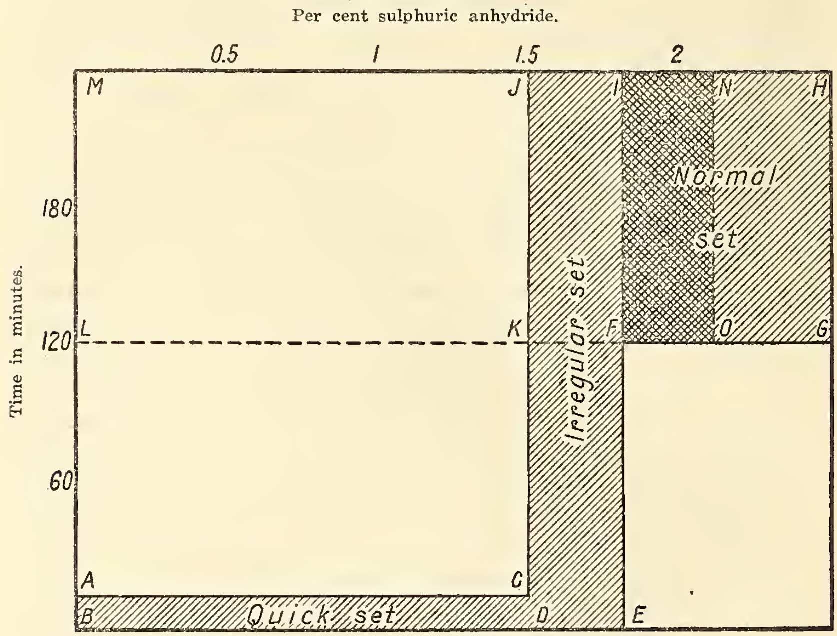

FIG. 2. Diagram showing the relation of initial set to sulphuric anhydride content.

ples. When the sulphuric anhydride content of a cement is less than 1.50 per cent, it will set in only a few minutes and its place on the diagram is within the rectangle *ACDB*. Between 1.50 and 1.80 per cent, the behavior is erratic. It may have a flash set or a normal set—rectangle *DJIE*. Above 1.80 per cent, the cement has a setting time of two to four hours. The area *MHGL* shows the behavior of laboratory samples. The average time of set is the same, with or without gypsum.

CONTROL OF GYPSUM AT THE PLANT

On the basis of the diagram just described, the gypsum control at the plant was adjusted a year ago and there has been no further difficulty with that phase of the manufacture. With the present raw materials and plant equipment, the sulphuric anhydride content must be kept between 1.80 per cent and 2.10

per cent. If less than 1.80 the set cannot be depended upon, and if greater than 2.10 the cement will not conform to Government specifications. This area is shown by the darkly shaded rectangle *INOF* (fig. 2).

At many plants the allowable variation in sulphuric anhydride is considerably greater than 0.3 per cent, and sufficient accuracy may often be obtained by measuring the gypsum; that is, by adding a certain volume to a given weight or volume of the clinker. This method was used formerly, and in a day's run the maximum variation of sulphuric anhydride was 0.46 per cent. By exercising greater care and stricter supervision, this was lowered to 0.30 per cent. With such small limits allowable, this was still not sufficiently accurate and other changes were made. It was found necessary to weigh both gypsum and clinker. Two small bins were made, each containing sufficient gypsum for a two-days' run of the mill. The gypsum to fill one of them is thoroughly mixed, and sampled as it is placed in the bin, and then analyzed. The weight of gypsum added to the clinker is calculated from this analysis. While the first bin is being used, material for the second is prepared. By this method the maximum variation for a day's run may be kept as low as 0.17 per cent. By comparing many analyses of the finished cement with the theoretical sulphuric anhydride content calculated from the mix, it has been found that on account of irregularities such as the sulphuric anhydride in the clinker, the loss of water in the gypsum during grinding, the loss of gypsum from dusting, and the like, there is practically a constant variation which can be corrected in the original calculation of the mix. Taking this into account, the sulphuric anhydride content can be kept within a few hundredths per cent of the calculated value.

THE EFFECT OF EXPOSURE TO THE AIR, AND OF HYDRATED LIME, IN PRESENCE OF CALCIUM SULPHATE

A cement may contain sufficient gypsum to render it normal setting at the time of manufacture, but may lose the effect of the retarder when exposed to the air. Quick-setting cement may also become normal under the same conditions. The effect of air exposure on a number of the samples in Table III was investigated. It has been shown that the effect of the atmosphere extends only a few millimeters below the surface,[7] but conditions more severe than cement is ever subjected to during

[7] *Philip. Journ. Sci., Sec. A* (1910), 5, 398.

storage were arranged. The cement was spread out in thin layers and thoroughly mixed from time to time to expose new surfaces. At intervals, portions were removed and tested for setting time. The results are shown in Table IV. Sample 13, with 0.62 per cent sulphuric anhydride, changed from a flash set to a normal set; sample 15, 1.72 per cent, changed from normal to quick setting; No. 1, 2.15 per cent, remained slow setting; No. 4, 1.92 per cent, became quick setting in nine days, but had returned to normal at the end of eighty-five days. In this series of experiments, it is evident that the effect of exposure is practically independent of the sulphuric anhydride content.

Hydrated lime is said to retard the set of cement.[8] Some tests were made to determine its effect in the presence of various amounts of gypsum. Cement having a flash set and containing 1.50 per cent sulphuric anhydride was used. Gypsum ground to equal fineness and containing 35.81 per cent sulphuric anhydride was mixed with this cement in proportions to give cements of 1.65, 1.75, and 2.00 per cent sulphuric anhydride, respectively. To the original cement and to each of the mixtures were then added 0.5, 1, and 2 per cent hydrated lime, respectively. The setting time of each mixture was then determined, and the results are shown in Table V. The effect of the lime is apparently independent of the sulphate present. The normal consistency increases with the lime present.

POSSIBLE CAUSES OF IRREGULARITY

The peculiar irregularity of this cement is difficult to explain. A number of quick-setting samples have been analyzed and the analyses compared with those of slow-setting samples having a lower sulphuric anhydride content. Some differences were found, but they were not sufficiently large to account for the irregularity. The cement is somewhat higher in iron and in alkalies than the average cement, but otherwise there is nothing unusual in its composition. High iron content should not make cement quick setting.[9] The various alkalies are present in constant amounts and therefore should have a uniform influence, unless their effect is caused to vary by changes taking place during the manufacturing process.

Since the irregularity has not been accounted for on the basis

[8] Carpenter, R. C., *Eng. Rec.* (1904), 50, 769; Meade, R. K., Portland Cement. Easton, Pa., The Chemical Publishing Co. (1911), 424.

[9] Meade, op. cit., 35.

of analyses, an explanation was sought on the basis of physical changes, or of chemical changes in the constituents, of such a nature that they could not be detected by analysis. It is believed that the irregularity results from changes that go on during the grinding of the clinker, though it has not been proved that such are entirely responsible. Slight variations in heat treatment in the kiln may partly account for it. However, it has been observed in connection with the grinding that such factors as the rate at which the clinker is fed to the mill, the hardness of the clinker, the relative size of the pieces, and the heat generated during the process have their effect.

With reference to the grinding, the following explanations of the irregularity of cement ground at the plant, and between the regular product and samples ground in a laboratory mill [10] have been offered:

1. The heat generated during grinding at the plant causes the formation of alkali carbonates, which influence the set of the finished cement. (A high temperature is often reached, and the clinker is high in alkalies.)

2. Though the 200-mesh fineness of the plant samples and of the laboratory samples is practically the same there may be a considerable difference in the fine particles that pass the sieve.

Neither of these hypotheses has been verified. On the contrary, there is evidence against them. A series of tests reported in the first paper of this series [11] shows that the set is only slightly affected by the presence of sodium carbonate. Therefore, even if considerable quantities of alkaline carbonates were found during grinding, the irregularity of set could not be accounted for on that basis. The tensile strength of laboratory samples and of plant samples is approximately the same. This would not be likely to be so, if the latter contained an appreciably greater percentage of fine particles.

SUMMARY

The cement under investigation is unique in its setting qualities when treated with calcium sulphate. If the clinker is ground in a small laboratory mill, its average time of set is independent of the amount of sulphate added. When ground in

[10] No. 1 was suggested and communicated to me by another investigator.
[11] Loc. cit.

the regular way at the plant, however, it must have a sulphuric anhydride content of 1.80 per cent to insure a normal set.

Considerable difficulty was experienced in controlling the gypsum content until many physical tests and chemical analyses had been made, and the limits of the sulphuric anhydride determined.

The effects of exposure to air and of additions of hydrated lime are independent of the sulphuric anhydride content.

Soundness is independent of the sulphuric anhydride content. Normal consistency is independent of sulphuric anhydride content, but increases with the amount of hydrated lime present.

TABLE I.—*Setting time of cement ground in laboratory.*

Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.
Per cent.	*Min.*	*Per cent.*	*Min.*	*Per cent.*	*Min.*	*Per cent.*	*Min.*
0	0	0.71	300	1.66	330	2.79	260
0	250	0.96	200	1.75	160	2.79	340
0	270	0.96	290	1.89	220	3.00	160
0	270	1.00	0	1.89	330	3.20	190
0.22	80	1.20	200	2.00	120	3.63	280
0.22	180	1.20	310	2.00	250	3.63	350
0.25	170	1.43	210	2.12	220	5.00	170
0.46	140	1.43	320	2.12	350	9.10	140
0.46	250	1.50	10	2.35	260	----------	----------
0.50	170	1.50	260	2.35	350	----------	----------
0.71	200	1.66	190	2.50	80	----------	----------

TABLE II.—*Setting time of cement ground in plant.*

Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.	Sulphuric anhydride.	Initial set.
Per cent.	*Min.*	*Per cent.*	*Min.*	*Per cent.*	*Min.*	*Per cent.*	*Min.*	*Per cent.*	*Min.*
1.35	150	1.75	20	2.04	150	2.25	230	2.44	180
1.45	0	1.75	220	2.10	140	2.26	130	2.50	130
1.45	0	1.80	0	2.11	100	2.27	80	2.50	240
1.45	0	1.82	125	2.11	200	2.28	170	2.51	190
1.50	0	1.87	125	2.13	180	2.29	130	2.75	240
1.52	0	1.87	180	2.18	250	2.30	140	----------	--------
1.52	160	1.91	130	2.19	120	2.31	220	----------	--------
1.59	0	1.92	180	2.20	130	2.32	180	----------	--------
1.61	0	1.95	180	2.22	110	2.33	170	----------	--------
1.61	0	2.00	110	2.22	160	2.33	230	----------	--------
1.62	0	2.00	230	2.22	160	2.35	160	----------	--------
1.65	10	2.02	140	2.22	200	2.36	180	----------	--------
1.68	0	2.02	170	2.23	210	2.39	135	----------	--------
1.74	0	2.03	200	2.25	190	2.41	170	----------	--------

TABLE III.—*Mill test to establish relation between sulphuric anhydride and setting time.*

Sample No.	Time.	Sulphuric anhydride.	Normal consistency.	Initial set.	Final set.	Fineness (200-mesh).
	p. m.	*Per cent.*		*Min.*	*Min.*	
1	6.00	2.15	24	170	270	89.0
2	6.30	2.15	24	140	270	----------
3	7.00	2.06	24	150	290	87.2
4	7.30	1.92	24	190	270	----------
5	8.00	1.13	----------	55	130	87.8
6	8.30	0.96	----------	flash	----------	----------
7	8.45	0.93	----------	flash	----------	----------
8	9.00	0.89	----------	flash	----------	88.9
9	9.15	0.82	----------	flash	----------	----------
10	9.30	0.79	----------	flash	----------	----------
11	9.45	0.75	----------	flash	----------	----------
12	10.00	0.69	----------	flash	----------	89.5
13	10.30	0.62	----------	flash	----------	----------
14	11.00	1.13	----------	flash	----------	89.6
15	11.30	1.44	24	170	220	----------
	a. m.					
16	12.00	1.72	24	130	230	86.2
17	12.30	1.64	24	170	230	----------
18	1.00	1.54	24	150	280	85.2

TABLE IV.—*Effect of exposing cement of various sulphuric anhydride contents to the atmosphere for different periods of time.*

Sample No.	Test.	Days of exposure.						
		None.	2.	4.	9.	16.	32.	85.
1	Initial set ---------- min.	170	200	240	240	210	300	170
1	Final set ---------- min.	270	400	450	300	600	540	260
1	Normal consistency ----------	24	24	24	24	25	33	33
4	Initial set ---------- min.	190	190	250	10	15	35	100
4	Final set ---------- min.	270	380	450	150	160	45	170
4	Normal consistency ----------	24	24	24	24	24	33	33
5	Initial set ---------- min.	55	0	35	3	7	25	80
5	Final set ---------- min.	125	0	300	220	160	35	160
5	Normal consistency ----------	24	24	24	24	25	33	33
13	Initial set ---------- min.	0	0	25	260	200	70	90
13	Final set ---------- min.	0	0	720	620	730	(a)	120
13	Normal consistency ----------	24	24	24	24	29	29	33
15	Initial set ---------- min.	170	10	120	10	10	25	45
15	Final set ---------- min.	220	350	540	280	140	40	170
15	Normal consistency ----------	24	24	24	24	24	29	33
16	Initial set ---------- min.	130	140	270	10	10	15	55
16	Final set ---------- min.	230	350	250	160	160	30	120
16	Normal consistency ----------	24	24	24	24	24	29	33
17	Initial set ---------- min.	170	125	190	5	5	15	60
17	Final set ---------- min.	230	330	330	200	100	30	140
17	Normal consistency ----------	24	24	24	24	24	29	33

[a] Time of set indefinite but more than twenty-four hours.

TABLE V.—*Effect of hydrated lime, in presence of various amounts of gypsum.*

Sample No.	Gypsum added (grams per kilo).	Calculated per cent SO_3.	Normal consistency.	Initial set in minutes.			
				With no addition of lime.	With 0.5 per cent lime.	With 1 per cent lime.	With 2 per cent lime.
			Per cent.				
1	0	1.50	25	0	10	5	45
2	4.2	1.65	26	5	65	40	80
3	7.0	1.75	27	20	60	65	110
4	14.0	2.00	28	105	125	145	160

ILLUSTRATIONS

TEXT FIGURES

EXPERIENCE WITH METHYLENE BLUE-EOSIN LACTOSE AGAR IN SEARCHING FOR BACILLUS DYSENTERIÆ IN STOOLS

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In the absence of suitable enrichment and selective media the isolation of *Bacillus dysenteriæ* from stools is handicapped by certain difficulties. It is true that in cases of acute bacillary dysentery the colonies of *B. dysenteriæ* that develop on the plates are at times numerous, and that practically no other colonies are found. On the other hand, experience teaches that even in a typical acute dysenteric stool the laboratory test fails to isolate *B. dysenteriæ*. If amœbæ be present in such a specimen, the clinician may easily be misguided and decide the case as amœbic dysentery. The clinical picture and the course of the disease may guide the clinician in the differential diagnosis of a particular dysentery case; but the clinical picture of either of the two forms of dysentery is surely not typical in every case, else the examination of stools for *B. dysenteriæ* would not be so persistently insisted upon by clinicians as it usually is, and rightly so.

The presence of amœbæ in acute dysentery stools does not necessarily exclude bacillary dysentery. One must consider the comparatively high percentage of amœbæ contact carriers. Furthermore, a superposed bacillary infection in a chronic case of amœbic dysentery is not so rare an occurrence as would appear at first thought. The theory advanced from some quarters that an attack of bacillary dysentery confers immunity and, therefore, if the patient gives history of previous attacks of dysentery it is amœbic and not bacillary dysentery is even theoretically untenable. Granted that the previous attacks were due to amœbic infection, this supposition does not prove that the present illness is not bacillary dysentery for the reason mentioned above.

From these considerations it is clear that the bacteriological diagnosis of bacillary dysentery is highly desirable. Hence any improvement in the laboratory technic which tends to facilitate the detection of *B. dysenteriæ* in stools will be welcomed by the laboratory worker as well as by the clinician.

It has been the good fortune of one of us to witness for some time the working out of the methylene blue-eosin plate by the authors [1] of this medium. They found it a very convenient medium in the bacteriological diagnosis of typhoid fever. *Bacillus dysenteriæ* and *B. typhosus* behave identically with regard to acidification of lactose. It naturally occurred to us to employ the methylene blue-eosin lactose agar in the bacteriological diagnosis of bacillary dysentery. Since we began work a paper by Meyer and Stickel,[2] which deals with the same subject, has been published. It is pleasing to note that our experience coincides with that of these workers.

During an outbreak of bacillary dysentery in Manila in 1918, we had an opportunity of subjecting the methylene blue-eosin lactose plate to a practical test as to its suitability in bacteriological diagnosis of bacillary dysentery. The stools were taken at random from hospital patients. Each stool was plated directly on litmus lactose agar and on methylene blue-eosin lactose agar. An equal amount of material was smeared on the surface of each plate.

In case of typical dysenteric stools a flake of bloody mucus was fished out, washed in salt solution, and smeared on the surface of the plate. Liquid or fæcal stools were used in four dilutions. A standard size loopful of each dilution was plated. The plates were incubated overnight. Colorless colonies were thoroughly searched for, and agglutination test was performed in hanging drop. Those colonies that showed positive agglutination were transplanted in sugar media for identification of the type. The advantages of the methylene blue-eosin plate, as given by the originators of this medium in typhoid diagnosis, were found to hold true in our examinations. Bacillary dysentery was found to form small colorless colonies, the various types of *B. dysenteriæ* showing no particular differences of growth.

The results of these examinations, thirty-eight specimens in all, are given in Table I.

Of the thirty-eight stools examined thirty-three were found positive. While the lactose litmus plate gave positive results in twenty-nine specimens (76 per cent), the methylene blue-eosin lactose plate showed a superiority of 8 per cent, giving positive results in thirty-two specimens (84 per cent). This is not the only advantage gained by the use of this medium; but, also, the

[1] Holt-Harris, J. E., and Teague, Oscar, *Journ. Infect. Dis.* (1916), **18**.
[2] Meyer, V. F., and Stickel, J. E., *Journ. Infect. Dist.* (1918), 23.

time necessary for the detection of *B. dysenteriæ* on this medium was much shorter as compared with the labor required to confirm the positive findings on the lactose litmus plate.

CONCLUSION

The methylene blue-eosin lactose medium designed by Holt-Harris and Teague, as modified by Meyer and Stickel and by us, is a considerable improvement in diagnostic technic.

We wish to thank Dr. P. T. Lantin, of the Philippine General Hospital, who kindly supplied us with the material.

TABLE I.—*Stool examinations.*

Specimen.	Serial No.	Lactose litmus plate.	Methylene blue-eosin plate.
4-10	1	+	+
5-58	2	+	+
5-23	3	+	+
5-27	4	+	+
45352	5	—	+
952	6	—	—
3-55	7	+	—
5-49	8	+	+
6-36 (63030)	9	+	+
6-18	10	+	+
6-26	11	+	+
5-61	12	+	+
5-53	13	+	+
5-50	14	+	+
3-359	15	+	+
5-53 Vazco	16	+	+
6-54 Matilde	17	+	+
5-60 Zuarez	18	+	+
5-55 Juan	19	+	+
5-70 Espinosa	20	—	+
5-56 Paguis	21	+	+
5-25 Catagayan	22	+	+
5-70 Espinosa	23	+	+
5-59 Balatbat	24	+	+
4-10 Beatriz	25	+	+
6-26 Ma. Fajardo	26	+	+
5-53 Telesforo	27	+	+
6-55 Ciriaca	28	+	+
5-58 Teydon	29	—	—
6-50 J. Aguilar	30	+	+
4-8 F. Madagep	31	+	+
4-6 Josefa Gy	32	+	+
5-58 Teydon	33	—	—
4-60 Praxides	34	+	+
4-9	35	—	—
3-361	36	—	+
3-346	37	—	—
57133	38	—	+

NOTES ON THE FLORA OF SUMATRA

By E. D. Merrill

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In the year 1860–61 Miquel[1] published a general summary of the Sumatran flora, enumerating all the species of Spermatophyta then known from the island and the neighboring smaller ones, especially Bangka. This work was based primarily on the collections of *Teysmann, Diepenhorst, Horsfield, Korthals, Junghuhn, Zollinger,* and *Amman,* and includes 2,642 species, of which about 700 were described by Miquel as new. Since Miquel's publication was issued, comparatively little has been published on the Sumatran flora as such. Some large collections of plants have been made, notably that by *Beccari,* but with the exception of the recent collections of *Robinson* and *Kloss,* those made by other botanists since Miquel's time have not been thoroughly studied.

In 1884 Van Hasselt and Boerlage[2] published a small contribution to our knowledge of the Sumatran flora, this being based on the relatively unimportant botanical collections made by the Veth expedition in connection with its anthropological and zoölogical investigations. In this work about 170 species are enumerated, a large number of them cellular cryptogams. Of the spermatophytes but four are described as new, most of the others enumerated having already been recorded from Sumatra.

The Sumatran collections made by Dr. S. H. Koorders in 1890 have been enumerated by Mrs. Koorders,[3] these totaling not more than 450 species in all groups, a considerable number of which have been determined only to the genus, and some only to the family. Of these species collected by Doctor Koorders

[1] Miquel, A. F. W., Florae Indiae Batavae. Supplementum I. Prodromus Florae Sumatranae (1860–61) XX + 1–656, *t. 1–4*. German edition, Sumatra, seine Pflanzenwelt und deren Erzeugnisse (1862) XXIV+1–656, *t. 1–4*.

[2] Van Hasselt, A. L. and Boerlage, J. G., Bijdragen tot de kennis der flora van Midden-Sumatra, in Veth, P. J. Midden-Sumatra 4 part 2[7] (1884) 1–49, *t. 1–8*.

[3] Koorders-Schumacher, A., Syst. Verzeich. Herb. Koord. 2 (1910–11) 1–62.

in Atjeh and in central Sumatra, about 30 were described as new. A high percentage of the others enumerated had already been recorded from Sumatra by Miquel.

The most important recent publication on the Sumatran flora as such is that by Ridley and others on the botany of Mount Korinchi, based on the collections of Messrs. H. C. Robinson and C. Boden Kloss.[4] In this publication 813 species are enumerated, of which 1 genus and 143 species are described as new. The percentage of novelties in this collection is certainly no less than can reasonably be expected from general collections made in any unexplored part of Sumatra where botanizing is largely confined to the forested areas. Among the previously described species enumerated by Ridley are naturally many that were already known from Sumatra, but there is also a considerable number originally described from other regions that had not previously been recorded from that island.

Sumatran species have been published from time to time in the extensive botanical periodical literature and in monographs of various natural groups. Including such species and those listed in the few publications wholly based on the Sumatran flora that have been issued since 1862, it is very doubtful if the list of species definitely known from Sumatra has been increased by more than 500 in all groups since the publication of Miquel's work. The list of Sumatran species known to-day would probably approximate about 3,000 in the spermatophytes alone, an indication of our lack of knowledge of the Sumatran flora as compared with other areas in the Malayan region, such as Java, with about 5,000 known species, Borneo with about 4,900 known species, and the Philippines with about 8,000 known species. On account of its large size, its varied climatic conditions, and its numerous high mountains, Sumatra can scarcely be less rich and varied in its flora than are the Malay Peninsula, Borneo, Java, and the Philippines; and from my present knowledge of the floras of these regions I should consider it very doubtful if we know more than one-third of the species that actually occur in Sumatra at the present time.

I have recently received for identification Sumatran collections aggregating about 500 numbers, made under the direction of Messrs. H. H. Bartlett and C. D. La Rue, chiefly in the vicinity of Asahan, East Coast. While the material represented in this collection for the most part represents rather common and widely

[4] Results of an expedition to Korinchi Peak, Sumatra, Botany, *Journ. Fed. Malay States Museums* 8[4] (1917) 1–145, *t. 1–4.*

distributed Malayan species, there are a few apparently undescribed forms, and a considerable number of known species previously not recorded from Sumatra. The collections were apparently made, for the most part, at low altitudes in the settled areas and in the second-growth forests; few species characteristic of the primary forests are represented. It is a well-known fact that collections made in any part of the Malayan region at low altitudes outside of the primary forest invariably present a high percentage of widely distributed species and hence those that are thoroughly well known. The endemic elements of any insular flora in Malaya—and the percentage of endemism is usually high in each of the larger islands of the Malay Archipelago—are for the most part confined to the primary forests. With our present state of knowledge of the Sumatran flora I have not considered it advisable to publish an enumeration of this collection, but have recorded some species, for the most part not previously credited to Sumatra, and also give below the descriptions of a few apparently undescribed species detected while studying the material.

URTICACEAE

DEBREGEASIA Gaudichaud

DEBREGEASIA LONGIFOLIA (Burm. f.) Wedd. in DC. Prodr. 16^1 (1869) 235.[24]

Urtica longifolia Burm. f. Fl. Ind. (1768) 297.

Karoland, Kaban Djahe, *Bartlett & La Rue 81*, with the local name *tjeppira.*

India to Java and the Philippines.

OREOCNIDE Miquel

(*Villebrunea* Gaudichaud)

OREOCNIDE NIVEA sp. nov.

Frutex vel arbor parva, ramulis villosis; foliis chartaceis, ellipticis ad elliptico-obovatis, 12 ad 17 cm longis, supra olivaceis, subtus niveis et densissime tomentosis, apice acuminatis, margine serrato-dentatis, nervis utrinque circiter 12, perspicuis; inflorescentiis fasciculatis, capitulis longe pedunculatis, globosis, 5 mm diametro.

A shrub or small tree, the branchlets and petioles rather densely villous with pale brownish hairs. Leaves chartaceous, elliptic to elliptic-obovate, penninerved, 12 to 17 cm long, 6 to 8 cm wide, serrate-dentate except at the base, the upper surface olivaceous when dry, the midrib and nerves more or less pubescent, the epidermis with few, scattered, rather long, white hairs, the lower surface white, densely tomentose, the pubescent midrib, nerves, and reticulations brownish, the base usually rounded, the apex shortly and sharply acuminate; lateral nerves about 12 on each side of the midrib, distinct, the petioles about 1.5 cm long; stipules lanceolate, acuminate, about 1 cm long. Inflorescences fascicled, axillary and from the axils of fallen leaves, the branches up to 2 cm long, simple, or bearing 2 or 3 heads, somewhat pubescent, the heads globose, about 5 mm in diameter. Achenes crowded, sessile, somewhat hispid, oblong-ovoid, narrowed upward, about 1.5 mm long.

SUMATRA, East Coast, Asahan, in mountain jungle at Linaboen, June 30, 1910, *Bartlett & La Rue 213*, with the local name *nderasi*.

This species is readily distinguished from all previously described forms of the genus by its leaves being white beneath in striking contrast to the dark-olivaceous upper surface.

OLACACEAE

ERYTHROPALUM Blume

ERYTHROPALUM SCANDENS Blume Bijdr. (1826) 921.

Karoland, Lau Bakal, *Bartlett & La Rue 170*, June 20, 1918.
India to Java and the Philippines.

LAURACEAE

LITSEA Lamarck

LITSEA UMBELLATA (Lour.) comb. nov.

Hexanthus umbellatus Lour. Fl. Cochinch. (1790) 196.
Litsea hexantha Juss. in Ann. Mus. Paris 6 (1805) 212.
Litsea amara Blume Bijdr. (1825) 563.

Karoland, Kampong Lingga, *Bartlett & La Rue 115*, June 5, 1918.

Loureiro's type is preserved in the herbarium of the British Museum, where it was examined by R. Brown, who thought it to represent the Australian species described by him as *Tetranthera ferruginea*. It is clear that Brown was in error in making this reduction, for Loureiro's species is apparently identical with the widely distributed Malayan one currently known as *Litsea amara* Blume, of which I have numerous specimens from Indo-China, the Malay Peninsula, and Java. The Australian species currently known as *Litsea ferruginea* (R. Br.) Benth. & Hook. f. needs a new name as the specific name is invalidated in *Litsea* by *L. furruginea* Blume; it should be known as **Litsea leefeana** (F. Muell.) (*Cylicodaphne leefeana* F. Muell.).

LITSEA PERAKENSIS Gamble in Kew Bull. (1910) 359, Journn. As. Soc. Beng. 75[1] (1912) 160.

Karoland, Kampong Lingga, *Bartlett & La Rue 117*, June 6, 1918.

Perak, Johore, Singapore.

LEGUMINOSAE

DESMODIUM Desvaux

DESMODIUM VIRGATUM Zoll. Nat. Geneesk. Archip. Ind. 3 (1846) 58; Prain in Journ. As. Soc. Beng. 66[2] (1897) 142.

Karoland, Bintang Mariah, *Bartlett & La Rue 128*, June 7, 1918, with the local name *gambir gambir.*

Chittagong, Burma, Perak, Java, and Luzon.

DESMODIUM ZONATUM Miq. Fl. Ind. Bat. 1[1] (1855) 250; Gagnep. in Not. Syst. 3 (1916) 297.

Karoland, Sarinambah, *Bartlett & La Rue 145*, June 8, 1918.

This species extends from Ceylon to the Philippines and New Guinea and in most recent literature appears as *Desmodium ormocarpoides* DC. The latter is, however, an entirely different species, as Gagnepain has shown.

DESMODIUM LASIOCARPUM (Beauv.) DC. Prodr. 2 (1825) 328.

Hedysarum lasiocarpum Beauv. Fl. Oware et Benin 1 (1804) 32, *t. 18.*

Desmodium latifolium DC. Prodr. 2 (1825) 328.

Karoland, Soesoek, *Bartlett & La Rue 321*, July 8, 1918, with the local name *gambir gambir.*

A common and widely distributed species in the tropics of the Old World.

MIMOSA Linnaeus

MIMOSA INVISA Mart. in Flora 20[2] (1837) Beibl. 121.

Asahan, Kampong Silau Meradja, *Bartlett & La Rue 394*, October 24, 1918, with the local name *si madoeridoeri.*

A native of Brazil, introduced here.

PITHECOLOBIUM Martius

PITHECOLOBIUM JIRINGA (Jack) Prain in Journ. As. Soc. Beng. 66[2] (1897) 267, in nota.

Mimosa jiringa Jack in Malay. Miscel. 1[1] (1820) 14.

Inga jiringa Jack op. cit. 2[7] (1822) 78.

Pithecolobium lobatum Benth. in Hook. Lond. Journ. Bot. 3 (1844) 208.

Asahan, Silau Meradja, *Bartlett & La Rue 148, 417*, June and October, 1918, with the local names *djering* and *djaring.*

The earlier names *Mimosa keoringa* Roxb. and *M. djiringa* Roxb., both proposed by Roxburgh in 1814, are *nomina nuda*, although Roxburgh published a description of the former in 1832. Jack's specific name should be adopted for this Malayan species which extends from Tenasserim to Java and Borneo, but which does not extend to the Philippines.

MELIACEAE

CIPADESSA Blume

CIPADESSA BACCIFERA (Roth) Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1868) 6.

Melia baccifera Roth Nov. Pl. Sp. (1821) 215.

Karoland, Bintang Mariah, *Bartlett & La Rue 326*, August 10, 1918, with the local name *koendoelen pamal*.

Ceylon to Java and the Philippines.

EUPHORBIACEAE

SUMBAVIOPSIS J. J. Smith

SUMBAVIOPSIS ALBICANS (Blume) J. J. Sm. in Meded. Dept. Landbouw 10 (1910) 357; Pax in Engl. Pflanzenreich 57 (1912) 14.

Adisca albicans Blume Bijdr. (1825) 611.

Karoland, Kampong Bintang Mariah, *Bartlett & La Rue 131*, June 7, 1918, with the local name *sempaling*.

A monotypic genus, the species now being known from Sumatra, Java, and Palawan.

CELASTRACEAE

PERROTTETIA Humbolt, Bonpland, and Kunth

PERROTTETIA ALPESTRIS (Blume) Loesen. in Engl. & Prantl Nat. Pflanzenfam. 3[5] (1892) 220; Koord. & Val. in Ic. Bogor. 2 (1904) 137, *t. 127*.

Celastrus alpestris Blume Bijdr. (1826) 1145.

Karoland, Sinaboen, *Bartlett & La Rue 218*, June 30, 1918, in mountain jungle.

Java, Borneo, and the Philippines.

RHAMNACEAE

ZIZYPHUS Jussieu

ZIZYPHUS CALOPHYLLA Wall. in Roxb. Fl. Ind. 2 (1824) 366.

Asahan, Silau Meradja, *Bartlett & La Rue 407*, October 27, 1918, with the local name *si silan niboet*.

Penang, Malay Peninsula, Singapore, Bangka (*Zizyphus ornata* Miq.).

VITACEAE

LEEA Royen

LEEA INDICA (Burm. f.) comb. nov.

Staphylea indica Burm. f. Fl. Ind. (1768) 75, *t. 23, f. 2.*
Aquilicia sambucina Linn. Mant. 2 (1771) 211.
Leea sambucina Willd. Sp. Pl. 1 (1797) 1177.

Asahan, Boenoet, *Bartlett & La Rue 48,* May 17, 1918, with the local name *pubentjil.*

This species is widely distributed in the Indo-Malayan region, Burman's type apparently being a Javan specimen. It is currently known as *Leea sambucina* (Linn.) Willd., but Burman's name being the older should be adopted. The Linnean binomial is apparently typified by Burman's figure and description, *Staphylea indica* Burm. f. being cited by Linnaeus as a synonym of his species; there is no specimen in the Linnean herbarium.

MALVACEAE

HIBISCUS Linnaeus

HIBISCUS MACROPHYLLUS Roxb. Hort. Beng. (1814) 51, *nomen nudum;* DC. Prodr. 1 (1824) 455.

Karoland, Soesoek, *Bartlett & La Rue 209,* June 30, 1918, with the local name *anoek anoek.*

India, Penang, Perak, Java.

SIDA Linnaeus

SIDA CORYLIFOLIA Wall. Cat. (1829) No. 1865, *nomen nudum;* Mast. in Hook. f. Fl. Brit. Ind. 1 (1874) 324.

Karoland, Kampong Lingga, *Bartlett & La Rue 149,* with the local name *oeboeng oeboeng;* Asahan, Kampong Silau Meradja, *Bartlett & La Rue 339,* with the local name *tamba loea.*

Burma, Indo-China, Hainan, Java, Madura, Boeton, Philippines; not recorded from the Malay Peninsula.

WISSADULA Medicus

WISSADULA PERIPLOCIFOLIA (Linn.) Thwaites Enum. Pl. Zeyl. (1859) 27.

Sida periplocifolia Linn. Sp. Pl. (1753) 684.

Asahan, Silau Meradja, *Bartlett & La Rue 340,* October 10, 1918, with the local name *boeloeng boeloeng pagar.*

A widely distributed tropical species not previously recorded from Sumatra.

STERCULIACEAE

FIRMIANA Marsigli

FIRMIANA COLORATA (Roxb.) R. Br. in Benn. Pl. Jav. Rar. (1844) 235.

Sterculia colorata Roxb. Pl. Coromandel 1 (1795) 26, *t. 25.*

Karoland, Kampong Goenoeng Merlawan, *Bartlett & La Rue 206,* June 28, 1918, with the local name *tjipa tjipa.*

India, Ceylon, and the Andaman Islands.

FLACOURTIACEAE

OSMELIA Thwaites

OSMELIA BARTLETTII sp. nov.

Frutex vel arbor, ramulis inflorescentiisque pubescens; foliis chartaceis oblongo-ellipticis, 7 ad 9 cm longis, glabris vel subtus ad costa nervisque leviter pubescentibus, acuminatis, nervis utrinque 4, curvatis, perspicuis; inflorescentiis paniculatis, ramis paucis, spiciformibus, elongatis; floribus 4-meris.

A shrub or tree, nearly glabrous except the pubescent younger parts and inflorescences. Branches terete, glabrous, grayish, the branchlets rather densely pubescent with subferrugineous hairs. Leaves chartaceous, oblong-elliptic, 7 to 9 cm long, 3.5 to 4.5 cm wide, entire, brownish-olivaceous when dry, the lower surface paler, base usually acute, sometimes obtuse, apex shortly acuminate, the upper surface entirely glabrous, the lower surface glabrous or obscurely pubescent on the midrib and nerves; lateral nerves usually 4 on each side of the midrib, distinct, prominently curved, not anastomosing, the reticulations slender, subparallel; petioles about 1 cm long, more or less pubescent. Panicles axillary, and terminating lateral leafy branchlets, the leaves on these branchlets much smaller than the normal ones, 2 to 3 cm long, the branches of the inflorescence few, simple, up to 10 cm in length, pubescent. Flowers subsessile, usually scattered, never glomerate, about 5 mm in diameter, 4-merous, their pedicels 1 mm long or less. Sepals 4, oblong-elliptic, obtuse, 3 mm long, slightly pubescent outside. Stamens 8, their filaments slightly pilose, equal, about 2 mm long, the alternating lobes united for the lower 0.8 mm, one lobe alternating with each filament, the free parts oblong-obovate, densely pilose, about 1 mm long; ovary oblong-elliptic, densely pubescent.

SUMATRA, East Coast, Asahan, in deep jungle at Bandar Poelo, *Bartlett & La Rue 37,* May 16, 1918.

This species is apparently most closely allied to *Osmelia maingayi* King, of the Malay Peninsula, and possibly is represented by *Beccari 928* from Sumatra mentioned by King in a note following his description. It is distinguished among all the hitherto described species of the genus by its few-nerved leaves. This small genus, for many years known only from Ceylon and the Philippines, is now represented by 7 or 8 species, the known range of the genus now being Ceylon, Sumatra, Malay Peninsula, Borneo, the Philippines, and Celebes.

MELASTOMATACEAE

MEMECYLON Linnaeus

MEMECYLON LARUEI sp. nov.

Frutex vel arbor parva, ramis teretibus, ramulis 4-angulatis et anguste 4-alatis; foliis coriaceis, lanceolatis, sessilibus vel subsessilibus, usque ad 20 cm longis et 5.5 cm latis, basi rotundatis, plerumque subcordatis, sursum angustatis, tenuiter acute acuminatis, nervis utrinque circiter 15, rectis, perspicuis, cum nervis marginalibus anastomosantibus; inflorescentiis axillaribus, solitariis, paniculatis, longe pedunculatis, 10 ad 15 cm longis.

A glabrous shrub or small tree, the branches terete, about 3 mm in diameter, the branchlets sharply 4-angled and narrowly winged, the wings not appendiculate at the nodes, the internodes 4 to 5 cm long. Leaves coriaceous, lanceolate, sessile or subsessile, base rounded and usually slightly cordate, gradually narrowed upward to the long, slenderly acuminate apex, 14 to 20 cm long, 3 to 5.5 cm wide, usually shining, the midrib impressed on the upper surface, very prominent on the lower surface; primary lateral nerves about 15 on each side of the midrib, distinct on the lower surface, anastomosing with the equally prominent, slightly arched, marginal nerves, 2.5 to 5 mm from the edge of the leaf, reticulations obsolete. Inflorescences axillary, solitary, long-peduncled, paniculate, 10 to 15 cm long, the branches few, opposite, spreading, the lower ones up to 4 cm long, usually sulcate. Flowers subumbellately arranged at the tips of the branchlets, their pedicels about 3 mm long, each subtended by several, lanceolate, acuminate, 1 mm long bracteoles, the bracts subtending the branches similar to the bracteoles but twice as long. Calyx shallowly cup-shaped, 2.5 to 3 mm in diameter, somewhat 4-toothed. Petals obliquely and broadly ovate, about 2 mm long.

SUMATRA, East Coast, Asahan, in second-growth jungle at Lau Boeloeh, *Bartlett & La Rue 236*, July 1, 1918.

This species belongs in the group with *Memecylon appendiculatum* Blume, *M. paniculatum* Jack and *M. costatum* Miq. and perhaps is most closely allied to Jack's species, the type of which was from Sumatra. It is well characterized by its lanceolate leaves, which are more or less gradually narrowed upward from the lower one-third to the slenderly and sharply acuminate apex.

ERICACEAE

VACCINIUM Linnaeus

VACCINIUM HASSELTII Miq. Ann. Mus. Bot. Lugd.-Bat. 1 (1863–64) 40.

Near Balige Taba, *Bartlett & La Rue 497*, October 4, 1918.

Malay Peninsula, Singapore, Bangka.

CLETHRACEAE

CLETHRA Linnaeus

CLETHRA SUMATRANA J. J. Sm. in Ic. Bogor. 4 (1910) *t. 319.*

Near Balige Taba, *Bartlett & La Rue 496*, October 4, 1918.

The second collection of this endemic species.

EBENACEAE

DIOSPYROS Linnaeus

DIOSPYROS WALLICHII King & Gamble in Journ. As. Soc. Beng. 74[2] (1905) 220.

Asahan, Silau Meradja, *Bartlett & La Rue 345*, October 11, 1918, with the local name *boea sahoepang.*

Widely distributed in the Malay Peninsula but hitherto not reported from elsewhere.

APOCYNACEAE

PARAMERIA Bentham

PARAMERIA BARBATA (Blume) K. Schum. in Engl. & Prantl Nat. Pflanzenfam. 4[2] (1895) 162.

Parsonsia barbata Blume Bijdr. (1826) 1042.

Karoland, Kampong Singga Manik, *Bartlett & La Rue 155*, June 14, 1918.

Burma and Indo-China southward and eastward to Java, the Philippines, and the Moluccas; it is more commonly known as *Parameria glandulifera* Benth.

VERBENACEAE

PREMNA Linnaeus

PREMNA PYRAMIDATA Wall. Cat. (1829) No. 1779, *nomen nudum;* Schauer in DC. Prodr. 11 (1847) 633.

Asahan, Boenoet, *Bartlett & La Rue 46,* May 17, 1918.
Burma to the Malay Peninsula, Java, and Timor.

CLERODENDRON Linnaeus

CLERODENDRON PANICULATUM Linn. Mant. 1 (1767) 90.

Asahan, Silau Meradja, *Bartlett & La Rue 406,* with the local name *si panggil.*

Formosa, Hainan, Indo-China, Siam, and the Malay Peninsula. It is of interest to note that the allied Philippine species, *Clerodendron intermedium* Cham., is currently known to the Tagalogs by a similar name, *casopanguil.*

CALLICARPA Linnaeus

CALLICARPA BREVIPETIOLATA sp. nov.

Frutex vel arbor parva, ramulis et subtus foliis densissime stellato-tomentosis; foliis chartaceis, lanceolatis, brevissime petiolatis, usque ad 10 cm longis, basi abrupte lateque rotundatis et distincte cordatis, apice tenuiter acuminatis, margine dentatis, nervis utrinque 10 ad 12; cymis axillaribus, breviter pedunculatis, sub fructu confertis, subglobosis, 1 ad 2 cm diametro.

A shrub or a small tree, the branchlets and lower surface of the leaves very densely and uniformly stellate-tomentose, the indumentum pale brownish, eglandular, the branchlets terete, 1.5 to 2 mm in diameter. Leaves lanceolate, chartaceous, brittle when dry, 7 to 10 cm long, 1.5 to 2.5 cm wide, the upper surface brownish olivaceous, more or less pubescent with short simple hairs, the base abruptly and broadly rounded, distinctly cordate, narrowed upward to the slenderly acuminate apex, the margins rather finely dentate; lateral nerves 10 to 12 on each side of the midrib, not prominent; petioles densely stellate-tomentose, 1 to 2 mm long. Cymes axillary, solitary, stellate-tomentose, peduncled, the peduncles 5 to 10 mm long, in fruit dense, subglobose, 1 to 2 cm in diameter. Fruits very numerous, crowded, globose, 2 to 2.5 mm in diameter, black and rugose when dry, the calyces stellate-pubescent, shallow, about 2 mm in diameter, 4-toothed.

SUMATRA, East Coast, Karoland, Kampong Bintang Mariah, *Bartlett & La Rue 323,* August 10, 1918, with the local name *laoe gappa gappa.*

The alliance of this species is manifestly with *Callicarpa rubella* Lindl., from which it is especially distinguished by its very dense stellate-tomentose indumentum, which completely covers the lower surfaces of the leaves.

RUBIACEAE

LASIANTHUS Jack

LASIANTHUS OBLONGUS King & Gamble in Journ. As. Soc. Beng. 73[2] (1904) 127.

Karoland, Sinaboen, *Bartlett & La Rue 212,* June 30, 1918.

Malay Peninsula.

LASIANTHUS RHINOCEROTIS Blume Bijdr. (1826) 996.

Karoland, Kampong Bintang Mariah, *Bartlett & La Rue 325,* August 10, 1918.

Malay Peninsula, Java.

TARENNA Gaertner

TARENNA MOLLIS (Wall.) Valeton in Engl. Bot. Jahrb. 44 (1910) 558, quoad syn. excl. spec. cit.

Stylocoryna mollis Wall. Cat. (1848) No. 8454, *nomen nudum.*
Webera mollis Hook. f. Fl. Brit. Ind. 3 (1880) 104.

Asahan and Karoland, Kaban Djahe, *Bartlett & La Rue 17, 89,* May and June, 1918, with the local name *djaroem djaroem.*

Malay Peninsula. The Bornean specimens originally referred to this species by Valeton represent the allied *Tarenna winkleri* Valeton. *Webera sumatrana* Boerl.[5] is probably referable to the genus *Pavetta.*

COMPOSITAE

BLUMEA De Candolle

BLUMEA PUBIGERA (Linn.) comb. nov.

Conyza pubigera Linn. Mant. 1 (1767) 113.
Blumea chinensis DC. Prodr. 5 (1836) 444, non *Conyza chinensis* Linn.
Conyza riparia Blume Bijdr. (1826) 699.
Blumea riparia DC. Prodr. 5 (1836) 444.

Asahan, Silau Meradja, *Bartlett & La Rue 452,* November 9, 1918.

The type of *Conyza pubigera* Linn. was a specimen grown at Upsala, the description conforming closely with the characters of this species currently known as *Blumea chinensis* DC. *Sonchus volubilis* Rumph.,[6] cited by Linnaeus as a synonym of *Conyza pubigera,* is a good representation of the species under consideration. The type of *Conyza chinensis* Linn., the name-bringing synonym of *Blumea chinensis* DC., was a specimen from China, collected by Toren, and the short original description clearly does not apply to the species currently called *Blumea chinensis* DC. The species, as here interpreted, extends from southern China and Formosa to the Malay Peninsula, Sumatra, Java, Borneo, the Philippines, and the Moluccas.

[5] In Veth Midden-Sumatra 4 pt. 2[7] (1884) 21, *t. 2.*
[6] Herb. Amb. 5: 299, *t. 103, f. 2.*

REVIEWS

Information | for the | Tuberculous | by | F. W. Wittich, A. M., M. D. | instructor in medicine and physician in charge tuberculosis | dispensary, University of Minnesota Medical School; | visiting physician, University Hospital, | Minneapolis, Minnesota | St. Louis | C. V. Mosby Company | 1918 | pp. 1–150, including index. Cloth, $1.

Mental Diseases | A Handbook Dealing with | Diagnosis and Classification | by | Walter Vose Gulick, M. D. | assistant superintendent Western State Hospital, | Fort Steilacoom, Washington | Illustrated | St. Louis | C. V. Mosby Company | 1918 | pp. 1–142, including index. Cloth, $2.

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THE PHILIPPINE
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VOL. XIV MARCH, 1919 No. 3

PELVIMETRY AND CEPHALOMETRY AMONG FILIPINO WOMEN AND NEWBORN BABIES

MADE ON ONE THOUSAND TWO HUNDRED THIRTY-SEVEN CASES [1]

By HONORIA ACOSTA-SISON and FERNANDO CALDERON

(From the Department of Obstetrics, University of the Philippines)

FIVE TEXT FIGURES

This paper is a continuation of the preliminary work which was presented before this Assembly in 1914.[2] Our object is to study in further detail and in a much greater number of cases the normal Filipino pelvis, its difference from the pelvis of the white woman, and its efficiency in obstetrics. In this paper we have increased our investigations. We have determined the available space in the posterior triangle of the pelvic outlet and studied its importance in effective delivery in cases where there is shortening of the intertuberal diameter. Moreover, the size of the full-term newborn child's head, the length of labor, the length of the second stage, and the influence of the weight of the baby and its position on the final outcome of parturition have also been observed.

MATERIAL

Our studies have been made on one thousand two hundred thirty-seven cases of the free obstetrical department of the Philippine General Hospital. For the purpose of investigating the effect of parity on the length of labor and size of the child, the data of the multiparæ were separated from those of the primiparæ. To obviate any error which might exist in the measurements taken by different persons, one of us (H. A. S.)

[1] Read at the IV Asamblea Regional de Médicos y Farmacéuticos de Filipinas, February, 1918.

[2] Philip. Journ. Sci. § B 9 (1914) 493–497.

exclusively made all the measurements with the exception of those of the diagonal conjugate, which were determined by Doctor Calderon.

METHOD OF MEASUREMENT

The spines, the crests, and Baudelocque's diameter were measured from two different points. One is on the outside of the bone, which is the method practiced by most obstetricians; the data obtained from these measurements are the figures used in comparing these diameters with those of other nationalities. The other point is in the inner boundary of the bone: namely, in the spines, the inner part of the anterosuperior spines; in the crests, the inner border of the ilium; and in the Baudelocque's diameter, the upper border of the symphysis.

The diagonal conjugate had been determined in two ways. One way, which is the method practiced by most investigators on living subjects, is the introduction of the fore and middle fingers into the vagina, reaching thereby the promontory of the sacrum. For one who has a small hand and short fingers, this method is impracticable; so, in the absence of Doctor Calderon, another means had to be thought of that could give just as good, if not better, results. An ordinary uterine sound is bent slightly near its tip to make it correspond with the natural curve of the pelvic canal. With the whole gloved and lubricated right hand in the vagina, the left hand introduces the uterine sound, whose tip is guided by the internal hand to the promontory where it is kept in firm position, while the external hand determines the level on the sound of the lower border of the symphysis pubis. The firmness of the sound and its freedom from any movement that the examining hand may have after the important points have been determined make this method, we believe, give more accurate results. For one who has a small, short hand, this method is of special advantage, for it is easily done and causes relatively less discomfort to the patient.

In the 1917 edition of his text book on obstetrics, Williams has quoted one of us (H. A. S.) as stating that the Filipino pelvis corresponds most closely to that of the American Negress. Since the writer made no such statement, it seems probable that Williams arrived at such a conclusion by comparing the Filipino measurements given by the writer with the Negro measurements reported by Riggs.

While admitting that the measurements given by the writer do correspond in a superficial way with those of the Negress, a closer study shows certain important differences. Such study

TABLE I.—*Pelvic measurements of Filipino women.*

[Measurements are in centimeters.]

Diameter.	Multiparæ; 780 cases.				Primiparæ; 457 cases.			
	Average.		Diameter.		Average.		Diameter.	
	Outside bone.[a]	Inner boundary of bone.	Least.	Greatest.	Outside bone.[a]	Inner boundary of bone.	Least.	Greatest.
Spines	23.74	20.58	15.9	25.0	23.69	20.245	16.0	23.3
Crests	25.4	22.339	19.0	27.0	25.39	22.29	19.1	26.8
Trochanter		27.62	24.1	31.8		27.473	23.0	32.0
Baudelocque's	17.7	16.695	14.1	20.1	17.59	16.32	14.2	19.0
Diagonal conjugate		11.39	10.0	13.0		11.38	9.5	13.0
Outlet anteroposterior		11.058	9.0	13.7		10.95	9.0	13.0
Ischiosacral		9.883	7.5	12.1		9.21	7.7	12.0
Anterior sagittal		5.51	4.0	7.7		5.2	3.8	6.3
Posterior sagittal		8.414	6.1	10.4		8.4	6.0	10.7
Intertuberal		11.111	8.0	14.0		10.7	8.7	13.5

[a] In comparing the Filipino measurements with those of other nationalities, the figures in this column have been used for the spines, the crests, and Baudelocque's diameter.

also shows that the published pelvic measurements most closely corresponding to the Filipino average are not those of the Negress, but those of the average contracted pelvis among white Americans (see Table II).

Here the authors wish to open a new line of investigation by asking a question. Eliminating the varieties of pelves caused by injuries or disease such as rickets, osteomalacia, etc., is it not possible that this average contracted pelvis among white Americans represents not an abnormality, but rather the normal pelvis of the southern European element in the composite American population? The great majority of native-born Americans are of northern European stock, and the southern European element would appear as a minor, or abnormal, type. The great difference between the average Negro pelvis of Riggs and that of the average white American is at once apparent upon the most casual comparison of their measurements. Is it not most natural to suppose, then, that the Asiatic races would present a type or types of pelvis different from both that of the Negro and that of the average white American? It seems to the writers that there is room here for much fruitful investigation.

Anthropologists have discovered that the publication of average measurements is the surest way of concealing rather than of demonstrating racial types. This is particularly true where the people measured are unquestionably of mixed race.

TABLE II.—*Average pelvic measurements of different nationalities.*

[Measurements are in centimeters.]

Diameter.	Normal white American.					"Abnormal" white American; Riggs.			Filipino. Acosta-Sison and Calderon; 1,237 cases.
	Riggs; 707 cases.	Edgar.	Williams.	Huntington.	Cragin.	Rachitic.	Simple flat.	Generally contracted.	
Spines	25.47	25.5	26.0	26.4	26	25.4	25.69	23.75	23.715
Crests	27.998	28.0	29.0	28.2	28	25.7	27.798	25.71	25.295
Trochanters	30.90	31.0	21.0			29.3	30.50	26.28	27.546
Baudelocque's	19.71	20.25		20.7	20	16.98	18.115	17.93	17.645
Diagonal conjugate	12.26	12.15				10.1	10.739	11.128	11.385
Outlet anteroposterior		12.0	11.5						11.004
Ischiosacral									9.546
Anterior sagittal			5.0						5.275
Posterior sagittal			7.5						8.407
Intertuberal	11.0	11.0	10.5						11.405

Diameter.	German?		Irish?	Jew?	Riggs; Negro.				Indian dry pelvis. Emmons; 217 cases.
						"Abnormal."			
	Ahlfeld.	Bumm.	Tweedy.	Jewet.	Normal.	Rachitic.	Simple flat.	Generally contracted.	
Spines	24	26	26	26.5	23.99	23.66	24.01	22.558	22.6
Crests	28	29	29	28.0	26.0	24.4	26.34	24.515	25.7
Trochanters	------	------	------	------	30.09	28.58	30.53	28.609	------
Baudelocque's	19.5 to 20.00	18.2	21	20	19.32	17.31	18.785	18.15	------
Diagonal conjugate	------	------	------	------	12.177	10.63	10.8	10.8	[a] 11.78
Outlet anteroposterior	------	------	------	------	------	------	------	------	[b] 11.59
Ischiosacral	------	------	------	------	------	------	------	------	------
Anterior sagittal	------	------	------	------	------	------	------	------	7.56
Posterior sagittal	------	------	------	------	------	------	------	------	------
Intertuberal	------	------	------	------	------	------	------	------	8.0

[a] 9.4 to 14.9 centimeters.

[b] 9 to 14.66 centimeters.

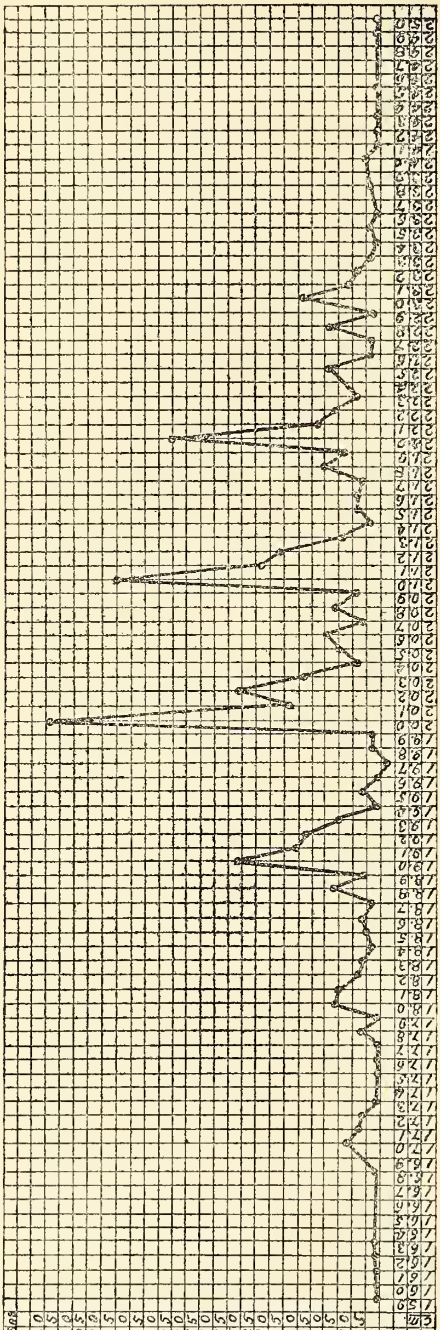

FIG. 1. Interspinous diameter (measured from tip).

The easiest method of bringing out the mixture of types is by plotting measurements in a graphic way, so that the resulting curve will show the proportion or percentage of individual cases of any and all particular types. The measurements of the one thousand two hundred thirty-seven pelves on which the present paper is based have been plotted in such graphic curves. For the whole number of cases the curves for each measurement are shown in figs. 1 to 5.

This investigation has shown that we are able to isolate three major, and two minor, types of Philippine pelvis, as has just been demonstrated. To associate any of these types of pelvis with particular racial varieties of man would be folly in the present state of our knowledge (or rather ignorance) of the other races of Oriental peoples, who surround the Philippines.

Anthropologists believe that the different racial types of India, China, Japan, Polynesia, and Melanesia—in addition to the late Spanish mixture from Europe—have all influenced our composite population. If it were possible to compare the measurements made in our investigation with the considerable series of others from all the different racial types just mentioned, we might hope to arrive at certain tentative conclusions. However, since practically no pelvic measurements from the regions mentioned

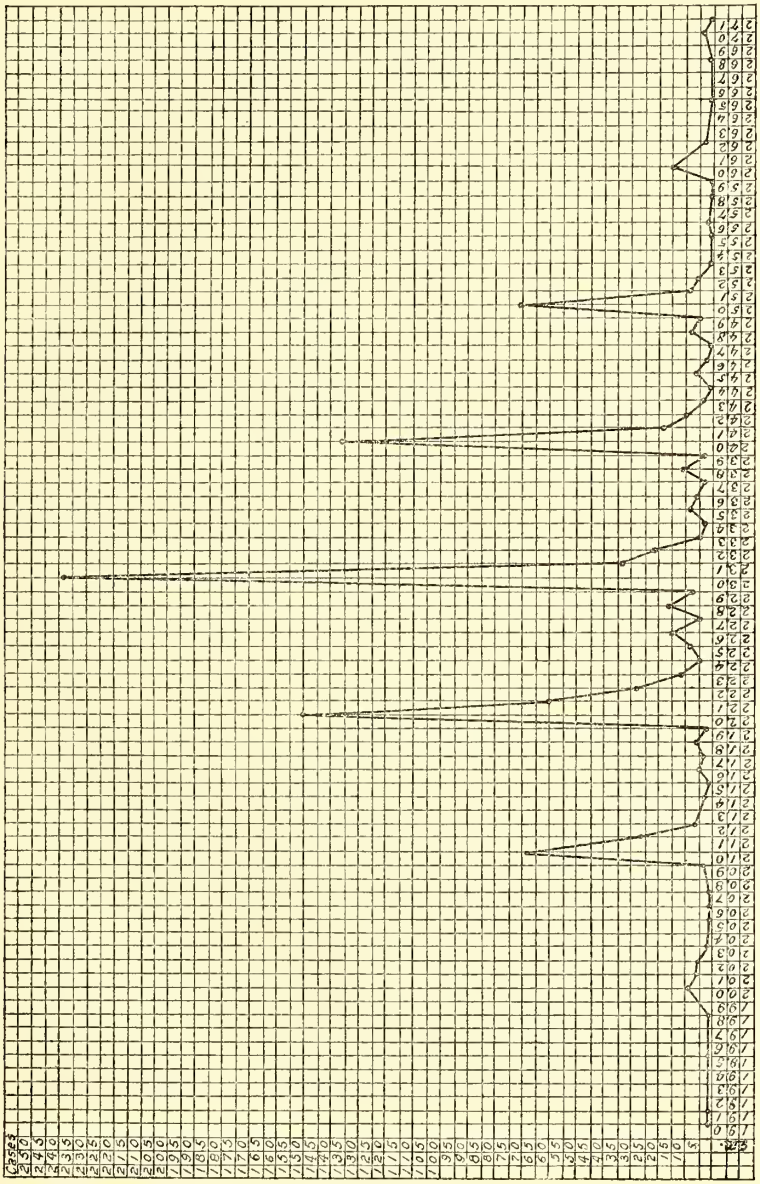

FIG. 2. Intercristal diameter (between upper borders of the iliac bones).

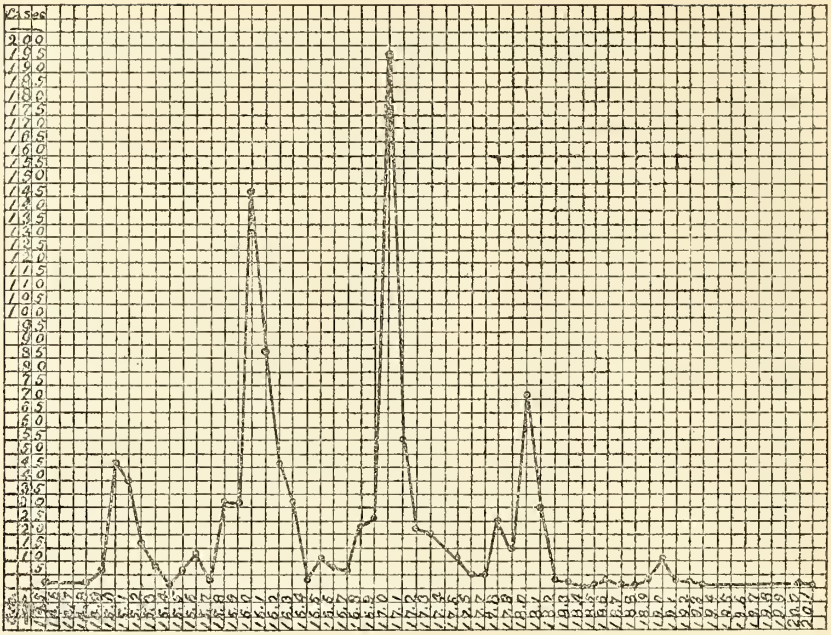

FIG. 3. Baudelocque's diameter.

have been published, the correlation of Philippine types with those of other oriental peoples must await the results of further investigations.[3]

On examining Table III, we find that the diagonal conjugates measuring from 11 centimeters to 12.4 centimeters have the greatest number of cases (which form 85 per cent of the total

[3] Though unable to draw conclusions from our pelvic measurements, it may be proper to state here that anthropologists have demonstrated from other sources that the predominant Philippine racial types are two: First, a type known as the Indonesian, which came into the Islands from the south and is related to the races of India; and, second, a Mongol-Chinese type, which came into the Islands chiefly from the north. The so-called Malayan Filipinos of to-day are essentially a mixture of these two types, with the addition of certain minor elements. The most important of the latter is a type represented by immigrants from Melanesia. Other minor types are of course the historical immigrations of Chinese and of Spanish Europeans. It is possible, then, that our five pelvic types correspond to these racial elements; though for the present such a conclusion must be regarded as mere speculation. (For discussions of Philippine racial types, see Beyer, Cole, Bean, Koeze, Keane, Montano, and Virchow.)

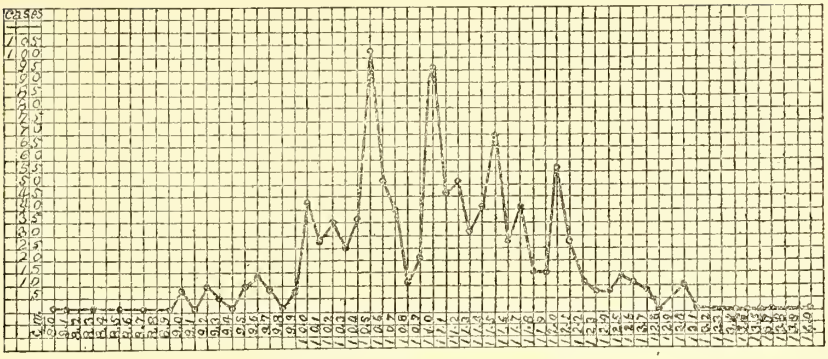

FIG. 4. Intertuberal diameter.

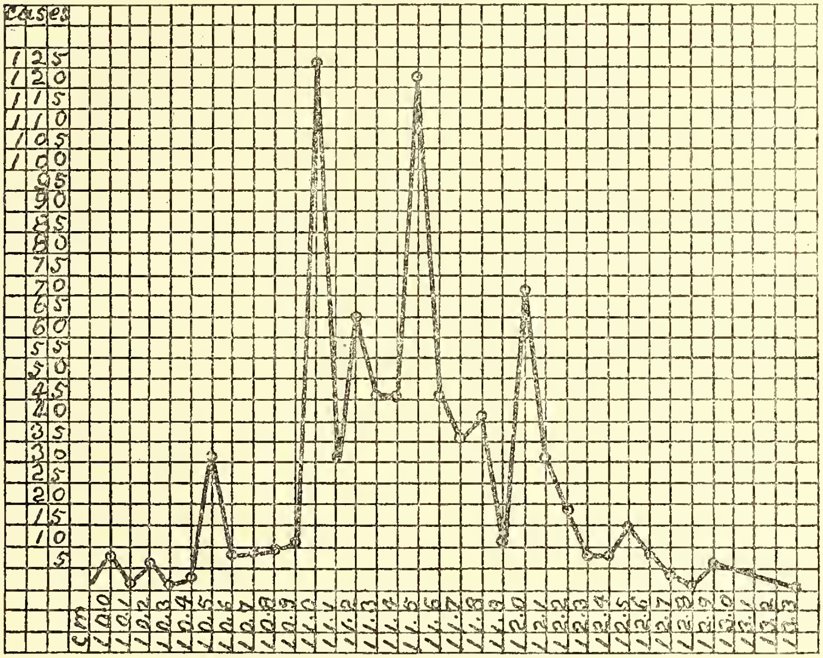

FIG. 5. Diagonal conjugate; primiparæ and multiparæ.

number) and the greatest percentage of spontaneous labor. From this it may be inferred that measurements within these figures represent the normal Filipino diagonal conjugate. The curve, fig. 5, shows that most of the cases have diagonal conjugates of, respectively, 11, 11.5, and 12 centimeters.

TABLE III.—*Diagonal conjugate from the point of view of efficiency and frequency of spontaneous labor in multiparæ; 610 cases.*

Measurement.	Cases.	Average length of labor.	Spontaneous labor.		Operations.	Indications for operation.
cm.		*H. m.*	*P. ct.*	*Cases.*		
10 to 10.4	13	14 10	69.23	9	Podalic version, 2	Uterine inertia.
					Mid forceps, 2	R. O. T., 1. L. O. T., 1.
10.5 to 10.9	50	10 17	92	46	Low forceps, 1	Prolonged second stage to L. M. A.
					High forceps, 1	Prolonged second stage.
					Mid forceps, 1	Uterine inertia.
					Podalic version, 1	Transverse position.
11 to 11.4	225	12 08	92	207	Podalic version, 4	Placenta previa, 2. L. O. P., big head, 1. R. Oc. A., 1.
					Low forceps, 5	Prolonged second stage, 3. Anasarca, 1. L. O. T., 1.
					Mid forceps, 6	R. O. T., 1. R. O. P. with hand prolapse, 1. Prolonged second stage, 4.
					High forceps, 3	Prolonged second stage, 1.
11.5 to 11.9	186	11 30	95.16	177	Low forceps, 2	Prolonged second stage, 1.
					Podalic version, 7	Placenta previa, 1. Big baby, 1. R. O. P., 3. Eclampsia, 1. Prolonged second stage due to concomitant birth of hand with head, 1.
12 to 12.4	107	9 33	97.1	104	Mid forceps, 2	Eclampsia, 1. R. O. P., 1.
12.5 to 13	28	10 18	71.43		Mid forceps, 1	L. O. P., narrow outlet, 1.
					Podalic version, 1	Placenta previa.
13.3	1	7 47				

TABLE IV.—*Diagonal conjugate from the point of view of efficiency and spontaneous labor in primiparæ.*

Measurement.	Cases.	Length of labor.		Spontaneous labor.		Operations.	Indications for operation.
cm.		*H.*	*m.*	*P. ct.*	*Cases.*		
10 to 10.4	9	15	35	88.88	8	Low forceps, 1	Prolonged labor.
10.5 to 10.9	21	18	42	97.76	19	Low forceps, 1 Mid forceps, 1	Do. Do.
11 to 11.4	92	15	11	97.83	90	Mid forceps, 2	Dry labor, 1. Meconium in vagina, (baby presenting by the vertex) 1.
11.5 to 11.9	74	18	50	98.64	73	Mid forceps, 1	Prolonged labor.
12 to 12.4	34	14	52	94.01	32	Mid forceps, 2	Do.
12.6 to 13	5	15	02	100	5		

Comparing Table IV with Table III on the multiparæ, one is struck with the apparently greater percentage of spontaneous labor in primiparæ. The cause of this is that in primiparous cases, our procedure has been to let nature do all it can before instrumental intervention so as to allow sufficient molding of the head. Moreover, many of the operative cases in primiparæ are not shown here for the reason that we made all of our measurements during the puerperium, and in order to avoid infection and relaceration of the repaired wounds, a regrettable occurrence in many of our earlier cases, we refrained from measuring the diagonal conjugate in patients who had been delivered instrumentally.

It is interesting to note, however, that the number of cases whose diagonal conjugate measures between 11 and 12.4 centimeters forms 87 per cent, which is a slightly greater proportion than that of the corresponding measurements in the multiparæ.

PELVIC OUTLET

An effort was first made to determine the relationship of the intertuberal diameter and the length of the second stage of labor, but the results soon demonstrated that this measurement when considered alone is of little significance. In cases of contracted intertuberal diameter where a prolonged second stage was expected it was found that, though the baby was not undersized, oftentimes the duration of the second stage was even shorter than the average normal. In these cases the posterior sagittal diameter had a compensatory lengthening, so that the index of the posterior plane of the pelvic outlet was either normal or larger than normal. This confirms the view of Williams, Daniels, and others, that a contracted intertuberal diameter does not necessarily mean a prolonged or operative labor so long as there is a corresponding lengthening of the posterior sagittal diameter.

Williams has stated that a spontaneous labor is exceptional with the following measurements (head, average size):

Transverse outlet.	Posterior sagittal.
cm.	cm.
8.00	7.5
7.00	8.0
6.5	8.5
6.0	9.0
5.5	10.0

but that, with these measurements, a safe delivery through the accustomed channel may be effected by instrumental means. Daniels, however, basing his calculations on the average normal measurements reported by Klein—namely, intertuberal diameter, 11 centimeters; posterior sagittal, 9.95 or 10 (Daniels uses 10 instead of 9.95)—has established the following rule: That the index of the posterior plane of the pelvic outlet in normal cases should be 55, as in the following equation:

$$\frac{\text{Intertuberal diameter (11)} \times \text{posterior sagittal (10)}}{2} = 55.0$$

or

$$\frac{\text{Intertuberal diameter} \times x}{2} = 55.$$

This index, according to Daniels, may be as low as 33.3 and no operation needed but perhaps the use of forceps.

Following the formula of Daniels, we find that in Filipino women, the normal index of the posterior plane of the pelvic outlet is much lower than what he considers to be normal for American women. It is

$$\frac{11 \times 8.5}{2} = 46.75 \text{ or } 46.8;$$

and an index as low as 31 may end in spontaneous delivery.

TABLE V.—*The relationship of the index of the posterior plane of the pelvic outlet to the length of the second stage and birth weight of the baby.*

Index of posterior plane of pelvic outlet in multiparæ.	Normal and spontaneously delivered. Cases, 651.	Average length of second stage of labor.	Average birth weight of baby.	Average grams of birth weight of baby per minute of second stage.
		H. m.	*g.*	
31 to 40.9	124	0 57.75	2,879	48.1
41 to 50.9	390	1 00	2,996	49.98
51 to 60.9	126	0 44	3,035	69.0
62 to 74.9	11	0 47	3,041	65.0

On examining Table V one notices the close relationship between the weight of the baby, the index of the posterior plane, and the length of the second stage of labor.

TABLE VI.—*Cases with prolonged second stage of labor; 43 cases; not included in Table V. Multiparæ.*

Index of the posterior plane of pelvic outlet.	Cases	Average length of second stage of labor.	Average birth weight.	Average grams of weight per minute of second stage.	Complications.	Operations.
		H. m.	*g.*			
31 to 40.9	10	3 54	3,133	13.4	Prolapse of hand with vertex, 1 Placenta previa, 1 L. O. P., 1 R. O. T., 1 L. O. T., 1 Prolonged labor, 5	Mid forceps, 1. Low forceps, 7. Podalic version, 1.
41 to 50.9	25	2 44	3,089	18.8	R. O. P., 8 L. O. P., 2 Placenta previa, 1 R. O. T., 1 Transverse position, 1 L. M. A., 3 Prolapse arm with vertex, 1 Uterine inertia, 1 Dry labor, 1 Prolonged labor, 3	Podalic version, 1. Mid forceps, 5. Low forceps, 3.
51 to 67.9	8	2 10	[a] 3,448	26.5	R. O. P., 4 Placenta previa, 1 Big baby, 3	Podalic version, 5.

[a] One baby weighed 6,320 grams.

The close relationship of the baby weight and malposition or malpresentation with the length of the second stage and the size of the index of the posterior plane of the pelvic outlet is here emphasized.

TABLE VII.—*Cephalic measurements in multiparæ and primiparæ; total cases, 1,237.*

[Measurements are in centimeters.]

Measurement.	Multiparæ, 780 cases.			Primiparæ, 457 cases.		
	Average.	Least.	Greatest.	Average.	Least.	Greatest.
Occipito-mental diameter	12.78	11.1	14.5	12.77	11.0	14.4
Occipito-frontal diameter	11.29	9.8	13.5	10.88	9.5	12.1
Suboccipito-bregmatic diameter	9.614	8.2	10.9	9.39	8.4	10.5
Biparietal diameter	9.031	7.5	10.2	8.9	7.9	10.0
Bitemporal diameter	7.992	6.9	9.0	7.89	7.1	9.1
Occipito-mental circumference	36.711	30.9	43.4	36.5	33.0	41.2
Occipito-frontal circumference	33.189	28.7	[a] 40 [b] 38			
Occipito-bregmatic circumference	31.158	27.3	35.8			

[a] L. M. A. [b] L. O. A.

Table VII shows a slight diminution of the cephalic diameters in primiparæ as compared with those of the multiparæ. This

TABLE VIII.—*Showing the relative duration of labor and length and weight of babies in multiparæ and primiparæ; 1,237 cases.*

	Multiparæ, 780.			Primiparæ, 457.		
	Average.	Least.	Greatest.	Average	Least.	Greatest.
Age ... years	27.07	16	45	18.37	15	45
Length of labor, spontaneous L. O. A ... hrs. min	9.01	1.00	48.00	16.00	4.20	72.00
Length second stage spontaneous L. O. A ... do	0.52	0.05	4.00	2.12	0.15	4.00
Length of baby, female; 360 of multiparæ ... cm	48.98	44	53	48.96	44	51
Length of baby, male; 420 of multiparæ ... cm	49.35	43.0	55			
Weight of baby, female, grams	2,972.59	1,700	4,500	2,728	1,260	4,180
Weight of baby, male ... do	3,039.08			2,831		
Weight of baby, both sexes ... do	3,005.83	1,700	4,500	2,831	1,260	4,180
Weight of babies of both sexes whose mothers stayed more than one week in hospital before parturition ... do	3,144					

diminution is most marked in the fronto-occipital and suboccipito-bregmatic diameters whereas the mento-occipital diameter is almost the same in both cases.

The figures in Table VIII are self-explanatory. As in other nationalities, the multiparæ have a shorter duration of labor, and longer and heavier babies than those of the primiparæ; also, the female babies are smaller than the male. The influence on the birth weight of the baby of a week's sojourn in the hospital before confinement is here well shown. The difference in the average birth weight of the babies whose mothers stayed one week or more in the hospital before parturition and those whose mothers entered the hospital on the day of, or a few days before, confinement is 139.35 grams in favor of the former.

TABLE IX.—*Average length of labor and duration of second stage in normal spontaneous deliveries in multiparæ. These form 92.307 per cent of 780 cases of multiparæ.*

Position.	Cases.	Length of labor.			Length of second stage.		
		Average.	Least.	Longest.	Average.	Shortest.	Longest.
		H. m.	*H. m.*	*H. m.*	*H m.*	*H. m.*	*H. m.*
L. O. A	614	9 01	1 00	48 00	0 52	0 10	4 00
R. O. A	75	12 05	2 00	48 00	1 02	0 15	3 00
L. O. P	5	23 34	6 40	60 00	1 33	-------	--------
R. O. P	13	28 55	4 20	72 00	1 31	0 20	3 00
R. O. T	6	27 14	7 00	72 00	1 40	0 40	3 00
Breech presentation	7	10 38	8 00	15 00	1 18	0 20	0 20

From Table IX it is evident that, as in women of other countries, the duration of labor and of the second stage in anterior vertex presentations is shorter than in the posterior or transverse vertex presentations. Moreover, the length of labor in left occipito-anterior position is shorter than the duration of normal labor as taught in most American obstetrical text-books.

The data in Table X indicate that the frequency of the different fœtal presentations is much the same as in other countries; only that, in vertex presentations, there is a relatively high percentage of those which occur in the left, those occurring in the right being correspondingly diminished.

The twenty-seven Cesarean sections performed in the obstet-

TABLE X.—*Frequency of various presentations and positions in the 780 cases of multiparæ.*

	Number.	Per cent.
Vertex presentation:		
L. O. A	634	84
R. O. A	82	10.9
L. O. P	7	0.93
R. O. P	17	2.26
R. O. T	9	1.19
L. O. T	3	0.39
Total	752	96.41
Face presentation	2	0.256
Transverse position	6	0.76+
Breech presentation	20	2.36+

TABLE XI.—*Operations in multiparæ.*

Operation.	Cases.	Position.	Cases.	Average length of— Labor.	Average length of— Second stage.
				H. m.	*H. m.*
High forceps	2	L. O. A	1	17 00	4 30
		R. O. A	1		
Mid forceps	12	L. O. A	4	17 38	2 31
		R. O. A	2		
		L. O. P	1		
		R. O. P	3		
		L. O. T	1		
		R. O. T	1		
Low forceps	13	L. O. A	9	26 36	3 12
		L. M. A	1		
		L. O. T	2		
		L. O. P	1		
Podalic version	20	Transverse position	6	15 30	1 40
		L. O. A., placenta previa	4		
		L. O. A., vertex born with hand	1		
		L. O. A., uterine inertia, big head	1		
		R. O. A., placenta previa	4		
		Brow	1		
		R. O. P	1		
		R. O. T.	2		
Breech extraction	13	R. S. A	4	11 38	0 47
		L. S. A	6		
		L. S. P	3		

TABLE XII.—*Operations in primiparæ.*

Operation.	Cases.	Position.	Cases.	Average length of— Labor.	Second stage.
				H. m.	*H. m.*
Low forceps	21	L. O. A	11	22 26	3 32
		R. O. A	1		
		L. O. P	2		
		R. O. P	3		
		L. O. T	2		
		R. O. T	2		
Mid forceps	21	L. O. A	11	32 34	4 09
		R. O. A	1		
		R. O. P	1		
		L. O. T	5		
		R. O. T	3		
Podalic version	2	L. Ac. A	1	5 15	2 30
		L. Ac. P	1		
Breech extraction	7	L. S. A	4	13 05	1 33
		R. S. A	3		

rical department of the Philippine General Hospital and one other similar operation performed at another hospital (Roxas) are not included in this report, for only those cases whose babies were born alive per vaginam were measured. Moreover, in all Cesarean sections made on Filipino women, only on two occasions was the disproportion of pelvis and child the indication. One was a case of a primipara whose baby had an enormously large hydrocephalic head whose mento-occipital diameter measured 19 centimeters; and the other, a case of osteomalacia (Roxas). The rarity of instances in which pelvic contraction, other than that caused by osteomalacia (which was found only once), can be an indication to Cesarean section is emphasized by the fact that of the twenty-seven Cesarean sections performed in the Philippine General Hospital prior to April, 1918 (Rustia), twenty-four were performed on Filipinas for an indication (except in the case of the primipara with a hydrocephalic fœtus, if that should be excluded) other than the disproportion between the fœtal head and the pelvis or pelvic contraction. Whereas the only Cesarean sections performed on American private patients (three cases) were necessary on account of dystocia caused by contracted pelvis.

CONCLUSIONS

1. The Filipino pelvis is of a type different from either the white American or the Negro pelvis, and its average normal measurements are similar to those of the generally contracted pelvis of the white American.

2. The index of the posterior pelvic plane in cases of contracted intertuberal diameter is important in the determination of the probable outcome of labor.

3. Contracted pelvis, except in cases of osteomalacia, is rarely an indication to Cesarean section among Filipino women.

4. There is practically no difference in the measurements of the pelvic diameters of multiparæ and primaparæ.

5. The newborn babies of multiparæ are longer and heavier than those of the primiparæ.

6. The babies of mothers who stayed in the hospital for one or more weeks before delivery are heavier than those whose mothers entered the hospital at the time of labor.

7. The male babies are in greater number and are longer and heavier than the female babies.

8. Labor is longer in primiparæ than in multiparæ.

ACKNOWLEDGMENTS

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REFERENCES

ACOSTA-SISON, H. Pelvimetry and cephalometry among Filipinas. *Philip. Journ. Sci.* § B 9 (1914) 493–497.

BEAN, ROBERT B. The Racial Anatomy of the Philippine Islanders. J. B. Lippincott Company, Philadelphia (1910). See also various articles by this author in the Philippine Journal of Science and the American Anthropologist (1908–1915).

BEYER, H. OTLEY. Population of the Philippine Islands in 1916. Part II. Philippine Education Co., Manila (1917).

IDEM. Ethnographic grouping in the Philippines. Manila (1918). (An unpublished manuscript placed at our service.)

BIDDLE, A. G. A new method of measuring the pelvic outlet. *Am. Journ. Obstetrics* (1912) 14.

COLE, FAY COOPER. The wild tribes of Davao district, Mindanao. Field Museum of Natural History, Chicago (1913) No. 170. See also various shorter articles by this author in the Philippine Journal of Science and the American Anthropologist (1908–1911).

DANIELS, C. D. A new and original method of calculating the required posterior-sagittal diameter of the outlet in a lateral contraction of the pelvis. *Am. Journ, Obstetrics,* 74, No. 2.

DE SOUZA, D. H. The measurements of the pelvis with special reference to obstetrics prediction. *Biometrika* 9 (1913) 486.

EDGAR, J. C. The Practice of Obstetrics. P. Blakiston Co.

EMMONS, A. B. A study of the variations in the female pelvis based on observations made on 217 specimens of the American Indian squaw. *Biometrika* 9 (1913) 34.

HIRST, B. C. A Text Book of Obstetrics. W. B. Saunders Co. (1918).

HUNTINGTON, J. The true value of certain pelvic measurements. *Am. Journ. Obstetrics* (1917) 76.

RUSTIA, G. Cesarean section—report of the cases performed in the service of the Philippine General Hospital. Memorias y Comunicaciones de la Cuarta Asamblea Regional de Médicos y Farmacéuticos de Filipinas (1918).

WILLIAMS, J. W. Frequency, etiology and practical significance of contractions of pelvic outlet. *Surg. Gyn. and Obstet.* 8 (1909) 619.

IDEM. The funnel pelvis. *Am. Journ. Obstetrics* 64, No. 403.

IDEM. Obstetrics Text-Book. D. Appleton & Co. (1917).

ILLUSTRATIONS

TEXT FIGURES

THE LUMBANG-OIL INDUSTRY IN THE PHILIPPINE ISLANDS

By R. H. Aguilar

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The manufacture of lumbang oil in a crude way antedates existing records. It has been mostly carried on by Chinese, who have made no attempt to improve the methods of production, and the oil that they express is dark in color and of a disagreeable odor.

The oil industry in the Philippine Islands is undergoing a radical change, for the manufacturers have adopted the motto of larger production and better quality. Some of the large local concerns, hitherto devoting themselves exclusively to the manufacture of coconut oil, are now turning their attention to other oils, among which lumbang holds an important place. There are several points to be taken into consideration, if the quality of the latter is to be improved and the industry placed on a commercial basis. The object of this paper is to discuss some of these points with a view to more profitable production.

There are two kinds of lumbang nuts known in the Philippine Islands from which oils are obtained; lumbang bato (*Aleurites moluccana*)[1] and lumbang banucalag (*Aleurites trisperma*). Lumbang bato is of wider distribution, more abundant, and better known than lumbang banucalag, and the attention of manufacturers at present is devoted to the production of oil from the former. Lumbang banucalag is almost unknown in the Manila market, and when the word "lumbang" is employed it is generally taken to mean lumbang bato. The Chinese, who are the largest dealers in lumbang oils,[2] are not willing to handle the banucalag variety, because it is supposed that contact causes skin eruptions;[3] but, in my opinion, there is no foundation for this belief.

[1] Richmond, G. F., and Rosario, M. V., Philip. Journ. Sci. § A 2 (1907) 441–443.

[2] For further data see Brill, H. C., and Agcaoili, F., Philip. Journ. Sci. § A 10 (1915) 113.

[3] Aguilar, R. H., Philip. Journ. Sci. § A 12 (1917) 236.

The supply of banucalag nuts is irregular and until a definite supply can be depended upon, the extraction of oil from these nuts would hardly be profitable as a separate industry; but no doubt it could be carried on profitably in connection with the extraction of lumbang bato oil. The close similarity [4] between lumbang banucalag oil and Chinese wood oil, and the fact that the latter is so highly appreciated [5] by United States paint manufacturers, constitute inducements for the production of banucalag oil.

Both varieties of lumbang fruits mature and drop from the trees in June and July, and the best time for gathering them is during July and August. Information obtained from local Chinese merchants indicates that the gathering of lumbang nuts could be much extended in Mindanao, more especially in the Davao Gulf district, where the nuts are known by the name "biao," and where now large quantities go uncollected.

Heretofore, merchants have hesitated to invest capital in the lumbang-oil industry for they believed insufficient nuts could be obtained to warrant the establishment of a factory. On the other hand a Manila firm in September, 1910, wrote with regard to this oil:

> With proper attention the Philippines would be in a position to export the oil profitably. Proper machinery installed near San Pablo, Laguna, would make profitable a large export business, for there seem to be sufficient lumbang seeds that could be secured from Laguna, Tayabas and Batangas provinces.

An estimate of the yearly Philippine crop of lumbang nuts is very difficult to make. It would not be legitimate to base such on the annual production of lumbang oil, because the portion of the crop now used for oil manufacture is very small. In 1911 one manufacturer claimed that there was a sufficient available supply with proper machinery to produce 5,000 kilograms of oil per day; this amount would represent about 9,000 kilograms of kernels or about 26,000 kilograms of dry unshelled nuts. On this basis the available nuts would supply a modern oil factory with a monthly capacity of 234 metric tons of nut kernels. The Bureau of Forestry is encouraging the planting of lumbang trees throughout the Archipelago, and it is estimated that approximately a half million trees are being planted annually. Therefore, an increasing supply of raw material for the man-

[4] Richmond, G. F., and Rosario, M. V., Philip. Journ. Sci. § A 2 (1907) 443.

[5] Drugs, Oils, and Paints 30 (1914) 207.

ufacture of lumbang oil is assured. The number of lumbang trees in the Islands is not definitely known, but the information at hand would seem to indicate that it is possible to secure an abundant supply of lumbang nuts and to make of the lumbang-oil industry a profitable business.

In the purchase of lumbang nuts care should be taken to base the price upon the dry nuts. Freshly gathered nuts, especially lumbang banucalag, contain from 10 to 22 per cent of moisture. The moisture content can be estimated as follows:

For lumbang bato, take about 1 kilogram or more of representative nuts, and place them in an oven at 90° C. to 95° C. for from two to three hours.

For lumbang banucalag, the same quantity may be taken, but the temperature should be carefully regulated between 65° C. and 70° C. for ten hours or more. This is extremely important, as the kernels of the banucalag nuts harden slightly and assume a darker color at a higher temperature.

Lumbang bato nuts may be stored for a year or more in a cool dry place without their undergoing an appreciable change in the amount or the composition of the oil; but lumbang banucalag nuts stored for the same length of time, probably due to oxidation, will be greatly affected in both the amount and the composition of the oil, with an increase in its acidity. No mold or fungus was observed on any of the nuts stored. Due to the comparatively thin shell the kernels of lumbang banucalag nuts can be easily separated from the shell after cracking; but considerable difficulty was experienced in trying to find some adequate means of separating the kernel from the shell of lumbang bato nuts; nuts gathered over a year ago showed, when opened, that the kernel still adhered firmly to the shell. Steaming has been used successfully with certain varieties of coconuts, but is unsuccessful in this case and, furthermore, darkens the kernel and the oil. The commonest procedure now in use is to crack the nuts and pick out the kernels by means of a pointed instrument, a very tedious operation.

LUMBANG BATO (ALEURITES MOLUCCANA)

Biau (Misamis, Davao); *lumbang* (Rizal, Laguna, Zamboanga, Batangas); *lumbang bato* (Cavite). Lumbang is the name officially adopted by the Bureau of Forestry.

The fruit of *Aleurites moluccana* is fleshy, ovoid, dark, dull green, 5 to 6 centimeters long, and contains one or two seeds. The seed is about 3 centimeters long and 2.5 centimeters broad. It has a very hard, rough, rigid shell about 2.5 millimeters thick.

This contains a white, oily, fleshy kernel consisting of a very thin embryo surrounded by a large endosperm. This is in turn covered by a thin, white, papery seed coat. This thin seed coat adheres firmly to both the shell and the kernel, so that the kernel is separated from the shell with difficulty.

The importance of lumbang bato oil has been known since 1873 when Prof. Julius Wiesner,[6] reporting on The Foreign Plant Stuffs in Industrial Use at the Vienna Universal Exhibition in that year, said:

> A source of oil not hitherto regarded by the European oil industry is the Bankul nut (from Aleurites triloba), which deserves to be brought into use, on account not only of the low price of the raw material, but also from the high quality of the oil.

In the Philippines the oil is now being used in the caulking of vessels, in the manufacture of soft soaps, and as a substitute for linseed oil in the local manufacture of paints; also there is a demand much in excess of the present production for this oil from United States paint manufacturers. Therefore, the great value of the oil for industrial purposes is now well established, and its extraction based upon a more systematic method should be carefully considered.

Among the various procedures now in use for the purpose of minimizing the work involved in removing the kernel from the shell of lumbang bato nuts, none of which has been found wholly satisfactory, are the following:

In some localities the Chinese place large quantities of nuts on the ground, cover them with straw and after burning the straw immediately sprinkle the nuts with cold water. They claim that with this method the nuts burst. In Laguna, Tayabas, and Batangas Provinces, the nuts are placed in tanks of boiling water and left there for from five to six hours. This loosens the kernel, and when sufficiently cool the nuts are cracked and the kernels are separated from the shells. These two methods produce brown kernels from which only brown oil can be expressed.

In Moro Province, along the coast of Davao, the nuts are dried in the sun until the kernels loosen sufficiently, which may be ascertained by occasionally cracking a few nuts for trial. The drying takes from five to ten days or more, depending upon the condition of the weather; the nuts are then cracked and the kernels removed. This process is very slow, although the kernel usually comes out whole and is of the best quality.

[6] Andes, L. E., Vegetable Fats and Oils, 2d ed. Greenwood and Co., London (1902) 6.

The method that has been developed in the Bureau of Science laboratory reduces somewhat the time and the labor involved in the preparation of the kernel and has no injurious effect on the oil. The nuts were heated in an oven at 95° C. for from three to four hours, dumped rapidly into cold water, and left overnight. The next morning the shells had burst, and the kernels were separated without difficulty.

To eliminate the time and labor involved in removing the kernel from the shell, it has been suggested to crush and grind the nuts, and then express the oil from the ground mixture of shell and kernel. This procedure has been tried in several places and seems to be reasonable from the standpoint of economy of time and labor; however, I am more inclined to favor the method of extracting the oil direct from the kernel, because (a) about 20 kilograms more oil per ton of nuts can be recovered from separated kernels than when the shell is ground with them, and (b) the fertilizing value of the cake, which Chinese manufacturers now sell at a good profit, will be very much reduced when shell is included in it, as will be shown later.

An idea of the commercial advantage of either of these methods over the other can be obtained by comparing the product of one factory utilizing kernels with that of another factory utilizing nuts for the expression of oil.

Before describing these two methods of procedure, it is interesting to note the variation existing in the kernel content of the different lots of lumbang bato nuts from Cavite Province. This variation is probably due to the age of the nut-bearing trees and the length of time the nuts lay uncollected on the ground.

TABLE I.—*Moisture content of nuts and percentage of kernels referred to the weight of dry nuts.*

Fresh nuts.	Moisture in nuts.	Dry nuts.	Kernels from dry nuts.	Kernels in dry nuts.
g.	*P. ct.*	*g.*	*g.*	*P. ct.*
3,000	19	2,430	845	34.77
2,000	22	1,560	561	35.96
--------	--------	2,000	676	33.80
--------	--------	2,000	652	32.60
--------	--------	2,000	685	34.25
2,000	10	1,800	589	32.73
Average	-----	--------	--------	34.02

In November, 1918, the price in Manila of lumbang bato nuts was 50 pesos per ton; kernels, 244 pesos per ton; and oil, 8.66

pesos per 5-gallon gasoline can. The average weight of 18.927 liters (5 gallons) at ordinary temperature (30° C.) is 17.33 kilograms.

Using the above data as a basis of calculation the following results are obtainable for 1 metric ton of kernels:

(1) *Factory utilizing nut kernels for the expression of oil.*

	Pesos.
Yield, 560 kilograms of oil, expressed at a pressure of 800 kilograms per square centimeter; selling at 8.66 pesos per can	279.83
Yield of press cake, 440 kilograms; selling at 25 centavos per kilogram	110.00
Total	389.83
Cost of 1 ton of kernels	244.00
Gross profit	145.83

(2) *Factory utilizing whole nuts crushed for the expression of oil.*

	Pesos.
Yield 501.24 kilograms of oil, 20 kilograms of oil per ton of nuts less than in the former process, at a pressure of 800 kilograms per square centimeter; selling at 8.66 pesos per can	250.47
2.938 tons of nuts (based on the average given in Table I), necessary to produce 1 ton of kernels, at 50 pesos per ton	146.90
Gross profit	103.57

The fertilizing value of the cake from this process is very much reduced, as is shown in Table III. It is doubted if a market for it can be obtained; furthermore, the oil from this process, while the same chemically, is relatively dirtier and harder to clarify than is that from the former.

The above results conclusively show the advantage of the first method over the second from a commercial standpoint, especially until a definite market is established for the cake from the latter. As many factors enter into any calculation of the cost of operation, it is difficult to furnish approximate and satisfactory data for the two processes. If the two factories were to operate in the same locality, under identical conditions, there is no doubt that the cost of production for the first factory would be relatively less. One large item of expense would lie in the fact that a factory utilizing nuts would need heavier crushers and larger presses and consequently more power, besides having to handle a greater bulk of material, thus lowering the daily output of oil and the general efficiency of the whole system.

To form an idea of the quality of the lumbang kernels sold in the market at prices ranging from 18 to 19 pesos per 75 kilograms, four different samples were secured from which the oil was expressed and analyzed; the results obtained are presented in Table II.

TABLE II.—*Quality of kernels sold in Manila.*

Sample No.	Kernel color.	Oil.		
		Based on kernel.	Color.	Acid value.
		P. ct.		
1	Light	55	Light colored	[a] 7.63
2	Brown	50	Light brown	[a] 24.75
3	do	51	Brown	[a] 66.53
4	do	52	do	[a] 72.28

[a] Milligrams KOH used to neutralize 1 gram of the oil.

Table III shows an analysis of oil expressed from fresh kernels as compared with two grades of oil obtained from the market.

TABLE III.—*Constants of three samples of oil.*

	Oil expressed from fresh kernels.	Oils obtained from the market.	
		Grade I.	Grade II.
Appearance	light colored	brown	dark brown
Specific gravity at 15.5° C	0.9261	0.9253	0.9237
Saponification value	188	193	194
Iodine number	154	157	160
Acid number	0.55	64.25	106.48

The results shown in Table III indicate clearly that the preparation of the kernel is one of the most important points to be taken into account in the manufacture of lumbang oils. Prolonged heating at high temperatures produces brown kernels, and consequently a brown oil that is high in free fatty acid, as shown by the acid values of samples 2, 3, and 4, in Table II. Long storage of the kernel also causes deterioration in the value of its oil content; for it is readily attacked by small black beetles, thus reducing the available amount of oil; and the oil content becomes more and more acid without any perceptible change in the appearance of the kernel or in the oil extracted. Sample 1, Table II, has the same appearance as the kernel prepared in the laboratory. Freshly prepared kernel, therefore, is the best material for the expression of oil.

To determine the change in the amount of free fatty acids of the oil content of kernels due to storage, a sample of fresh kernels was secured and divided into two portions. The first portion was expressed immediately and gave an oil with an acidity of 0.55. The second portion was stored in a cool, open, dry place for a month, when the oil was expressed, and found to have an acidity of 5.32. The fertilizing value of the cake from the kernels as well as that of cake obtained from crushed nuts are shown in Table IV.

TABLE IV.—*Fertilizing value of lumbang bato cake from kernels and crushed nuts.*

	Cake from kernels.[a]	Cake from crushed nuts.[b]
	Per cent.	*Per cent.*
Moisture	11.13	8.46
Nitrogen (N_2)	8.86	1.25
Potash (K_2O)	1.67	0.68
Phosphorus (P_2O_5)	1.02	0.25

[a] Price in November, 1918, 25 centavos per kilogram. [b] No market established.

LUMBANG BANUCALAG (ALEURITES TRISPERMA)

Baguilumbang, *balucalad* (Laguna); *banucalag*, *lumbang banucalag*, *lumbang gubat* (Cavite); *balucanag* (Batangas); *lumbang* (Oriental Negros, Camarines). Baguilumbang is the name officially adopted by the Bureau of Forestry.

The fruit is 5 to 6 centimeters in diameter, somewhat rounded and obscurely angled, usually 3-celled, the cells 1-seeded, tardily dehiscent. The seed is somewhat ellipsoid, slightly flattened, brown, rather smooth, and has a rather brittle shell about 0.5 millimeter thick. This contains a white, oily, fleshy kernel, consisting of a very thin embryo surrounded by a large endosperm. This in turn is covered by a thin, white, papery seed coat. When dry the kernel with the thin seed coat shrinks slightly away from the shell so that the shell and the kernel are easily separated.

The close similarity between Chinese wood oil and lumbang banucalag oil[7] and the important place Chinese wood oil is now occupying in the paint industry of the world,[8] clearly show the industrial possibilities of banucalag oil.

The kernel of lumbang banucalag nuts is not so difficult to separate from the shell as is that of lumbang bato. When the

[7] Richmond, G. F., and Rosario, M. V., Philip. Journ. Sci. § A 2 (1907) 443.

[8] Wilson, E. H., Bull. Imp. Ins. 11 (1913) 13, 454.

nut is dry the kernel shrinks somewhat, and it can be easily separated after cracking the shell. No banucalag kernels are being sold in the market, and the industry of lumbang banucalag at present is very limited. This may be due to two important reasons, namely:

(1) The banucalag kernels when stored undergo a change, probably due to partial oxidation, as the result of which the oil becomes much more difficult to express and assumes a darker color.

(2) The banucalag oil when expressed, unless kept in air-tight containers, becomes rancid and foul smelling.

These facts constitute the main drawbacks to the production of lumbang banucalag oil; but, if certain precautions are strictly followed, there is no doubt that the industry of lumbang banucalag oil in connection with lumbang bato oil may become a profitable enterprise.

Freshly gathered nuts, free from moisture, produce kernels of the best quality, and the yield of oil by expression at 800 kilograms per square centimeter may be as much as 56 per cent of the weight of the kernels. This amount represents about 35 per cent of the weight of the dry nuts, whereas the oil obtained from lumbang bato kernels represents only about 19 per cent. The banucalag oil so prepared is of very good quality, light amber in color, and altogether satisfactory in its physical and chemical properties. If the oil is placed in air-tight containers while fresh, it will keep longer and no appreciable change in its composition will be noticed. On the other hand, unshelled nuts that were kept for sixteen months underwent so great a change in their oil value that the yield by expression was reduced from 56 per cent to 40 per cent of the weight of the kernel, and the oil was high in free fatty acids and much darker in color. The results obtained are shown in Table V.

TABLE V.—*Constants of banucalag oil.*

	Oil expressed from the kernels of fresh nuts.	Same oil after being kept for 16 months in a well-stoppered bottle.	Oil expressed from the kernels of nuts stored in a sack in a cool dry place for 16 months.
Per cent of oil based on the weight of kernels	56	----------	40
Color of oil	light amber	amber	dark amber
Specific gravity at 15.5° C	0.9362	0.9385	0.9441
Saponification value	191	192	200
Iodine value	166	170	160
Acid value	2.22	5.51	49.14

The results shown in Table V demonstrate conclusively the advisability of expressing the oil from the kernels of freshly gathered nuts, and of avoiding as much as possible long storage. These precautions should be strictly followed to ensure the production of a clear, light-colored oil, low in free fatty acids. The properties that make this oil so sensitive are the ones that make it valuable. The excellent drying qualities of this oil have been already reported.[9]

Lumbang banucalag nuts may be crushed and finely ground in an oil mill and the oil expressed directly from the crushed nuts. However, this procedure is even less commendable than in the case of lumbang bato; in the first place, the oil thus obtained is dirty, highly contaminated with shell particles, and darker colored; in the second place, the acid value is relatively higher, as shown in the following test:

From one sample lot of banucalag nuts two samples of oil were taken; in one case the oil was expressed from the kernel after separating the shell, and in the other case from the crushed nuts without separating the shell from the kernel. After one week the sedimentation by gravity was complete, and the two samples of oil were clear. The acid value of the first was 3.65; that of the second, 10.65.

The better quality of oil obtained when extraction was made from the kernels fully justifies the relatively small amount of additional work required to separate the kernel from the shell of lumbang banucalag nuts. Clear oil may be obtained, either by sedimentation or through filter presses, and kept in air-tight containers for storage.

The fertilizing value of lumbang banucalag cake compares very favorably with that of lumbang bato cake, as will be seen by a comparison of Tables VI and IV.

TABLE VI.—*Fertilizing value of lumbang banucalag cake from kernels and crushed nuts.*

	Cake from kernel.	Cake from crushed nuts.
	Per cent.	*Per cent.*
Moisture	7.67	9.45
Nitrogen (N_2)	6.20	2.99
Potash (K_2O)	1.79	0.90
Phosphorus (P_2O_5)	1.13	0.95

[9] Aguilar, R. H., Philip. Journ. Sci. § A 12 (1917) 235.

SUMMARY AND CONCLUSIONS

The lumbang oil industry, if properly developed, will become a profitable business.

It is much less desirable for a factory devoted to the manufacture of lumbang oils to purchase kernels than the nuts from which to prepare its own kernels, because oil from kernels that are being sold in the market is almost always of lower grade than that from freshly prepared ones.

No appreciable change can be noticed in the available oil content of uncracked lumbang bato nuts stored for over a year; but the content and the quality of the oil of unshelled banucalag nuts stored for the same length of time is considerably reduced. In the latter case even the shell is insufficient to protect the oil in the kernel from oxidization by the air, and shelled kernels deteriorate very rapidly.

Both oils after expression may be kept satisfactorily in proper containers. In view of these facts, a lumbang-oil factory engaged in the commercial expression of both bato and banucalag oils, in order that the maximum yield and best quality of both bato and banucalag oils may be obtained, preferably should commence the season with the expression of banucalag oil and store the bato nuts until the other species is finished.

164891——3

NEW PHILIPPINE GALL MIDGES

By E. P. Felt

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This paper is supplemental to an earlier one;[1] it not only describes and records the food habits of a number of Philippine gall midges, but also establishes the occurrence in the eastern tropics of *Ctenodactylomyia* Felt or a closely related genus, previously known only in subtropical America. This was to be expected, since studies on distribution show that certain subtropical genera have a range which would suggest their probable occurrence in all warmer climates where food plants permit their existence. This record is analogous to the discovery of species of the genus *Aplonyx* in such widely separated parts of the world as the Mediterranean region and the vicinity of Salt Lake, Utah—localities apparently agreeable to the host plants as well as to the insects.

This collection, like the preceding, was received through the courtesy of Prof. Charles S. Banks, chief of the department of entomology of the College of Agriculture, University of the Philippines, who collected some of the species, as detailed below. Mr. L. B. Uichanco reared a number of species from various galls; the galls, I understand, are to be described in detail in another paper.

Ctenodactylomyia antidesmæ sp. nov.

Female.—Length, 1.5 millimeters. Antennæ extending to the base of the abdomen, sparsely haired, reddish brown, the basal segments reddish orange, probably of 14 segments, the fifth cylindrical, its length two and one-half times its diameter. Palpi presumably triarticulate, first segment irregularly and broadly oval, second a little longer, slenderer, third three times as long as its width and somewhat dilated. Eyes black, holoptic. Mesonotum pale yellowish, sparsely clothed with coarse setæ. Scutellum translucent yellowish. Postscutellum yellowish orange. Abdomen reddish orange, distal segments rather thickly clothed

[1] Felt, E. P., New Philippine gall midges, with a key to the Itonididæ, *Philip. Journ. Sci.* § D 13 (1918) 281.

with coarse, dark setæ or scales. Wings hyaline, their length about twice their width, third vein uniting with margin well before apex, fifth vein obsolescent distad and joining margin at distal fourth, its branch near basal third. Membrane rather thickly clothed with dark hairs. Halteres whitish transparent basad, fuscous apicad. Coxæ and femora basad yellowish orange. Femora distad and tibiæ dark straw. Tarsi mostly fuscous, the anterior pair with narrow, indistinct, yellowish annulations at articulations. Claws quadridentate, there being at least three minor stout teeth nearly as long as, though more slender than, the main claw. Pulvilli about one-half length of claws. Ovipositor about one-half length of abdomen. The terminal lobes five times as long as wide and sparsely setose.

Type.—Cecid. a2881, New York State collection.

LUZON, Laguna Province, Mount Maquiling, October 2, 1917, College of Agriculture accession No. 18157 (*L. B. Uichanco*).

The single female, described above, was reared from leaf galls on *Antidesma leptocladum* Tul. The species is tentatively placed in this genus, though the wings are decidedly broader than in the type species, and there is a possibility that it should be referred to a new genus. Such action is deferred until both sexes can be secured.

Lasioptera falcata sp. nov.

Female.—Length, 1.5 millimeters. Antennæ extending to near base of abdomen, sparsely haired, dark brown, of 24 segments, the fifth as long as its diameter. Terminal segment slightly produced and narrowly oval. First segment of palpi short, irregular; second about three times as long as its diameter; third nearly one-half longer, slenderer; fourth a little longer and slenderer than third. Mesonotum reddish brown, apparently denuded. Scutellum reddish orange. Postscutellum dark brown. Abdomen mostly dark brown, first segment margined caudad with a narrow white line, the others though badly rubbed show submedian whitish spots; terminal segment yellowish. Wings hyaline, third vein uniting with costa near distal third. Halteres yellowish. Coxæ yellowish orange. Legs mostly dark brown. Ovipositor nearly as long as body, terminal lobe about four times as long as wide, slightly curved, sparsely setose, and with an oval group of heavy, stout, hastate spines basad and a group of rather long, moderately slender, chitinous hooks.

Type.—Cecid. a2887, New York State collection.

LUZON, Laguna Province, Los Baños, January 3, 1917, College of Agriculture accession No. 18183 (*Uichanco*).

The single female, reared from a stem gall on a wild cucurbit, is presumably undescribed, and there is little question that it is the producer of the gall. The insect is remarkable because of the unusually long, somewhat falcate, terminal lobes of the ovipositor.

Asphondylia grewiæ sp. nov.

Male.—Length, 1.5 millimeters. Antennæ probably nearly as long as body, sparsely haired, basal portion, at least, dark brown, presumably of 14 segments, fifth with a length four times its diameter and with moderately high circumfila. Palpi probably triarticulate. Mesonotum dark reddish brown. Scutellum and postscutellum yellowish brown. Abdomen dark brown, sparsely haired. Wings unusually broad and rather thickly clothed with fuscous hairs. Third vein unites with margin near apex, fifth at distal third, its branch at basal fourth; fork unusually long. Halteres fuscous yellowish. Legs dark brown. Claws long, moderately stout, pulvilli as long as claws. Genitalia: Basal clasp segment short, stout, and bidentate, with a distinct rudimentary tooth near the bottom of the excavation; dorsal plate divided, the lobes irregularly triangular, lobes of ventral plate rounded.

Type.—Cecid. a2880, New York State collection.

LUZON, Laguna Province, Mount Maquiling, September 23, 1917, College of Agriculture accession No. 18137 (*Uichanco*).

The one male described above was reared from a leaf gall on *Grewia stylocarpa* Warb. The species is remarkable in this genus because of the unusually broad wings, these having a length nearly one-half greater than the diameter. The specimen was badly broken and rumpled.

Contarinia saltata sp. nov.

Male.—Length, 1.25 millimeters. Antennæ one-fourth longer than body, thickly haired, reddish brown, of 14 segments, fifth having stems with a length equal to, and one-half greater than, their diameters, respectively. Basal enlargement subglobose, distal enlargement somewhat produced, both with moderately long circumfila; basal portion of terminal segment with the stem short, distal enlargement irregularly fusiform and tapering slightly to a very broad, broadly rounded apex. Length of first segment of palpi about two and one-half times its diameter; second a little longer, slenderer; third a little longer than second; fourth as long as third and somewhat dilated apicad. Mesonotum dark reddish brown. Scutellum reddish orange. Postscutellum dark brown. Abdomen reddish brown. Wings hyaline, moderately narrow, third vein uniting with margin at apex. Halteres yellowish basad, reddish apicad. Coxæ and legs mostly reddish brown. Claws long, slender, strongly curved apicad, pulvilli as long as claws. Genitalia: Basal clasp segment very short and stout; terminal clasp segment moderately long and stout, dorsal plate short, broad, narrowly incised, lobes obliquely truncate, lateral angles broadly rounded; ventral plate deeply and triangularly emarginate, lobes somewhat divergent and tapering to a narrowly rounded vertex; style moderately long, tapering strongly, narrowly rounded apicad.

Type.—Cecid. a2884, New York State collection.

LUZON, Laguna Province, Los Baños, February 6, 1918, College of Agriculture accession No. 18180 (*Uichanco*).

A series of specimens was taken from a spider's web on a leaf of *Andropogon sorghum* Linn. It is possible that this insect lives upon *Andropogon*, though it is very different from *Contarinia sorghicola* Coq., which is well known in America. It is described here because it is believed that the peculiar characters will make the recognition of this species easy and, therefore, no confusion need arise from a description not based in part upon a food-plant record.

Bremia macrofilum sp. nov.

Male.—Length, 1 millimeter. Antennæ one-half longer than body, thickly haired, dark brown, of 14 segments, fifth with stems having a length one and one-half and two and one-half times their diameters, respectively. Basal enlargement subglobose, distal enlargement oval, its length one and three-fourths times its diameter. Dorsal loops on basal circumfilum produced nearly to distal enlargement and dorsal loops of distal circumfilum extending to apex of basal enlargement of next segment. Terminal segment greatly produced, basal portion of stem with a length about five times its diameter, distal enlargement pyriform, its basal third rather strongly constricted. Appendage long, irregular, and slightly fusiform. First segment of palpi with a length about three times its diameter; second a little longer, stouter; third as long as second; fourth one-half longer than third and slenderer. Mesonotum dull dark brown. Scutellum yellowish brown. Postscutellum dark brown. Abdomen dark brown, almost black, sparsely haired; genitalia yellowish. Wings hyaline. Halteres yellowish basad, reddish apicad. Coxæ dark brown. Legs mostly reddish brown. Claws moderately long, slender, strongly curved, the anterior ones unidentate, pulvilli rudimentary. Genitalia: Basal clasp segment moderately long, stout; terminal clasp segment long, slender, swollen basad; dorsal plate deeply and triangularly emarginate, the lobe sparsely setose, tapering to a narrowly rounded apex; ventral plate apparently very long and slender and with a somewhat curved, quadrate, obliquely truncate, lateral process at the basal third, the length of which is approximately one-third that of the entire organ. The distal portion of the ventral plate beyond this process is slender and a little longer than the basal part; harpes chitinized, indistinct; style rather short, stout, obtuse apicad.

Female.—Length, 1.5 millimeters. Antennæ a little shorter than body, sparsely haired, dark brown, of 14 segments, fifth with a stem one-fourth the length of the cylindrical basal enlargement. The latter is two and one-half times as long as its diameter. It bears a sparse subbasal whorl of long, stout setæ and a median band of shorter, slender, curved setæ. Circumfila unusually heavy, terminal segment produced, length of basal portion four times its diameter, appendage knoblike. Mesonotum dark brown, submedian lines sparsely haired. Scutellum yellowish fuscous. Postscutellum dark brown. Abdomen mostly dark brown, basal segments with a dark orange hue. Legs mostly dark brown, fourth tarsal segment of anterior legs and distal tarsal segment of middle pair of legs white in certain lights. Ovipositor short, the lobes roundly triangular and sparsely setose, otherwise as in the male.

Type.—Cecid. a2888, New York State collection.

MINDANAO, Lanao District, Kolambugan, June 10, 1914, College of Agriculture accession No. 18184 (*C. S. Banks*).

The midges described above were accompanied by the statement that they were caught on a spider's web. They were dancing on the web, by the thousand, on a bright sunshiny afternoon. This peculiar species has unusually heavy circumfila in the female, and the male genitalia present striking characteristics.

Arthrocnodax copræ sp. nov.

Male.—Length, 0.75 millimeter. Antennæ a little longer than body, thickly haired, reddish brown, of 14 segments, fifth having stems with a length one-half and one and one-half times their diameters, respectively. Basal enlargement subglobose, distal broadly ovoid, both with moderately long and unusually heavy circumfila; basal enlargement of terminal segment subglobose, stem relatively short, distal enlargement broadly cylindrical, apex almost truncate. First segment of palpi short, irregular; second with a length three times its width; third a little shorter than second, more dilated; fourth one-half longer than second. Mesonotum shining dark brown. Scutellum and postscutellum dark reddish brown. Abdomen yellowish fuscous. Wings hyaline, third vein uniting with costa well before apex; fifth obsolescent distad, joining posterior margin at distal fourth, its branch at basal third. Halteres translucent whitish basad, fuscous apicad. Coxæ dark brown. Legs mostly yellowish brown. Claws rather long, evenly curved, slender, pulvilli rudimentary. Genitalia: Basal clasp segment moderately long, stout; terminal clasp segment rather long, swollen basad, dorsal plate deeply and triangularly emarginate, lobes triangular and sparsely setose; ventral plate moderately long, broad, broadly rounded apicad; style long, stout, and tapering to a narrowly rounded apex.

Female.—Length, 0.75 millimeter. Antennæ a little shorter than body, rather thickly haired, yellowish brown, of 14 segments, fifth with a stem about one-half the length of cylindrical basal enlargement, the latter about three times as long as its diameter. First segment of palpi short, irregular; second somewhat dilated, its length over twice its diameter; third one-half longer than second, slenderer; fourth a little longer than third and more dilated. Mesonotum dark reddish brown. Scutellum yellowish, darker basad. Postscutellum yellowish. Abdomen deep red. Halteres yellowish basad, fuscous apicad. Legs mostly yellowish fuscous, distal tarsal segments somewhat darker. Ovipositor short, lobes with a length two and one-half times width and sparsely setose.

Type.—Cecid. a2883, New York State collection.

The coloration in this species is evidently variable, another male having a shining reddish brown mesonotum, yellowish scutellum and postscutellum, and dark reddish abdomen. A second female had a shining, very dark brown, almost black mesonotum.

LUZON, Laguna Province, Los Baños, December 6, 1917, College of Agriculture accession No. 18173 (*C. S. Banks*).

A series of midges was reared from copra (dried coconut meat) kept in the laboratory for breeding *Necrobia rufipes* de Geer. The glass vessel had not been opened for a month. The characteristic short stems of the flagellate antennal segments and the heavy circumfila lead me to place this species here, though the poorly developed pulvilli would indicate an affinity with *Silvestrina* Kieff. or *Planodiplosis* Kieff., the latter known only by the female. It is probable that the larvæ are scavengers, as is the case with *A. aphiphila* Felt and some other American species.

Itonida paederiæ sp. nov.

Male.—Length, 1 millimeter. Antennæ probably twice the length of body, thickly haired, pale yellowish, probably with 14 segments, fifth having basal portion of stem with a length one-fourth greater than its diameter, distal portion three times as long as its diameter; basal enlargement subglobose, terminal enlargement subcylindrical, somewhat expanded distad and with a length one and three-fourths times its diameter, circumfila moderately long, terminal segment missing. First segment of palpi moderately long, irregular, length of second three times its diameter; third one-half longer and slenderer than second; fourth as long as third and somewhat dilated. Scutellum reddish brown. Postscutellum and abdomen mostly yellowish brown, abdomen thickly clothed with long hairs. Wings hyaline, membrane rather thickly haired, third vein uniting with costa just beyond apex, fifth obsolescent at the distal third, its branch at the basal third. Halteres translucent yellowish. Legs mostly dark straw. Claws moderately long, rather strongly curved, simple, pulvilli about three-fourths length of claws. Genitalia: Basal clasp segment rather long, slender; terminal clasp segment moderately long, stout and curved; dorsal plate moderately long, broad, deeply and triangularly emarginate, interior margin with a distinct setose process at basal third; lobes triangular and sparsely setose; ventral plate long, broad, deeply and roundly emarginate, lobes slender and setose apicad; style long, moderately stout and broadly rounded apicad.

Female.—Length, 1.5 millimeters. Antennæ probably nearly as long as body, rather thickly long haired, mostly reddish brown, of 14 (?) segments, fifth with a stem nearly three-fourths length of cylindrical basal enlargement. The latter is about three times as long as its diameter. First segment of palpi short, irregular; second narrowly ovoid, with a length three times its diameter; third one-half longer than second; fourth a little longer than third. Mesonotum yellowish brown, sparsely long haired. Scutellum brownish yellow. Postscutellum and abdomen reddish brown, the latter sparsely haired. Halteres yellowish basad, fuscous apicad. Coxæ yellowish brown. Legs mostly dark brown. Ovipositor short, terminal lobes sparsely setose, their length about three times their width. Ventral lobe much shorter and broadly rounded apicad.

Type.—Cecid. a2882, New York State collection.

LUZON, Laguna Province, Los Baños, October 13, 1917, College of Agriculture accession No. 18165 (*Uichanco*).

The specimens were reared from leaf galls on *Paederia tomentosa* Blume.

Cecidomyia philippinensis sp. nov.

Female.—Length, 2 millimeters. Antennæ about one-half the length of body, rather sparsely haired, reddish brown, of 14 segments, fifth with a stem one-fourth the length of the cylindrical basal enlargement, which latter is about three and one-half times as long as its diameter; a rather sparse whorl of stout setæ basad and a somewhat thick band of slenderer setæ subapicad; basal portion of terminal segment with a length about two and one-half times its diameter, the distal portion long and digitate. Each palpus consisting of one narrowly ovoid segment. Eyes holoptic. Mesonotum dull reddish brown, submedian lines yellowish, thickly haired. Scutellum pale yellowish. Postscutellum brownish yellow. Abdomen mostly dark red, thickly haired. Wings hyaline, slender, the length being nearly three times the width, subcosta united to costa by a rather distinct chitinized area and ending near basal third. Third vein nearly straight and joining margin well beyond apex of wing, fifth vein uniting with posterior margin at distal fourth, its branch near basal half. Halteres yellowish basad, reddish apicad. Coxæ pale yellowish. Femora distad reddish brown, tibiæ and tarsi mostly pale straw. Claws wanting. Ovipositor short, terminal lobes rather broadly ovoid and somewhat thickly setose.

Type.—Cecid. a2889, New York State collection.

LUZON, Laguna Province, Mount Maquiling, September 3, 1917, College of Agriculture accession No. 18316 (*Uichanco*).

The one female described above was accompanied by the following statement: "It is doubtful whether this is the cause of the numerous galls on the leaves of this plant (*Spatholobus philippinensis* Merr.), as this insect was bred out of a narrow thistle-shaped case, attached to the leaf and not from the galls." Despite the above, there is a fair probability that this is the gall producer; and, as there is a definite food-plant record, I have described the species from a somewhat mutilated specimen. Since the characters are sufficiently marked, there should be comparatively little difficulty in establishing the identity of the insect later.

THE PALMS OF THE PHILIPPINE ISLANDS

By O. Beccari

(*Florence, Italy*)

THREE PLATES

The species of palms at present known to be indigenous to the Philippines number one hundred twenty, not including a few semiwild or cultivated forms. Of that number but about a dozen are species of relatively wide geographic distribution, all the others being endemic forms. The nonendemic element is in part derived from species growing in swamps or at the mouths of rivers, along the coasts of neighboring countries, and are the following: *Oncosperma filamentosa, Oncosperma horrida, Caryota mitis, Licuala spinosa, Nipa fruticans, Korthalsia laciniosa,* and three species of *Calamus.* The following are also nonendemic Philippine palms: *Actinorhytis calapparia, Arenga saccharifera, Corypha elata, Metroxylon Rumphii, Caryota Rumphiana, Livistona cochinchinensis,* and *L. rotundifolia,* some of which may have been introduced by man or by other means. *Heterospatha elata,* which is common in the Philippines, is reported as growing also in the Moluccas, but I have not seen specimens of it collected in those islands. In fact the genus *Heterospatha* is represented in the Philippines by four species and may be considered as a Polynesian element in the Philippine flora. With this exception and that of *Adonidia,* discussed below, all the Philippine endemic species belong to genera more frequently found in the Malay Peninsula, the Malayan islands, and in Cochinchina; these genera are *Areca, Pinanga, Arenga, Caryota, Orania, Ptychoraphis, Oncosperma, Livistona, Korthalsia, Zalacca, Plectocomia, Calamus,* and *Daemonorops.*

Only one genus appears to be exclusively Philippine, *Adonidia,* mentioned above, which belongs in a group of palms very rich in genera and species in the Papuan and Polynesian regions, but only scantily represented in southern Asia and in Malaya proper.

It is rather surprising that some common Malayan genera are either not at all or at most very poorly represented in the Philippines. Thus the genus *Iguanura* is entirely wanting. In *Licuala,* a genus with numerous species in the primeval Malayan and Papuan forests as undergrowth palms, only the widespread and littoral *L. spinosa* has been found in the Philippines, where it occurs in the more southern islands of the Archipelago.

Other southern Asiatic or Malayan genera of which representatives are wanting in the Philippines are: *Pholidocarpus, Nenga, Cyrtostachys, Bentinckia, Gigliolia, Zalaccella, Calospatha, Pigafetta, Ceratolobus, Plectocomiopsis,* and *Myrialepis.* The genus *Eugeissonia* also, which is largely represented in Borneo, seems to be unrepresented in the Philippines.

Areca and *Pinanga,* among the Arecinaceae, and *Calamus* and *Daemonorops,* among the Lepidocaryeae, furnish two-thirds of the species of palms known as indigenous to the Philippines and form the great bulk of its palm flora.

The genus *Areca* is particularly remarkable, as out of the total number of thirty-six species known to me at present no less than ten are very characteristic Philippine ones. In this number is also included *Areca Catechu,* of which we have good grounds for believing that it may have acquired its actual specific characters in some part of the Philippines. Even leaving out of consideration the fact that a variety of *Areca Catechu* (var. *silvatica*) has been found growing as a real forest plant in Palawan, there occur in the Philippines other fine species of *Areca,* closely related to *A. Catechu,* although certainly specifically distinct from it. Of this number are *A. macrocarpa, A. parens, A. Whitfordii,* and perhaps *A. Camarinensis. Areca Catechu* var. *longicarpa,* which may perhaps represent a distinct species, is also, apparently, a wild-growing plant in Polillo. The group to which all the above-mentioned species belong has no representative elsewhere; and if we consider *A. Catechu* as a palm introduced into the Philippines, where can we look for the allied species, from which we may suppose it to have been derived? As is more fully shown in the detailed treatment of the genus *Areca,* several species besides those mentioned above are indigenous to the Philippines. It is plainly evident, therefore, that the genus *Areca* has found in the Philippines more favorable evolutionary conditions for the plasmation of its endemic forms than elsewhere, and especially for the species related to *Areca Catechu.*

In the genus *Pinanga* eighty species are now known to me (the descriptions of some of them not yet published), and 25 per cent of these are endemic Philippine species. However, this genus, unlike *Areca,* presents no conspicuous or anomalous Philippine representatives differentiating them much from the common Malayan types; but several are fine large palms deserving the name of trees; such as *Pinanga insignis*, *P. batananensis*, *P. sibuyanensis*, and *P. speciosa*. Among the small forms *P. maculata* alone shows close affinities with the Malayan *P. disticha*.

The genus *Orania* has also found in the Philippines very favorable conditions for evolution and is there represented by several forms, all of which, however, are apparently derived from two species belonging to two different and widely separated regions; namely, *O. macrocladus*, of the Malay Peninsula, and *Orania moluccana* and *O. regalis*, of the Moluccan and the Papuan regions.

In *Caryota* forms are found that are but slight modifications of Malayan species, and the same may be said of the genus *Arenga*. The variety *philippinensis* of *Caryota Rumphiana* may, perhaps, be considered as an endemic species of the second degree, but its great affinity with the other forms of that polymorphic palm, which is widely spread throughout the entire Malayan region, is plainly evident.

Arenga saccharifera is, I think, to be considered as an introduced and naturalized plant.

Oncosperma filamentosa, the elegant gregarious palm which so frequently gives so special a feature to the vegetation of the swampy estuaries in Borneo and Sumatra, is found in the Philippines only in Palawan. *Oncosperma horrida* is another Malayan type from which the two endemic species *O. platyphylla* and *O. gracilipes* have apparently been derived.

Livistona rotundifolia and *L. cochinchinensis*, two nonendemic species, are widely distributed in the Philippines, and their presence in the Archipelago may be accounted for by the transport of their fruits from Indo-China, Celebes, and the Moluccas through the agency of birds or perhaps by that of flying foxes. *Livistona rotundifolia*, however, has given rise to some local forms in the Philippines. *Livistona Merrillii* and *L. Robinsoniana* are endemic.

The Philippine Lepidocaryeae number fifty-five, of which thirty-six belong to *Calamus*, thirteen to *Daemonorops*, three to *Korthalsia*, one to *Plectocomia*, and one to *Zalacca*. *Metroxylon Rumphii*, which seldom produces fertile fruits, is probably an introduced plant in Mindanao and other islands in the southern part of the Archipelago.

The Philippine species of *Calamus*, with only three exceptions, are endemic. The nonendemic species are *C. symphysipus*, a common plant in Celebes; and *C. ornatus* and *C. Diepenhorstii*, the last two rather common littoral Malayan species, although represented in the Philippines by distinct varieties.

The thirteen species of *Daemonorops* are also, with the exception of *D. Margaritae*, of southern China, all endemic, but several of them are closely related to species growing in neighboring countries. Thus *D. Gaudichaudii*, *D. affinis*, and *D. gracilis* are related to the common *D. hystrix; D. ochrolepis* approaches *D. Rumphii*, of the Moluccas; and *D. virescens* is allied to *D. longipes*, a common littoral Malayan species.

Korthalsia laciniosa is also a common littoral plant in southern Asia, but *K. scaphigeroides* and *K. Merrillii* are endemic, although related to Malayan species.

The only *Zalacca* known from the Philippines, *Z. Clemensiana*, belongs to the group which have the fruits covered with spiculiferous scales, as *Z. edulis* and allied species.

Plectocomia Merrillii is evidently a derivation from the Bornean *P. Muellerii.*

On the whole we are led to conclude that the Philippine palms have in great measure originated in the Archipelago, but their phylogeny may be traced to species growing chiefly in Borneo, Celebes, the Moluccas, and Indo-China, excluding about a dozen species, which possess adaptations for easy dissemination, and for this reason are palms of rather wide geographic distribution. In addition a Polynesian element is represented by *Adonidia* and *Heterospathe.*

The palm flora of the Philippines has, therefore, no individuality as to genera, the only genus peculiar to the Archipelago being the monotypic new genus *Adonidia*.

In the Philippines a few large genera have varied so much as to give origin to numerous species, quite different in that respect from what has happened in Polynesia, where monotypic or oligotypic genera are numerous, and where no genus occurs that contains a great number of species.

ENUMERATION OF THE PALMS INDIGENOUS TO, OR NATURALIZED IN, THE PHILIPPINE ISLANDS

Areca Catechu Linn. (var. *communis*).
Areca Catechu var. *silvatica* Becc.
Areca Catechu var. *batanensis* Becc.
Areca Catechu var. *longicarpa* Becc.
Areca macrocarpa Becc.
Areca Whitfordii Becc.
Areca Whitfordii var. *luzonensis* Becc.
Areca parens Becc.
Areca Ipot Becc.
Areca Ipot var. *polillensis* Becc.
Areca camarinensis Becc.
Areca Caliso Becc.
Areca costulata Becc.
Areca Vidaliana Becc.
Areca Hutchinsoniana Becc.
Pinanga maculata Porte.

Pinanga geonomaeformis Becc.
Pinanga modesta Becc.
Pinanga isabelensis Becc.
Pinanga heterophylla Becc.
Pinanga Barnesii Becc.
Pinanga Copelandi Becc.
Pinanga Curranii Becc.
Pinanga philippinensis Becc.
Pinanga Elmerii Becc.
Pinanga urdanetana Becc.
Pinanga samarana Becc.
Pinanga urosperma Becc.
Pinanga rigida Becc.
Pinanga Woodiana Becc.
Pinanga sclerophylla Becc.
Pinanga negrosensis Becc.
Pinanga insignis Becc. (forma *typica*).
Pinanga insignis var. *gasterocarpa* Becc.
Pinanga insignis var. *leptocarpa* Becc.
Pinanga insignis var. *Loheriana* Becc.
Pinanga batanensis Becc.
Pinanga basilanensis Becc.
Pinanga speciosa Becc.
Pinanga sibuyanensis Becc.
Actinorhytis calapparia Wendl. & Drude.
Heterospathe elata Scheff.
Heterospathe sibuyanensis Becc.
Heterospathe philippinensis Becc.
Heterospathe negrosensis Becc.
Ptychoraphis microcarpa Becc.
Ptychoraphis intermedia Becc.
Ptychoraphis Elmerii Becc.
Ptychoraphis cagayanensis Becc.
Adonidia Merrillii Becc.
Oncosperma filamentosa Blume.
Oncosperma horrida Scheff.
Oncosperma platyphylla Becc.
Oncosperma gracilipes Becc.
Orania philippinensis Scheff.
Orania philippinensis var. *sibuyanensis* Becc.
Orania paraguaensis Becc.
Orania decipiens Becc.
Orania decipiens var. *mindanaoensis* Becc.
Orania decipiens var. *montana* Becc.
Orania rubiginosa Becc.
Arenga saccharifera Labill.
Arenga mindorensis Becc.
Arenga tremula Blanco.
Arenga Ambong Becc.
Caryota Rumphiana var. *philippinensis* Becc.
Caryota Rumphiana var. *oxyodonta* Becc.
Caryota Cumingii Lodd.
Caryota Merrillii Becc.
Caryota majestica Linden.
Caryota mitis Lour.
Cocos nucifera Linn.
Nipa fruticans Wurmb.
Phoenix Hanceana Planch. var. *philippinensis* Becc.
Licuala spinosa Wurmb.
Livistona cochinchinensis Mart.
Livistona Merrillii Becc.
Livistona rotundifolia Mart.
Livistona rotundifolia var. *luzonensis* Becc.
Livistona rotundifolia var. *mindorensis* Becc.
Livistona Robinsoniana Becc.
Corypha elata Roxb.
Metroxylon Rumphii Mart.
Zalacca Clemensiana Becc.
Plectocomia Elmerii Becc.
Korthalsia scaphigeroides Becc.
Korthalsia Merrillii Becc.
Korthalsia laciniosa Mart.
Korthalsia squarrosa Becc.
Calamus mollis Blanco.
Calamus mollis var. *major* Becc.
Calamus mollis var. *palawanicus* Becc.
Calamus Meyerianus Schauer.
Calamus Blancoi Kunth.
Calamus melanorhynchus Becc.
Calamus filispadix Becc.
Calamus Diepenhorstii var. *exulans* Becc.
Calamus ornatus var. *philippinensis* Becc.
Calamus discolor Mart.
Calamus discolor var. *negrosensis* Becc.
Calamus Cumingianus Becc.
Calamus simphysipus Mart.
Calamus Merrillii Becc. (forma *typica*).

Calamus Merrillii var. *Nanga* Becc.
Calamus Merrillii var. *Merrittianus* Becc.
Calamus Foxworthyi Becc.
Calamus manillensis H. Wendl.
Calamus trispermus Becc.
Calamus Arugda Becc.
Calamus vinosus Becc.
Calamus Moseleyanus Becc.
Calamus Mindorensis Becc.
Calamus multinervis Becc.
Calamus grandifolius Becc.
Calamus Jenningsianus Becc.
Calamus Samian Becc.
Calamus megaphyllus Becc.
Calamus Elmerianus Becc.
Calamus mitis Becc.
Calamus Reyesianus Becc.
Calamus spinifolius Becc.
Calamus viridissimus Becc.
Calamus microsphaerion Becc.
Calamus microsphaerion var. *spinosior* Becc.
Calamus ramulosus Becc.
Calamus Vidalianus Becc.
Calamus siphonosphathus Mart.
Calamus siphonosphathus var. *sublaevis* Becc.
Calamus siphonosphathus var. *oligolepis major* Becc.
Calamus siphonosphathus var. *oligolepis minor* Becc.
Calamus siphonosphathus var. *polylepis* Becc.
Calamus siphonosphathus var. *batanensis* Becc.
Calamus dimorphacanthus Becc.
Calamus dimorphacanthus var. *montalbanicus* Becc.
Calamus dimorphacanthus var. *zambalensis* Becc.
Calamus microcarpus Becc.
Calamus microcarpus var. *diminutus* Becc.
Calamus halconensis Becc.
Calamus discolor Becc.
Daemonorops Margaritae var. *palawanicus* Becc.
Daemonorops virescens Becc.
Daemonorops ochrolepis Becc.
Daemonorops urdanetanus Becc.
Daemonorops pedicellaris Becc.
Daemonorops Loherianus Becc.
Daemonorops pannosus Becc.
Daemonorops oligolepis Becc.
Daemonorops Clemensianus Becc.
Daemonorops Gaudichaudii Becc.
Daemonorops affinis Becc.
Daemonorops Curranii Becc.
Daemonorops gracilis Becc.

NATURALIZED SPECIES

Areca Catechu Linn.
Actinorhytis Calapparia Wendl. & Drude.
Arenga saccharifera Labill.
Cocos nucifera Linn.
Metroxylon Rumphii Mart.

NONENDEMIC SPECIES

Heterospathe elata Scheff.
Oncosperma filamentosa Blume.
Oncosperma horrida Scheff.
Nipa fruticans Wurmb.
Licuala spinosa Wurmb.
Livistona cochinchinensis Mart.
Livistona rotundifolia Mart.
Korthalsia laciniosa Mart.
Calamus Diepenhorstii var. *exulans* Becc.
Calamus ornatus var. *philippinensis* Becc.
Calamus simphysipus Mart.
Daemonorops Margaritae var. *palawanicus* Becc.
Caryota mitis Lour.
Caryota rumphiana Mart.
Corypha elata Roxb.

ARECA Linnaeus

Ten species of *Areca* are at present known from the Philippines; all, with the exception of *A. Catechu*, are endemic. There are, moreover, several distinct varieties, for generally speaking the same species is rarely represented by individuals offering an absolute uniformity of characters, when inhabiting different islands, even when these are not separated by a wide extent of sea. There are some large species specially worthy of remark, for they are so much like *A. Catechu,* as to render it uncertain whether they are to be regarded, at times, as simply varieties of that palm or as distinct species; they are *A. macrocarpa, A. Whitfordii,* and *A. Catechu* var. *longicarpa.* The first two are really forest plants, and apparently also the last is a forest plant. *Areca Catechu* var. *silvatica* possibly represents the true wild plant of that widely cultivated species (of which the true place of origin has not been ascertained), for in the Philippines various forms of *Areca* occur so closely related to *A. Catechu* as to afford good ground for belief that it was in those Islands that *A. Catechu* finally assumed the specific characters it now exhibits. In support of this opinion I would observe that in no other part of southern and eastern Asia or Malaya is any species of *Areca* to be found which in any way approaches *A. Catechu* in specific characters, whereas in the Philippines an entire group of species exists closely related to it. *Areca parens* is another fine species, endemic in the Philippines, which, although endowed with characteristic and easily appreciable diagnostic characters, evidently belongs to the group of *A. Catechu.*

The fruits of *Areca Ipot* and *A. camarinensis* in their principal characters and general appearance are also very much like those of *A. Catechu,* but these two species belong to the group that produces female flowers, and then fruits, densely grouped around the main axis of the spadix, and are therefore related to the species for which was established the subgenus *Balanocarpus,* which includes *A. glandiformis,* of the Moluccas; *A. macrocalyx,* of the Papuan Islands, and a few others.

Areca costulata is no doubt related to *A.* (*Mischophloeus*) *paniculata* Scheff., a palm growing in northern Celebes and in the Moluccas; not only on account of its male flowers having the cyathiform calyx slightly 3-toothed and with a solid base, but also in its general habit. *Areca Caliso* is somewhat related to *A. costulata,* from which, however, it differs by the calyx of the male flower being divided into three small distinct sepals; its nearest allied species is probably *A. oxycarpa,* of Celebes. *Areca Vidaliana* and *A. Hutchinsoniana* are of the type of the very widespread *A. triandra,* not only on account of the male flowers being inserted in pairs on unilateral notches of the floriferous branches, but also because the male flowers have six stamens, but *A. triandra* has 3-androus flowers; on that account *A. Vidaliana* and *Hutchinsoniana* agree with *A. laosensis*, of Indo-China, which also, although of the general habit of *A. triandra*, has male flowers with six stamens.

Conspectus of the Philippine species.

a^1. Floriferous branches bearing only one or very few female flowers, sessile on their basal thickened part, and the geminate male flowers in distichous alternate indentures in their upper slender part.

b^1. Spadices spreadingly twice or thrice branched; palms with tall slender stems and relatively large fruits. (§ *Euareca.*)

c^1. Male flowers narrowly lanceolate (unknown in *A. Whitfordii*); rudimentary ovary conspicuous, trifid, as long as, or longer than, the stamens; anthers acute or acuminate. Female flowers with broadly imbricate sepals about as broad and long as the petals. Fruit with the pericarp finally entirely disintegrating into very fine and soft fibers.

d^1. Fruit having the mesocarp considerably thicker at both ends than at the sides, and the seed inserted considerably above the base.

e^1. Seed having the vascular bundles of the integument arching on the sides, and strongly anastomosing immediately from its base, even on the raphal side............................1. *A. Catechu.*

f^1. Fruit orange-red; globose-ovoid or ovoid-ellipsoid, not more than one-third or one-fourth longer than broad (4 to 5 cm long, 3 to 4 cm broad). Seed subglobose with a more or less flattish base................*A. Catechu* (forma *communis*.)

f^2. Fruit ovoid-ellipsoid, rather ventricose, smaller than usual (4 cm long and 3 cm or a little less broad); seed globose-depressed or broader than high, the base flat.
A. Catechu var. *silvatica.*

f^3. Stems thicker and shorter than in forma *communis;* spadix denser and with shorter floriferous branches.
A. Catechu var. *batanensis.*

f^4. Fruit narrowly ellipsoid; twice, and even more, as long as broad (5.5 to 7 cm long, 2.5 cm broad). Seed ovoid-conical with a blunt apex and flat base, slightly longer than broad.
A. Catechu var. *longicarpa.*

e^2. Seed having the vascular bundles of the integument arising straight, almost erect, from the raphal side and slightly branching. Fruit elongate-ellipsoid, twice as long as broad (7 cm long, 3.2 to 3.5 cm broad). Seed ovoid-conical with a blunt apex...2. *A. macrocarpa.*

d^2. Fruit ellipsoid-fusiform, twice and more as long as broad, having the mesocarp not much thicker at the ends than at the sides. Seed placed nearly in the middle of the pericarp and equally narrowing to both ends.

e^1. Fruit 4 to 4.5 cm long, 1 to 2 cm broad...........3. *A. Whitfordii.*

e^2. Fruit larger, 5.5 cm long, 2 cm broad.
A. Whitfordii var. *luzonensis.*

c^2. Male flowers relatively large, ovoid-subtrigonous or trapezoidal; rudimentary ovary small, slender, entire, subulate, shorter than the stamens; anthers very obtuse. Sepals of the female flower considerably smaller than the petals. Fruit large, ovoid, about 6 cm long, 3.5 cm broad, the pericarp fibrous in its outer half, woody in the inner half. Seed broadly ovoid, its vascular bundles very numerous, parallel and almost undivided, ascending from the raphal side...4. *A. parens.*

b^2. Spadices simply branched. Female flowers clustered around the main axis, solitary, sessile or nearly so, at the base of the branchlets; the latter slender and bearing alternately distichous male flowers. (§ *Balanocarpus.*) (Of *A. camarinensis* the detached fruits only are known, and it is doubtfully placed here.)

c^1. A palm with the habit of *Areca Catechu* but smaller (stem about 4 m high, 7 to 12 cm in diameter); fruiting spadix dense, cylindraceous-oblong, about 14 cm long, 6 to 7 cm thick. Fruit ovoid, very similar to that of *A. Catechu*, 5 cm long, 3 cm broad. Seed globose with rounded (not flat) base and with the vascular bundles of the integument very close together, much anastomosing and forming very narrow loopholes all around the seed. 5. *A. Ipot.*

d^1. A smaller plant, the stem 5 cm in diameter, the spadix smaller, with fewer female flowers, and forming a shorter mass. *A. Ipot* var. *polillensis.*

c^2. Fruit ovoid, 4 to 5 cm long, 3 cm broad. Seed conical-ovoid; the vascular bundles of the integument forming a uniform network all around the seed with lozenge-shaped loopholes. Otherwise the fruit is similar to that of *A. Catechu*.........6. *A. camarinensis.*

a^2. Floriferous branches bearing several female flowers on their basal parts, gradually narrowing above and bearing male flowers only in pairs on alternating notches. Low palms with relatively small or medium-sized fruits. (§ *Arecella.*)

b^1. Spadix simply branched, with thickish floriferous branches appressed to the main axis, and bearing in their basal part numerous, approximate, alternate, female flowers. Male flowers hexandrous, the calyx with three small, distinct sepals; anthers acute. Fruiting perianth cupular, truncate, the petals exactly equaling the sepals. Fruit ellipsoid, 3 to 3.5 cm long, 20 to 22 mm thick, the pericarp entirely dissolving into very fine, soft fibers.................7. *A. Caliso.*

b^2. Spadix twice loosely branched; floriferous branches slender, bearing in their basal part three or four alternate, rather distant, female flowers, and in the upper and slenderer part alternate male flowers. Calyx of the male flowers subpedicelliform, shortly 3-dentate with a solid base; anthers bifid at the apex. Fruit small, pluricostulate, ellipsoid, the pericarp formed by only two layers of rigid complanate fibers... 8. *A. costulata.*

a^3. Spadix diffusely, two or three times branched, the floriferous branches bearing one or more female flowers in their lower part, and above male flowers in pairs in unilateral notches. Low slender palms having very small male flowers, with the calyx completely divided into three sepals. Fruit small. (§ *Arecopsis.*)

b^1. Male flowers 2.5 to 3 mm long; stamens 6; rudimentary ovary as long as the stamens, divided into three points. Female flowers ovate, obtuse, 8 mm long, 4.5 to 5 mm broad. Fruit small, oblong-ellipsoid or subfusiform, 17 to 19 mm long and broad; pericarp rather thin, the mesocarp formed by only two layers of slender, but rigid, flattened, parallel fibers..........................9. *A. Vidaliana.*

b^2. Male flowers smaller than in *A. Vidaliana* (2 mm or a little longer); stamens 6; rudimentary ovary as long as the stamens, trifid. Female flowers ovoid, conical, narrowing to an acute point, larger than in *A. Vidaliana*, 13 to 14 mm long, 7 mm broad at the base. Fruit also larger, ellipsoid-elongate or subfusiform, about 3 cm long, 9 mm broad..........................10. *A. Hutchinsoniana.*

1. ARECA CATECHU Linn. (forma COMMUNIS).

Commonly cultivated throughout the Archipelago and occasionally spontaneous. The specimens collected in Mindanao on the edge of the forest at Katajan, Mount Malindang, Misamis Province, *For. Bur. 4717 Mearns & Hutchinson* were probably from a semiwild plant.

ARECA CATECHU Linn. var. BATANENSIS Becc.

Areca Catechu (non Linn.) Becc. in Philip. Journ. Sci. 3 (1908) Bot. 340.

BATAN ISLANDS, Batan, Santo Domingo de Basco, *Bur. Sci. 3834 Fénix*, along a mountain stream.

According to the collector this is 7 to 8 m high with a trunk 25 cm in diameter. It is therefore a plant with a relatively shorter but thicker trunk than the common *Areca Catechu.* The spadix is also denser than in that palm and with shorter floriferous branchlets, the latter only 10 to 12 cm in length. I have not seen the fruits of this apparently very local variety.

ARECA CATECHU Linn. var. SILVATICA Becc.

Trunk 10 to 12 m high, 10 to 15 cm in diameter. Leaves 2 to 2.5 m long with about 30 pairs of leaflets. Spadix diffuse, with very elongate and slender floriferous branchlets. Male flowers 4 mm long, in shape exactly as in the type, with 6 stamens and the rudimentary ovary divided into 3 acuminate points. Female flowers relatively narrow, tapering above to a conical and rather acute point, 12 to 14 mm long, 7 mm thick. Fruit reddish-yellow, ovoid-ellipsoid, broadly conical in the upper part, 4 cm long (including the perianth), 28 mm thick. Seed (placed almost in the center of the fruit) globular-depressed or slightly broader than high (16 mm high, 22 mm broad), regularly rounded above and flattish in its basal part; embryo conical; rumination and network of the surface of the integument exactly as in the type; walls of the pericarp 3 mm thick at the sides (in the dry fruit). Fruiting perianth 2 cm broad at the mouth.

PALAWAN, near Lake Manguao, in a narrow valley along a small stream in the primeval forest, *Merrill 9447*, April, 1913.

This differs from the common form in having smaller fruits with the seed globular-depressed and in its more acuminate female flowers.

As to the possibility of this being a really wild form of *Areca Catechu,* Mr. Merrill writes to me from Manila under date of October 2, 1914, as follows:

As to *Areca Catechu* the specimen that I collected in Palawan is the only one that I have seen growing in primeval forests in all my travels in the Philippines. At the place where found the plants, few in number, were growing in a forested ravine along a small stream at a place where an old and apparently much traveled native trail crossed the stream.

I strongly suspect that the trees that I found in this place originated from seeds accidentally left there by natives. The species is of course very common and very widely distributed in the Philippines, but normally is found only in the settled areas and in cultivation. It is, however, distinctly self seeded and one frequently finds young plants in thickets, fence rows, etc., that have not been purposely planted, but which have originated from seeds fallen from neighboring trees.

ARECA CATECHU Linn. var. LONGICARPA Becc. in Philip. Journ. Sci. 6 (1911) Bot. 229.

POLILLO, *Bur. Sci. 10470 McGregor,* October–November, 1909. It is not known whether or not the specimens were collected from cultivated or wild plants.

This is a very remarkable variety on account of its elongate-ellipsoid fruit, almost equally tapering at both ends, and with a conical apex, varying from 5.5 to 7 cm in length (including the perianth) and from 2.5 to 3 cm in diameter, or more than twice as long as broad. The pericarp is 3 to 4 mm thick at the sides, and is solid in most of its lower half, the seed being inserted very high, or only a little less than half the entire length of the pericarp. The mesocarp is not so filled with fibers as in the other forms of *Areca Catechu,* and in its central and basal part the fibers extend through a very soft and spongy tissue. The seed is 24 mm long (in one specimen), has a nearly or quite flat (22 mm broad) base, and suddenly assumes a conical shape, yet it is blunt at the apex; the vascular branches of the integument start from the raphe at an angle of about 45° and form a close network as in the typical form. The male flowers are 6 mm long and 1.5 mm broad, or somewhat longer, narrower, and more acuminate than in forma *communis.* The fruits are said to be yellow.

It seems to represent rather a subspecies of *Areca Catechu* than a simple variety of that plant.

2. ARECA MACROCARPA Becc. in Philip. Journ. Sci. 4 (1909) Bot. 601.

MINDANAO, Zamboanga District, Port Banga, *For. Bur. 9103 Whitford & Hutchinson*, January, 1908.

This seems to be a close ally of *Areca Catechu*, but unfortunately its male flowers are not known for a precise comparison with the latter. Its fruit, however, is considerably larger than that of *A. Catechu*, from which it is further distinguishable by its being equally tapering at both ends, twice as long as broad; by the seed inserted very high, or somewhat above the lower third of the entire fruit; by the ovoid-conical seed with flat base; and by the vascular branches of the integument ascending in great numbers from the raphe and arching on the sides at an angle of 45°, forming there a rather close network. In the only seed I dissected, the embryo was globular-depressed, whereas it is conical in *A. Catechu* and all its varieties. The fruiting perianth is distinctly campanulate.

3. ARECA WHITFORDII Becc. in Philip. Journ. Sci. 2 (1907) Bot. 219.

MINDORO, in the semiswampy forests called "guipa" by the natives, near sea level, Bongabon River, *Whitford 1372*, Tagalog, *bungan gubat*.

I formerly supposed that *Areca Whitfordii* was related to the species having male flowers with three stamens; but now that I am in possession of additional material, although even now incomplete, it appears to me that its real affinities are with *A. Catechu* and especially with the variety *longicarpa*, because the floriferous branchlets of *A. Whitfordii* bear, as does *A. Catechu*, alternate and not unilaterally geminate male flowers as is the case in *A. triandra* and allied species; although the male flowers of typical *A. Whitfordii* are as yet unknown. It differs, however, from *A. Catechu* var. *longicarpa* especially in its ovoid-ellipsoid seed, narrowed at both ends, symmetrically placed in the central part of the fruit, of which it occupies almost the entire length, the pericarp extending below and above the seed only 7 mm.

ARECA WHITFORDII Becc. var. LUZONENSIS Becc. var. nov.

This differs from the type only in its larger fruits. The fruits seen by me, not thoroughly mature but apparently having attained their definitive dimensions, are ellipsoid-fusiform, 5.5 cm long, equally narrowed at both ends, and 2 cm in diameter in their central part. The seed, from the size and the shape of the endocarpal cavity, is apparently equally narrowed at both ends, 28 mm long and 16 to 17 mm through at its middle; the portion of solid pericarp remaining above and below the seeds is 1 cm in length. The leaves have 20 to 25 pairs of leaflets.

LUZON, Nueva Vizcaya Province, vicinity of Dupax, *Bur. Sci. 11384 McGregor.* The collector notes that it is a really wild, and not a cultivated, plant and that its fruits are used as a substitute for those of *A. Catechu.* Not differing from the above is *For. Bur. 17770 Curran* from Cagayan Province, Luzon, where it is common in overflowed river swamps.

4. **ARECA PARENS** Becc. sp. nov.

Major, *A. Catechu* similis. Frondium segmenta majuscula conspicue bicostulata, falcato-acuminata. Spadix duplicato-ramosus, ramis floriferis in parte basilari crassiusculis, superne zigzag sinuosis. Flores ♂ pro rata majusculi, ovato-subtrigoni vel trapezoidei, 7 mm longi, 4 mm lati; calyce minuto, sepalis triangularibus, acuminatis; staminum filamentis brevibus; antheris linearibus, obtusis; ovarii rudimento parvo subulato. Flores ♀ ovati, 12 ad 15 mm longi, sepalis quam petala conspicue brevioribus. Fructus ovato-ellipticus, inter majores, 6 et ultra cm longus, 3.5 cm crassus, utrinque aequaliter attenuatus; pericarpio ad latera 5 ad 6 mm spisso, in dimidia inferiori parte lignoso, caetero fibris tenuibus percurso. Semen prope tertiam inferiorem partem insertum, ovoideo-conicum, 28 mm longum, 22 mm crassum, integmenti ramificationibus vascularibus numerosis, parallelis, indivisis, a raphe adscendentibus, superne et in facie antirapheali tantum anastomosantibus. Albumen lamellis rectis numerosis descentibus ruminatum.

Apparently of the general habit and dimensions of *Areca Catechu* and with the same kind of leaves. One of the leaflets is about 1 m long and 8 cm broad, very strongly bicostulate and with an acuminate falcate point. The spadix has the same kind of branching as that of *Areca Catechu;* its ultimate divisions or floriferous branches are 15 to 20 cm long, 3 mm thick at their bases, angular, strongly zigzag-sinuous with only one female flower in their basal part but covered elsewhere with distinctly distichously alternate male flowers; the latter are in pairs at every flexure and furnished with two very small triangular bracteoles; they are asymmetrical, irregularly ovoid-subtrigonous or trapezoidal by mutual pressure, and relatively broad (7 mm long, 4 mm broad) ; the calyx has three, very small, triangular-acuminate, dorsally keeled sepals; petals pergamentaceous, rather rigid, ovate, bluntish; stamens 6, the filaments terete, short; anthers linear, more or less sinuous, bluntish, with parallel cells, and dark connective; rudimentary ovary very small, subulate, scarcely as long as the filaments. Female flowers sessile on a horizontal cushion, the latter furnished with a small rim representing the floral bract; they are ovate, obtuse, 12 to 15 mm long, 10 mm broad; sepals broadly triangular, acute or acuminate, considerably smaller than the petals; the latter, one-third or more longer than the sepals, very broadly obtuse or else cucullate at the apex. Fruit regularly ovoid-ellipsoid, equally narrowed at both ends, 63 mm long and 35 mm through (in two specimens) or a little less than twice as long as broad. The pericarp is 5 to 6 mm thick at the sides, and only in its outermost half at maturity does it disintegrate into capillary fibers, its inner half remaining woody; the apex in its internal part is also woody, but the base is entirely fibrous. The seed is inserted a little below the lower third of the entire fruit, ovoid with a flattish base and a very obtuse apex, 28 mm long, 22 mm broad; the vascular branches of the integument are very numerous and arise parallel and undivided at an acute angle from the base, anastomosing only above and on the ventral or antiraphal side; the rumination of the albumen is produced by numerous straight and descending lamellæ. Embryo broadly ovoid.

LUZON, Camarines Province, *For. Bur. 21712 Peñas, Soriano, & Abellanosa*, April 23, 1914, with the Bicol name *tacohtoh*.

This is a wild-growing species approaching *Areca Catechu*, although doubtless specifically distinct from it. The spadix, in flower, has the appearance of that of *A. Catechu*, but its floriferous branches are more robust and strongly zigzag-sinuous in the male flower-bearing portion. The male flowers are larger and broader than those of *Areca Catechu* and differ also in having very blunt anthers and a short rudimentary ovary. Furthermore, the female flowers of *A. parens* differ also from those of *A. Catechu* especially in the sepals being considerably shorter than the petals, the latter being usually blunt and more or less cucullate at apex. The fruit of *Areca parens* resembles that of *A. macrocarpa*, but differs from the fruit of all the species approaching *A. Catechu* in having the outer half of the pericarp disintegrable into soft fibers only, the inner half being woody. The seed is also characterized by the very numerous vascular branches of the integument lying close together, parallel and undivided laterally and on the raphal side, and by the lamellæ which cause the rumination of the albumen being straight and inclined toward the base of the seed.

5. **ARECA IPOT** Becc. in Leafl. Philip. Bot. 2 (1909) 639.

Areca Catechu Linn. var. *humilis* Blanco, Fl. Filip. (1837) 716, ed. 2 (1845) 495, ed. 3, 3 (1879) 120.

LUZON, Tayabas Province, Sampaloc, *For. Bur. 10178 Curran* (cultivated specimen); Lucban, *Elmer 9292*, local name *bunga ipot*.

This is chiefly distinguishable by its simply branched spadix having all the female flowers crowded around the main axis and by the male flowers being geminate or solitary in alternate notches of the slender branchlets, each of which starts from the base of a female flower. The ovoid fruit closely resembles that of *Areca Catechu* and the seed also is similar, but in *A. Ipot* the vascular ramifications of the integument of the seed are more numerous, more anastomosing, and form a closer network than in *A. Catechu*, and the rumination of the albumen is formed by more numerous and straighter lamellae, all converging toward the center of the seed. The pericarp entirely disintegrates into soft capillary fibers, except in the innermost part for the extent of about a millimeter.

ARECA IPOT Becc. var. POLILLENSIS Becc. in Philip. Journ. Sci. 6 (1911) Bot. 229.

POLILLO, *Bur. Sci. 10463, 10469 McGregor, Bur. Sci. 6938 Robinson,* along streams at about 25 meters' elevation (apparently a wild plant).

This differs from the type in being a smaller plant, with a stem about 4 m high and 4 to 5 cm in diameter, and in having a shorter spadix.

6. ARECA CAMARINENSIS Becc. sp. nov.

Gracilis, caudice circiter 3 cm diametro, internodis longiusculis (7 cm longis in specimene suppetenti). Frondium (circiter 2 m longum) segmenta numerosa, utrinque 8 ad 10, aequidistantia, alterna vel subopposita, 4 ad 6 cm inter se dissita, angusta, elongata, falcato-sigmoidea, 2- vel 3-costulata, costulis conspicuis, complanatis, 2 mm elevatis; segmentis inferioribus et intermediis acuminatissimis, majoribus 60 ad 75 cm longis, 2.5 ad 5 cm latis, nonnullis superioribus apice attenuatis et falcatis, attamen inciso-dentatis, duobus terminalibus 6- vel 7-costulatis, brevioribus, circiter 30 cm longis, 4 ad 5 cm latis, apice truncatis et duplicato-inciso-dentatis, dentibus brevibus. Petiolus longiusculus, subteres. Rachis compressa, in parte basilari subtus rotundata, apicem versus compressa et subtus plana, superne angulo elevato acuto percursa, marginibus acutis. Spadix * * *. Fructus rubri, ovati, 4 ad 5 cm longi, 3 cm crassi, utrinque rotundati, areola stigmatiferia plana, minime elevata, coronati; mesocarpio crasso, fibris tenuibus numerosissimis percurso; endocarpio tenuiter lignoso, intus albescenti et laevi; semine conoideo, 2 cm longo, 15 mm diametro, apice obtuso, basi truncato, distincte reticulato, lamellis approximatis rectis, descendentibus ruminato.

LUZON, Camarines Province, Goa, on the lower slopes of Mount Isarog, *For. Bur. 14268 Aguilar*, April, 1909, Bicol *mono*.

I have seen one leaf and one fruit only. It seems, however, to be a very peculiar and interesting palm, apparently belonging to the section *Balanocarpus*, although its true affinities remain somewhat uncertain; neither the entire spadix nor the male flowers are known. The fruit somewhat resembles that of *Areca Catechu* and of *A. Ipot*, but it differs from both by the vascular bundles of the integument which form a distinct and rather regular network with 1.25 mm wide lozenge-shaped loopholes. From *A. Catechu* the fruit also differs in the numerous and approximate lamellae of the rumination which converge toward the center in a straight and descending course.

7. ARECA CALISO Becc. in Leafl. Philip. Bot. MS.

MINDANAO, Davao District, Mount Apo, Todaya, at about 1,000 meters' elevation, *Elmer 11898*, September, 1909, locally known as *caliso:* Agusan Subprovince, Mount Urdaneta, along the Dalahcan River, *Elmer 13814*. BILIRAN, *Bur. Sci. 18875 McGregor*. LEYTE, Dagami, *Bur. Sci. 15388 Ramos*, August, 1912; in this specimen the fruit is a little larger than in the Mindanao plant.

8. ARECA COSTULATA Becc. sp. nov.

Mediocris, caudice circiter 5 m longo. Folia inaequaliter pinnatisecta, segmentis rigide papyraceis, 2-3-costulatis, falcatis, vel in apice duplicato-bifidis, majoribus 60 cm longis, 7 cm latis. Spadix patule laxeque ramosus; ramulis floriferis in parte basilari, flores 2 ad 4 remote alterne ferentibus, superne zigzag-sinuosis et floribus masculis geminis alterne onustis. Flores masculi majusculi, 6 ad 8 mm longi; calyce campanulato, basi plaeno, breviter 3-dentato; staminibus 6; antheris apice profunde bipartitis; ovarii rudimento inconspicuo papillaeformi. Fructus ovoideo-elliptici, 3 cm longi, 13 mm crassi, conspicue longitudinaliter pluricostulati; pericarpio coriaceo, 2 mm spisso, fibris rigidis biseriatis percurso. Perianthium fructiferum campanulatum, non marcescens.

Apparently of medium or rather small size. Stem (slender?) 5 m high. The leaves have very unequal and inequidistant, firmly papyraceous leaflets, the latter with very robust main nerves (costae) and sharp secondary nerves, which render both surfaces distinctly striate; all nerves are sprinkled, especially on the lower surface, with very minute glanduliform papillae. The lower leaflets in the specimen before me are 3-costulate, 60 cm long, 7 cm broad, base broad, apex falcate; upper leaflets smaller, 2- to 3-costulate, double-toothed at the apex, the primary teeth 4 to 6 cm long, the secondary teeth short, acute; uppermost leaflets narrow, straight, their secondary teeth short, acute. Spadix loosely twice branched; primary branches 20 to 30 cm long, bearing few, gradually diminishing, floriferous branchlets; the latter have a naked basal part 3 to 4 cm in length, then bear three or four alternate female flowers and above them the male flowers, which are alternately inserted in pairs at every indenture on the rather elongate, filiform, zigzag-sinuous upper part of the branchlets. Female flowers ovoid, coriaceous, 8 to 10 mm long; corolla very slightly longer than the calyx, the petals surpassing the sepals solely by their small, apical, valvate, 1.5 mm long, triangular, bluntish apices; floral bracts small. Male flowers lanceolate, acute or acuminate, 6 to 8 mm long; calyx campanulate, shortly and broadly 3-toothed, solid in its lower part and flat at the base; corolla about four times as long as the calyx; petals pergamentaceous, lanceolate-acuminate; stamens 6, very slightly shorter than the petals; filaments terete, unequal, some of them at times as long as their respective anthers, the latter linear, slightly sinuous, deeply bipartite at apex and with the cells deeply separated at the base; rudimentary ovary inconspicuous, papillaeform. Fruits ovoid-ellipsoid, slightly ventricose in the middle, equally tapering to both ends, 3 cm long, 13 mm broad, boldly longitudinally striate or pluricostulate (when dry), terminated by a circular areola 3 mm in diameter bearing the remains of the stigmas. Pericarp coriaceous, not quite 2 mm thick, formed by two layers of relatively very robust and hard fibers (the cause of the ribs on the dry fruit). Seeds ovoid-oblong, rounded above, deeply ruminated. Fruiting perianth campanulate, not accrescent, the apices of the sepals and petals unchanged (not marcescent).

LEYTE, Dagami, *Bur. Sci. 15236 Ramos*, August, 1912, in forests.

So far as I can judge from the very fragmentary specimens at my disposal, this seems to be a plant of modest dimensions. It is especially characterized by its relatively firm leaflets, which are very minutely papillose-punctulate on the nerves, especially on the lower surface; by its diffusely branched spadix; by the relatively large male flowers, having a subpedicelliform, campanulate, shortly 3-toothed calyx, solid in its lower part; by the stamens with relatively long filaments and anthers, which are linear and deeply incised at their apices; by the inconspicuous rudimentary ovary; by the floriferous branches bearing few distant flowers in their basal part and alternate pairs of male flowers in their zigzag-sinuous upper parts; by the campanulate fruiting perianth unchanged; and by the small, ellipsoid, pluricostulate fruits, having in the pericarp a double series only of very rigid robust fibers.

9. ARECA VIDALIANA Becc. in Philip. Journ. Sci. 2 (1907) Bot. 222.

Areca mammillata Becc. op. cit. 220.

PALAWAN, *Vidal 3955* in Herb. Becc. *Areca mammillata* Becc. was also collected in Palawan, *For. Bur. 3816 Curran*, 1906, in swampy places along the Sariban River; Taytay, *Merrill, Phil. Pl. 1464*, May, 1913.

I previously considered the plant collected by *Curran* in Palawan and named by me *Areca mammillata* to be a species distinct from *A. Vidaliana*, because the specimens at that time at my disposal presented some remarkable differences in the leaves, the segments being 3- or 4-costulate in *A. Vidaliana* and 1-costulate in *A. mammillata;* but after the inspection of more complete material I have found that in *A. Vidaliana* the character derived from the number of main costae in the leaflets is a very variable one, and that the flowers and fruit offer no differences in the two plants. *Areca Vidaliana* is very similar in habit to *A. triandra,* but its male flowers are always 6-androus, and not 3-androus as is the case in the latter.

10. ARECA HUTCHINSONIANA Becc. nom. nov.

Areca mammillata Becc. var. *mindanaoensis* Becc. in Philip. Journ. Sci. 4 (1909) Bot. 602.

A slender palm. Stem about 3 cm in diameter. Leaves about 1 m in length. Leaflets numerous, subequidistant, 4 to 6 cm apart on each side of the rachis, usually bicostulate, but at times 1- to 4-costulate, falcate-sigmoid, slightly attenuate at the base, and gradually narrowed upward to a long, linear, caudate tip, when unicostate, 2 cm, when bicostulate, 4 to 4.5 cm broad; the 3- or 4-costulate leaflets are, of course, proportionally larger; the two of the apex are united by their bases, truncate and almost praemorse, and with as many incisions as there are costae; the resulting primary teeth are shallowly and obtusely 2-toothed. Spadix broadly panicled, twice branched, its pedicellar part very short and flattened, 10 to 15 mm long; the main branches, after the fall of the male flowers, are spreading and devaricate; the lowest branches are the largest, 15 to 20 cm long or more, and are unilaterally divided into several small secondary or floriferous branchlets, each of which carries in its basal part one or two sessile female flowers, and is very slenderly filiform in its upper part; this part is unilaterally and very closely notched, and carries two male flowers at each notch. The male flowers are very small, 2 mm or slightly longer, lanceolate, acute or bluntish; the calyx is very small, trigonous, and almost entirely divided into three acuminate sepals; the corolla is about four times as long as the calyx; stamens 6, slightly shorter than the petals; anthers linear-lanceolate, acute-apiculate; rudimentary ovary represented by three filiform bodies as long as the stamens. Female flowers ovoid, obsoletely angular, rounded or flattish at the base, gradually attenuate above, acute, 13 to 14 mm long, 7 mm broad at the base; sepals broadly ovate, minutely ciliate, obsoletely keeled and slightly thickened below the bluntish or only slightly acute apices; petals imbricate, broadened at both sides in their basal part, and suddenly contracted into a thick, triangular, acute, valvate apex, the latter, 3 to 4 mm long, protruding entirely above the calyx; ovary oblong, attenuate below; stigmas 3-gonous, spreading. Fruit very narrowly ellipsoid-oblong or subfusiform, diminishing considerably toward both ends, about 3 cm long, 9 mm in diameter. Pericarp thin, formed by only 2 or 3 layers of slender, parallel, complanate fibers, which render the surface of the dry fruit very finely striate longitudinally. Seed 13 mm long, 6.5 mm thick. Fruiting perianth cyathiform, 12 mm high.

MINDANAO, Zamboanga District, Port Banga, in forests at about 20 meters above sea level, *For. Bur. 9141 Whitford & Hutchinson* (specimen with fruits). BASILAN, near the southwest end of Mindanao, Mount Balanting, at about 100 meters above sea level, *For. Bur. 4019 Hutchinson*, February, 1906, a palm 3 meters high, flowers white, fruit white; very common, local name *pisa*.

Apparently also referable to *A. Hutchinsoniana* is *Vidal 4065* (in Herb. Beccari), from Siassi, one of the smaller islands in the Sulu Archipelago, southwest of Basilan.

The description above, as regards the fruit, is derived from *Whitford & Hutchinson 9141*, otherwise from *Hutchinson 4019*. It is closely related to *Areca Vidaliana*, from which it differs in its smaller male and larger female flowers and, especially, in its larger fruits.

PINANGA Blume

Conspectus of the species.

a^1. Very slender plants having simple flabellate leaves or only one or two segments on each side of the rachis.

- b^1. Leaves mottled (at least those of young plants), deeply bilobed, otherwise entire.......... 1. *P. maculata.*
- b^2. Leaves with a terminal, deeply bilobed flabellum and 1 or 2 acinaciform segments on each side of the rachis. Spadix simple. Fruit distichous.......... 2. *P. geonomaeformis.*

a^2. Leaves having few (4 to 9), very unequal, inequidistant segments on each side of the rachis. Spadix branched. Small plants with slender stems 1 to 3 cm in diameter.

- b^1. Fruits biseriate.

c^1. Leaves short with very few (4 or 5), unequal, sigmoid-acinaciform, 3- to 7-costulate segments on each side of the rachis, ashy-puberulous underneath, at least in newly expanded leaves. Spadix with 3 or 4 branches only. Fruits exactly distichous, narrowly ovoid, with a conical point, 15 to 16 by 6 to 7 mm. Seed caudiculate at the base; vascular branches of the integument rather numerous, nearly simple... 3. *P. modesta.*

c^2. Leaves having on each side of the rachis 8 or 9, narrow, 2- to 4-costulate, distant, ensiform-subfalcate, very acuminate segments, which are glabrous underneath. Spadix with 5 or 6 branches. Fruits exactly distichous, narrow, conical-subfusiform, broadest below their middle, 16 to 18 by 6 mm; seed elongate, conical in its upper part; vascular branches of the integument very few (3 or 4), almost simple.. 4. *P. isabelensis.*

b^2. Fruits 3-seriate. Leaves having on each side of the rachis 7 or 8 very inequidistant, unequal, 1- to 4-costulate, narrowly falcate-sigmoid, long-acuminate segments, which are glabrous underneath. Spadix with few (5) triquetrous branches. Fruit small, 11 to 12 by 5 to 5.5 mm, narrowly ovoid-ellipsoid, acute, equally narrowed to both ends. Seed ovoid, with a conical point; vascular branches of the integument 8 or 9, slightly anastomosing.. 5. *P. heterophylla.*

a^2. Leaves with more numerous segments.

b^1. Segments ashy-puberulous underneath; plants of moderate size.

c^1. Fruits 3-seriate. Segments relatively not very numerous, very unequal, inequidistant, 3- to 7-costulate, deeply incised into 3 to 7 bifid laciniae, the latter falcate, acuminate. Spadix with few (5 or 6) branches. Fruits relatively large, ovoid-ellipsoid, 2.5 to 3.3 cm long. Fruiting perianth low, cupular, not contracted at the mouth. Stem 3 to 5 cm in diameter......................6. *P. Barnesii.*

c^2. Fruits 2-seriate.

d^1. Segments rather numerous, very unequal, 1-pluricostulate, sigmoidal; when with more than one midcosta then deeply cleft at the apex into falcate-acuminate points. Spadix with the upper branches spirally scattered. Fruit obovoid, 18 to 20 by 13 mm. Seed spherical, with a horizontal embryo fovea. Fruiting perianth very shallowly cupular or almost explanate.
7. *P. Copelandii.*

d^2. Segments numerous, 2- or 3-costulate, almost straight, not deeply incised at the apex, the divisions 2-toothed, the teeth acute. Fruit ovoid-ellipsoid, obtuse, small, 15 by 9 mm. Seed with a very oblique embryo fovea. Fruiting perianth shallowly cupular, with nearly vertical walls, not contracted at the mouth.
8. *P. Curranii.*

b^2. Segments glabrous underneath.

c^1. Spadix with rather few branches.

d^1. Fruits distichous. Small or medium-sized plants.

e^1. Stem 2 to 5 cm in diameter. Leaf-sheaths densely covered with a grayish tomentum. Segments rather numerous, slightly sigmoid, acuminate, usually 3-costulate and relatively broad, or else narrow and 1-costulate. Spadix with few, scattered or subdistichous branches. Fruit narrowly ovoid-ellipsoid, acuminate, 11 to 14 by 5 to 8 mm. Fruiting perianth cupular, contracted at the mouth.................................9. *P. philippinensis.*

e^2. Very similar to the preceding. Stem 2 to 4 m high, 2 to 5 cm in diameter. Leaf-sheaths covered with appressed rusty scales (not tomentose). Segments rather numerous and subequidistant; usually 1-costulate, slightly falcate acuminate or nearly straight. Spadix with a few scattered spreading branches. Fruit ovoid-ellipsoid, 12 to 14 by 7 to 8 mm. Fruiting perianth cupular, contracted at the mouth.
10. *P. Elmerii.*

e^3. Stem 2 to 3 cm in diameter. Leaf-sheaths sprinkled with dark-purple scales. Segments rather numerous, equidistant, 8 to 9 cm apart on each side of the rachis, 3-costulate, ensiform, about 60 cm long, 4 to 4.5 cm wide, paler or subglaucous, and not sprinkled with microlepidia underneath, the apices acuminate-caudate and very slightly falcate. Spadix with 14 or 15 spirally alternate branches. Immature fruits fusiform, 14 to 15 mm long (ovate-ellipsoid at complete maturity?). Fruiting perianth contracted at the mouth..11. *P. urdanetana.*

e^4. Of medium size (?). Segments lanceolate-ensiform, acuminate, unequal, straight, 60 cm long, 3.5 cm wide, their lower surface in the dry specimens reddish-brown and densely sprinkled with extremely minute, light-colored dots (microlepidia). Spadix with strongly flattened branches. Fruit thickly fusiform, equally narrowing to both ends, 15 to 18 mm long, and about 1 cm thick. Fruiting perianth very low, contracted at the mouth..12. *P. samarana.*

e^5. Of medium size. Segments very numerous, equidistant, approximate, long, narrow, slightly falcate, very acuminate, all unicostulate. Spadix with 5 or 6 much flattened branches. Fruit relatively large, ovoid-ellipsoid, conical-mammillate at the apex, the base narrow and subpedicelliform when dry, 23 to 32 mm long, 13 to 14 mm thick. Seed ovoid, suddenly prolonged at the base into a slender caudiculum; embryo fovea broad and slightly oblique; vascular branches of the integument simple on the raphal or dorsal side and anastomosing anticously. Fruiting perianth truncate, not contracted at the mouth..13. *P. urosperma.*

d^2. Fruits 3-seriate, at least in the lower part of the branches.

e^1. Segments straight, not falcate at their apices. Plants of medium size. Fruits small.

f^1. Segments numerous, very approximate, inserted at a very acute angle, unicostulate, lanceolate-ensiform, quite straight, concolorous, the apex bifid, its divisions acuminate. Spadix with several spirally inserted branches. Fruits 3-seriate from the base to the end of the branches, ovoid-ellipsoid, the apices mammillate, 13 to 15 by 6 to 7 mm. Seed globular-ovoid, rounded above, not caudiculate at the base; embryo fovea oblique; vascular branches of the integument few (5 or 6), not or only very slightly divided. Fruiting perianth very low, 1.5 mm high, 4 mm broad, contracted at the mouth...14. *P. rigida.*

f^7. Segments numerous, equidistant, 6 to 7 cm apart on each side of the rachis, ensiform, 1- or 2-costulate, straight, rigid, concolorous, very acuminate, bifid at the apex. Spadix with several, triquetrous, spirally inserted branches. Fruits 3-seriate in the lower part of the branches, bifarious near the end, small, 12 to 15 by 7 to 8 mm, ovoid-ellipsoid; seed ovoid, not caudiculate at the base; embryo fovea very oblique; vascular branches of the integument 5, all slightly anastomosing. Fruiting perianth low, 2 mm high, 4 mm broad, slightly contracted at the mouth.
15. *P. Woodiana.*

f^8. Segments numerous, equidistant, thickish and rigid, 1-costulate, concolorous, narrow, very long-acuminate. Spadix with several, 3-gonous, spirally inserted branches. Fruit broadly ovoid, 13 by 8 to 9 mm. Seed broadly ovoid; embryo fovea almost horizontal; vascular branches of the integument 8 or 9, of which two are undivided and pass over the apex, and 2 or 3 on each side are arched and slightly anastomosing. Fruiting perianth 2 mm high, 4 mm broad, contracted at the mouth.........16. *P. sclerophylla.*

e^2. Segments falcate at their apices, numerous, equidistant, rigid, concolorous, narrow, very long-acuminate, 1- or 2-costulate. Spadix with several spirally inserted branches, trigonous in their lower part and flattened above. Fruit 3-seriate in the lower part of the branches, and bifarious above, rather narrowly ovoid-ellipsoid, narrowing a good deal to both ends, 12 to 13 by 6 mm. Seed caudiculate at the base; embryo fovea slightly oblique. Fruiting perianth contracted at the mouth.
17. *P. negrosensis.*

c^2. Spadix large with numerous branches inserted spirally at different levels. Large arboreous plants.

d^1. Fruits biseriate.

e^1. Segments very numerous, uniform, equidistant, ensiform, quite straight, rigid, very acuminate, very strongly 2-costulate, more or less deeply bifid at their apices, subconcolorous, very finely granulate-scabrid on the secondary and tertiary nerves on the lower surface. Fruits rather large, ovoid-ellipsoid, narrowing to both ends, 24 to 25 by 13 to 14 mm; pericarp containing several layers of capillary fibers. Seed obsoletely caudiculate at the base, the embryo fovea very broad, oblique. Fruiting perianth 3.5 mm high, 8 mm broad, not or only very slightly contracted at the mouth.................18. *P. insignis.*

f^1. Fruit shorter than in the species and more ventricose, 20 to 22 by 13 to 14 mm............................*P. insignis* var. *gasterocarpa.*

f^2. Fruit narrower than in the species or thickly fusiform, 20 to 22 by 8 to 9 mm........................*P. insignis* var. *leptocarpa.*

f^3. Fruit very broadly ovoid, 20 to 22 by 13 to 15 mm. Pericarp with rigid fibers, rendering the surface of the fruit striate. Leaflets dusty-subglaucous underneath.
P. insignis subsp. *Loheriana.*

e^2. Segments very numerous, unicostulate, very approximate by twos on each side of the rachis, ensiform, quite straight, very acuminate. Fruits ovoid, broad at the base and suddenly apiculate-mammillate, 20 by 12 mm. Seed ovoid, blunt; vascular branches of the integument simple on the raphal side, elsewhere rather closely anastomosing. Fruiting perianth broadening at the mouth........19. *P. batanensis.*

e^3. Segments elongate-lanceolate, 3-costulate, 1 meter long or more, spadix with slender, strongly flattened, pendulous branches. Fruit of medium size, 20 by 12 mm, slightly obovoid or ovoid-olivaeform; pericarp somewhat fleshy, traversed by a few slender fibers. Seed relatively small, 13 by 8 to 9 mm. Fruiting perianth deeply cupular or subcampanulate, not contracted at the mouth, 4 mm high, 6 mm broad.
20. *P. basilanensis.*

e^4. Segments equidistant, large, straight, 2- to 3-costulate, of a rather herbaceous texture, the basilar and the intermediate segments acuminate, the upper with as many not very deep incisions as there are costae, and with the resulting divisions shortly 2-toothed. Fruits small, 15 by 9 mm, obovoid, rounded above. Seed oblong, the embryo fovea very slightly oblique; vascular branches of the integument almost simple.
21. *P. speciosa.*

d^2. Fruit 3-seriate. Segments ensiform, strongly bicostulate, the apex divided into two straight points. Fruits rather large, ovoid-ellipsoid, with a conical apex, 25 to 28 by 15 to 17 mm. Seed broadly ovoid, rounded above, the embryo fovea somewhat oblique; vascular branches of the integument much branched and forming a network all around the seed. Fruiting perianth somewhat contracted at the mouth.
22. *P. sibuyanensis.*

1. **PINANGA MACULATA** Porte in Illustr. Hort. **10** (1863) 92, 188, *t. 361,* Belgique Hort. (1863) 236; H. Wendl. in Kerch. Les Palms 253; Drude in Bot. Zeit. (1877) 637, *t. 5, f. 12–13* (ovulum); Becc. Malesia **3** (1886) 145, et in Perkins Fragm. Fl. Philip. (1904) 48, et in Webbia (1905) 325; Curtis's Bot. Mag. *t. 8011.*

PALAWAN, along Ewiig River, *Merrill 712* (sterile specimen).

Of this fine small *Pinanga* I have seen only the sterile specimen cited above. The leaves appear distinctly mottled even in the dry condition and have a petiole about 20 cm long; the blade, 30 cm long, has 9 or 10 main costae on each side of the rachis, tapers gradually to the base, and is divided down to its lower one-third into two lobes.

Fertile specimens received from the botanic garden at Buitenzorg, Java, under the name of *Pinanga maculata,* do not seem to me to differ from *P. disticha;* they have the uniformly green blade parted only to the middle, and the petiole is shorter and thicker than in the Palawan plant. Probably the leaves of young plants only are variegated and possibly also in gardens the very similar *Pinanga disticha* may also go under the name of *P. maculata*. In fact Ridley[1] actually reduces *P. maculata* to *P. disticha*. I think, however, that true *Pinanga maculata* of the Philippines is distinguishable from the Malayan *P. disticha* by the leaves having a longer petiole and the blade being more deeply bilobed. The flowers and the fruit probably offer other diagnostic characters, but I have not seen fertile specimens of the wild Philippine plant.

2. **PINANGA GEONOMAEFORMIS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 602.

LUZON, Tayabas Province, *For. Bur. 10155 Curran:* Laguna Province, San Antonio, *Bur. Sci. 20474 Ramos:* Rizal Province, Pantao, *Loher 7055* in Herb. Kew. and Becc.

3. **PINANGA MODESTA** Becc. in Philip. Journ. Sci. 2 (1907) Bot. 223.

MINDANAO, Davao District, *Copeland:* Lanao District, Camp Keithley, *Mary Strong Clemens 487:* Bukidnon Subprovince, *Bur. Sci. 15751 Fénix.* BASILAN, *For. Bur. 3987 Hutchinson.*

4. **PINANGA ISABELENSIS** Becc. sp. nov.

Gracilis, caudice 2 ad 2.5 cm diametro. Frondium vaginis squamuloso-pubescentibus, segmentis aequidistantibus, utrinque 8 vel 9 inter se remotis, elongato-ensiformibus et subfalcatis, acuminatissimis, 2- ad 4-costulatis, subtus glabris vel vix secus nervos papillosis; spadicis ramis paucis (5 vel 6); fructibus exacte distichis, anguste ovoideo-conicis, vel in dimidia inferiori parte latiusculis et superne conico-attenuatis, 16 ad 18 mm longis, 6 mm latis; semine elongato, apice conico, fovea embrionali obliqua; integumenti ramis vascularibus 3 vel 4, fere indivisis; perianthio fructifero cupulari truncato.

LUZON, Isabela Province, Biocbian Bay, *Bur. Sci. 10660 McGregor,* in beach forest, about 50 meters from the sea.

A slender plant, the stem 2 cm in diameter, with short internodes (3 to 4 cm long). The wood is very hard, and it is apparently a slow-growing plant, as the surface of the stem is covered with crustaceous lichens in its lower and older parts. Leaf-sheaths finely and softly tomentose. The only leaf seen by me is 90 cm long in the piniferous part; the petiole is 20 cm long, slightly scurfy, or sprinkled with brown scales; the segments are subopposite, very few (6 or 7) and 8 to 9 cm apart on each side of the rachis; two or three of the lowest segments are very narrow; the intermediate ones are elongate-ensiform,

[1](Mat. Fl. Mal. Penins. Monocot. 2 (1907) 139).

slightly sigmoidal and falcate above, very long and slenderly acuminate, 3- or 4-costulate, about 50 cm long and 3.5 to 4.5 cm broad, reddish-brown underneath in dry specimens and under a strong lens appear finely hairy-papillose along the nerves; the two terminal segments are narrowly linear, 2 to 2.5 cm broad and 30 cm long, truncate and shortly incised-toothed at the apex. Spadix small with a very few (5 or 6) flattened, about 13 cm long, floriferous branches. Fruits exactly biseriate, elongate-ovoid-conical, 16 to 18 mm long, 6 mm thick, having their broadest part below the middle and the base suddenly contracted into a caudiculum, the latter extending into the perianth. Seed ovoid-conical, 11 mm long, 5 mm thick, with the areola of the embryo oblique; the vascular bundles of the integument are 3 or 4 only, very slightly anastomosing. Fruiting perianth cupular, truncate, not contracted at the mouth, 2 mm high, 3.5 mm wide.

5. **PINANGA HETEROPHYLLA** Becc. sp. nov.

Gracilis, caudice 1.5 cm diametro. Frondium segmentis utrinque 7 vel 8, inaequidistantibus, valde inaequalibus, 1- ad 4-costulatis, falcato-sigmoideis, longe acuminatis, chartaceis, subtus glabris; spadicis ramis paucis (5) triquetris; fructibus 3-seriatis, parvis, anguste ovato-ellipsoideis, utrinque aequaliter attenuatis, acutis, 11 ad 12 mm longis, 5 ad 5.5 mm latis; semine ovato, superne conico; integumenti ramis vascularibus 8 ad 10, modice anastomosantibus.

NEGROS, Mount Maripari, *For. Bur. 17346 Curran*, September, 1909, in forests.

Slender, stem 15 mm in diameter. Leaf-sheaths elongated, 22 cm in one specimen, the mouth very oblique (not split) for the extent of 5 to 6 cm, strongly striate, and more or less covered with rusty-brown scales; the ligule at the base of the petiole is membranaceous, triangular, acuminate, 12 to 15 mm long; petiole 20 to 25 cm long, 3-gonous, also covered with rusty scales; the piniferous part is about 85 cm long, and has 7 or 8 segments on each side; the segments are very unequal, inequidistant, often separated by vacant spaces as much as 8 cm long; the lower surface is glabrous and paler than the upper, narrowly falcate-sigmoid, very acuminate; the intermediate segments are 35 to 40 cm long and of very variable breadth, some of them being 1-costulate, and only 7 cm broad, while others are 2- to 4-costulate and 2 to 4 cm broad; the two terminal segments are united by their bases and are shorter and broader than the others, pluricostulate, incised-toothed, the teeth divided again into two short, narrow, acuminate, secondary teeth. The spadix has very few branches (5 in the specimen at hand), spreading, triquetrous, 7 to 9 cm long. Fruits 3-seriate, small, narrowly ovoid-ellipsoid, equally attenuate at both ends, their apex acute, 11 to 12 mm long, 5 to 5.5 mm thick. Seed ovoid, conical in its upper part, 7.5 mm long, 5 mm thick, noncaudiculate at the base; areola of the embryo small, slightly oblique; vascular branches of the integument 8 to 10, ascending from the base, slightly anastomosing. Fruiting perianth cupular, truncate, slightly contracted at the mouth.

This species resembles *Pinanga Elmerii*, even as to its dimensions, but the fruits are 3-seriate.

6. **PINANGA BARNESII** Becc. in Webbia 1 (1905) 320, Philip. Journ. Sci. 3 (1908) Bot. 340, 6 (1911) Bot. 229.

Pinanga Barnesii var. *macrocarpa* Becc. in Philip. Journ. Sci. 2 (1907) Bot. 227.

LUZON, Bataan Province, Lamao River, *For. Bur. 122 Barnes* (type specimen), *For. Bur. 2762 Meyer:* Tayabas Province, Lucban, *Elmer 7924;* Kabibihan, *Bur. Sci. 13248 Ramos:* Cagayan Province, *For. Bur. 17756 Ramos:* Rizal Province, *Bur. Sci. 13419 Ramos:* No precise locality *Loher 7069, 7068* in Herb. Kew.: Union Province, Mount Tonglon, *Loher 7067* in Herb. Kew. POLILLO, *Bur. Sci. 6937 Robinson, Bur. Sci. 10466 McGregor.* BABUYAN ISLANDS, Camiguin, *Bur. Sci. 4144 Fénix.* MINDORO, *McGregor 275* (var. *macrocarpa*). The size of the fruit in the cited specimen is very variable as many are immature.

7. **PINANGA COPELANDI** Becc. in Webbia 1 (1905) 317.

MINDANAO, Davao District, Todaya, *Copeland 1283* Herb. Manila (type specimen), *Elmer 10467:* Butuan Subprovince, *Weber 1134, Bur. Sci. 15918 Fénix:* Agusan River, *Merrill 7281;* Mount Urdaneta, *Elmer 13875.* NEGROS, Gimagaan River, *Whitford 1669.* LUZON, Camarines Province, *Phil. Pl. 1594 Ramos.*

8. **PINANGA CURRANII** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 226.

PALAWAN, near Puerto Princesa, *For. Bur. 3515 Curran.*

9. **PINANGA PHILIPPINENSIS** Becc. Malesia 3 (1887) 180, Perk. Fragm. Fl. Philip. (1904) 48, Webbia 1 (1905) 44.

LUZON, Sorsogon Province, Mount Bulusan, *Vidal 3950, 4064,* in Herb. Becc. (type specimens): Bataan Province, Mount Mariveles, *Whitford 333, Elmer 6825, Merrill 3316* (specimens very similar to the typical ones): Rizal Province, Mount Matulid, *Loher 7065* in Herb. Kew.: Tayabas Province, Mount Banahao, *Elmer 9300* (with very narrow, 1-costate, falcate segments): Cagayan Province, *For. Bur. 11317 Klemme:* Laguna Province, Mount Maquiling, *Bur. Sci. 13679 Ramos:* Benguet Subprovince, *Bur. Sci. 12907 Fénix.* The last four are with difficulty distinguishable from *P. elmerii* Becc.

10. **PINANGA ELMERII** Becc. in Webbia 1 (1905) 322, Philip. Journ. Sci. 3 (1908) Bot. 341.

BABUYAN ISLANDS, Camiguin, *Bur. Sci. 4149 Fénix.* LUZON, Benguet Subprovince, Baguio, *Elmer 6067, For. Bur. 10891 Curran, Bur. Sci. 12907 Fénix:* Ifugao Subprovince, Mount Polis, *Bur. Sci. 19782 McGregor* (a slender plant with very narrow leaflets, perhaps representing a distinct variety): Ilocos Norte Province, Mount Piao, *For. Bur. 14011 Merritt & Darling:* Nueva Vizcaya Province, *Bur. Sci. 11370, 20204, 20205 McGregor:* Bataan Province, Mount Mariveles, *Merrill 3846* (typical), *For. Bur. 1578 Borden, Whitford 130:* Rizal Province, *Bur. Sci. 13413 Ramos:* Laguna Province, Mount Maquiling, *Bur. Sci. 17119 Robinson:* Zambales Province, Mount Tapulao, *For. Bur. 8263 Curran & Merritt:* Tayabas Province, Mount Pular, *Bur. Sci. 19416 Ramos:* Without precise locality, *Loher 7064, 7063* in Herb. Kew. MINDORO, Mount Halcon, *Merrill 5555.* LEYTE, Dagami, *Bur. Sci. 15259 Ramos.*

Pinanga Elmerii is very closely related to *P. philippinensis*, and at times is distinguishable from it only with difficulty.

11. **PINANGA URDANETANA** Becc. sp. nov. in Leafl. Philip. Bot. MS.

MINDANAO, Agusan Province, Camilanan Peak, Mount Urdaneta, *Elmer 14137.*

12. **PINANGA SAMARANA** Becc. sp. nov.

Mediocris. Frondium segmentis intermediis rectis (apice minime falcato) inaequalibus, lanceolato-ensiformibus, 6 ad 7 cm inter se dissitis, 2–3-costulatis, 60 cm longis, 3.5 ad 6 cm latis, in sicco brunneis et subtus punctulis minutissimis pallidis conspersis; spadicis ramis valde complanatis; fructibus bifarius, crasse fusiformibus vel ovoideo-ellipticis, nonnihil utrinque attenuatis ac acutis, 15 ad 18 mm longis et circiter 10 mm crassis; perianthio fructifero parvo, 1.5 mm alto, 3 mm lato et in ore parum constricto.

SAMAR, Mount Cauayan, *Bur. Sci. 17535 Ramos*, March 29, 1914.

This is very incompletely known, as of it I have seen only a small portion of a leaf and fragments of the spadix bearing not thoroughly mature fruits. In the dry specimens the leaflets have the upper surface green, and the lower very minutely dotted and of a reddish-brown color. In general habit *Pinanga samarana* resembles *P. urdanetana,* but the fruits of the former are larger than those of the latter in which the leaflets of the dry specimens are brownish above and grayish-glaucescent underneath, without any traces of the very minute and numerous dots (microlepidia) peculiar to *P. samarana.*

13. **PINANGA UROSPERMA** Becc. in Philip. Journ. Sci. 3 (1908) Bot. 341.

BABUYAN ISLANDS, Camiguin, *Bur. Sci. 4044 Fénix.*

14. **PINANGA RIGIDA** Becc. in Leafl. Philip. Bot. 2 (1909) 642.

NEGROS, Cuernos Mountains, *Elmer 10187.*

15. PINANGA WOODIANA Becc. in Philip. Journ. Sci. 4 (1909) Bot. 604.

MINDORO, Mount Halcon, *Merrill 5680*. MINDANAO, Davao District, Mount Apo, *Elmer 10485* (the fruit a little larger than in the Mindoro specimen).

16. PINANGA SCLEROPHYLLA Becc. in Philip. Journ. Sci. 4 (1909) Bot. 603.

MINDORO, Mount Halcon, *Merrill 4468*.

17. PINANGA NEGROSENSIS Becc. in Leafl. Philip. Bot. 2 (1909) 642.

NEGROS, Dumaguete, Cuernos Mountains, *Elmer 10030*.

18. PINANGA INSIGNIS Becc. in Philip. Journ. Sci. 2 (1907) Bot. 223.

MINDORO, Bongabong River, *Whitford 1388* (type specimen). MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 13950:* Surigao Province, *Bolster 222*. LUZON, Nueva Vizcaya Province, *Bur. Sci. 11233 McGregor:* Laguna Province, San Antonio, *Bur. Sci. 15111 Ramos:* Tayabas Province, Lucban, *Elmer 8028, Bur. Sci. 13236 Ramos:* Rizal Province, Siya Bundoc, *Loher 7059*, Herb. Kew. (All the Luzon specimens agree very well with the typical Mindoro form.) LEYTE, *Wenzel 534*, perhaps representing a local variety with narrower and more approximate fruits, but the fruits are very immature.

PINANGA INSIGNIS Becc. var. GASTEROCARPA Becc.

LUZON, Laguna Province, Mount Maquiling, *For. Bur. 7791 Curran & Merritt, Loher 7093*, Herb. Kew. NEGROS, *For. Bur. 17348 Curran;* Faraon, *For. Bur. 13560 Meyer & Foxworthy*. MASBATE, *For. Bur. 11555 Rosenbluth*.

PINANGA INSIGNIS Becc. var. LEPTOCARPA Becc.

NEGROS, Mount Silay, *Whitford 1621*.

PINANGA INSIGNIS Becc. subsp. LOHERIANA Becc.

LUZON, Laguna Province, Mount Banahao, 1,000 meters' altitude, *Loher 7092*, Herb. Kew. and Becc.

19. PINANGA BATANENSIS Becc. in Philip. Journ. Sci. 3 (1908) Bot. 340.

BATAN ISLANDS, Batan, Santo Domingo de Basco, *Bur. Sci. 3841 Fénix*.

20. PINANGA BASILANENSIS Becc. sp. nov.

Major; frondium segmentis intermediis ultra metralibus, 9 cm latis, elongato-lanceolatis, 3-costulatis, rectis; spadicis ramis gracilibus, fructiferis pendulis, valde compressis; fructibus e ramorum basi usque ad apicem distichis, ovoideo-olivae formibus, aut laeviter obovatis, 2 cm longis, 12 mm latis; pericarpio nonnihil carnoso, fibris tenuibus paucis percurso; semine pro rata parvo, 13 mm longo, 8 ad 9 mm crasso, oblongo, apice rotundato; perianthio fructifero profunde cupulari vel subcampanulato in ore non coarctato, 4 mm longo, 6 mm lato.

Apparently a large species of the dimensions of *P. insignis*. The only leaf-segment seen by me is strongly 3-costulate, 106 cm long and 9 cm broad in its intermediate part, elongate-lanceolate, straight, narrowed a little in its lowest part but, nevertheless, attached to the rachis by a broad base; it narrows also in its upper part, and has the upper margin prolonged into an acuminate straight point, whereas the lower margin, toward the apex, is marked by several narrow teeth, the upper teeth gradually surpassing in length those below; in the dry state the segment is concolorous on both surfaces, the lower surface is glabrous, but is covered (occasionally?) with small granulations pertaining to the parenchyma, which are wanting or are much less visible on the upper surface. The spadix is apparently large and has numerous slender, floriferous branches, about 30 cm long; the latter are strongly flattened and bear the fruits in two series, even on their lowest parts. Fruit ovoid-olivaeform or very slightly obovoid, apex round, slightly narrowed toward the base, 2 cm long, 12 cm thick; the pericarp contains a few slender fibers and has the appearance of having been rather fleshy at maturity. Seed oblong, rounded above, relatively small, 13 mm long, 8 to 9 mm thick; the embryo area slightly oblique; the vascular branches of the integument rather numerous, but slightly anastomising. Fruiting perianth rather deeply cupular-subcampanulate, broadening a little at the mouth, 4 mm high and 6 mm broad.

BASILAN, *Bur. Sci. 16119 Reillo.*

This is related to *Pinanga insignis,* but is distinguishable by the fruiting perianth being slightly widened, not contracted, at the mouth and relatively very deep and nearly campanulate; by the fresh mature fruit being pulpy and with few fibers; by the leaf-segments having the lower margin near the apex incised-toothed, the teeth looking like ascending steps (this character is probably present in some segments only).

21. **PINANGA SPECIOSA** Becc. in Webbia 1 (1905) 316.

MINDANAO, Davao District, Todaya, *Copeland 1265, Elmer 10484,* locally known as *sadawag:* Lanao District, Camp Keithley, *Mary Strong Clemens 374:* Zamboanga District, *For. Bur. 9271 Whitford & Hutchinson:* Agusan Province, Cabadbaran, *Elmer 13739, 13941, 14023,* locally known as *salacon* and *saraway.*

A large palm with a relatively slender stem, 8 to 10 m high, 10 to 12 cm in diameter. Leaves large, the segments numerous, uniform, equidistant, 7 to 10 cm apart, of a not very rigid structure (perhaps rather herbaceous when fresh), glabrous, straight, lanceolate-ensiform, narrowed somewhat toward the base; the lower and intermediate segments very long-acuminate, usually 2-costulate, 1 to 1.2 m long, 8 to 10 cm wide, the upper ones gradually shorter, not very deeply 2- or 3-lobed at the apex, the lobes shortly 2-toothed. Spadix large, divided into several, spirally alternate, strongly flattened floriferous branches, the lower of which are 30 to 40 cm long, and the upper gradually shorter. The fruits are exactly distichous throughout the entire length of the branches, small, obovoid, apex round, base (in the part included in the perianth) acute, 15 to 17 mm long and 9 mm thick. Seed oblong, rounded above, 10 to 11 mm long, 7 mm thick, with the areola of the embryo very slightly oblique; vascular branches of the integument almost simple. Fruiting perianth shallowly cupular, very slightly broadening at the mouth, 2.5 to 3 mm high, 5 mm broad.

This was first described from very incomplete material. The various specimens with fruits, received later, correspond very well to the typical ones, which had flowers only. All the herbarium specimens I have examined have acquired a uniform yellowish tint on both surfaces, are not very rigid but rather flexible, and look as if they had been rather herbaceous in the living plant.

22. **PINANGA SIBUYANENSIS** Becc. sp. nov.

Inter majores, subelata, caudice ad 9 m longo, 15 cm diametro; frondium segmentis numerosis, aequidistantibus, late ensiformibus, usque ad apicem rectissimis, utrinque virentibus, subtus paullo pallidioribus, validissime bicostulatis, apice inaequaliter bifidis; spadicis ramis numerosis, spiraliter insertis; fructibus 3-seriatis, majusculis, 25 ad 28 mm longis, 15 ad 17 mm latis, ovato-ellipticis, utrinque aequaliter attenuatis; semine late ovato, superne rotundato; fovea embryonali nonnihil obliqua; integumenti ramis vascularibus numerosis, undique reticulatim anastomosantibus; perianthio fructifero ad faucem nonnihil coarctato.

SIBUYAN, Mount Giting-Giting, *Elmer 12425*.

This is allied to *Pinanga insignis*, but is apparently a smaller plant yet with larger fruits, and with the vascular branches of the integument forming a network all around the seed.

ACTINORHYTIS Wendland et Drude

ACTINORHYTIS CALAPPARIA Wendl. et Dr. in Linnaea 39 (1875) 184.

MINDANAO, Davao District, Todaya, *Elmer 11238*, with the local name *tangalo*.

A fine but almost useless palm, very widely spread in the Malay Archipelago and in the Moluccas, but probably of foreign origin in the Philippines.

HETEROSPATHE Scheffer

Conspectus of the species.

a^1. Large trees.

b^1. A tree 8 to 10 m high. Leaflets with strong secondary nerves, the midrib without paleolae underneath. Spadix three times branched, floriferous branches slender. Fruit globular, 7 to 7.5 mm in diameter, excentrically apiculate, the surface granulose from short scattered sclerosomes. Seed spherical.................................. 1. *H. elata.*

b^2. A tree as much as 9 m high, 12 cm in diameter. Leaflets having rather distinct secondary nerves, and the midrib furnished underneath with conspicuous brown paleolae. Spadix three times branched; floriferous branches thickish (2.5 mm thick). Fruit ovoid, 1 cm long, 7 mm thick, having the point conical and slightly oblique and the surface shagreened by linear sclerosomes. Seed globose-ovoid, blunt.. 2. *H. sibuyanensis.*

a^2. Shrubs or small trees.

b^1. Stem slender, 1 to 3 m high, 2 to 3 cm in diameter. The largest leaflets 25 to 30 cm long, 10 to 15 mm broad, secondary nerves faint. Spadix twice branched in its basal part, simply branched above. Fruit ovoid, 10 to 11 mm long, 6 mm thick, very suddenly, and nearly centrally, apiculate, the surface closely shagreened by conspicuous, shortly fusiform sclerosomes. Seed globose-ovoid, blunt. 3. *H. philippinensis.*

b^2. More robust than the preceding, 3 to 5 m high. Stem 4 to 5 cm in diameter. Leaflets 35 to 40 cm long, 2 to 2.5 cm wide, the secondary nerves rather distinct. Spadix twice branched. Fruit ovoid-ellipsoid, narrowing above to a conical, nearly symmetrical point, 9 to 11 mm long, 5 mm thick. Seed ovoid, acute. 4. *H. negrosensis.*

1. **HETEROSPATHE ELATA** Scheff. in Ann. Jard. Bot. Buitenz. 1 (1876) 141, 162; Becc. in Webbia 1 (1905) 328; Farnsworth Philip. Bur. Ed. Bull. 54 (1915) 66, 67, *plate.*

LUZON, Tayabas Province, *For. Bur. 10352 Curran:* Camarines Province, *For. Bur. 10481 Curran:* Cagayan Province, *For. Bur. 17064 Curran:* Laguna Province, Mount Maquiling, *For. Bur. 19749 Villamil.* CEBU, *Piper 4.* MINDANAO, Zamboanga District, *For. Bur. 9030 Whitford & Hutchinson:* Davao District, Todaya, *Elmer 11968.* MINDORO, Bongabong River, *Whitford 1395.* Local names: *Saguisi, sagisé, seguise, niog-niogan, tagisi, balaniug, salaniog.*

2. **HETEROSPATHE SIBUYANENSIS** Becc. in Leafl. Philip. Bot. MS.

SIBUYAN, Mount Giting-Giting, at about 230 meters' elevation, *Elmer 12350,* local name *bilis.*

This is the representative of *Heterospathe elata* in Sibuyan. It differs from *H. elata* in the leaflets being furnished with conspicuous paleolae on the lower surface; in the fruit being ovoid, with an obliquely conical upper part; and in the seed being slightly longer than broad (not spherical).

3. **HETEROSPATHE PHILIPPINENSIS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 610.

Ptychoraphis philippinensis Becc. in Ann. Jard. Bot. Buitenz. 2 (1885) 90, Webbia 1 (1905) 47, Cuming Exsicc. No. 1476 in Herb. Webb. at Florence.

LUZON, Benguet Subprovince, *For. Bur. 10856 Curran, For. Bur. 18019 Merritt:* Ifugao Subprovince, Mount Polis, *Bur. Sci. 19784, 19785 McGregor:* Nueva Vizcaya Province, *Bur. Sci. 8198 Ramos:* Camarines Province, *For. Bur. 21752 Fischer:* Rizal Province, Mount Matulid, *Loher 7054.* LEYTE, Dagami, *Bur. Sci. 15260 Ramos.*

4. **HETEROSPATHE NEGROSENSIS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 611.

NEGROS, Mount Silay, *Whitford 1539;* Cuernos Mountains, *Elmer 9439, 10147;* Mount Maripari, *For. Bur. 13639 Curran & Foxworthy. Bur. Sci. 9443, 9358 Robinson* are doubtfully referable to *Heterospathe negrosensis;* both were collected at about 900 meters' altitude on Mount Binuang, Infanta, Tayabas Province, Luzon. In regard to *9358* the collector notes that it is a plant 2 m high with the trunk 7 cm in diameter (this is probably the diameter of the upper part of the stem when covered with the mass of petiolar bases) and of the other that it is 4 m high.

PTYCHORAPHIS Beccari

Conspectus of the species.

a^1. Fruit longer than broad.

b^1. Of medium size. Leaflets furnished underneath with a few paleolae on the midrib only. Spadix twice branched. Fruit narrowly ovoid, tapering above to a slightly oblique, conical point, 10 to 12 mm long, 5 mm thick. Seed ovoid-ellipsoid, subacute, 7 mm long, 4 mm thick; vascular branches of the integument loosely anastomosing.
1. *Pt. microcarpa.*

b^2. Of medium size. Leaflets furnished underneath with paleolae, often on three nerves. Spadix twice branched. Fruit ovoid-ellipsoid, not or very slightly and asymmetrically obtuse-acuminate, 12 mm long, 7 mm thick. Seed ovoid, rounded at both ends; vascular branches of the integument very closely anastomosing.
2. *Pt. intermedia.*

b^3. Robust, stem about 15 m high. Spadix thrice branched. Leaflets rigid, without paleolae on the lower surface; secondary nerves well marked; margins somewhat thickened. Fruit narrowly ovoid, tapering above to a conical, slightly oblique point, 12 to 13 mm long, 5 mm broad. Seed ovoid-ellipsoid, acute, 9 mm long, 4.5 mm thick; vascular branches of the integument loosely anastomosing.
3. *Pt. Elmerii.*

a^2. Fruit spherical. Stem about 6 m high. Leaflets long-acuminate, the point slightly falcate. Spadix thrice branched, floriferous branches 12 to 15 cm long, 2.5 to 3 mm thick. The bracteoles of the female flower form a regular cupular caliculum. Fruiting perianth shallowly cupular. Fruit spherical, 7 mm in diameter, with the remains of the stigmas nearly central and apical, the surface not granulose. Seed spherical, 5.5 mm in diameter .... 4. *Pt. cagayensis.*

1. PTYCHORAPHIS MICROCARPA Becc. sp. nov.

Mediocris; frondium segmentis numerosissimis, rectissimis, majoribus 70 cm longis, 3.5 cm latis, costa media tantum subtus paleolis induta; spadice duplicato-ramoso, ramis floriferis rigidis, crassiusculis; fructibus anguste ovoideis, superne vix oblique conice attenuatis, 10 ad 12 mm longis, 5 mm crassis; semine ovato-elliptico, subacuto, 7 mm longo, 4 mm crasso; integumenti ramificationibus vascularibus laxe anastomosantibus.

Apparently of medium size. Leaves rather large, perhaps about 3 m long, very regularly pinnate; petiolar part smooth, strongly convex underneath, deeply channeled above (at least in its uppermost part) ; rachis also convex, smooth and glabrous underneath, 2.5 cm wide in its basal part. Leaflets very numerous, equidistant, ensiform, quite straight, attached to the rachis by a rather narrow base, with the margins there strongly reduplicate, very long acuminate in their upper part to a slender undivided point, which however has a tendency to split down the middle, firmly papyraceous, glabrous and subconcolorous on both surfaces, the margins slightly thickened; midrib almost equally prominent on both surfaces, provided, on the lower surface, especially near the base, with distant, brown, linear paleolae; the latter at times present (on each side of the mid-costa) on a secondary nerve, which is usually stronger than the other; tertiary nerves not very sharp, being immersed in the parenchyma; transverse veinlets obsolete; intermediate segments up to 70 cm long, and 3.5 cm wide; the lowest segments considerably smaller; the upper ones gradually diminish in length and breadth; all, however, are of one shape. Spadix over 1 meter in length, but about one-half of it consists of an undivided, strongly flattened, peduncular part; the latter is 17 to 18 mm wide, the margins obtuse, covered with a very dark tobacco-colored, furfuraceous scurf; panicle diffuse, twice branched, its primary divisions short, angular, and subdivided into 2 or 3 floriferous branches; the latter are rigid, thickish (4 mm thick) throughout their entire length (not including the flowers), 15 to 22 cm long, uniformly covered with glomerules from the base to the apex, each composed of three flowers. Spathes two, falling to pieces at the time of fruiting, the outer, or basal, spathe coriaceous, brittle; the second inserted on the peduncular part 15 cm above the other. Glomerules not very regularly yet rather closely arranged, although often with vacant spaces interposed, around the branches, on very shallow scrobiculi. Male flowers * * *. Female flowers * * *. Fruiting perianth 5 mm high, the petals twice as long as the sepals; the bracts of the female flowers form a shallow truncate cup, 3 mm wide. Fruit narrowly ovoid, 10 to 12 mm long, 5 mm broad, slightly asymmetrical, being faintly obliquely conical in its upper part, the apex marked by a minute mammillaeform areola, bearing the remains of the stigmas; the surface is dull and even (not roughened by underlying sclerosomes), the epicarp thinly crustaceous, the mesocarp with 3 or 4 layers of strongly flattened, yet soft, fibers, the endocarp very thin, pellicular. Seed ovoid-ellipsoid, rather acute, 7 mm long, 4 mm thick; hilum sharply impressed all along one side; testa brown and polished; the vascular branches of the integument form a loose network all around the seed; albumen radiately ruminate; embryo basal.

CAMIGUIN DE MISAMIS, a small island north of Mindanao, *Bur. Sci. 14678 Ramos.*

This species is closely related to *Ptychoraphis intermedia*, but is distinguishable by its smaller fruits, considerably narrowing in their upper part, and by the ellipsoid, acute seeds having the vascular branches loosely anastomosing.

2. **PTYCHORAPHIS INTERMEDIA** Becc. in Leafl. Philip. Bot. MS.

MINDANAO, Agusan Province, between Duras and Canilan Peaks, Mount Urdaneta, over 1,000 meters' altitude, *Elmer 13663*, September, 1912, Manobo name *marighoy*. BILIRAN, *Bur. Sci. 18107 McGregor*, June, 1914, this specimen agreeing very well with that from Mindanao.

This species is closely related to *Ptychoraphis microcarpa*, from which it differs in its larger spadix having longer and thicker fructiferous branches and in the leaflets having paleolae not only on the midcosta but also on three nerves underneath, but more especially in the shape and size of the fruit and in the seed, which is rounded at both ends and marked by the close network of the vascular branches of the integument. Both *Ptychoraphis microcarpa* and *Pt. intermedia* are more closely related to *Pt. angusta*, of the Nicobar Islands, than to *Pt. singaporensis*, of the Malay Peninsula and Singapore.

3. **PTYCHORAPHIS ELMERII** Becc. comb. nov.

Heterospathe Elmerii Becc. in Leafl. Philip. Bot. 2 (1909) 646.

NEGROS, Dumaguete, Cuernos Mountains, *Elmer 9559*, altitude about 1,000 meters, local name *bilisan*.

4. **PTYCHORAPHIS CAGAYENSIS** Becc. comb. nov.

Heterospathe cagayensis Becc. in Philip. Journ. Sci. 4 (1909) Bot. 611.

LUZON, Cagayan Province, *For. Bur. 12286 Klemme*, locally known as *dumayaca*.

An imperfectly known palm, somewhat uncertain in its generic position, but greatly resembling *Heterospathe elata* in its fruit;

the fruit of the latter, however, has a smooth (not granulose) surface, the pericarp apparently being without sclerosomes. For this reason I have thought proper to transfer it from the genus *Heterospathe* to *Ptychoraphis*. The fruit is spherical, almost centrally apiculate, 7 mm in diameter, and has the hilum conspicuously marked all along one side. The spadix is thrice branched, and its fruiting branches are thicker than in *Heterospathe elata* (2.5 to 3 mm in diameter), almost torulose; the scrobiculi are approximate, have a raised rim, and the floral bracts form a shallow cup; the fruiting perianth is very shallowly cupular and does not have a pedicelliform appearance. The leaflets have slightly falcate apices with no paleolae underneath on the midrib.

ADONIDIA Beccari genus novum

Normanbyae sp. Becc. in Philip. Journ. Sci. 4 (1909) Bot. 606.

After a more complete revision of all the palms belonging to the Ptychospermeae I now think it advisable to establish an autonomous genus for the Philippine palm which was formerly considered by me as a member of the Australian genus *Normanbya*, in consideration of the fact that, notwithstanding the great similarity in the flowers and fruit, *Adonidia* differs greatly from *Normanbya Muellerii* in the leaves, the vegetative characteristics being of great importance in the delimitation of the genera of the subtribe of Ptychospermeae. In *Adonidia* the leaflets are regularly set, narrow, elongate, acuminate, bifid at the apex, 1-costulate, and with a strong nerve at both margins; whereas in *Normanbya* the leaflets are very peculiarly arranged in groups, each group resulting, apparently, from the spliting of one leaflet into several, which yet remain united by their bases; furthermore, the resulting leaflets are narrow, have a truncate praemorse apex, and have no marginal nerves.

The separation of *Adonidia* from *Normanbya* gives us a genus peculiar to the Philippines and the only endemic one in the family.

1. ADONIDIA MERRILLII Becc. comb. nov.
    Normanbya Merrillii Becc. in Philip. Journ. Sci. 4 (1909) Bot. 606, *t. 30, 31.*

PALAWAN, in sandy soil of the woods fronting the beach south of Brooke's Point, *Elmer 12708*, February, 1911, locally known as *oring-oring;* Apulit Island, Taytay Bay, on the coast of Palawan, growing abundantly, often gregariously, on steep limestone slopes, altitude 10 to 100 meters, *Merrill 9415*, May, 1913. The species is commonly cultivated in Manila for ornamental purposes.

ONCOSPERMA Blume

Conspectus of the species.

a^1. Gregarious. Floriferous branches of the spadix numerous, long, slender, and inserted at different levels on the rachis. Male flowers with 6 stamens. Fruit small, spherical, 11 to 12 mm in diameter. 1. *O. filamentosa.*

a^2. Stem very tall, solitary. Spathe very densely covered with criniform spines. Spadix with numerous, long, floriferous branches, which gradually narrow from a very thick base to a slender apex. Fruit large, spherical, 20 to 22 mm in diameter........................ 2. *O. horrida.*

a^3. Rather large and growing in clumps. Spadix with rather short and thick floriferous branches; the latter clustered together and very closely scrobiculate. Fruit spherical or very slightly longer than broad, 15 to 16 mm in diameter, with the remains of the stigmas placed laterally, about half way or a little above.................. 3. *O. platyphylla.*

a^4. Trunk slender. Spadix with relatively few, clustered, thickish, very closely scrobiculate, floriferous branches. Spathe not densely spinose. Fruit spherical, 14 to 15 mm in diameter, with nearly apical remains of the stigmas. Fruiting perianth 12 mm in diameter.. 4. *O. gracilipes.*

1. **ONCOSPERMA FILAMENTOSA** Bl. Rumphia 2 (1836) 97, *t. 82, 103;* Becc. in Philip. Journ. Sci. 4 (1909) Bot. 610.

PALAWAN, Caranagan River, *For. Bur. 3790 Curran;* Brooke's Point, *Elmer 12662.* Quite identical with the Malayan plant.

2. **ONCOSPERMA HORRIDA** Scheff. in Nat. Tijdsch. Nederl. Ind. 32 (1871) 189; Becc. in Philip. Journ. Sci. 4 (1909) Bot. 610.

MINDANAO, Zamboanga District, San Ramon, *Copeland 1626:* Agusan Province, Cabadbaran, *Elmer 13886:* Davao District, Todaya, Mount Apo, *Elmer 11876.* POLILLO, *Bur. Sci. 9277 Robinson.*

This is slightly different from the Malayan plant, but it seems to me not sufficiently so to consider it as even a variety. In the specimens I have examined the spines that cover the spathe are criniform or considerably slenderer than in the typical Malayan form. The fruit also has the pericarp slightly thinner, and the remains of the stigmas are less prominent in the dry fruit than in the Malayan plant.

3. **ONCOSPERMA PLATYPHYLLA** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 609.

NEGROS, Gimagaan River, *Whitford 1670, For. Bur. 17347 Curran.*

4. **ONCOSPERMA GRACILIPES** Becc. in Philip. Journ. Sci. 2 (1907) Bot. 228, 4 (1909) Bot. 610.

LUZON, Tayabas Province, Atimonan, *Merrill 4010;* Guinayangan, *Bur. Sci. 13213 Ramos;* between Paete and Piapi, *For. Bur. 10148 Curran.* BILIRAN, *Bur. Sci. 18490 McGregor.*

The type specimen is *Merrill 4010,* of which it is stated that the trunk was 7 to 10 m high. Curran's field note indicates that the plant grows in clumps, and that the trunk is 10 m high and 12 cm in diameter.

ORANIA Blume

Representatives of *Orania* are rather common in the forests of the Philippines, especially in the more southern islands of the group, but their specific delimitation is often difficult and uncertain, as individuals apparently belonging to the same species seldom exhibit constant characters, when growing in separate islands, or even in remote localities in the same island. This is not confined to *Orania*, but is an almost general occurrence in other genera of Philippine palms.

After a careful study of the specimens that offer the greatest divergence of characters, especially in the flowers and the fruits, I have concluded that there exist in the Philippines three primary species of *Orania;* namely, *Orania philippinensis*, *O. rubiginosa*, and *O. decipiens* (*O. paraguanensis* is perhaps only a derivation from *O. philippinensis*) ; but numerous variations are presented by these main types, especially in the size and shape of the fruits and in the thickness of their mesocarps, so as to render not inconsistent the opinion that in the Philippines we have only one "synspecies" of *Orania*, represented by several "microspecies" the latter however derived, we may suppose, by the interbreeding of two foreign elements. *Orania philippinensis* is apparently derived from the Papuan *O. regalis*, of which varieties or allied species exist also in the Moluccas; whereas the more typical form of *O. decipiens* is plainly allied to the Malayan *O. macrocladus*.

Conspectus of the species.

a^1. Floriferous branches ultimately glabrous.

b^1. Male flowers angular, lanceolate, 6 to 8 mm long, 3 to 3.5 mm broad, or about twice as long as broad, having the stamens one-third to one-half shorter than the petals; anthers linear-oblong. Female flowers broadly ovate-trigonous, the calyx cupular, very low; petals triangular, subaequilateral. Fruit spherical or very slightly narrowed at the base, usually 5.5 to 6 cm in diameter, at times somewhat less; mesocarp about 5 mm thick........................ 1. *O. philippinensis*.

c^1. Fruit exactly spherical, larger than in the species (6.5 cm in diameter), yet with a thinner mesocarp (3.5 to 4 mm thick). *O. philippinensis* var. *sibuyanensis*.

b^2. Male flowers narrow, linear, 8 mm long, 2 mm broad, or about four times as long as broad, having the stamens nearly as long as the petals and the anthers very narrowly linear. Fruit spherical, smaller than in *O. philippinensis*, 4.5 to 4.7 cm in diameter, the mesocarp 3.5 to 4 mm thick.. 2. *O. paraguanensis*.

b^3. Male flowers narrowly linear. Fruit slightly narrowing to the base, or slightly pyriform, considerably smaller than in the preceding species, 4 to 4.5 cm long, 35 to 37 mm thick; kernel spherical, extended at the base into a broadly obconical blunt point; mesocarp relatively thick (3 to 4 mm) and furnished with many short and stout woody fibers. Seed about 25 mm in diameter.. 3. *O. decipiens.*

c^1. Fruit smaller than in the species (37 mm long, 31 to 32 mm thick), but always more or less narrowing to the base; mesocarp also thinner (2.5 mm thick) .... *O. decipiens* var. *mindanaoensis.*

c^2. Fruit spherical, not narrowing to the base, 42 mm in diameter; mesocarp 4 to 5 mm thick........................ *O. decipiens* var. *montana.*

a^2. Floriferous branches more or less permanently rusty-tomentose. Male flowers very narrow and long, 1 cm long, 2 to 3 mm broad. Female flowers pyramidate-trigonous, acuminate, twice as long as broad, calyx campanulate. Fruit subpyriform, 40 to 45 mm long, 30 to 38 mm thick; mesocarp thin, 1.5 to 2 mm thick........................ 4. *O. rubiginosa.*

1. **ORANIA PHILIPPINENSIS** Scheff. ex Becc. in Ann. Jard. Bot. Buit. 2 (1885) 156, *t. 14;* Becc. in Webbia 1 (1905) 335.

Orania Palindan Merr. in Govt. Lab. Publ. 27 (1905) 88, Philip. Journ. Sci. 1 (1906) Suppl. 32.

Palindan Blanco Fl. Filip. (1837) 444 (partly ?).

Caryota Palindan Blanco Fl. Filip. ed. 2 (1845) 513 ?

LUZON, Bataan Province, Mount Mariveles, *For. Bur. 1610 Borden,* this number with mature spherical fruits agreeing entirely with Scheffer's typical specimens: Tayabas Province, *For. Bur. 10410 Curran,* fruit slightly smaller than in Borden's specimen and slightly narrowed below, 5.3 cm long, 4.5 cm thick: Laguna Province, Calauan, *Bur. Sci. 12391 McGregor:* Zambales Province, *For. Bur. 8413 Curran & Merritt:* Cagayan Province, *For. Bur. 17068 Curran;* the last three specimens have immature fruits.

ORANIA PHILIPPINENSIS Scheff. var. **SIBUYANENSIS** Becc. var. nov.

SIBUYAN, along Patao River, Mount Giting-Giting, *Elmer 12066,* local name *banga.*

A tree about 5 m high, the stem 12 cm in diameter. Spadix about 1.50 m long; one spathe, persistent and coriaceous, is 1.40 m long, lanceolate, 5 cm broad, slightly rusty-furfuraceous outside. Fruit of a citron-yellow color.

2. **ORANIA PARAGUANENSIS** Becc. in Webbia 1 (1905) 335.

PALAWAN (Paragua), Taytay, *Merrill 9269, Merrill Phil. Pl. 1316;* Separation Point, *Merrill 869* (type specimen).

This is the representative in Palawan of *O. philippinensis* and perhaps should be considered as a variety of that species. It was first described by me from incomplete specimens, the fruits attached on very thick (perhaps abnormal?) branchlets (*Merrill 869*). Other specimens subsequently collected also by *Merrill* in Palawan at Taytay (*1316* and *9269*) have floriferous branches not differing from those of the typical *O. philippinensis* from Luzon, but have the male flowers much narrower than in that form, linear, 8 mm long, 2 mm thick, with stamens as long as the petals, and very narrowly linear anthers. The fruits are somewhat smaller than in the Luzon plant, 45 to 47 mm in diameter, with the mesocarp 3.5 to 4 mm thick.

3. **ORANIA DECIPIENS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 614.

MINDORO, Bongabong River, at about 70 meters above the sea level, *For. Bur. 4120 Merritt,* Tagalog and Visayan name *banga.*

This is distinguishable by its relatively small fruit, yet having a thick mesocarp. In the size and the shape of the fruit *O. decipiens* could be mistaken for *O. macrocladus,* and among the Philippine species, for *O. rubiginosa,* but in these the mesocarp is rather thin, whereas it is relatively very thick in *O. decipiens.*

ORANIA DECIPIENS Becc. var. **MINDANAOENSIS** Becc. var. nov.

MINDANAO, Zamboanga District, Port Banga, *For. Bur. 9179 Whitford & Hutchinson.*

Fruit a little smaller than in the species, 37 mm long, 31 to 32 mm thick, slightly narrowing to the base; mesocarp 2.5 mm thick.

ORANIA DECIPIENS Becc. var. **MONTANA** Becc. var. nov.

MINDANAO, Davao District, Mount Apo, at about 1,000 meters' altitude, *Elmer 11881:* Agusan Province, Cabadbaran (Mount Urdaneta), at about 830 meters' altitude, *Elmer 13970.*

The fruit is exactly spherical or else slightly broader than high, 42 mm in diameter; mesocarp 4 to 5 mm thick. In *Elmer 13970* the male flowers are very narrowly linear, 7 to 9 mm long, 2 mm broad.

4. **ORANIA RUBIGINOSA** Becc. sp. nov.

Frondium rachi et spadicis parte axilli et ramis ferrugineo-scrophulosis; floribus masculis angustissimis, 1 cm longis; floribus foemineis trigono-pyramidatis, acuminatis; fructibus globoso-subpyriformibus, quam in *O. philippinensi* minoribus, mesocarpio tenui (1.5 ad 2 mm spisso).

Apparently a smaller plant than *Orania philippinensis,* 6 to 8 m high, the stem 10 to 15 cm in diameter, the leaves also smaller and with fewer and narrower leaflets, the latter about 30 on each side of the rachis. Base of the leaves and rachis covered, especially underneath, with a rusty, very appressed indumentum, evanescent in age. The leaflets have on each side of the midrib 2 or 3 very strong secondary nerves, especially prominent on the lower surface near the base; the intermediate segments are 60 to 70 cm long and 3.5 to 4 cm broad, very obliquely truncate, and erose-toothed at the apex, and prolonged along the upper margin into a somewhat elongated point; in the upper leaflets the apex is truncate, irregularly lobulate and erose-toothed; the lower surface is as usual whitish and is, furthermore, sprinkled, especially in newly expanded leaves, with minute rusty scales (microlepidia), and has the upper margin marked by a rusty furfuraceous band. The spadix has more or less permanently rusty-furfuraceous, 10 to 20 cm long or less, floriferous branches, bearing on their lower parts a few female flowers, each of which is accompanied, as usual, on each side, by a male flower; the upper parts of the branches present male flowers only. The male flowers are very narrow, 1 cm long and 2 to 3 mm broad, sinuous, acuminate; calyx very shortly campanulate, sharply 3-toothed; petals about five times longer than the calyx, narrowly lanceolate, with the tips acuminate and more or less falcate; stamens 6, slightly shorter than the petals; filaments short; anthers linear, sinuous, emarginate at the apex. Female flowers pyramidal-trigonous, acuminate, 6 to 8 mm long; calyx relatively large, shallowly cupular, with three, broad, acuminate teeth, but latter splitting into three broad lobes; corolla about two and one-half times as long as the calyx; petals elongate-triangular, acuminate, 6 to 7 mm long, 3 mm broad at their bases; staminodia 6, subulate, not bearing rudimentary anthers. Fruiting perianth measuring about 9 mm between the tips of the petals. Fruit globose, slightly diminishing toward the base, or subpyriform, 4 to 4.5 cm long, 3 to 3.8 cm broad; mesocarp relatively thin, 1.5 to 2 mm thick; kernel, when detached from the mesocarp, with a blunt, not clearly defined prominence at the base; walls of the endocarp 0.33 mm thick at the sides. Seed globular with a flattish base, the vascular branches of the integument few, ascending, sinuous, not or very slightly divided. Embryo very slightly and excentrically apical.

LUZON, Cagayan Province, on the east coast, *Bur. Sci. 10575 McGregor, For. Bur. 17259, 17192 Curran:* Isabela Province, Biocbian Bay, *Bur. Sci. 10658 McGregor:* Tayabas Province, Tagcauayan, *Bur. Sci. 13390 Ramos.*

This is easily distinguishable from *Orania philippinensis* by the general rusty coating which covers the leaf-rachis and the axial parts of the spadix; by its long and narrow male flowers, three to four times longer than broad; by the trigonous, acuminate female flowers having a campanulate calyx, and the petals elongate-triangular, twice as long as broad, at least; and by the subpyriform fruit, considerably smaller than that of *O. philippinensis*, and with a thin mesocarp.

Apparently also referable to *O. rubiginosa* is *Loher 7090* collected at Angilog, Rizal Province, Luzon (Herb. Kew.), of which the collector notes that it is a tree 3 to 4 m high with a thick stem. In this specimen the leaflets are larger than in the type, and the fruits also are somewhat larger, 5 cm long and 4 cm thick, and have the mesocarp 2.5 mm thick.

ARENGA Labillardière

Conspectus of the species.

a^1. Leaflets elongate, narrow, having smooth or remotely and minutely toothed margins, the secondary nerves parallel, all starting from the base.

b^1. Large, with solitary stems. Fruit more or less turbinate, 3 cm or more in diameter. Male flowers with very numerous stamens; anthers aristate........ 1. *A. saccharifera*.

b^2. Relatively small and caespitose. Male flowers with 20 to 30 stamens; anthers blunt or slightly apiculate. Fruit spherical, 15 to 18 mm in diameter........ 2. *A. mindorensis*.

a^2. Leaflets elongate, yet broad, margins very irregularly undulate or else very boldly toothed, or lobed; secondary nerves divergent from the rachis at different levels.

b^1. Caespitose; stem attaining 2 to 3 m in height and 15 cm in diameter. Male flowers with a rounded top. Stamens about 150. Fruit longer than broad, rounded at both ends........ 3. *A. tremula*.

b^2. Stem short and thick, about 30 cm in diameter. Male flowers apiculate. Stamens about 100. Fruit spherical........ 4. *A. Ambong*.

1. ARENGA SACCHARIFERA Labill. in Mém. Inst. Fr. 4 (1801) 209; Griff. Palms Brit. Ind. (1845) 164, *t. 135A;* Becc. in Perkins Fragm. Fl. Philip. (1904) 48, Philip. Journ. Sci. 6 (1911) Bot. 229.

Saguerus saccharifer Wurmb in Verh. Bat. Genootsch. 1 (1779) 350; Blume Rumphia 2 (1836) 128, *t. 123–4.*

LUZON, Tayabas Province, Lucban, *Elmer 7644;* Guinayangan, *Merrill 2043.* POLILLO, *Bur. Sci. 9041 Robinson, Bur. Sci. 10468 McGregor.* BILIRAN, *Bur. Sci. 18941 McGregor.*

2. ARENGA MINDORENSIS Becc. in Perkins Fragm. Fl. Philip. (1904) 48, Webbia 1 (1905) 49.

MINDORO, Calapan, *Merrill 1790* (type), *For. Bur. 8768 Merritt,* locally known as *dumayaca.* LUZON, Tayabas Province, Atimonan, *For. Bur. 10203 Curran;* Mauban, *Bur. Sci. 19468 Ramos,* with the female flowers well developed, the staminate ones not yet open: Bataan Province, *For. Bur. 5469 Curran:* Laguna Province, Calauan, *Bur. Sci. 12395 McGregor.* MINDANAO, Davao District, Mount Apo, *Elmer 11192,* a more robust plant than the Mindoro and Luzon form but otherwise presenting no peculiar characters.

3. ARENGA TREMULA Becc. in Philip. Journ. Sci. 4 (1909) Bot. 612.

Caryota tremula Blanco Fl. Filip. (1837) 744; Kunth Enum. Pl. 3 (1841) 549.

Didymosperma tremulum Wendl. et Dr. in Kerch. Les Palms (1878) 243.

LUZON, Tayabas Province, *For. Bur. 10213, 10280 Curran,* very common, *Bur. Sci. 1737 McGregor.* PALAWAN, Victoria Peak, *Bur. Sci. 735 Foxworthy;* near Irauan (altitude, 200 meters) *For. Bur. 3542 Curran,* Brooke's Point, *Elmer 12596.* BALABAC, *Merrill 5372.*

4. ARENGA AMBONG Becc. in Philip. Journ. Sci. 2 (1907) Bot. 229.

Wallichia oblongifolia (non Griff.) Becc. in Webbia 1 (1905) 328.

MINDANAO, Zamboanga District, *Garcia 653*, *Copeland 1681*, *Merrill 8367*. Moro name *ambong*.

CARYOTA Linnaeus

The genus *Caryota* is represented in the Philippines by few species, which however seem rather variable, and which, so far as I can determine from dry, very often incomplete, herbarium specimens, present, at times, forms with ambiguous or uncertain characters and are therefore difficult to identify.

The doubt is not altogether to be excluded that occasionally some of the ambiguous forms may be of hybrid origin. Two principal species are frequently met with throughout the Philippines, one of which, a large and fine palm, is to be considered, I think, not specifically distinct from the very widely spread and very variable *Caryota Rumphiana;* the other, considerably smaller, is an endemic species, *C. Cumingii*, which at times presents forms not easily distinguishable, at least in the herbarium, from *C. mitis* Lour., a plant common in Cochinchina and in the Malayan region. Specimens of *Caryota mitis*, agreeing in every respect with the Cochinchina plant, have been collected in Palawan; *C. Cumingii*, however, is always solitary, not suboliferous.

Caryota Merrillii and *C. majestica* are species of which I have only an incomplete knowledge; both are apparently related to *C. Cumingii* or perhaps are varieties of that, and properly to be understood they require the examination of more complete material than I have had at my disposal or, better still, an examination of the living plants in their native country. *Caryota Rumphiana* var. *oxyodonta* Becc., collected only once and established on a single incomplete specimen, is another form of which more complete material is desired.

Conspectus of the species.

a^1. Large trees. Stem tall, solitary. Fruit 1- or 2-seeded. Fruiting perianth 10 to 11 mm in diameter. Male flowers large, 15 to 17 mm long, with numerous stamens.

b^1. Leaflets of the full-grown plant long and narrow, having the upper margin at times very obsoletely, yet at times rather sharply, and very unequally toothed, and the lower margin much produced into a taillike point. Male flowers with 40 to 60 stamens. Stem up to 30 to 40 cm in diameter............ 1. *C. Rumphiana* var. *philippinensis*.

b^2. Leaflets having the upper margin deeply and acutely toothed, the teeth long, narrow, acuminate, and very close together. Male flowers with 27 to 30 stamens. A smaller plant than var. *philippinensis*. *C. Rumphiana* var. *oxyodonta*.

a^2. Of medium size. Fruit always 1-seeded. Male flowers (where known) small and with few stamens.

b^1. Stem solitary. Male flowers with 6 to 9 stamens only.

c^1. Trunk 5 to 8 m high, 10 to 20 cm in diameter. Leaflets erect-spreading, dimidiate-rhomboidal. Male flowers 6 to 7 mm long, with 9 stamens. Fruiting perianth 6 to 7 mm in diameter. Fruit 12 to 17 mm in diameter, spherical. Seed with a chestnut-brown polished surface. Branches of the spadix strongly hairy-scurfy .... 2. *C. Cumingii.*

c^2. Leaflets very spreading or horizontal, frequently opposite, very sharply toothed. Male flowers * * *. Fruit spherical, 12 mm in diameter. Seed nearly spherical, 8 to 9 mm in diameter, with a black, even, and polished surface.......... 3. *C. Merrillii.*

c^3. Leaflets ascending, very narrow and very deeply and sharply toothed. Male flowers having 6 stamens only. Fruit 11 to 12 mm in diameter. Seed slightly broader than high, 9 mm broad, of a shiny chestnut-brown color, the surface slightly grooved. 4. *C. majestica.*

b^2. Soboliferous or with stems in clusters, about 4 m high and 10 cm in diameter. Male flowers 8 to 12 mm long, with 12 to 16 stamens. Fruit 15 to 16 mm in diameter, frequently broader than high. Fruiting perianth 8.5 to 9 mm in diameter.......... 5. *C. mitis.*

1. **CARYOTA RUMPHIANA** Mart. var. **PHILIPPINENSIS** Becc.

Caryota Rumphiana (vix Mart.) Becc. in Perkins Fragm. Fl. Philip. 1 (1904) 48, Webbia 1 (1905) 331.

Caryota urens (non Linn.) Blanco Fl. Filip. (1837) 740 (pro parte).

LUZON, Tayabas Province, *For. Bur. 7850 Curran & Merritt;* Lucban, *Elmer 9301:* Laguna Province, Santa Maria Mavitac, *For. Bur. 10064 Curran;* Mount Maquiling, *For. Bur. 19961 Villamil:* Manila, *Merrill 8037* (cultivated). MINDORO, Bongabong, *Whitford 1373.* MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 13623,* Manobo name *pogahan:* Davao District, Todaya (Mount Apo), *Elmer 10940,* Bagobo name *pola.*

CARYOTA RUMPHIANA Mart. var. **OXYODONTA** Becc.

LUZON, Laguna Province, Santa Maria Mavitac, *For. Bur. 10045 Curran.*

The specimen of this variety seen by me has dimidiate-rhomboidal leaflets, much more acutely toothed than in the species, the teeth being very close together, very narrow, and very acuminate, and on the average 10 mm long; the lower margin of the leaflets is prolonged into an acuminate, not very long point; the largest leaflets on the sides of the ultimate divisions of the rachis are 18 to 20 cm long and 4 to 5 cm broad; the basal divisions are broader and less acuminate. The floriferous branches are very similar to those of var. *philippinensis* and of the same dimensions. The male flower-buds are globose, 7 mm in diameter with the corolla not yet produced outside the calyx, but even in that condition they show that they would have acquired the dimensions usual to var. *philippinensis.* The stamens are numerous. According to the collector the plant had a trunk 7 m high and 10 cm in diameter, and leaves 2 to 3 m long.

2. CARYOTA CUMINGII Lodd. ex Mart. Hist. Nat. Palm. 2:195 (2d ed.); Becc. in Perk. Fragm. Fl. Philip. (1904), Webbia 1 (1905) 331. Curtis's Bot. Mag. III 25 (1869) *t. 5762;* Farnsworth Philip. Bur. Ed. Bull. 54 (1915) 59, with plates.

Caryota urens (non Linn.) Blanco (partly) Fl. Filip. (1837) 740, ed. 2 (1845) 510, ed. 3, 3 (1879) 141 *t. 349.*

Caryota sp. Cuming exsicc. No. 1915; Vidal Phan. Cuming (1885) 153.

LUZON, Manila, *Gaudichaud* in Herb. Delessert, *Merrill 8036,* cultivated: Tayabas Province, *For. Bur. 10348 Curran:* Union Province, Bauang, *Elmer 5647.* MINDORO, *For. Bur. 6216 Merritt,* local name *apican.* PANAY, Miagao, *Vidal 4067* in Herb. Becc. GUIMARAS, *For. Bur. 119 Gamill,* local name *patisan.* MINDANAO, Zamboanga District, Banga, *For. Bur. 9077 Whitford & Hutchinson.* PALAWAN, *Bur. Sci. 873 Foxworthy;* Taytay, *Merrill 9360.*

The Mindanao and Palawan specimens do not seem to be such typical representatives of *Caryota Cumingii* as those from Luzon.

3. CARYOTA MERRILLII Becc. in Webbia 1 (1905) 333.

LUZON, Pangasinan Province, Bautista, *Merrill 2880.*

This is known only from the type collection, a rather imperfect specimen; it may perhaps be but a variety of *C. Cumingii.*

4. CARYOTA MAJESTICA Lind. Illustr. Hort. 28 (1881) 16 (name only); Becc. in Perk. Fragm. Fl. Philip. (1904) 48, Webbia 1 (1905) 334.

Caryota urens (non Linn.) *foliis angustioribus* Blanco Fl. Filip. (1837) 740.

LUZON, Rizal Province, Bosoboso, *Merrill 1892, Merrill 8490,* local name *anibung.* Perhaps *Vidal 3949* (Herb. Becc.) from Tarlac (sterile specimen) is also referable to this species.

5. CARYOTA MITIS Lour. Fl. Cochinch. (1790) 569.

PALAWAN, *For. Bur. 3838, 4148 Curran.*

These specimens are indistinguishable from typical specimens of *C. mitis* collected in Cochinchina; the male flowers are larger than in *C. Cumingii* and with 12 to 18 stamens. I consider also *Elmer 12606* collected at Brooke's Point, Palawan, with the local name *bato* as referable to *C. mitis.* Of this it is noted that the stems are usually 3 to 5 in a cluster, which is one of the essential characteristics of *C. mitis.*

NIPA Rumphius

NIPA FRUCTICANS Wurmb in Verh. Bat. Genootsch. 1 (1779) 349.

LUZON, Cagayan Province, *For. Bur. 17265 Curran.* BILIRAN, *Bur. Sci. 18700 McGregor.* POLILLO, *Bur. Sci. 9061 Robinson, Bur. Sci. 10462 McGregor.* PALAWAN, *Bur. Sci. 273 Bermejos.*

Along tidal streams throughout the Philippines, in places gregarious over very large areas, forming the so-called "nipales" or nipa swamps.

COCOS Linnaeus

COCOS NUCIFERA Linn. Sp. Pl. (1753) 1188.

Cultivated throughout the Philippines both in the coastal region and in the interior in those regions where there is no prolonged dry season.

PHOENIX Linnaeus

PHOENIX HANCEANA Naud. var. **PHILIPPINENSIS** Becc. in Philip. Journ. Sci. 3 (1908) Bot. 339.

BATAN ISLANDS, Sabtan, *Bur. Sci. 3744 Fénix.*

The collector's note gives the diameter of the trunk of this variety as 45 cm, which he afterwards explained was an error for its circumference.

LICUALA Rumphius

LICUALA SPINOSA Wurmb in Verh. Bat. Genootsch. 2 (1780) 469.

PALAWAN, *Merrill 1463, Bur. Sci. 836 Foxworthy, Bur. Sci. 269 Bermejos.* BALABAC, *Bur. Sci. 448 Mangubat.* CULION, *Merrill 543.*

In thickets at low altitudes, in some regions growing in mud immediately back of the mangrove swamps.

LIVISTONA R. Brown

Conspectus of the species.

a^1. Leaves irregularly parted into primary 2- to 6-costulate segments; secondary segments 1-costulate, very deeply parted into two very long flaccid laciniae. Petiole armed, especially in its lower portion, with very robust spines. Flowers sessile and in small groups on the branchlets. Fruit globose or very slightly reniform, bluish even when dry, 11 to 15 mm in diameter.................................. 1. *L. cochinchinensis.*

a^2. Leaves entire in their central part, and with the periphery more or less deeply divided into always unicostulate segments. Flowers solitary, spirally inserted around the branchlets.

b^1. Flowers relatively large, 4 to 4.5 mm long. Leaves of adult plants having unarmed or, at times, slightly spinose petioles. The dry mature fruit spherical, 22 to 23 mm in diameter, with a very dark brown polished surface. The young fruits are slightly oblong and narrow a little toward the base.. 2. *L. Merrillii.*

b^2. Flowers very small, at most 2 mm in diameter.

c^1. Petioles of the adult plant spinose in their basal part, unarmed elsewhere. Spadix composed of three main inflorescences, free from their bases and all issuing from a common flattened spathe; upper spathes very tightly sheathing throughout, truncate at the mouth, and, as are all the other parts of the spadix, reddish-brown when dry. Fruit spherical even when young, dark-violaceous when fresh, quite black when dry......................... 3. *L. rotundifolia.*

Forma *typica* (not yet found growing in the Philippines) is especially characterized by the seed having the intrusion of the raphe penetrating only two-thirds of the albumen.

d^1. Fruit 2 cm in diameter. Seed traversed completely from base to apex by the intrusion of the raphe. Leaves of very young plants having the petioles armed, in their basal part, with conspicuous spines, as much as 15 to 20 mm in length, the leaves of adult plants with the central segments shortly bifid. *L. rotundifolia* Mart. var. *luzonensis.*

d^2. Fruit 12 to 15 mm in diameter, the kernel alone 10 to 13 mm in diameter. Seed 8 to 10 mm in diameter, more or less traversed by the intrusion of the raphe. Central segments of the adult leaves shortly bifid at their apices. *L. rotundifolia* var. *microcarpa.*

d^3. Fruit of medium size. Central segments of the adult leaves parted into two 15 to 20 cm long laciniae. *L. rotundifolia* var. *mindorensis.*

c^2. Petioles of leaves in the adult plant unarmed, at least in their upper part; in young plants armed with very small spines. The mature fruit yellowish orange when fresh, yellowish brown when dry. Spathes straw-colored, slashed at the mouth. 4. *L. Robinsoniana.*

1. **LIVISTONA COCHINCHINENSIS** Mart. Hist. Nat. Palm. **3** (1838) 319; Hook. f. Fl. Brit. Ind. **6** (1892) 434; Becc. Malesia **3** (1886) 69.

Livistona spectabilis Griff. in Calcutta Journ. Nat. Hist. **5** (1845) 336, Palms Brit. Ind. (1845) 130, *t. 266, C.*

Livistona inaequisecta Becc. in Philip. Journ. Sci. **4** (1909) Bot. 616.

LUZON, Cagayan Province, *For. Bur. 17145, 17302, 17156 Curran,* local name *tarao, For. Bur. 14762 Darling:* Laguna Province, Santa Maria Mavitac, *For. Bur. 10079 Curran;* Cavinti, *Loher 7058.*

2. **LIVISTONA MERRILLII** Becc. in Perk. Fragm. Fl. Philip. (1904) 45, Webbia **1** (1905) 339.

Livistona Whitfordii Becc. in Webbia op. cit. 341, Philip. Journ. Sci. **4** (1909) Bot. 615.

LUZON, Cagayan Province, Mount Narig, *For. Bur. 17811 Curran,* common at 200 meters' altitude, forming small groves in *Shorea* forests, trunk 20 m by 60 cm; *For. Bur. 17278 Curran,* on rocky coral limestone hills near the seashore, altitude 60 meters, locally known as *ballang,* the leaves used for thatching houses and for raincoats, the stems for bows and for flooring: Tayabas Province, Guinayangan, *Merrill 2071* (type), *For. Bur. 10189 Curran;* Atimonan, *Whitford 731* (type of *L. Whitfordii* Becc.): Zambales Province, *For. Bur. 5876 Curran,* locally known as *telsis.*

3. **LIVISTONA ROTUNDIFOLIA** Mart var. **LUZONENSIS** Becc.

Livistona rotundifolia (vix Mart.) Becc. in Leafl. Philip. Bot. **2** (1909) 647.

LUZON, Zambales Province, *For. Bur. 5834 Curran:* Albay Province, *For. Bur. 15322 Aguilar,* local name *anahao* or *bulus:* Tayabas Province, Lucban, *Elmer 9293* (in flower): Union Province, Castillo (specimen with mature fruits), *Loher 7070* in Herb. Kew.: Benguet Subprovince, Sablan, *Bur. Sci. 12687 Fénix* (leaves from a young plant), *Merrill 3799.*[3]

[3] For the uses of the anahao palm see Philip. Bur. Ed. Bull. **54** (1917) 68, 69, *plates.*

LIVISTONA ROTUNDIFOLIA Mart. var. **MICROCARPA** Becc.

Livistona microcarpa Becc. in Philip. Journ. Sci. 2 (1907) Bot. 231.

PALAWAN, Caranugan River, *For. Bur. 3784 Curran*, in river swamps. MINDANAO, Davao District, a few miles west of Digas at Todaya (Mount Apo), *Elmer 11967*, local name *balla.*

LIVISTONA ROTUNDIFOLIA Mart. var. **MINDORENSIS** Becc.

Livistona mindorensis Becc. in Philip. Journ. Sci. 4 (1909) Bot. 615.

MINDORO, Bongabong River, *For. Bur. 4108 Merritt*, very common, Tagalog name *panobao.*

4. **LIVISTONA ROBINSONIANA** Becc. in Philip. Journ. Sci. 6 (1911) Bot. 230.

POLILLO, *Bur. Sci. 9265 Robinson, Bur. Sci 10471 McGregor*, Tagalog *pilig.* LUZON, Laguna Province, Cavinti, *Loher 7056*, in Herb. Kew.

CORYPHA Linnaeus

CORYPHA ELATA Roxb. Fl. Ind. ed. 2, 2 (1832) 176; Griff. Palms Brit. Ind. (1845) 112, *t. 220 D.*

Corypha Gebanga Bl. Rumphia 2 (1836) 59, *t. 97, 98 et 105.*
Livistona Vidalii Becc. in Webbia 1 (1905) 343.
Corypha umbraculifera (non Linn.) Vidal Sinopsis Atlas (1883) 91, *t. 93;* F.-Vill. Novis. App. (1883) 281, incl. var. *cubang* and *sylvestris.*

LUZON, Pangasinan Province (cultivated), *For. Bur. 8410 Curran & Merritt;* Union Province, Naguilian, *Bur. Sci. 13000 Fénix:* Tayabas Province, Lucban, *Elmer 9294:* Pampanga Province, Arayat, *Garcia 63* (leaf from a very young plant, the type of *Livistona Vidalii* Becc.). SIBUYAN, Mount Giting-Giting, *Elmer 12567.* MINDORO, Bongabong River, *For. Bur. 4121 Merritt.* MINDANAO, *Elmer 11965*, with the local name *serrar.*

This species is the buri palm. Leaf strips from it are used in the Philippines for making different sorts of hats [3] and other valuable commercial materials.[4]

The specimens from Mindoro have floriferous branchlets larger than usual, as much as 40 cm in length.

Corypha elata Roxb. is distinguishable from the allied species by the trunk, which in the full-grown plant is very high and relatively slender and is marked all around by a slightly depressed spiral trace of the insertion of the fallen leaves; it is also characterized by its pyramidate inflorescence representing from one-fourth to one-fifth of the entire plant, and by its globular fruit, 20 to 23 mm in diameter, born on pedicels 3 to 5 mm long.

Specimens of *Corypha* collected on Biliran Island by *McGregor* in June, 1914, *Bur. Sci. 18720,* have a secondary branch

[3] See Robinson, C. B., Philippine hats in *Philip. Journ. Sci.* 6 (1911) *Bot.* 106, 113, *t. 7, 8.*

[4] See Farnsworth, C. G., Philip. Bur. Ed. Bull. 54 (1915) 62, 63, *plates.*

of the inflorescence divided into several very short (3 to 5 cm long) fructiferous branchlets, and the fruits are smaller than usual (16 to 18 mm in diameter, the seed 12 mm in diameter). I do not know if this specimen is to be considered an abnormal one, or if it represents a constant characteristic; in the latter case it ought to be considered as a species distinct from *Corypha elata.*

METROXYLON Rottboell

METROXYLON RUMPHII Mart. Hist. Nat. Palm. 3 (1838) 214, 313, *t. 102, 159;* Becc. in Ann. Bot. Gard. Calcutta 12[2]: *t. 105.*

MINDANAO, Davao District, Todaya, *Elmer 11160,* local name *lumbia:* Surigao Province, Catel, *Merrill 5448.*

ZALACCA Reinwardt

ZALACCA CLEMENSIANA Becc. in Philip. Journ. Sci. 4 (1909) Bot. 618, Ann. Bot. Gard. Calcutta 12[2]: *t. 49.*

MINDANAO, Lanao District, Camp Keithley, *Mrs. Clemens 1109;* Davao District, Todaya, *Elmer 11879,* local name *lacaubi.*

PLECTOCOMIA Martius et Blume

PLECTOCOMIA ELMERII Becc. in Ann. Bot. Gard. Calcutta 12[2]: *t. 22.*

MINDANAO, Davao District, Todaya, *Elmer 11887.*

KORTHALSIA Blume

Conspectus of the species.

a^1. Spikes amentiform with very closely crowded flowers and appressed spathels.
  b^1. Leaf-sheaths produced at the base of the petioles into an inflated elongate-elliptic ocrea; leaflets more or less nearly white underneath .... 1. *K. scaphigeroides.*
  b^2. Leaf-sheaths produced at the bases of the petioles into a closely sheathing, densely spinous ocrea.
    c^1. Slender; leaflets of the upper part of the fertile plant small, rhomboidal, green on both surfaces or slightly paler beneath than above .... 2. *K. Merrillii.*
    c^2. Robust; leaflets large, cuneate-rhomboidal or trapezoidal, sharply double-toothed, paler beneath than above .... 3. *K. laciniosa.*
a^2. Spikes of squarrose appearance, the spathes scarious and not appressed; leaves furnished with an elongate, cornet-shaped ocrea which is truncate at the apex; leaflets cuneately rhomboidal, white underneath .... 4. *K. squarrosa.*

1. **KORTHALSIA SCAPHIGEROIDES** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 619, Ann. Bot. Gard. Calcutta 12[2]: *t. 67.*

MINDANAO, Zamboanga District, *For. Bur. 4816 Hutchinson:* Butuan Subprovince, Agusan River, *Merrill 7313.* BASILAN, *For. Bur. 6106 Hutchinson.*

2. **KORTHALSIA MERRILLII** Becc. in Ann. Bot. Gard. Calcutta 12[2]: *t. 81.*

PALAWAN, Malampaya Bay, *Merrill 9410.*

3. **KORTHALSIA LACINIOSA** Mart. Hist. Nat. Palm. 3 (1838) 211, 343.
Korthalsia sp., *Vidal No. 4066;* Becc. in Philip. Journ. Sci. 4 (1909) Bot. 621.

LUZON, Sorsogon Province, Mount Bulusan, *Elmer 16672,* July, 1916, in flower. Vidal's sterile specimen (*4066*), also from Sorsogon, is doubtless this species, to which is also referable another sterile specimen collected at Laguimanoc, Tayabas Province, Luzon, by *Klemme,* November, 1904. Local name *daanan* (which is also the Malay name for several species of *Korthalsia*). Possibly to *Korthalsia laciniosa* Mart. also belongs a sterile specimen collected in Polillo, *Bur. Sci. 10464 McGregor.*

4. **KORTHALSIA SQUARROSA** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 620, Ann. Bot. Gard. Calcutta 12^2: *t. 103.*

PALAWAN, near Iwahig, *For. Bur. 4185 Curran.* BALABAC, *Merrill 5384.*

CALAMUS Linnaeus

Conspectus of the species.

a^1. Leaves noncirriferous (the rachis not prolonged into a filiform, clawed or aculeate appendix).
b^1. Female flowers and fruits sessile or nearly so; that is, not furnished with a distinct pedicel derived from the lengthened involucrophore.
c^1. Leaflets almost equally green on both surfaces.
d^1. Leaflets narrow, linear or linear-lanceolate, 1- to 3-costulate.
e^1. Spadices shortly flagelliferous, about as long as the leaves; fruits small, ovoid; seeds with equable albumen.
f^1. Leaf-sheaths armed with slender straight spines; primary spathes also spinulous; leaflets very numerous; spathels of the female spikelets very short, bracteiform. A very variable plant, of which it is difficult to establish well-defined varieties, as one merges into the other by intermediate forms.................. 1. *C. mollis.*
g^1. Sheathed stem usually 15 to 20 mm in diameter; leaf-sheaths more or less densely spinous; leaves 50 to 80 cm long .... *C. mollis* (forma *typica*).
g^2. Robust; sheathed stem 2.5 to 3 cm in diameter; leaves up to 1.2 m long.................. *C. mollis* var. *major.*
g^3. Slender; sheathed stem 12 to 15 mm in diameter; leaf-sheaths almost spineless.......... *C. mollis* var. *palawanensis.*
f^2. Leaf-sheaths and spathes unarmed; leaflets numerous; spathels of the female spikelets very short, bracteiform.
2. *C. meyenianus.*
f^3. Very slender; leaflets very few and very inequidistant; spathels of the female spikelets shortly infundibuliform.
3. *C. Blancoi.*
e^2. Spadices (male and female) extremely long, and flagelliform, considerably longer than the leaves.
f^1. Leaflets sparingly spinulous on three nerves above, the midrib alone minutely hairy-spinulous underneath; female spadix with thickish spikelets drawn together around the main axis; fruit nearly spherical (13 to 14 by 10 mm), with a broad, blunt, black beak; seed pitted-ruminate.
4. *C. melanorhynchus.*

f^1. Leaflets having three slightly bristly nerves on the upper surface and covered throughout on the lower surface with numerous fulvous bristles; female spadix with slender, very spreading spikelets; fruit small, globose-ovoid (11 to 12.5 by 7 mm), with a narrow beak; seed pitted-ruminate.
5. *C. filispadix.*

f^2. Leaflets with two bristly lateral nerves and the midrib smooth on the upper surface, the midrib bristly and the lateral nerves smooth underneath; spadices very loosely branched; male spikelets short, comblike; fruit spherical, 15 to 16 mm in diameter; seed very deeply ruminate throughout .... 6. *C. Diepenhorstii* var. *exulans.*

d^2. Leaflets lanceolate, 5-costulate; very robust; leaflets large, equidistant; fruit large, ellipsoid, 3.5 cm long, 2.3 mm thick; seed quadrangular .... 7. *C. ornatus* var. *philippinensis.*

c^2. Leaflets conspicuously discolorous, green above, white underneath; leaf-sheaths flagelliferous; spadix flagelliferous at its apex; primary spathes much lacerated in their upper part.

d^1. Leaflets bristly on three nerves above and on the midrib alone beneath .... 8. *C. discolor.*

d^2. Leaflets without bristles or nearly so on the upper surface, densely sprinkled with numerous subspiny bristles beneath.
C. discolor var. *negrosensis.*

b^2. Female flowers supported by a distinct pedicel derived from the elongation of the involucrophore; leaves of the upper part of the plant having the apices with gradually diminishing, pluricostulate leaflets, and the rachis clawed and subcirriferous.

c^1. Leaflets distinctly grouped, broadly oblanceolate and suddenly apiculate, slightly paler below than above; spikelets branched; fruit pisiform .... 9. *C. Cumingianus.*

c^2. Leaflets not grouped, lanceolate, gradually acuminate, more or less covered underneath with a very thin, adherent, ochraceous coating; spikelets simple, elongate; fruit pisiform........ 10. *C. simphysipus.*

a^2. Leaves having the rachis prolonged into a clawed cirrus.

b^1. Male and female spadices having the spikelets provided with a very distinct pedicellar part which is inserted at the bottom of the spathes.

c^1. Very robust; leaf-sheaths covered with slender spiculae, the latter individually distinct or more or less confluent by their broadened bases; leaflets more or less furnished with long bristles, especially on the midrib underneath; secondary spathes coriaceous, entire; fruit spherical, 10 to 12 mm in diameter; secondary spathes smooth.. 11. *C. Merrillii* (forma *typica*).

d^1. Secondary spathes prickly................ *C. Merrillii* var. *Merrittianus.*

d^2. Secondary spathes smooth or nearly so; a smaller plant and with slenderer spikelets than in the species, the fruit also smaller (9 mm in diameter)................ *C. Merrillii* var. *Nanga.*

c^2. Moderately large; leaf-sheaths very densely covered with blackish uniform bristles; leaflets with long bristles on three costae on both surfaces; fruit spherical, 10 to 12 mm in diameter.
12. *C. Foxworthyi.*

b^2. Male and female spadices having sessile spikelets inserted at or near the mouths of their respective spathes.

c^1. Primary spathes elongate and closely sheathing.

d^1. Fruit containing three seeds.

e^1. Robust; leaflets large, subequidistant, lanceolate, long-acuminate, plicate-pluricostulate; spikelets thickish, as much as 15 to 16 cm long; fruit spherical, 14 to 17 mm in diameter. 13. *C. manillensis.*

e^2. A smaller plant; leaflets broadly lanceolate, shortly acuminate, subequidistant in the full-grown plant, in pairs on each side of the rachis in young plants; fruit obovoid, conspicuously beaked .... 14. *C. trispermus.*

d^2. Fruit 1-seeded.

e^1. Leaflets equidistant or nearly so.

f^1. Leaflets broadly lanceolate, pluricostulate.

g^1. Two female flowers at every spathel with a neuter one interposed between the two.

h^1. Female spadix very dense and with short branches; spikelets short and with few flowers; female flowers relatively large, 6 mm long; immature fruits fusiform; fruiting perianth campanulate .... 15. *C. Arugda.*

h^2. Female spadix very diffusely branched; spikelets elongate and with numerous flowers; fruit globose-ovoid; fruiting perianth shortly pedicelliform.............. 16. *C. vinosus.*

g^2. One female flower only at each spathel, with a neuter flower at its side.

h^1. Fruit small, pisiform; seed pitted, the albumen equable or nearly so.

i^1. Leaflets narrowly elliptic-lanceolate, equally narrowed at both ends, more or less spinulose on some nerves above, smooth underneath; fruit 8 to 9 mm in diameter, having squarrose scales in twelve longitudinal series .... 17. *C. Moseleyanus.*

i^2. Leaflets lanceolate, acuminate, more or less spinulous on some nerves above, smooth underneath; fruit 6.5 mm in diameter, having appressed scales in 18 to 20 longitudinal series .... 18. *C. mindorensis.*

i^3. Leaflets lanceolate, very long-acuminate without bristles or spines on either surface; fruit globose-ovoid, 6 mm in diameter, shortly conical-ovoid, and having squarrose scales; leaf-sheaths quite unarmed. 19. *C. multinervis.*

h^2. Fruit rather large; seed with a deeply ruminated albumen.

i^1. Leaflets large, broadly lanceolate, 40 to 42 cm long, 4 to 4.5 cm wide, pluricostulate and with the nerves smooth on both surfaces; fruit spherical, 2 cm in diameter .... 20. *C. grandifolius.*

i^2. Leaflets 5-costulate, elliptic-lanceolate, 22 to 25 cm long, 30 to 32 mm wide, with the nerves smooth on both surfaces; fruit ovoid-ellipsoid, conspicuously beaked, 25 mm long, 18 mm thick. 21. *C. Jenningsianus.*

f^2. Leaflets very narrowly lanceolate, 3-costulate; leaflets more or less bristly-spinulous on three nerves above and smooth underneath; fructiferous spikelets curved-scorpioid; fruit spherical, shortly and obtusely beaked, 12 to 13 mm in diameter; albumen deeply ruminated; leaf-sheaths armed with scattered spines .... 22. *C. Samian.*

e^2. Leaflets conspicuously inequidistant.

f^1. Leaflets more or less distinctly geminate on each side of the rachis, 5-pluricostulate, oblong or lanceolate, the leaflets of each pair parallel, that is, not approximate by their bases and not divaricating; fruiting perianth pedicelliform, the fruit itself furnished with a short, pedicelliform or necklike involucrophore.

g^1. Robust; leaflets very large, pluricostulate oblong-spathulate with smooth nerves on both surfaces; 35 to 45 cm long, 6 to 10 cm wide; fruit spherical, 13 mm in diameter; leaf-sheaths unarmed .... 23. *C. megaphyllus.*

g^2. Rather slender; leaf-sheaths armed with slender spines; leaflets elliptic-lanceolate or oblanceolate, 15 to 25 cm long, 3 to 6.5 cm wide, with five slender costae almost smooth on both surfaces........................ 24. *C. Elmerianus.*

g^3. Slender; leaf-sheaths unarmed; leaflets oblanceolate-elliptic or oblong-spathulate, 20 to 24 cm long, 5 to 6.5 cm wide, smooth on both surfaces; fruit globose, 9 to 10 mm in diameter.. 25. *C. mitis.*

f^2. Leaflets 5-costulate, those of each pair very approximate by their bases and divaricate; female spikelets having the involucrophorum (where known) not the least pedicelliform or necklike, but immersed within its spathel.

g^1. Of medium size; leaf-sheaths strongly spinous; leaflets elliptic-lanceolate, 22 to 25 cm long, 6 to 6.5 cm wide, very frequently furnished with one or two rigid spines on the midrib above near the base, otherwise smooth on both surfaces; fruiting perianth obconical, almost spreading .... 26. *C. Reyesianus.*

g^2. Slender; leaf-sheaths smooth or very sparingly spinulous; leaflets elliptic-lanceolate, 10 to 16 cm long, 2 to 3.5 cm wide, usually furnished with a few erect needlelike spines on some of the five costae on the upper surface and on the margins or else entirely smooth; fruiting perianth almost explanate; fruit spherical, 10 to 11 mm in diameter... 27. *C. spinifolius.*

g^3. Leaf-sheaths 2.5 cm in diameter, armed with short spines; leaflets deep green and smooth when dry, almost equally shiny on both surfaces, lanceolate-elliptic, quite devoid of hairs or spinules even at the apex and on the margins, occasionally furnished above with a robust spinule on the midrib near the base; male spikelets flattened-pectinate, with contiguous flowers and very approximate bracteiform spathels............................ 28. *C. viridissimus.*

f^3. Leaflets in distant groups; the latter composed of more than two leaflets on each side of the rachis; leaf-rachis smooth.

g^1. Slender; leaf-rachis smooth above; leaflets in groups of 2 to 4 on each side of the rachis, lanceolate, very long-acuminate to a filiform tip, 3- sub 5-costulate, 20 to 30 cm long, 15 to 20 cm wide; female spadix very diffusely paniculate; spikelets filiform; fruit very small, spherical, 5 mm in diameter............ 29. *C. microsphaerion.*

h^1. Leaf-sheaths unarmed; leaflets glabrous on both surfaces. *C. microsphaerion* (forma *typica*).

h^2. Leaf-sheaths strongly armed with short spines; leaflets slightly bristly-spinulous on one to three nerves on the upper surface...... *C. microsphaerion* var. *spinosior.*

g^2. Rather slender; leaflets in distant groups of 3 to 9 on each side of the rachis, linear, 1-, sub 3-costulate, smooth on both surfaces, 20 to 25 cm long, 1 cm wide; female spadix very diffuse and much branched; spikelets filiform; fruiting perianth shortly pedicelliform; fruit very small, globose.. 30. *C. ramulosus.*

f^4. Leaflets very inequidistant, yet not distinctly grouped on each side of the rachis, the latter strongly prickly above, at least in its lower portion; leaflets elongate, linear-lanceolate, rigid, 3-costulate, more or less spinuliferous on the upper surface, smooth underneath, 30 to 32 cm long, 20 to 25 mm wide; leaf-sheaths about 2 cm in diameter, armed with scattered, pale, acicular spines; male and female spadices shorter than the leaves, simply and spreadingly branched.. 31. *C. Vidalianus.*

c^3. Primary spathes very loosely sheathing, usually short, and more or less inflated in their upper part. The species of this group are difficult to discriminate if the specimens are not with mature fruits; the male spadices alone do not offer appreciable characters for specific distinction.

d^1. Fruit very small, having convex scales, the latter only slightly or not at all grooved along the center and with the points not appressed or subsquarrose.

e^1. Leaf-sheaths armed with scattered slender spines or almost smooth; fruiting perianth pedicelliform, terete.

f^1. Leaf-sheaths armed with scattered slender spines; primary spathes aculeolate; fruit ovoid or subobovoid, 6 mm long, 3.5 to 4 mm thick, the scales arranged in fifteen longitudinal series............ 32. *C. siphonospathus* (forma *typica*).

f^2. Leaf-sheaths almost spineless; primary spathes smooth; fruit with scales arranged in fifteen longitudinal series. *C. siphonosphathus* var. *sublaevis.*

f^3. Fruit with scales in twelve longitudinal series; leaflets with five bristly nerves on the upper surface. *C. siphonospathus* var. *oligolepis major.*

f^4. Smaller; fruit with scales in twelve longitudinal series; leaflets with three bristly nerves on the upper surface. *C. siphonospathus* var. *oligolepis minor.*

f^5. Primary spathes aculeolate; fruit with scales in eighteen longitudinal series............ *C. siphonospathus* var. *polylepis.*

f^6. Primary spathes very slightly inflated; fruit elongate-ellip-

soid, 10 to 11 mm long (including the perianth), 5 mm thick; scales in fourteen or fifteen longitudinal series.
C. siphonospathus var. *batanensis*.

e^2. Leaf-sheaths very densely armed, at least in their upper part, with ascending unequal spines.

f^1. Leaf-sheaths armed with elongate, ascending, very narrowly laminar spines; the elongate ligula densely armed with similar spines; petiole and rachis armed irregularly with unequal spines; leaflets with rigid bristles on the midrib alone above, smooth underneath; margins conspicuously spinulous-ciliate; fruit small, ovoid-ellipsoid, 8 to 9 mm long, 5 mm thick; fruiting perianth campanulate, sub-pedicelliform........ 33. *C. dimorphacanthus* (forma *typica*).

g^1. Leaf-sheaths armed with unequal long spines, some of which are very slender and criniform, others laminar; the very elongate ocrea is also armed with similar spines; leaflets with rigid bristles on three nerves above and smooth underneath; margins closely and finely ciliate-spinulous.
C. dimorphacanthus var. *montalbanicus*.

g^2. Leaf-sheaths very densely armed, in their upper part mostly, with very rigid subcriniform spines; leaflets very rigid, furnished on the upper surface with distant coarse bristles on the midrib alone, the lower surface smooth, margins coarsely spinulous; fruit larger than in the species, globose, 13 mm long, 10 mm thick; supported by the short terete pedicelliform perianth.
C. dimorphacanthus var. *zambalensis*.

d^2. Fruit covered by strongly gibbous scales, very deeply grooved along the center, and with very appressed points.

e^1. Fruit ovoid or subglobose-ovoid, 8 to 12 mm long, including the short, terete, supporting perianth, and 5 to 8 mm thick, obtusely beaked.

f^1. Leaflets numerous, elongate, 10 to 15 mm wide; leaves with subequidistant leaflets, at least in their lower part, and more or less grooved above.
34. *C. microcarpus* (forma *typica*).

f^2. Very slender; leaflets very narrow, not numerous, and very inequidistant; spadix small..*C. microcarpus* var. *diminutus*.

e^2. Fruit ovoid or subovoid, minutely beaked, 17 mm long, including the short, terete, pedicelliform perianth, and 12 mm through .... 35. *C. halconensis*.

c^3. The primary spathes at first enveloping the partial inflorescences, then splitting longitudinally and opening flat, becoming laminar and finally falling in decay; leaflets conspicuously discolorous, green above and with a chalky coating underneath; fruit small, ovoid or globose-ovoid, 8 to 9 mm long, including the short, terete, pedicelliform perianth, and 5 mm thick .... 36. *C. bicolor*.

1. **CALAMUS MOLLIS** Blanco Fl. Filip. (1837) 264; ed. 2 (1845) 184; ed. 3, 1 (1877) 329; Kunth Enum. Pl. 3 (1841) 594; Mart. Hist. Nat. Palm. 3 (1838) 336; Walp. Ann. 3 (1853) 486, 5 (1858) 831;

Miq. Fl. Ind. Bat. 3 (1855) 123; Becc. in Rec. Bot. Surv. Ind. 2 (1902) 204, Perk. Fragm. Fl. Philip. 1 (1904) 46, Webbia 1 (1905) 345, Philip. Journ. Sci. 3 (1908) Bot. 342, Ann. Bot. Gard. Calcutta 11 (1908) 212, *t. 61, 62* and Suppl. 21; C. B. Robinson in Philip. Journ. Sci. 6 (1911) 117; Farnsworth Philip. Bur. Ed. Bull. 54 (1915) 19; 72–73 with fig.

Calamus Haenkeanus Mart. l. c. 3: 212 (1st ed.) and 337; Kunth Enum. Plant 3 (1841) 211; Walpers Ann. 3 (1852) 488, 5 (1858) 831; Miq. Fl. Ind. Bat. 3 (1855) 127.

Calamus usitatus (not of Blanco) Mart. op. cit. 340; Vidal Sinopsis Atlas (1883) *t. 93, f. D.*

Calamus sp. Cuming No. 1478; Vidal Phan. Cuming Philip. (1885) 154.

LUZON, Camarines Province, *Cuming 1478:* "Manilla," *Gaudichaud* in Herb. Deless.: Rizal Province (Morong) *Vidal 1939,* Herb. Kew.; Bosoboso, *Loher 1372, 1367,* Herb. Kew., *Bur. Sci. 381 Ramos;* Montalban, *Loher 7081,* Herb. Kew.; Antipolo, *For. Bur. 389 Ahern's collector:* Bataan Province, Mount Mariveles, *Warburg 12506,* Herb. Berol., *For. Bur. 6372 Curran, For. Bur. 3026 Borden, For. Bur. 2481 Barnes:* Bulacan Province, Baliuag, *Bur. Sci. 9571 Robinson:* Nueva Ecija Province, *For. Bur. 8484 Curran:* Ilocos Norte Province, *Bur. Sci. 7723 Ramos:* Bontoc Subprovince, *For. Bur. 17034 Curran:* Nueva Vizcaya Province, Dupax, *Bur. Sci. 11218, 11322 McGregor:* Cagayan Province, *For. Bur. 17273 Curran,* local name *barit.* BABUYAN ISLANDS, Camiguin, *Bur. Sci. 4032 Fénix.* BILIRAN, *Bur. Sci. 18634 McGregor.* MINDANAO, Surigao Province, *Bolster 347:* Zamboanga District, *For. Bur. 4819 Hutchinson:* Davao District, Todaya, Mount Apo, *Elmer 11969,* local name *arit.*

CALAMUS MOLLIS Blanco var. **MAJOR** Becc. in Webbia 1 (1905) 345, Ann. Bot. Gard. Calcutta 11: Suppl. 23; Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 31.

LUZON, Bataan Province, Lamao River, Mount Mariveles, *For. Bur. 2499 Meyer,* local name *uay.*

CALAMUS MOLLIS Blanco var. **PALAWANICUS** Becc. in Philip. Journ. Sci. 2 (1907) Bot. Gard. Calcutta 11: Suppl. 22.

PALAWAN, *For. Bur. 3613 Curran, Bur. Sci. 609 Foxworthy;* Puerto Princesa, *Bur. Sci. 191, 196 Bermejos;* Brooke's Point, *Elmer 12607.*

Barely distinguishable from the type; the leaflets, however, are frequently almost equidistant.

2. **CALAMUS MEYENIANUS** Schauer in Nova Acta Acad. Caes. Nat. Cur. 19 (1843) Suppl. 1: 425; Becc. in Rec. Bot. Surv. Ind. 2 (1902) 217, Ann. Bot. Gard. Calcutta 11 (1908) 215, *t. 63.*

LUZON, Pangasinan Province, near the village of San Mateo on Mount Masiquie, *Callery* in Herb. Paris; Umingan, *Bur. Sci. 17755 Otanes:* Nueva Vizcaya Province, vicinity of Dupax, *Bur. Sci. 11442 McGregor.*

3. **CALAMUS BLANCOI** Kunth Enum. Pl. 3 (1841) 595; Mart. Hist. Nat. Palm. 3 (1849) 343; Walpers, Ann. 3 (1853) 492, 5 (1858) 832; Miq. Fl. Ind. Bat. 3 (1855) 139; Becc. in Rec. Bot. Surv. Ind. 2 (1902) 204.

Calamus gracilis (not of Roxb.) Blanco Fl. Filip. (1837) 267, ed. 2 (1845) 186, ed. 3, 1 (1877) 332.

Calamus brevifrons Mart. op. cit. 3: 338; Miq. op. cit. 127.

Calamus parvifolius Vidal Phan. Cuming. Philip. (1885) 154, non Roxb.

LUZON, Albay Province, *Cuming 1225:* Bataan Province, Mount Mariveles, *Loher 1376:* Zambales Province, *For. Bur. 387 Maule.* LEYTE, Palo, *Elmer 7282.*

4. **CALAMUS MELANORHYNCHUS** Becc. in Ann. Bot. Gard. Calcutta 11: Suppl. 30, *t. 16.*

MINDANAO, Davao District, Mount Apo, *Elmer 11708.*

5. **CALAMUS FILISPADIX** Becc. in Philip. Journ. Sci. 6 (1911) Bot. 230, Ann. Bot. Gard. Calcutta 11 (1908) Suppl. 28, *t. 15.*

Calamus Hookerianus Becc. in Philip. Journ. 5 (1909) Bot. 621 (non in Ann. Bot. Gard. Calcutta 11: 226).

LUZON, Albay Province, Adlumay Hills, *For. Bur. 10630 Curran* (with young fruits; type specimen): Tayabas Province, Kabibihan, *Bur. Sci. 13128 Foxworthy & Ramos* (♀ specimen in flower); Rizal Province, Montalban, *Loher 7084* in Herb. Kew. (this specimen was erroneously mentioned by me under *C. Diepenhorstii* var. *exulans* Becc. in Ann. Bot. Gard. Calcutta, Suppl. 51). POLILLO, *Bur. Sci. 10467 McGregor.* PALAWAN, Puerto Princesa, *Elmer 12769;* Taytay, *Merrill 7251* (sterile specimen) (the Palawan plant perhaps represents a distinct variety). MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 13949* (perhaps representing a distinct variety).

6. **CALAMUS DIEPENHORSTII** Miq. var. **EXULANS** Becc. in Philip. Journ. Sci. 5 (1909) Bot. 627, 6 (1911) Bot. 230, Ann. Bot. Gard. Calcutta 11: Suppl. 51 (excl. *Loher 7054*).

PALAWAN, Taytay, *Merrill 9357;* Mount Victoria, *Bur. Sci. 756 Foxworthy.* POLILLO, *Bur. Sci. 9111 Robinson.*

7. **CALAMUS ORNATUS** Blume var. **PHILIPPINENSIS** Becc. in Ann. Bot. Gard. Calcutta 11 (1908) 370.

Calamus maximus Blanco Fl. Filip. ed. 1 (1837) 265, ed. 2 (1845) 185, ed. 3, 1 (1877) 331; Kunth Enum. 3 (1841) 595; Mart. Hist. Nat. Palm. 3 (1849) 343; Walp. Ann. 3 (1853) 492, 5 (1858) 832; Miq. Fl. Ind. Bat. 3 (1855) 138.

LUZON, without definite locality, *Loher 1387* Herb. Kew.: Bataan Province, Mount Mariveles, *Whitford 343, 502, For. Bur. 212 Barnes, For. Bur. 2489 Borden:* Tayabas Province, Lucban, *Elmer 7625;* Unisan, *Reyes:* Laguna Province, San Antonio, *Bur. Sci. 16619 Ramos:* Cagayan Province, *For. Bur. 17252 Curran* (♂ flowers): Rizal Province, Montalban, *Loher* in Herb. Kew., Tagalog name *limuran* or *alimoran.* MINDORO, Bongabong River, *For. Bur. 3911, 3913 Merritt.* NEGROS, *For. Bur. 6089 Everett.* BASILAN, *For. Bur. 6107 Hutchinson.* POLILLO, *Bur. Sci. 9266 Robinson, Bur. Sci. 10461 McGregor,* Tagalog name *limuran.* MINDANAO, Davao District, Mount Apo, *Elmer 11236.*

8. **CALAMUS DISCOLOR** Mart. Hist. Nat. Palm. 3: 212 (1st ed.) and 341; Kunth Enum. Pl. 3 (1841) 212; Walp. Ann. 3 (1853) 491, 5 (1858) 832; Miq. Fl. Ind. Bat. 3 (1855) 136; Becc. in Ann. Bot.

Gard. Calcutta 11 (1908) 495, *t. 228*, and Suppl. 125, *t. 71*, Leafl. Philip. Bot. 2 (1909) 649.

Calamus Lindenii Rodigas Illustr. Hort. 30 (1883) 157, *t. 489;* Ridley in Journ. Str. Branch Roy. As. Soc. 44 (1905) 200.

LUZON, Tayabas Province, Lucban, *Elmer 9299:* Laguna Province, San Antonio, *Bur. Sci. 12035 Ramos*, Tagalog *hamlis*.

CALAMUS DISCOLOR Rodigas var. **NEGROSENSIS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 635, Ann. Bot. Gard. Calcutta 11: Suppl. *t. 72.*

NEGROS, Cadiz, *For. Bur. 12432 Danao, For. Bur. 20893 Tamesis.*

9. **CALAMUS CUMINGIANUS** Becc. in Record Bot. Surv. Ind. 2 (1902) 210, Ann. Bot. Gard. Calcutta 11 (1908) 348, *t. 142.*

Calamus sp. Vidal Phan. Cuming. Philip. (1885) 18, 154.

LUZON, Tayabas Province, *Cuming 762* in Herb. Kew.

To this species apparently also belongs *Elmer 13646*, collected at Cabadbaran, Mount Urdaneta, Agusan Province, Mindanao.

10. **CALAMUS SIMPHYSIPUS** Mart. Hist. Nat. Palm. 3: *t. Z, 8, f. 14;* Becc. in Ann. Bot. Gard. Calcutta 11 (1908) 346, *t. 141.*

MINDANAO, Agusan Province, Cabadbaran (Mount Urdaneta), along Cantagan Creek at about 900 meters' altitude, *Elmer 13902*, Manobo name *balanog*.

11. **CALAMUS MERRILLII** Becc. Ann. Bot. Gard. Calcutta 11 (1908) 390, *t. 167*, and Suppl. 78, *t. 41*, Webbia 1 (1905) 347, Philip. Journ. Sci. 4 (1909) Bot. 629.

Calamus maximus (not of Blanco) Becc. in Perk. Fragm. Fl. Philip. (1904) 45.

LUZON, Rizal Province, Bosoboso, *Merrill 1893* (type specimen); Mount Matulid (1,200 meters' altitude), *Loher 7074* in Herb. Kew. (male specimen); Montalban, *Loher 7076* in Herb. Kew. (fruit): Laguna Province, *For. Bur. 20654 Villamil.* MINDANAO, Lake Lanao, Camp Keithley, *Mrs. Clemens 1112, 1124:* Agusan Province, Cabadbaran, Mount Urdaneta, *Elmer 13926*, Manobo name *palasan:* Davao District, Todaya, Mount Apo, *Elmer 11885*, Bagobo name *acab-acab*.

The specimens from Mindanao represent a transition to var. *Merrittianus*. Apparently it grows also in Basilan Island, judging from a sterile specimen collected by *Hutchinson, For. Bur. 6098.*

CALAMUS MERRILLII Becc. var. **NANGA** Becc. in Ann. Bot. Gard. Calcutta 11: Suppl. 79.

MINDANAO, Davao District, Mount Apo, *Elmer 11874, 11110.*

CALAMUS MERRILLII Becc. var. **MERRITTIANUS** Becc. in Ann. Bot. Gard. Calcutta 11: Suppl. 78 *t. 42.*

Calamus Merrittianus Becc. in Philip. Journ. Sci. 2 (1907) Bot. 233, 4 (1909) Bot. 629.

MINDORO, Bongabong River, *For. Bur. 3912 Merritt.*

12. **CALAMUS FOXWORTHYI** Becc. in Ann. Bot. Gard. Calcutta 11: Suppl. 81, *t. 45.*

PALAWAN, Victoria Peak, *Bur. Sci. 690 Foxworthy.*

13. **CALAMUS MANILLENSIS** H. Wendl. in Kerch. Les Palm. (1878) 237; Becc. in Rec. Bot. Surv. India 2 (1902) 215, Webbia 1 (1905) 349, Ann. Bot. Gard. Calcutta 11 (1908) 413, *t. 226, f. 1,* and Suppl. 98, *t. 55.*

Daemonorops manillensis Mart. Hist. Nat. Palm. 3: 330, *t. 175, VIII, f. 1–3;* Walp. Ann. 3 (1853) 480, 5 (1858) 829.

LUZON, "Manilla," *Gaudichaud* in Herb. Delessert: Nueva Vizcaya Province, Dupax, *Bur. Sci. 18994 McGregor.* MINDANAO, Davao District, Mount Apo, *Elmer 11714, 10560:* Agusan Province, Mount Urdaneta, *Elmer 14133, 14011, 14173.*

14. **CALAMUS TRISPERMUS** Becc. in Perk. Fragm. Fl. Philip. (1904) 46, Ann. Bot. Gard. Calcutta 11 (1908) 412, *t. 180,* and Suppl. 97, Webbia 1 (1905) 349.

LUZON, Rizal Province, Antipolo, *Merrill 1645;* Montalban, *Loher 7071* in Herb. Kew.

15. **CALAMUS ARUGDA** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 622, Ann. Bot. Gard. Calcutta 11: Suppl. 90, *t. 50.*

LUZON, Cagayan Province, Lalloc, *For. Bur. 6649 Klemme.*

16. **CALAMUS VINOSUS** Becc. in Leafl. Philip. Bot. MS.

MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 14158.*

A well-characterized species, resembling *C. multinervis,* but offering the very uncommon characters of two female flowers at every spathel with a neuter one interposed, and the wine red color of the ripe fruits.

17. **CALAMUS MOSELEYANUS** Becc. in Record Bot. Surv. Ind. 2 (1902) 211, Ann. Bot. Gard. Calcutta 11 (1908) 396, *t. 171,* and Suppl. 82, Webbia 1 (1905) 348.

MALANIPA near Basilan, *Moseley* in Herb. Kew. MINDANAO, Zamboanga District, San Ramon, *Hallier:* Davao District, Mount Apo, *Elmer 11886.*

18. **CALAMUS MINDORENSIS** Becc. in Ann. Bot. Gard. Calcutta 11: Suppl. 82, *t. 46.*

MINDORO, Balete, on Baco River, *McGregor 309, For. Bur. 6217 Merritt,* local name *tumalin.*

19. **CALAMUS MULTINERVIS** Becc. Ann. Bot. Gard. Calcutta 11: Suppl. 88, *t. 49.*

MINDANAO, Davao District, Mount Apo, *Elmer 11955* (male plant), Bagobo name *balala;* and in the same district, south of the Baruring River, *Elmer 11791* (specimen with young fruits), Bagobo name *ubbli.*

20. **CALAMUS GRANDIFOLIUS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 629, Ann. Bot. Gard. Calcutta 11: Suppl. 94, *t. 53.*

LUZON, Laguna Province, Mount Banahao, *Loher 7088* in Herb. Kew.: Tayabas Province, Infanta, *Bur. Sci. 9448 Robinson.*

21. **CALAMUS JENNINGSIANUS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 623, Ann. Bot. Gard. Calcutta 11: Suppl. 91, *t. 51.*

MINDORO, Mount Halcon, *For. Bur. 4400 Merritt.*

22. **CALAMUS SAMIAN** Becc. Ann. Bot. Gard. Calcutta 11: Suppl. 92, *t. 52.*

MINDANAO, Davao District, Mount Apo, *Elmer 11336,* Bagobo name *samian.*

23. **CALAMUS MEGAPHYLLUS** Becc. in Ann. Bot. Gard. Calcutta 11: Suppl. 66, *t. 35.*

MINDANAO, Davao District, Mount Apo, *Elmer 11878:* Agusan Province, Mount Urdaneta, *Elmer 13542.*

24. **CALAMUS ELMERIANUS** Becc. in Leafl. Philip. Bot. 2 (1909) 647, Ann. Bot. Gard. Calcutta 11: Suppl. 69, *t. 37.*

LUZON, Tayabas Province, Lucban, *Elmer 9298* (type specimen). MINDANAO, Davao District, Mount Apo, *Elmer 11756;* Agusan Province, Mount Urdaneta, *Elmer 14166;* Agusan River, *Merrill 7289.* (The Mindanao plant perhaps represents a distinct variety.)

25. **CALAMUS MITIS** Becc. in Philip. Journ. Sci. 3 (1908) Bot. 341, Ann. Bot. Gard. Calcutta 11: Suppl. 68, *t. 36.*

BATAN ISLANDS, Batan, *Bur. Sci. 3817 Fénix.*

26. **CALAMUS REYESIANUS** Becc. in Philip. Journ. Sci. 2 (1907) Bot. 237, Ann. Bot. Gard. Calcutta 11: Suppl. 86, *t. 48.*

LUZON, Tayabas Province, Unisan, *Reyes;* Tagcauayan, *Bur. Sci. 13312 Ramos.*

Probably a sterile specimen collected by *Hutchinson, For. Bur. 6105,* in Basilan Island is referable to this species.

27. **CALAMUS SPINIFOLIUS** Becc. in Rec. Bot. Surv. Ind. 2 (1902) 202, Ann. Bot. Gard. Calcutta 11 (1908) 410, *t. 178, 179,* Suppl. 95, Webbia 1 (1905) 348.

PANAY, Iloilo Province, Igbaras, *Vidal 3954* in Herb. Kew. and Beccari (sterile specimen). LUZON, Pampanga Province, Arayat, *Loher 1373,* Herb. Kew., *Garcia 59,* local name *curacling* (sterile): Bataan Province, *For. Bur. 17309 Curran* (male specimen), *For. Bur. 1454 Ahern's collector* (fruiting specimen), *For. Bur. 20947 De Leon.*

28. **CALAMUS VIRIDISSIMUS** Becc. Ann. Bot. Gard. Calcutta 11: Suppl. 84, *t. 47.*

MINDANAO, Davao District, Mount Apo, *Elmer 11938,* Bagobo name, *acal.*

Probably the following sterile specimens also belong to *C. viridissimus:* MINDANAO, Zamboanga District, *For. Bur. 4820, 5180 Hutchinson.*

29. **CALAMUS MICROSPHAERION** Becc. in Perk. Fragm. Fl. Philip. (1904) 45, Webbia 1 (1905) 349, Ann. Bot. Gard. Calcutta 11 (1908) 543, *t. 204,* and Suppl. 113.

CULION, Halsey Harbor, *Merrill 507.*

Apparently a sterile specimen collected by *Hutchinson* in Mindanao, *For. Bur. 4818*, also belongs to this species. In this specimen the sheathed stem is only 8 to 9 mm in diameter, and the sheaths are provided with some very small, scattered, tuberculiform spines.

CALAMUS MICROSPHAERION Becc. var. **SPINOSIOR** Becc. var. nov.

Sheathed stem 2 to 3 cm in diameter; leaf-sheaths densely armed with scattered rather robust spines 5 to 12 mm long and having broad subbulbous bases. Leaflets bristly-spinulous on 1 to 3 costae above.

PALAWAN, Taytay, *Merrill 9358* (with ♂ flowers), *9247* (with fruits).

80. **CALAMUS RAMULOSUS** Becc. in Perk. Fragm. Fl. Philip. (1904) 46, Webbia 1 (1905) 349, in Ann. Bot. Gard. Calcutta 11 (1908) 454, *t. 205*.

LUZON, Tayabas Province, Guinayangan, *Merrill 2070*.

31. **CALAMUS VIDALIANUS** Becc. in Rec. Bot. Surv. Ind. 2 (1902) 212, Webbia 1 (1905) 350, Ann. Bot. Gard. Calcutta 11 (1908) 464, *t. 121*, and Suppl. 114, *t. 64*.

Calamus horrens ? Vidal Rev. Pl. Vasc. Filip. (1886) 280 (not of Blume).

LUZON, Tayabas Province, Unisan, *Vidal 933*, in Herb. Kew. (type specimen); Guinayangan, *Bur. Sci. 13214 Ramos* (♂ specimen in flower): Rizal Province, Montalban, *Loher 7087* in Herb. Kew., Tagalog *bogtong* (♀ specimen in flower): Bataan Province, *For. Bur. 20948 De Leon:* Nueva Ecija Province, *For. Bur. 22162 Alvarez* (♂).

32. **CALAMUS SIPHONOSPHATHUS** Mart. Hist. Nat. Palm. 3: 342; Walpers Ann. 3 (1853) 491, 5 (1858) 832; Miq. Fl. Ind. Bat. 3 (1855) 137; Becc. in Rec. Bot. Surv. Ind. 2 (1902) 213, Webbia 1 (1905) 350, Ann. Bot. Gard. Calcutta 11 (1908) 471, and Suppl. 115.

Calamus sp. Vidal Rev. Pl. Vasc. Filip. (1886) 330 (No. 931 and 1942).

Calamus siphonospathus is a very variable plant; it is, however, easily distinguishable by its spadices sheathed in gradually diminishing, subimbricate, loosely-tubular, subinflated spathes; by their dense and short, supradecompound, female inflorescences; and by the very small fruits. The inflated spathes of this *Calamus* are, apparently, ant-harboring organs.

CALAMUS SIPHONOSPATHUS Mart. forma **TYPICA** Becc. in Ann. Bot. Gard. Calcutta 11 (1908) 473.

LUZON, "Manila," *Perrottet* in Herb. Delessert: Rizal Province, Bosoboso, *Merrill 1891*, *Loher 1364* in Herb. Kew.; Montalban, *Loher 7089* in Herb. Kew. (♀) and *7077* (♂): Isabela Province, Cabagan River, *For. Bur. 18558 Alvarez* (♂), Negrito name *jusi*.

I am not quite sure that the sterile specimen, *Garcia 60*, mentioned in "Asiatic Palms" really is *C. siphonospathus*.

CALAMUS SIPHONOSPATHUS Mart. var. **SUBLAEVIS** Becc. in Webbia 1 (1905) 352, Ann. Bot. Gard. Calcutta 11 (1908) 474.

LUZON, Bataan Province, Lamao River, *Whitford 308*, *For. Bur. 1577 Borden*, *For. Bur. 2635 Meyer*, *For. Bur. 6225*, *6514 Curran:* Ilocos Norte Province, Mount Piao, *For. Bur. 13985 Merritt & Darling*.

CALAMUS SIPHONOSPATHUS Mart. var. **FARINOSUS** Becc. Ann. Bot. Gard. Calcutta 11 (1908) 474.

LUZON, Rizal Province, Montalban, *Loher 7083* in Herb. Kew.

CALAMUS SIPHONOSPATHUS Mart. var. **OLIGOLEPIS** (*major*) Becc. in Webbia 1 (1905) 353, Ann. Bot. Gard. Calcutta 11 (1908) 475, *t. 215*.

Calamus inflatus Warb. in Herb. Berol.; Becc. in Perk. Fragm. Fl. Philip. (1904) 45.

LUZON, Tayabas Province, Sampaloc, *Warburg* in Herb. Berol.

CALAMUS SIPHONOSPATHUS Mart. var. **OLIGOLEPIS** (*minor*) Becc. in Webbia 1 (1905) 353, Ann. Bot. Gard. Calcutta 11 (1908) 476, *t. 217*.

LUZON, Isabela Province, Malunu, *Warburg* in Herb. Berol.

CALAMUS SIPHONOSPATHUS Mart. var. **BATANENSIS** Becc. in Philip. Journ. Sci. 3 (1908) 342, Bot. Ann. Gard. Calcutta 11: Suppl. 115.

BATAN ISLANDS, Batan, *Bur. Sci. 3611 Fénix*.

33. **CALAMUS DIMORPHACANTHUS** Becc. in Rec. Bot. Surv. Ind. 2 (1902) 214, Ann. Bot. Gard. Calcutta 11 (1908) 479 *t. 219*, Suppl. 117, Philip. Journ. Sci. 4 (1909) Bot. 631.

PANAY, Iloilo Province, Igbaras, *Vidal 3956*, in Herb. Becc. and Kew., local name *taguiti*. LUZON, Union Province, *Loher 1371* in Herb. Kew.: Benguet Subprovince, *Loher 1370* in Herb. Kew.; Mount Santo Tomas, *Elmer 6238*.

Perhaps a variety of this species is *Bur. Sci. 20559 Ramos*, from San Antonio, Laguna Province, with ♂ flowers; the leaflets are very inequidistant and have three nerves covered with bristly spinules above, and the midrib minutely spinulous underneath.

CALAMUS DIMORPHACANTHUS Becc. var. **MONTALBANICUS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 631, Ann. Bot. Gard. Calcutta 11: Suppl. 117, *t. 118*.

LUZON, Rizal Province, Montalban, Mount Batay, *Loher 7085* in Herb. Kew.

CALAMUS DIMORPHACANTHUS Becc. var. **ZAMBALENSIS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 632, Ann. Bot. Gard. Calcutta 11: Suppl. 118.

LUZON, Zambales Province, *For. Bur. 8412 Curran & Merritt*.

34. **CALAMUS MICROCARPUS** Becc. in Rec. Bot. Surv. Ind. 2 (1902) 213, Webbia 1 (1905) 355, Ann. Bot. Gard. Calcutta 11 (1908) 477, *t. 218*, and Suppl. 116, Philip. Journ. Sci. 4 (1909) Bot. 627, 6 (1911) Bot. 230.

LUZON, Camarines Province, *Vidal 3952* in Herb. Becc. and Kew.: Rizal Province, Montalban, *Loher* in Herb. Kew.: Laguna Province, Mount Maquiling, *For. Bur. 13305 Tamesis, For. Bur. 20668 Villamil:* Tayabas Province, *Bur. Sci. 12326 Foxworthy.* MINDANAO, Lanao District, Lake Lanao, *Mrs. Clemens 1232:* Agusan Province, Cabadbaran, *Elmer 13551:* Davao District, Todaya, Mount Apo, *Elmer 10676.* POLILLO, *Bur. Sci. 9131 Robinson, Bur. Sci. 10465 McGregor.*

Apparently a specimen with male spadices, from Abulug River, Cagayan Province, Luzon, *For. Bur. 11625 Fischer* also belongs to *C. microcarpus.*

CALAMUS MICROCARPUS Becc. var. **DIMINUTUS** Becc. var. nov.

Very slender, sheathed stem 8 to 10 mm in diameter. Leaves with very narrowly linear, very long-acuminate, very inequidistant, and more or less distantly grouped leaflets, the latter 4 to 5 mm wide. Spadix very short. Fruit globular, 8 mm in diameter.

LUZON, Laguna Province, San Antonio, *Bur. Sci. 16599 Ramos.*

I am uncertain if we have to do with a case of occasional slenderness of *Calamus microcarpus* or with a really distinct and constant variety or even a subspecies of it. Very similar to the preceding specimen is another, which is a little larger and with a male spadix. The sheathed stem is 11 mm in diameter; the leaflets are 5 to 6 mm wide. Kabibihan, Tayabas Province. *Bur. Sci. 13240 Ramos.*

35. **CALAMUS HALCONENSIS** Becc. in Philip. Journ. Sci. 4 (1909) Bot. 633, Ann. Bot. Gard. Calcutta 11: Suppl. 116, *t. 65.*

MINDORO, Mount Halcon, *For. Bur. 4399 Merritt.*

36. **CALAMUS BICOLOR** Becc. in Ann. Bot. Gard. Calcutta 11. Suppl. 126, *t. 73.*

MINDANAO, Davao District, Mount Calelan, Mount Apo, *Elmer 10618, 10541,* Bagobo names *sambonotan* and *lassee* or *rassee.*

DAEMONOROPS Blume

Conspectus of the species.

*a*¹. *Cymbospatha.* Spadix, ♂ and ♀, contracted. Primary spathes cymbiform, beaked, the outermost completely inclosing the inner ones.
1. *D. Margaritae* var. *palawanicus.*

*a*². *Piptospatha.* Spadix, ♂ and ♀, elongated. Inner primary spathes gradually longer than the outermost.

*b*¹. Leaflets very inequidistant, ensiform, the largest 40 to 50 cm long, 2.5 to 3 cm wide; fruit ovoid-ellipsoidal, 25 mm long, 16 to 17 mm thick, very shortly pedicellate .... 2. *D. virescens.*

b^2. Leaflets equidistant.

c^1. The mouths of the leaf sheaths unarmed.

d^1. Leaflets lanceolate-ensiform, the largest 30 to 45 cm long, 3 to 3.5 cm wide, the midrib only sparsely bristly below, smooth above or else minutely spinulous near the apex; fruit spherical, mammillate-beaked, 18 to 20 mm in diameter..... 3. *D. ochrolepis.*

d^2. Leaflets less than 3 cm wide, bristly on three to five nerves above.

e^1. Leaflets 30 cm long, 15 to 16 mm wide (the largest), bristly on three nerves above, and on the midrib only underneath; the axis of the spadix and spikelets coated with a rusty-brown scurf; fruit carried on a pedicel 8 to 10 mm long, globose-ovoid, obtusely mammillate-beaked. 4. *D. urdanetanus.*

e^2. Leaflets very narrowly lanceolate, 20 to 23 cm long, 14 to 18 mm wide (the largest), bristly on three nerves above, and with a few long bristles on the midrib only underneath. Male flowers very long and slender (12 mm long). 5. *D. Loherianus.*

e^3. Leaflets 30 cm long, 15 to 20 mm wide (the largest), bristly on five nerves above, but only on the midrib beneath, fruit 12 to 17 mm long, 9 to 11 mm through, ovoid-ellipsoid, carried on a pedicel 4 to 6 mm long.............................. 6. *D. pedicellaris.*

d^3. Leaflets less than 3 cm wide, having the midrib alone spinulous, on only one or on both surfaces.

e^1. Leaflets 30 to 32 cm long, 2 to 2.5 cm wide (the largest), having the midrib alone spinulous on both surfaces; axis of the spadix and spikelets densely coated with a copious brown felt; fruit ovoid-ellipsoid, blunt-mammillate, carried on a thick, 5 to 6 mm long pedicel.............................. 7. *D. pannosus.*

e^2. Leaflets 30 to 40 cm long, 2 to 2.5 cm wide (the largest), smooth or nearly so on the upper surface, underneath the midrib alone remotely spinulous; axial parts of the spadix and spikelets coated with adherent rusty-brown scurf; fruit globose and obtusely mammillate, 17 to 18 mm in diameter, with a few well-conformed scales, and carried on a pedicel 10 to 12 mm long.. 8. *D. oligolepis.*

c^2. The mouths of the leaf-sheaths armed with erect spines, longer than those on the body.

d^1. Fruit large, over 2 cm in diameter; leaflets narrowly ensiform, 40 to 42 cm long, 13 to 15 mm broad (the largest), spinulous on three nerves above and bristly on the midrib alone beneath; fruit spherical, 20 to 24 mm in diameter.... 9. *D. Clemensianus.*

d^2. Fruit less than 2 cm in diameter.

e^1. Leaflets linear-ensiform, 35 to 45 cm long, 16 to 24 mm broad (the largest), with three bristly nerves on the upper surface, underneath the midrib alone or, occasionally, also three nerves bristly; partial inflorescences and spikelets spreading; fruit globose, mammillate-beaked, often slightly depressed, 15 to 18 mm in diameter...................................... 10. *D. Gaudichaudii.*

e^2. Leaflets narrowly ensiform, 55 to 60 cm long, 20 to 22 mm broad (the largest), almost smooth above and with only a few short bristles on the midrib underneath; partial inflorescences and spikelets inserted at a very acute angle; fruit globose, conically beaked, 12 mm in diameter. 11. *D. affinis.*

e^3. Leaflets lanceolate-ensiform, 33 to 40 cm long, 17 to 20 mm broad, bristly on three to five nerves on the upper surface and on the midrib alone underneath; spikelets spreading; fruit globular or shortly ovoid, minutely beaked, 12 mm in diameter.. 12. *D. Curranii.*

e^4. Leaflets linear-lanceolate, 25 to 28 cm long, 12 to 14 mm broad (the largest), sparingly spinulous on three nerves above and underneath with only a few bristles on the midrib from the middle upward; fruit small, broadly ovoid-ellipsoid, 12 mm long, 9 mm thick. A slender plant, sheathed stem 12 to 15 mm in diameter.. 13. *D. gracilis.*

1. **DAEMONOROPS MARGARITAE** Becc. var. **PALAWANICUS** Becc. Ann. Bot. Gard. Calcutta 12 (1912) 57, *t. 10.*

PALAWAN, *Bur. Sci. 899 Foxworthy;* Taytay, *Merrill 9359;* Puerto Princesa, *Elmer 12943.*

2. **DAEMONOROPS VIRESCENS** Becc. in Perk. Fragm. Fl. Philip. (1904) 47, Webbia 1 (1905) 357, Ann. Bot. Gard. Calcutta 12 (1912) 201, *t. 91.*

PALAWAN, San Antonio Bay, *Merrill 868.*

3. **DAEMONOROPS OCHROLEPIS** Becc. in Perk. Fragm. Fl. Philip. (1904) 47, Webbia 1 (1905) 356, Ann. Bot. Gard. Calcutta 12 (1912) 160, *t. 65,* Philip. Journ. Sci. 6 (1911) Bot. 230.

Daemonorops ochrolepis var. *radulosus* Becc. in Ann. Bot. Gard. Calcutta 12 (1912) 162, *t. 66.*

LUZON, Tayabas Province, Guinayangan, *Merrill 2069;* Kabibihan, *Bur. Sci. 13101 Foxworthy & Ramos, Bur. Sci. 13235 Ramos,* local name *palanog* (♂), *For. Bur. 10190 Curran:* Rizal Province, *Loher 1365,* in Herb. Kew.; Siya Bundoc, *Loher 7078* in Herb. Kew.: Nueva Ecija Province, *For. Bur. 8490 Curran.* POLILLO, *Bur. Sci. 9039 Robinson.* MINDANAO, Lanao District, Camp Keithley, *Mary Strong Clemens 898:* Agusan Province, Mount Urdaneta, *Elmer 14120:* Davao District, Mount Apo, *Elmer 11875.*

The variety *radulosus,* after the inspection of more complete material, can hardly be considered as distinct. The plant from Mindanao differs from that of Luzon and Polillo by its somewhat smaller fruits.

4. **DAEMONOROPS URDANETANUS** Becc. in Elm. Leafl. Philip. Bot. MS.

MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 14201.*

5. **DAEMONOROPS LOHERIANUS** Becc. in Ann. Bot. Gard. Calcutta 12 (1912) 104, *t. 41.*

LUZON, Rizal Province, Siya Bundoc, *Loher 7073* in Herb. Kew.

6. **DAEMONOROPS PEDICELLARIS** Becc. in Elmer Leafl. Philip. Bot. MS.

MINDANAO, Davao District, Mount Apo, *Elmer 11896:* Agusan Province, Mount Urdaneta, *Elmer 13853, 14132:* Lanao District, Camp Keithley, *Mary Strong Clemens 1280.*

7. **DAEMONOROPS PANNOSUS** Becc. in Elm. Leafl. Philip. Bot. MS.

MINDANAO, Davao District, Mount Apo, *Elmer 11600.*

8. **DAEMONOROPS OLIGOLEPIS** Becc. in Elm. Leafl. Philip. Bot. MS.

MINDANAO, Davao District, Mount Apo, *Elmer 11757.*

9. ? **DAEMONOROPS CLEMENSIANUS** Becc. in Ann. Bot. Gard. Calcutta 12 (1912) 163, *t. 67.*

MINDANAO, Lanao District, Camp Keithley, *Mary Strong Clemens 1227.*

The fruit of *Daemonorops Clemensianus* is so much like that of *D. ochrolepis,* that I have a suspicion that the portion of leaf attributed to the first plant and reproduced in the quoted plate as such, is not its own, but that of a different species; consequently, *D. Clemensianus* is for the present to be regarded as a doubtful species.

10. **DAEMONOROPS GAUDICHAUDII** Mart. Hist. Nat. Palm. 3 (1849) 331; Becc. Ann. Bot. Gard. Calcutta 12 (1912) 157, *t. 64,* Perk. Fragm. Fl. Philip. (1904) 47, Webbia 1 (1905) 365, Philip. Journ. Sci. 3 (1908) Bot. 342.

LUZON, Rizal Province, Montalban, *Loher 7072, 7086* in Herb. Kew.; Bosoboso, *Bur. Sci. 1212 Ramos:* Nueva Ecija Province, Dupax, *Bur. Sci. 11358, 14192 McGregor, For. Bur. 22163 Alvarez:* Tayabas Province, Guinayangan, *Hagger 25;* Unisan, *Vidal 4063* in Herb. Becc.; Sampaloc, *Warburg* in Herb. Berol.: Bataan Province, Mount Mariveles, *For. Bur. 17310 Curran, For. Bur. 2601 Meyer:* Camarines Province, *For. Bur. 21713 Abellanosa:* province not indicated, *Langlassé 141* in Herb. de Candolle. NEGROS, *For. Bur. 20892 Tamesis.* MINDORO, Bongabong River, *Whitford 1371, For. Bur. 3741 Merritt;* Calapan, *Bur. Sci. 948 Mangubat.* SIBUYAN, *Elmer 12494.* BABUYAN ISLANDS, Camiguin, *Bur. Sci. 4066 Fénix.* MINDANAO, Surigao Province, *Bolster 353:* Davao District, Mount Apo, *Elmer 11880.*

11. **DAEMONOROPS AFFINIS** Becc. in Elm. Leafl. Philip. Bot. MS.

MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 13978.*

12. **DAEMONOROPS CURRANII** Becc. in Philip. Journ. Sci. 2 (1907) Bot. 238, Ann. Bot. Gard. Calcutta 12 (1912) 142 (exclusive of the portion of leaf-sheath and the fragment of the spadix on the left side of that plate, as these parts really belong to *D. pedicellaris* Becc., *Clemens 1280*).

PALAWAN, *For. Bur. 3791 Curran;* Brooke's Point, *Elmer 12663.*

13. **DAEMONOROPS GRACILIS** Becc. in Elm. Leafl. Philip. Bot. MS.

PALAWAN, Puerto Princesa, Mount Pulgar, *Elmer 12945.*

ILLUSTRATIONS

[In all of the plates the fruits and seeds are natural size, and the male flowers are enlarged 7 diameters. All the figures are reproduced from camera-lucida drawings by the author.]

PLATE I

FIG. 1. *Areca Catechu* Linn. (*semisilvatica*). Vertical section of a fruit, preserved in alcohol, collected by L. S. Gibbs in a semiwild condition at Tuaran at the foot of Mount Kinabalu in British North Borneo. This and Plate II, figure 1, although not presenting Philippine specimens, are here given to show the commonest Malayan forms of the fruits of *A. Catechu*, for comparison with the Philippine ones.

2. *Areca Catechu* Linn. var. *silvatica* Becc.; *a*, fruit entire; *b*, vertical section of the fruit, showing one side of the seed, entire, in situ; *c*, vertical section of the seed; *d*, *e*, male flowers; *f*, section of a male flower, showing one petal and its respective two stamens and the rudimentary ovary. From *Merrill 9447*, collected in Palawan.

3. *Areca Catechu* Linn. (forma *communis*); *a*, vertical section of the fruit, showing one side of the seed, entire, in situ (from a specimen collected at Lucban, Luzon, *Elmer 9295* in Herb. Beccari); *b*, male flower; *c*, section of a male flower, showing one petal with its respective two stamens, and the rudimentary ovary (from *Mearns & Hutchinson 4717*, collected in Mindanao).

PLATE II

FIG. 1. *Areca Catechu* L. var. *alba* Bl.; *a*, vertical section of the fruit, showing one side of the seed, entire, in situ; *b*, male flower; *c*, section of a male flower, showing one petal with its respective two stamens, and the rudimentary ovary. From a plant cultivated in the botanic garden at Buitenzorg.

2. *Areca Catechu* L. var. *longicarpa* Becc.; *a*, vertical section of the fruit, showing one side of the seed in situ; *b*, a male flower; *c*, section of a male flower showing one petal with its respective two stamens, and the rudimentary ovary. From *McGregor 10470*, collected in Polillo.

3. *Areca Catechu* L. var. *portoricensis* Becc.; *a*, vertical section of the fruit; *b*, male flower; *c*, section of a male flower showing one petal with its respective two stamens, and the rudimentary ovary. From *Sintenis 5749* in the Berlin Herbarium.

I have given here a figure of the fruit of this very anomalous American variety of *Areca Catechu*, because of its great resemblance to the fruit of the Philippine *A. macrocarpa* and of the variety *longicarpa* of *A. Catechu*. The figure is drawn from *Sintenis 5749* from plants cultivated near houses in the vicinity of Aquadilla, Porto Rico; which specimens have been referred by

Urban in his "Symbolae" 4 (1903) 130 to *Areca Catechu* Linn. Notwithstanding the unusual form of the fruit of the var. *portoricensis*, there is no doubt about its belonging to *Areca Catechu* (in a wide sense), as the fruiting specimen is accompanied by spadices having female and male flowers. The male flowers are furnished with six stamens and conspicuous, 3-pointed, rudimentary ovary; the male flowers of the American plant not differing in that respect, in the slightest particulars, from those of the common *A. Catechu* of the Orient. As to the origin of this American variety the hypothesis of its direct importation into the New World from the Orient cannot be absolutely discarded, but I would observe that among the innumerable individuals of *Areca Catechu* seen by me in the regions where that palm grows profusely, and where it presents numerous varieties, I have not seen a single plant having fruits approaching in shape to those of var. *portoricensis*, nor have I found any such plant mentioned in botanical works. However, the general shape of the fruit of *A. Catechu* var. *portoricensis* is so much like that of *A. Catechu* var. *longicarpa* and *A. macrocarpa*, both Philippine palms, that we are led to surmise that the American variety may have had a Philippine origin, even if it be not precisely identifiable with any of the actually known Philippine forms. Otherwise we may contemplate the possibility of the case of a sudden neogenesis, originated from changed ambient condition, during the acclimatization in the New World of a plant characteristic of the tropical regions of the Orient.

PLATE III

FIG. 1. *Areca parens* Becc.; *a*, vertical section of the fruit; *b*, seed, side view; *c*, *d*, male flowers; *e*, section of a male flower, showing a petal and three of its six stamens, with the small rudimentary ovary among them. From *Abellanosa 21712*.

2. *Areca macrocarpa* Becc.; *a*, vertical section of the fruit, showing the dorsal or raphal side of the seed, entire; *b*, seed, side view; *c*, seed, vertical section. From *Whitford and Hutchinson 9103*.

3. *Areca camarinensis* Becc.; *a*, vertical section of the fruit; *b*, seed, side view. From *Aguilar 14268*.

4. *Areca Ipot* Becc.; *a*, vertical section of the fruit; *b*, seed, side view. From *Elmer 9292* in Herb. Beccari.

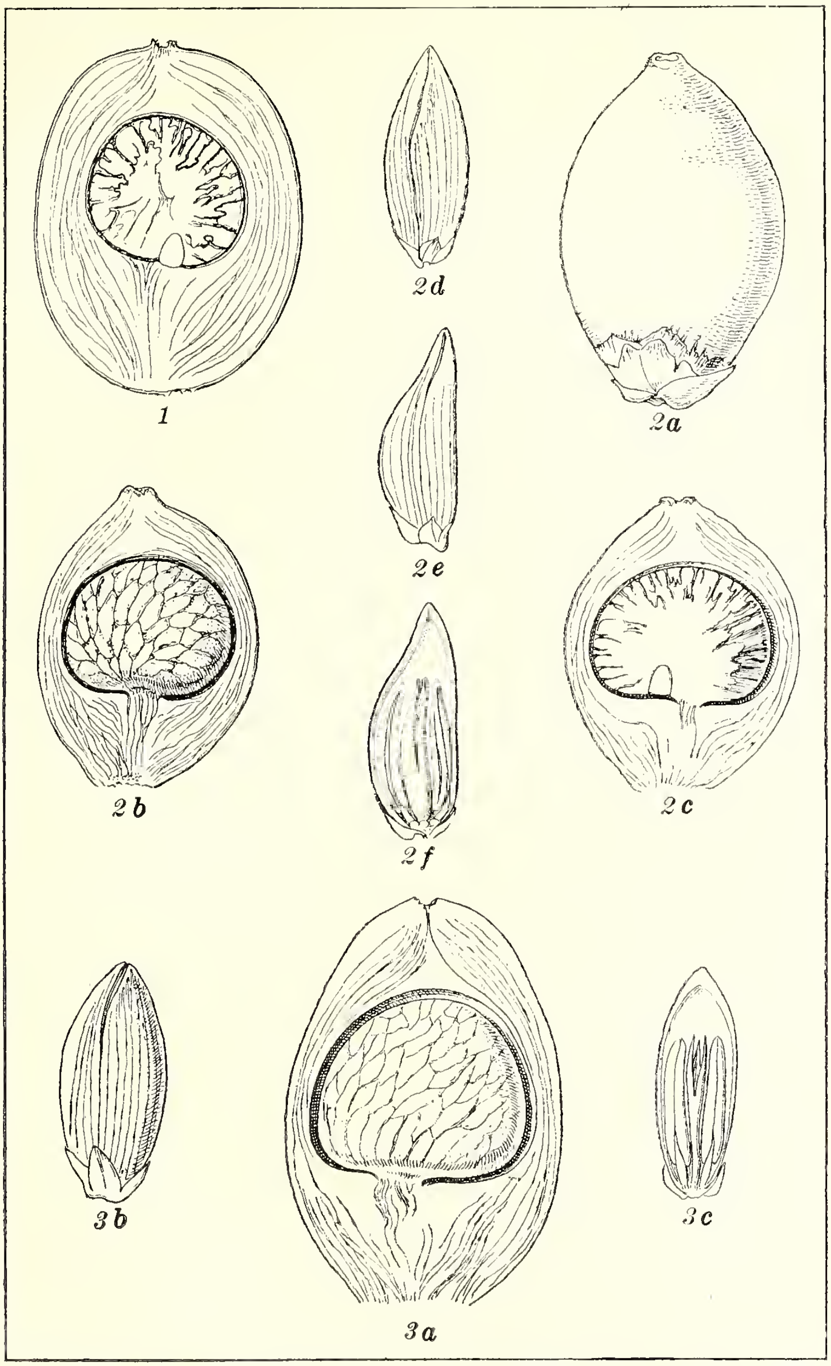

Fig. 1. Areca catechu (semisilvatica). 2. A. Catechu var. silvatica. 3. A. Catechu (communis).

PLATE I.

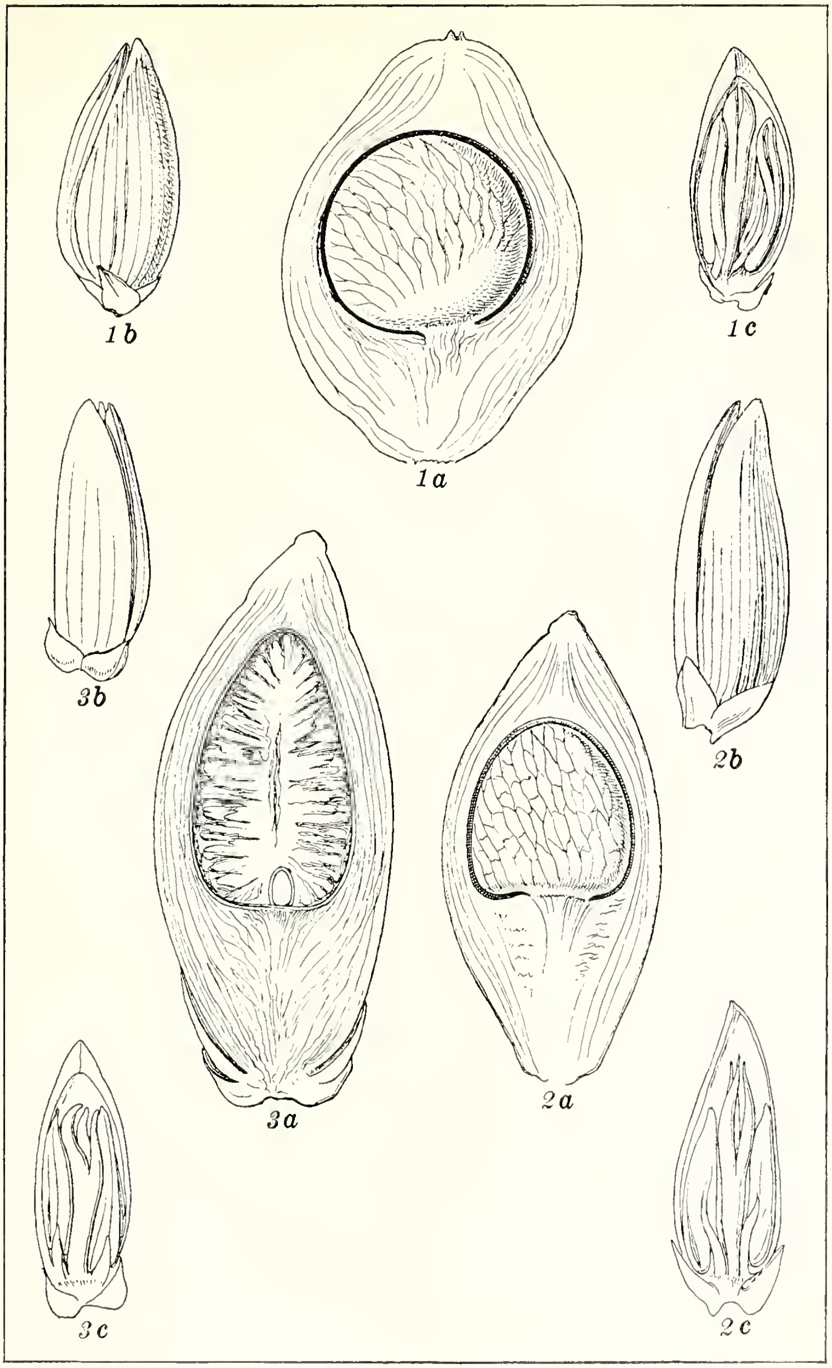

Fig. 1. Areca Catechu var. alba. 2. A. Catechu var. longicarpa. 3. A. Catechu var. portoricensis.

PLATE II.

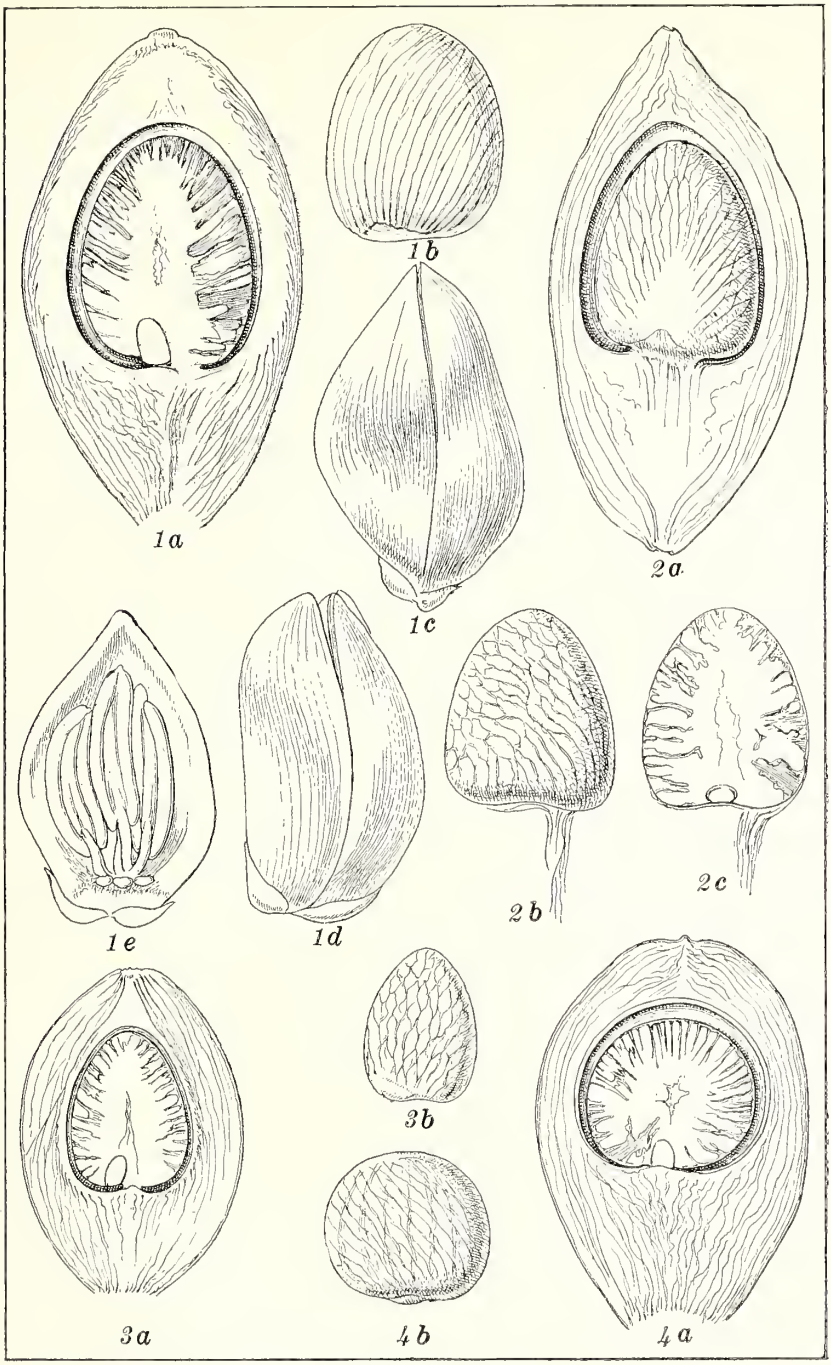

Fig. 1. Areca parens. 2. A. macrocarpa. 3. A. camarinensis. 4. A. Ipot.

PLATE III.

REVIEWS

The Treatment of | War Wounds | by | W. W. Keen, M. D., LL. D. | Major, Medical Reserve Corps, U. S. Army | emeritus professor of surgery | Jefferson Medical College, Philadelphia | second edition, reset | Philadelphia and London | W. B. Saunders Company | 1918. 434 pp., including index. Cloth, $4.

This little book of 276 pages is well written, and the subject is clearly presented. The author shows how this war differs widely, from a surgical standpoint, from all other wars in five principal respects, as follows:

1. The huge numbers in the armies and, therefore, of the wounded.
2. The new means of transportation.
3. The new weapons, especially in the artillery.
4. Rampant infections of wounds.
5. The conquest of infection by more efficient antiseptics and by new methods.

While it is essentially a book for army doctors, yet it is invaluable also for all men doing surgery as well as for general practitioners. The chapter on the Carrel-Dakin method of wound treatment is especially valuable as it goes minutely into the technic. The treatment of burns is not only up to date in technic but gives the formula for "No 7 Parraffin" of Lt. Col. A. J. Hull of the British Army, which he states is superior to the much talked of and advertised Amberine of Dr. Barthe de Sandfort, the preparing of which has been kept a secret in "absolute contravention of American Medical Ethics."

A. M. GIFFEN.

A Text-book of | General | Bacteriology | by | Edwin O. Jordan, Ph.D. | professor of bacteriology in the University of Chicago | and in Rush Medical College | fully illustrated | sixth edition, thoroughly revised | Philadelphia and London | W. B. Saunders Company | 1918. 691 pp. Cloth, $3.75 net.

FROM THE PREFACE

This book is the outgrowth of lectures given to students in the University of Chicago during the past few years. The subject is one that the writer believes should find a place in every general scientific course. Bacteriology is chiefly of professional interest to the medical student, but the subject also bears technical relations to household administration, to agriculture, to sanitation and sanitary engineering and to various industries and technological pursuits. For the general scientific student and reader bacteriology presents certain aspects that tend to widen the outlook upon a variety of human interests.

It need hardly be said that within the compass of this work an exhaustive treatment of all sides of bacteriology is impossible. The needs of the advanced worker can be met only—and that but in part—by such monumental special treatises as the Handbuch der Pathogenen Mikroörganismen, edited by Kolle and Wassermann, and the Technische Mykologie, edited by Lafar. A general introduction to the subject, however, with some regard for perspective and with emphasis on general rather than on special questions has seemed worth attempting.

The reader who wishes to acquire greater familiarity with the subject will find some bibliographical references given as a sort of first aid to the investigator. These include references to some articles of classic or historic interest, to some giving valuable summaries or bibliographies of important subjects and to a few in fields where investigation is very active or opinions considerably at variance. No pretension to completeness is made.

The fundamental principles and methods of laboratory work are treated as fully as seems desirable in a book of this class. The tendency manifested in all the natural sciences towards the elaboration of special laboratory manuals and guides has much in its favor. A number of such guides for bacteriology are in existence, among which may be mentioned the excellent manuals of Frost, Gorham, Heinemann, Moore and Novy, to mention only American authors. In any case a proper familiarity with laboratory methods can be gained only with the assistance of a skilled laboratory instructor possessed of individuality and resource.

FROM PREFACE TO THE SIXTH EDITION

In this edition the chapter on *The Pneumococcus* has been entirely rewritten and that on *The Meningococcus* extensively revised. Several new sections have been added, including brief summaries of our present knowledge of infectious jaundice, ratbite fever, and trench fever. A number of minor changes and corrections have also been made throughout the text.

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THE PHILIPPINE
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VOL. XIV APRIL, 1919 No. 4

NEW OR NOTEWORTHY PHILIPPINE PLANTS, XV

By E. D. MERRILL

(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila, P. I.)

This series of papers was commenced in 1904,[1] the present contribution being essentially like the preceding ones. In the series have been included the descriptions of new genera and species, notes on nomenclature and on obscure species, and records of known genera and species not previously reported from the Philippines. Fourteen genera and about one thousand one hundred fifty-five species, including those of the present paper, have been described as new.

The present paper consists chiefly of the descriptions of one hundred new or presumably new species, with the records of eighteen previously known ones not hitherto recorded from the Philippines. Nine genera are for the first time recorded as Philippine; namely, *Tripogon*, *Festuca* (introduced), *Cryptocoryne*, *Haematocarpus*, *Citriobatus*, *Erodium* (introduced), *Villaresia*, *Sloanea*, and *Cloëzia*. Of these *Citriobatus* and *Cloëzia* are of special interest from the standpoint of phytogeography. *Cloëzia* has hitherto been known only from New Caledonia, where it is represented by six species, the seventh species occurring in the mountains of northeastern Mindanao. *Citriobatus*

[1] Merrill, E. D. New or noteworthy Philippine plants, I, *Govt. Lab. Publ. (Philip.)* 6 (1904) 1–18; II, *op. cit.* 17 (1904) 1–47; III, *op. cit.* 29 (1905) 1–50; IV, *op. cit.* 35 (1905) 1–77; V, *Philip. Journ. Sci.* 1 (1906) *Suppl.* 169–246; VI, *op. cit.* 3 (1908) *Bot.* 219–267; VII, *op. cit.* 4 (1909) *Bot.* 247–330; VIII, *op. cit.* 5 (1910) *Bot.* 167–257; IX, *op. cit.* 7 (1912) *Bot.* 257–357; X, *op. cit.* 9 (1914) *Bot.* 261–337; XI, *op. cit.* 10 (1915) *Bot.* 1–84; XII, *op. cit.* 10 (1915) *Bot.* 287–349; XIII, *op. cit.* 13 (1918) *Bot.* 1–66; XIV, *op. cit.* 13 (1918) *Bot.* 263–333.

is an interesting Australian type, the genus being confined to Australia with the exception of the Javan *C. javanicus* Boerl. & Koord., which is now also recorded from Luzon. Another interesting Australian type, previously known only from Australia and Formosa, is *Ipomoea polymorpha* Roem. & Schultes, now recorded from two localities in northern Luzon.

PANDANACEAE

PANDANUS Linnaeus

PANDANUS PANAYENSIS sp. nov. § *Vinsonia.*

Erectus, circiter 5 m altus; foliis crassissime coriaceis, rigidis, circiter 2.5 m longis, 7 cm latis, basi leviter inflatis et 11 cm latis, apice angustatis, vix acuminatis, margine, basi et apice exceptis, dentibus rigidis armatis; infructescentiis pendulis, syncarpiis 4, ellipsoideis ad oblongis, racemose dispositis, 12 ad 20 cm longis, 8 ad 10 cm diametro; drupis numerosis, $\frac{1}{2}$ superioribus liberis, utrinque subaequaliter angustatis, obscure 5-angulatis, circiter 4 cm longis, 5- ad 10-locellatis, apice truncatis, 5 ad 8 mm diametro, inter loculis leviter sulcatis; stigmatibus planis, subreniformibus, circiter 1.5 mm diametro.

Erect, about 5 m high. Leaves very thickly coriaceous, rigid, about 2.5 m long, the base slightly inflated, about 11 cm wide, soon narrowed to about 7 cm and about this width for most of their length, apex narrowed, scarcely acuminate, the apical and basal margins unarmed, the margins otherwise with distinct, sharp, rigid teeth which gradually decrease in size upward, the midrib on the lower surface armed with short scattered teeth in the median and upper parts. Infructescences peduncled, pendulous, their peduncles up to 40 cm in length, 3-angled, about 1.5 cm in diameter. Syncarps 4, ellipsoid to oblong, 12 to 20 cm long, 8 to 10 cm in diameter, the peduncles of the lateral ones stout, very short, of the terminal one up to 8 cm in length. Drupes very numerous, the upper one-half free, subequally narrowed to both base and apex, about 4 cm long, 1.5 to 2 cm in diameter, somewhat 5-angled, usually 5- to 10-celled, the apex truncate, 5 to 8 mm in diameter, slightly sulcate between the loculi, the sulci about 1 mm deep. Stigmas plane, orbicular to somewhat reniform, about 1.5 mm in diameter.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30796 Ramos & Edaño*, April 22, 1918, on forested slopes.

This species resembles *Pandanus philippinensis* Merr., from which it is distinguished especially by its differently shaped syncarps, the drupes of which are free in the upper one-half and scarcely sulcate between the loculi. In *Pandanus philippinensis* the stigmas are distinctly oblique, while in the present species they are plane and not at all elongated, so that the two species scarcely belong in the same section of the genus.

PANDANUS CAMARINENSIS sp. nov.

Frutex erectus, circiter 2 m altus; foliis coriaceis, circiter 2.4 m longis et 5.5 cm latis, margine perspicue armatis, sursum angustatis et tenuiter caudato-acuminatis; syncarpiis solitariis, erectis, oblongo-cylindraceis, circiter 30 cm longis et 13 cm diametro; drupis numerosis, obovoideis, circiter 5 cm longis et 2.5 ad 3 cm diametro, angulatis, plerumque 7-locellatis, apice truncatis, laevis, stigmatibus planis, haud productis.

An erect shrub, about 2 m high, the leaves about 2.4 cm long and 3.5 cm wide, gradually narrowed upward to the slenderly caudate-acuminate apex, the margins armed with rather prominent antrorse teeth. Syncarps solitary, erect, at maturity nearly enclosed by the leaflike bracts, oblong-cylindric, about 30 cm long and 13 cm in diameter. Drupes numerous, obovoid, somewhat angled by mutual pressure, narrowed below, usually 7-celled, about 5 cm long, 2.3 to 3 cm in diameter, the upper 1 cm free, very slightly narrowed, the apex truncate, flat, smooth, about 2 cm in diameter. Stigmas usually 7, obscure, not at all projecting.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33635 Ramos & Edaño*, December 21, 1918, in damp forests at low altitudes.

This species is closely allied to *Pandanus esculentus* Martelli from which it is distinguished chiefly by its much larger, differently shaped syncarps.

GRAMINEAE

ANDROPOGON Linnaeus

ANDROPOGON PHILIPPINENSIS sp. nov. § *Isozygi, Arthrolepis.*

Culmis erectis, tenuibus, usque ad 80 cm longis; foliis usque ad 20 cm longis et 4 mm latis, leviter scabridis; racemis longe exsertis, solitariis multifloris, 7 ad 10 cm longis, vagina vix inflata; spiculis sessilibus lanceolatis, 9 mm longis, gluma II aristata, IV longe aristata, arista circiter 3 cm longa; spiculis pedicellatis ♂, circiter 8 mm longis, haud aristatis.

An erect, rather slender, glabrous, apparently tufted grass, 60 to 80 cm high, unbranched, the culms 1 to 1.5 mm in diameter. Leaves up to 20 cm long, about 4 mm wide, slightly scabrid, very slenderly acuminate; nodes glabrous; ligule bearded. Raceme solitary, long-exserted, many flowered, 7 to 10 cm long, the uppermost sheath scarcely inflated, the rachis rather fragile, its joints about 4 mm long, deeply sulcate on one side, the margins prominently white-bearded, obliquely cucullate at their tips. Spikelets green or green and purple, the sessile ones perfect, lan ceolate, about 9 mm long; first glume firm, lanceolate, acuminate, 9 mm long, 2-keeled, the margins inflexed; second glume thinner, 7 mm long, acuminate, keeled above and with a slender, 10 to 12 mm long, apical awn; third glume hyaline, oblong, 5 mm long; fourth glume hyaline, 4 mm long, cleft, about 1 mm wide, the awn geniculate, about 3 cm long. Pedicelled spikelets lanceolate, acuminate, about 8 mm long, not awned, their pedicels 3 to 3.5 mm long, sulcate, margins bearded; first glume lanceolate, acuminate, 2-keeled, usually 7-nerved, the inflexed margins ciliate in the upper part; second glume as long as the first one, hyaline, 1-nerved; third and fourth glumes shorter and narrower, the latter subtending a staminate flower.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32946* (type), *32755 Ramos*, July, 1918, growing on open, dry, rocky slopes at low altitudes.

This species is well characterized by its solitary, long-exserted racemes and is distinctly anomalous in the section *Arthrolepis* by this character and also by its sulcate rachis-joints and pedicels; the second glume of the sessile spikelet is long-awned and hence the present species cannot be placed in any of the other subgenera of the series *Isozygi*. The sessile spikelets are all alike throughout the entire length of the raceme, hence it cannot be placed in any of the subgenera of the series *Heterozygi*. So far as I am able to determine it is most closely allied to *Andropogon longipes* Hack., of British India, from which it is readily distinguished by its solitary racemes as well as by its floral characters.

ANDROPOGON GRYLLUS Linn. var. PHILIPPINENSIS var. nov.

Glaberrima, circiter 75 cm alta; foliis 15 ad 27 cm longis, 5 mm latis; paniculis oblongis 12 ad 15 cm longis, purpureis, rachibus ramulisque laevis; spiculis lanceolatis, ⚥ circiter 6 mm longis, callo 1.5 mm longo, fulvo-barbato, gluma II breviter aristata, arista 2 ad 3.5 mm longa, ♂ lineari-lanceolatis, 5 ad 6 mm longis, vacuis, gluma II acuminata, vix aristata.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 30964 Ramos & Edaño*, April 10, 1918, on bowlders and ledges in stream beds, observed only in this habitat.

Andropogon gryllus Linn. extends from southern Europe to Australia and was recorded from the Philippines by F.-Villar, Novis. App. (1883) 316, as *Chrysopogon gryllus* Trin. The typical form of the species certainly does not occur in the Archipelago, nor can I refer the specimens cited above to any of the described varieties of it. It is apparently most closely allied to the Australian *Andropogon gryllus* Linn. subsp. *genuinus* Hack., var. *pallidus* (R. Br.) Benth., but has distinctly smaller spikelets than this variety, while the pedicellate spikelets are empty and not awned.

ANDROPOGON SANGUINEUS (Retz.) Merr. in Philip. Journ. Sci. 12 (1917) Bot. 101.

Rottboellia sanguinea Retz. Obs. 3 (1783) 25.
Thelepogon sanguineus Spreng. Syst. 1 (1825) 299.
Andropogon pseudograya Steud. Syn. 1 (1855) 365.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32777 Ramos*, August 5, 1918, on open grassy slopes at low altitudes.

Southern China, India, Ceylon, and Madagascar.

FESTUCA Linnaeus

FESTUCA MYUROS Linn. Sp. Pl. (1753) 74; Hook. f. Fl. Brit. Ind. 7 (1897) 356.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31913 Santos*, April 25, 1918, in open grassy places, altitude about 2,300 meters.

A grass of wide distribution in the North Temperate Zone, a native of Europe or Asia, now also abundant in North America; undoubtedly a recently introduced plant in Benguet.

TRIPOGON Roth

TRIPOGON CHINENSIS (Franch.) Hack. in Bull. Herb. Boiss. II 3 (1903) 503.

Nardurus filiformis Steud. var. *chinensis* Franch. in Nouv. Arch. Hist. Nat. Paris. II 7 (1894) 149.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33237 Ramos*, August 8, 1918, on dry, open, rocky slopes.

This genus is new to the Philippines, the specimen cited above agreeing perfectly with the descriptions and with a series of specimens from Chili Province, collected by Mrs. Clemens. It is reported from as far south as Formosa.

CYPERACEAE

MARISCUS Gaertner

MARISCUS NIVEUS (Murr.) comb. nov.

Schoenus niveus Murr. in Linn. Syst. Veg. ed. 13 (1774) 81.
Scirpus glomeratus Linn. Sp. Pl. (1753) 52, excl. syn. Gronov., non *Mariscus glomeratus* Barton.
Schoenus coloratus Linn. var. β Linn. Sp. Pl. ed. 2 (1762) 64.

Cyperus kyllingiaeoides Vahl Enum. 2 (1806) 312.
Mariscus dregeanus Kunth Enum. 2 (1837) 120; C. B. Clarke in Hook. f. Fl. Brit. Ind. 6 (1893) 620.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32826 Ramos*, July 24, 1918, on rocky open slopes at low altitudes, abundant.

This species has previously not been reported from the Philippines. India to tropical Africa, the Malay Peninsula, Singapore, and Borneo.

ELEOCHARIS R. Brown

ELEOCHARIS SPIRALIS (Rottb.) Steud. Syn. 2 (1855) 81; C. B. Clarke in Hook. f. Fl. Brit. Ind. 6 (1893) 627.

Scirpus spiralis Rottb. Descr. Ic. (1773) 45, *t. 15, f. l.*

LUZON, in swamps between Manila and Caloocan, *Merrill 9788*, December, 1914.

India to Ceylon, Burma, Indo-China and ? Mauritius. Not previously reported from the Philippines. It is to be noted that R. Brown does not make the actual combination, *Eleocharis spiralis*, Prodr. (1810) 224, but merely indicates that *Scirpus spiralis* Rottb. belongs in the genus *Eleocharis*.

ARACEAE

CRYPTOCORYNE Fischer

CRYPTOCORYNE APONOGETIFOLIA sp. nov.

Herba glabra, aquatica, demersa; foliis membranaceis, anguste oblongo-lanceolatis, perspicue bullatis, utrinque angustatis, basi acutis vel obtusis, apice acutis et apiculatis, 25 ad 35 cm longis, 3 ad 5 cm latis; petiolo usque ad 30 cm longo; spathis anguste cylindraceis, haud contortis, circiter 25 cm longis, lamina glabra, lanceolata, caudato-acuminata, 6 cm longa, deorsum 1 cm lata.

An entirely glabrous submerged herb from short, rather stout, nearly erect rhizomes about 1 cm in diameter. Leaves membranaceous, narrowly oblong-lanceolate, conspicuously bullate, the midrib very prominent, subequally narrowed to the acute or obtuse base and to the acute and slightly apiculate apex, 25 to 35 cm long, 3 to 5 cm wide; lateral nerves slender, ascending, 5 or 6 on each side of the midrib; petioles up to 30 cm long. Peduncles 4 to 7 cm long. Spathe cylindric, not twisted, slender, including the limb about 25 cm long, slightly inflated at the base, not at all contracted below the limb, the limb lanceolate, glabrous, caudate-acuminate, 6 cm long, about 1 cm wide in the lower part. Carpels usually 6, the slender stipe of the staminate inflorescence about 6 mm long; staminal inflorescence oblong, about 4 to 5 mm long, the sterile tip 1.2 mm in length.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31119 Ramos & Edaño,* April 14, 1918, in shallow water of streams, the spathes pinkish white. To this species I also tentatively refer a sterile specimen from Negros, *For. Bur. 19411 Curran*, June, 1910.

This species is manifestly allied to *Cryptocoryne ciliata* Fisch. from which it is readily distinguished by its membranaceous, conspicuously bullate leaves, which resemble those of some species of *Aponogeton;* and by its much narrower, differently shaped, caudate-acuminate limb of the spathe, which is entirely glabrous.

CRYPTOCORYNE PYGMAEA sp. nov.

Herba glabra, depauperata; foliis membranaceis, oblongis ad oblongo-ovatis, 1.5 ad 4 cm longis, acutis, basi perspicue auriculato-cordatis, nervis utrinque 2, tenuis; spathis circiter 3.5 cm longis, inflatis, tubo oblongo, supra contracto; lamina tubo aequantibus, lanceolatis, caudato-acuminatis, planis, haud contortis.

An entirely glabrous dwarfed plant from short stout rhizomes. Leaves membranaceous, oblong to oblong-ovate, 1.5 to 4 cm long, 1 to 1.5 cm wide, the apex acute, base conspicuously auriculate-cordate; lateral nerves very slender, ascending, about 2 on each side of the midrib; petioles in young plants shorter than the leaves, in mature plants up to 5 cm long, slender, sheathing at the base. Peduncles in anthesis 8 mm long or less, in fruit up to 3 cm long. Spathe greenish white, about 3.5 cm long, the tube and limb of equal length; tube somewhat inflated, oblong, contracted at the apex; limb lanceolate, caudate-acuminate, about 6 mm wide at the base, 1.8 cm long, dark-purple on the inner surface. Carpels usually 6; stigma obtuse; staminate inflorescence ovate, 3 mm long, its sterile tip oblong, 2 mm in length, the slender stipe 6 to 7 mm long.

MINDANAO, Zamboanga District, Sax River, *Merrill 8174*, December 6, 1911 (type); *Copeland s. n.*, in fruit. This species grows in the crevices of ledges, in stream beds, in very damp shaded ravines, in situations subject to overflow, at an altitude of about 300 meters.

This species is manifestly very closely allied to the Bornean *Cryptocoryne auriculata* Engl. but is smaller in size, with much slenderer, longer, less conspicuously sheathing petioles and fewer nerves; while the tube of the spathe equals the limb in length and is conspicuously contracted at the apex.

URTICACEAE

ELATOSTEMA Forster

ELATOSTEMA PANAYENSE sp. nov.

Herba erecta, 15 ad 40 cm alta, ramis subadpresse hirsutis; foliis inaequilateralibus, oblongo-obovatis, 2.5 ad 7 cm longis, subsessilibus, superne perspicue dentatis, subtus ad costa nervisque perspicue adpresse hirsutis; inflorescentiis ♂ 1 ad 1.5 cm diametro, longe pedunculatis, bracteis exterioribus late ovatis, circiter 7 mm longis, perspicue corniculatis; inflorescentiis ♀ sessilibus vel brevissime pedunculatis, confertis, circiter 8 mm diametro; floribus, 4-meris.

An erect, simple or sparingly branched herb, 15 to 40 cm high, the basal parts of the stems often prostrate and rooting, the stems and branches subappressed-hirsute. Leaves membranaceous and olivaceous when dry, inequilateral, oblong-obovate, 2.5 to 7 cm long, 1.5 to 4 cm wide, sessile or subsessile, the apex rounded to acute, the terminal tooth usually acute, the broader side with 8 to 10, prominent, acute teeth, the narrower side usually with about 5 similar teeth, the margins in the lower one-half entire, base auriculate-rounded on the broader side, acute on the narrower side, somewhat obliquely cordate, the upper surface with numerous, conspicuous, irregularly arranged cystoliths, sometimes with a few long hairs, more often glabrous, the lower surface appressed-hirsute on the conspicuous nerves and reticulations, the cystoliths obscure or obsolete; petioles 2 mm long or less, appressed-hirsute; stipules membranaceous, oblong, glabrous, about 5 mm long. Staminate inflorescences in full anthesis 1 to 1.5 cm in diameter, their pedicels slender, glabrous, 1 to 1.5 cm long; outer bracts very broadly ovate, about 7 mm long, 6 mm wide, conspicuously corniculate, the apical projection 1.5 to 2.5 mm long, the margins ciliate, the inner bracts oblong-obovate, apiculate, 2.3 mm wide; bracteoles spatulate, membranaceous, 4 to 5 mm long, 1 to 1.5 mm wide, ciliate. Staminate flowers 4-merous, very numerous, their pedicels 4 to 5 mm long. Sepals elliptic to elliptic-ovate, 2 to 2.3 mm long, with a few long white hairs near the apex, two of them minutely cucullate and obscurely apiculate. Pistillate inflorescences axillary, sessile, or subsessile, densely many-flowered, up to 8 mm in diameter, the bracteoles spatulate, ciliate, about 3 mm long.

PANAY, Antique Province, Culasi, *Bur. Sci. 32396* (type), *31032, 31082, 31083, 31084, 30921, 30924, 30925 Ramos & Edaño,* April and May, 1918, in damp forests along streams.

This species belongs in the group with *Elatostema obovatifolia* Wedd. and in many characters is similar to **Elatostema elmeri** nom. nov. (*E. pictum* Elm., non Hallier f.), from which it is easily distinguished by its appressed-hirsute branches, nerves, and reticulations on the lower surface of the leaves; *Elatostema elmeri* is glabrous.

ELATOSTEMA MACGREGORII sp. nov.

Herba prostrata, usque ad 16 cm longa, ramis et subtus foliis ad costa nervisque perspicue hirsutis; foliis subsessilibus, obovatis ad oblongo-obovatis, 6 to 12 mm longis, inaequilateralibus basi leviter oblique cordatis, dentibus in partibus superioribus 4 vel 5, conspicuis; inflorescentiis ♂ tenuiter pedunculatis, bracteis exterioribus late ovatis, corniculatis, ♀ sessilibus, bracteolis perspicue ciliatis; floribus, 4-meris.

A slender, prostrate or somewhat ascending, simple or sparingly branched herb, the stems 16 cm long or less, the latter with scattered, ascending or somewhat spreading, hirsute hairs. Leaves green when dry, sessile or subsessile, obovate to oblong-obovate, inequilateral, 6 to 12 mm long, 5 to 8 mm wide, the apex obtuse to subacute, the apical part with 4 or 5 conspicuous, usually rounded teeth, the margins in the lower two-thirds to three-fourths entire, base rounded-auriculate on the broader side, obtuse on the narrower side, somewhat obliquely cordate, the upper surface glabrous and with scattered cystoliths, the lower surface somewhat appressed-hirsute on the midrib and nerves, the latter 2, rarely 3, on each side of the midrib, the cystoliths obsolete; stipules membranaceous, oblong, glabrous, about 2 mm long. Staminate receptacles axillary, solitary, 4 to 5 mm in diameter, their peduncles slender, glabrous, 1 to 2 cm long; outer bracts broadly ovate, about 4 mm long and wide, the apex rounded or retuse, prominently keeled and corniculate, the apiculus about 1.2 mm long, glabrous or nearly so, the inner bracts oblong-ovate, somewhat ciliate; bracteoles spatulate, sparingly ciliate, 3 mm long. Flowers 4-merous, shortly pedicelled. Sepals oblong to oblong-elliptic, 1.5 mm long, two slightly cucullate and minutely apiculate, usually with a few long ciliate hairs above. Pistillate inflorescences sessile, densely many-flowered, about 4 mm in diameter, the bracteoles linear-lanceolate, about 2 mm long, prominently ciliate. Flowers minute, shortly stalked. Achenes 0.8 mm long.

PANAY, Antique Province, Culasi, *Bur. Sci. 32396* (type), *32407*, *32438*, *32538 McGregor*, May 24 and June 14, 1918, in damp forests, altitude 800 to 1,300 meters.

This species is very similar in appearance to *Elatostema filicaule* C. B. Rob., from which it is easily distinguished by its hirsute stems and the hirsute midrib and nerves on the lower surface of the leaves.

ELATOSTEMA ZAMBOANGENSE sp. nov.

Herba erecta, ramis et petiolis et pedunculis dense pallide pubescentibus; foliis plerumque oblongo-ovatis, 7 ad 13 cm longis, in siccitate viridibus, chartaceis ad subcoriaceis, valde inaequilateralibus, utrinque cystolithis numerosis perspicuis instructis, apice acuminatis, margine sursum grosse dentatis; receptaculis ♂ axillaribus, solitariis, pedunculatis, 1 ad 1.5 cm diametro, pedunculo usque ad 2 cm longo, bracteis exterioribus pubescentibus, late rotundatis, bracteolis sepalisque glabris.

An erect, simple herb, attaining a height of 35 cm, the stems, very short petioles, and peduncles rather densely pubescent with short, somewhat appressed, pale hairs. Leaves variable, green when dry, chartaceous to subcoriaceous, very inequilateral, mostly oblong-ovate, 7 to 13 cm long, 3 to 5.5 cm wide, both surfaces with very short, numerous, irregularly disposed, elongated cystoliths, distinctly visible to the naked eye, the apex somewhat acuminate, base broadly rounded on one side, narrowly rounded on the other and laterally cordate, margins entire near the base, rather coarsely toothed above, the teeth broadly triangular; lateral nerves above the basal ones 3 or 4 on each side of the midrib, very prominent on the lower surface, the reticulations lax, prominent; stipules linear-lanceolate, acuminate, 1 to 1.2 cm long. Staminate receptacles axillary, solitary, 1 to 1.5 cm in diameter, their peduncles up to 2 cm long; outer bracts pubescent, apparently reniform and more or less grown together, broadly rounded, about 1 cm wide, somewhat pubescent externally and with numerous, very densely disposed cystoliths; bracteoles narrowly oblong, membranaceous, 4 mm long, glabrous. Staminate flowers very numerous, their pedicels 3 to 4 mm long, glabrous. Sepals 4, membranaceous, glabrous, oblong, two of them distinctly cucullate and more or less corniculate, 2 to 2.5 mm long.

MINDANAO, Zamboanga District, Sax River, back of San Ramon, *Merrill 8228*, November 27, 1911, in a damp, shaded ravine, altitude about 200 meters.

Among the Philippine species with peduncled staminate receptacles this species is apparently most closely allied to *Elatostema carinoi* W. R. Shaw, but is readily distinguished by its pubescent stems and its much elongated pubescent peduncles.

ELATOSTEMA ACUMATISSIMUM sp. nov.

Herba erecta, circiter 50 cm alta, ramulis junioribus pubescentibus, foliis subtus ad costa nervisque parce pilosis; foliis lanceolatis ad anguste lanceolatis, membranaceis, 9 ad 16 cm longis, leviter falcatis, apice tenuiter caudato-acuminatis, margine grosse dentatis, dentibus numerosis, plerumque leviter acuminatis; receptaculis ♂ axillaribus, solitariis, sessilibus, subglobosis, bracteis exterioribus late ovatis ad reniformi-ovatis, 9 mm latis, leviter carinatis, haud corniculatis; bracteolis spatulatis, hirsutis.

An erect, usually unbranched herb, about 50 cm high, the tips of the branches slightly pubescent, the leaves with scattered, rather weak, spreading, pale hairs on the lower surface, the nerves and reticulations beneath dark brown in contrast with the greenish epidermis. Leaves lanceolate to narrowly lanceolate, membranaceous, 9 to 16 cm long, 2 to 3.5 cm wide, olivaceous when dry, somewhat falcate, the upper surface with numerous, irregularly disposed, somewhat elongated cystoliths, these obsolete on the lower surface, the apex slenderly caudate-acuminate, the base slightly inequilateral, both sides of the lamina acute to obtuse, the margins very coarsely toothed, the teeth usually 20 or more on each side, somewhat ovate, their tips usually somewhat acuminate and often incurved, those of the acumen extending at least half way to the midrib; lateral nerves above the basal ones, about 10 on each side of the midrib, very prominent on the lower surface, the reticulations lax, prominent. Staminate receptacles sessile, axillary, solitary, subglobose, about 9 mm in diameter; outer bracts broadly ovate to reniform-ovate, about 9 mm wide, somewhat hirsute, more or less keeled, but scarcely corniculate, the inner bracts oblong, hirsute, keeled, about 4 mm long; bracteoles spatulate, hirsute, as long as the inner bracts. Staminate flowers numerous, pedicelled, the sepals oblong-elliptic, about 2 mm long, their apices prominently ciliate with long white hairs.

LUZON, Tayabas Province, Umiray, *Bur. Sci. 29015 Ramos & Edaño,* June 2, 1917, in damp forests along the river at low altitudes.

The alliance of this species is with *Elatostema angustatum* C. B. Rob. and *Elatostema contiguum* C. B. Rob., but more especially with the latter from which it is especially distinguished by its much larger and more prominently toothed, caudate-acuminate leaves.

ELATOSTEMA ROBINSONII sp. nov.

Herba glabra, erecta, ramosa, 15 ad 30 cm alta; foliis numerosis, chartaceis, viridibus, oblongo-ovatis ad oblongo-ellipticis, sessilibus, 7 ad 15 mm longis, utrinque cystolithis numerosis instructis, acutis, basi 3-plinerviis, inaequilateralibus, margine in $\frac{1}{2}$ inferiore parte integris, superne dentatis, dentibus paucis; inflorescentiis ♂ axillaribus, solitariis, in siccitate flavido-viridibus, brevissime pedicellatis, 5 mm diametro; bracteis exterioribus late ovatis, carinatis, vix corniculatis, vel admodum obscure corniculatis.

An erect, much-branched, glabrous herb, 15 to 30 cm high, the stems apparently succulent when fresh, hard when dry, and about 4 mm in diameter, somewhat sulcate; lower branches up to 20 cm in length, yellowish green when dry. Leaves numerous, chartaceous, green when dry, oblong-ovate to oblong-elliptic, sessile, 7 to 15 mm long, 4 to 7 mm wide, green when dry, both surfaces with numerous, large, irregularly disposed cystoliths, apex acute, base inequilateral, 3-plinerved, one side rounded or obtuse, the other acute, the margins entire in the lower one-half, above with 3 or 4 teeth on one side and 3 to 5 on the other, the teeth distinct, blunt, usually less than 1 mm long; stipules linear-lanceolate, 2 to 2.5 mm long. Staminate receptacles axillary, solitary, numerous, yellowish green when dry, very shortly pedicellate, turbinate, about 5 mm in diameter, with as many as 14 flowers, but few developing at one time; pedicels about 1 mm long; outer two bracts very broadly obovate, densely longitudinally striate, broadly rounded, 3.5 to 4 mm long, keeled, firm, sometimes very slightly corniculate; bracteoles membranaceous, oblong-obovate, about 3 mm long, somewhat thickened in the median part. Pedicels in anthesis 2 mm long. Sepals 4, membranaceous, oblong to elliptic-oblong, 2 mm long, two distinctly corniculate at their apices, the other two acute.

LUZON, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19727 McGregor*, January 30, 1913, altitude not indicated.

This species apparently belongs in the group with *Elatostema benguetense* C. B. Rob., but is entirely different from that and all other species known to me; the yellowish-green color of the branchlets and staminate receptacles is very characteristic. The late C. B. Robinson has indicated on the sheet "*Elatostema* sp. nov. = Vidal 3857."

ELATOSTEMA PILOSUM sp. nov.

Herba erecta, sublignosa, ramosa, saltem 40 cm alta, ramulis densissime pilosis, subtus foliis ad costa nervisque perspicue longe pilosis; foliis oblongis, chartaceis, 1 ad 1.5 cm longis, utrinque angustatis, apice leviter acuminatis, basi inaequilateralibus, margine deorsum integris, superne utrinque 2- vel 3-dentatis; inflorescentiis ♂ axillaribus, solitariis, sessilibus, circiter 4 mm diametro; bracteis exterioribus oblongo-ovatis, acutis, pilosis, haud carinatis; bracteolis linearis, ciliatis.

An erect, woody, much-branched plant, at least 40 cm high, the branchlets densely cinereous-pilose with long spreading hairs, the leaves conspicuously pilose beneath on the midrib and nerves. Old stems about 5 mm in diameter, sparingly pilose with weak hairs. Leaves oblong, chartaceous, 1 to 1.5 cm long, 4 to 7 mm wide, narrowed to the inequilateral base and to the somewhat acuminate apex, the upper surface dark brownish-olivaceous when dry, with numerous irregularly scattered short cystoliths, the margin in the lower two-thirds entire, in the upper one-third usually with two teeth on the narrower side and three on the broader side, base inequilateral, one side of the lamina longer than the other, acute to obtuse, the narrower side acute; stipules linear-lanceolate, about 1.2 mm long. Staminate heads solitary, axillary, sessile, about 4 mm in diameter, the flowers in each head up to 20; outer two bracts oblong-ovate, acute, pilose, 2 mm long, not keeled or corniculate; bracteoles linear, ciliate, membranaceous, 1.5 mm long; pedicels ciliate, as long as the bracteoles. Sepals oblong, membranaceous, ciliate, 1.3 mm long, acute or obtuse, not keeled or corniculate.

LUZON, Nueva Vizcaya Province, near Imugan, *Bur. Sci. 20060 McGregor*, December 29, 1912.

In habit and general appearance this species is similar to *Elatostema halconense* C. B. Rob., from which it differs especially in the dense indumentum on the branchlets, the midrib and nerves beneath being pilose with long spreading hairs, and its distinctly smaller, less prominently toothed leaves.

ELATOSTEMA SUBORBICULARE sp. nov.

Herba prostrata, ramosa, usque ad 15 cm longa, ramulis leviter adpresse hirsutis; foliis orbicularis ad orbiculari-ovatis, inaequilateralibus, 5 ad 13 mm longis, apice rotundatis vel obtusis, basi valde inaequilateralibus, margine superne utrinque paucidentatis; receptaculis ♂ axillaribus, solitariis, sessilibus, circiter 5 mm diametro, bracteis exterioribus obovatis, leviter hirsutis, perspicue carinatis, vix corniculatis, interioribus cum bracteolis oblongo-spatulatis et cum sepalis plus minusve hirsutis vel ciliatis.

An apparently prostrate, more or less branched herb, the main stems at least 15 cm long, the branches 1.5 to 5 cm long, slender, sparingly appressed hirsute. Leaves suborbicular to orbicular-obovate, inequilateral, 5 to 13 mm long, brownish when dry, the apex rounded or obtuse, base strongly inequilateral and shallowly laterally cordate, entire below, the upper two-thirds on the broader side with about 4 rounded teeth, the narrower side in the upper one-third with 2 or 3 similar teeth, upper surface with irregularly scattered, distinct, elongated cystoliths, these obsolete on the lower surface; stipules oblong-elliptic, membranaceous, glabrous, usually obtuse to acute, 3 mm long. Staminate receptacles axillary, solitary, sessile, about 5 mm in diameter; bracts broadly obovate, about 5 mm long, sparingly hirsute, prominently keeled, scarcely corniculate, the apex broadly rounded, the inner ones thinner, somewhat hirsute, truncate, keeled, as long as the outer ones, about one-half as wide; bracteoles membranaceous, hirsute, oblong-spatulate, narrowly oblong-obovate, 4 mm long, obtuse; sepals oblong-elliptic, membranaceous, about 2 mm long, two acute, two distinctly corniculate, all sparingly ciliate at their apices. Pistillate receptacles axillary, solitary, 5 mm in diameter.

LUZON, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19729 McGregor*, February 14, 1913.

The alliance of this species is with *Elatostema obovatum* Wedd., from which it is especially distinguished by its smaller, suborbicular leaves, which have much fewer teeth.

ELATOSTEMA DIVERSILIMBUM sp. nov.

Herba erecta, usque ad 30 cm alta, e basi decumbente, simplex vel leviter ramosa, caulis adpresse hirsutis; foliis valde variabilis, 1 ad 9 cm longis, 1 ad 4 cm latis, inaequilateralibus, plerumque obovatis ad oblongo-obovatis, glabris, cystolithis utrinque numerosis, apice acuminatis, basi 3-plinerviis, leviter inaequilateraliter cordatis, margine grosse dentato-serratis; receptaculis axillaribus, solitariis, sessilibus, 8 ad 10 diametro, bracteis exterioribus rotundatis vel reniformibus, glabris, haud corniculatis, bracteolis membranaceis, leviter ciliatis, spatulatis, 3 ad 4 mm longis; sepalis 2 ad 2.5 mm longis, 2 distincte corniculatis.

An erect or ascending herb from a decumbent base, up to 30 cm long, simple or sparingly branched, the stems succulent, when dry brownish, more or less hirsute. Leaves chartaceous, greenish-olivaceous when dry, exceedingly variable, strongly inequilateral, 1 to 9 cm long, 1 to 4 cm wide, the smaller ones on young plants and on the few branchlets, mostly obovate to oblong-obovate, distinctly acuminate, base somewhat narrowed, obtuse and laterally cordate, the margins coarsely dentate-serrate, the teeth on the broader side 8 to 10, on the narrower side 4 to 6; nerves and reticulations prominent on the lower surface, the latter lax, brownish, the base 3-plinerved. Pistillate and staminate receptacles axillary, solitary, sessile, 8 to 10 mm in diameter. Outer bracts rounded to reniform, glabrous, not at all corniculate, the inner ones obovate to oblong-obovate; bracteoles spatulate, membranaceous, 3 to 4 mm long, slightly ciliate above. Sepals of the staminate flowers membranaceous, 2 to 2.5 mm long, two of them distinctly corniculate.

MINDANAO, Zamboanga District, mountains back of Zamboanga, *Merrill 9127*, December 6, 1911, in damp shaded ravines along small streams on banks and ledges, altitude 200 to 400 meters.

This species is most strikingly characterized by its very diverse leaves, which vary enormously in size, even on the same plant; in the larger specimens they are as much as 9 cm long and 4 cm wide, but on some of the smaller specimens and on the branches they are very much smaller, sometimes not more than 1 cm long and wide. The general alliance of the species appears to be with *Elatostema carinoi* W. R. Shaw.

ELATOSTEMA APPENDICULATUM sp. nov.

Herba erecta e basi decumbente, usque ad 30 cm alta, ramis et subtus foliis ad costa nervisque hirsutis; foliis membranaceis, inaequilateralibus, leviter falcatis, oblongis, 6 ad 11 cm longis, acutis, basi inaequilateralibus, 3-plinerviis, margine grosse dentato-serratis, pagina superiore cystolithis multis instructis, in siccitate olivaceis, nervis reticulisque subtus brunneis, valde perspicuis; receptaculis ♂ axillaribus, solitariis, sessilibus, subglobosis, 6 ad 8 mm diametro, bracteis exterioribus orbicularibus, leviter ciliatis, 8 mm diametro, longe corniculatis, bracteolis membranaceis, oblongis ad oblanceolatis, perspicue longe ciliatis, dorso longe tenuiter appendiculato; sepalis 2 ad 2.5 mm longis, sursum ciliato-hirsutis, 2 distincte corniculatis.

An erect unbranched herb, 25 to 30 cm high, the stems and the leaves beneath on the nerves and reticulations conspicuously hirsute with spreading, pale or brown hairs. Leaves membranaceous, olivaceous or greenish-olivaceous when dry, somewhat falcate, oblong, inequilateral, 6 to 11 cm long, 2 to 3 cm wide, the prominent nerves and lax reticulations on the lower surface dark brown in contrast to the greenish epidermis, the apex acute, base inequilateral, rounded on one side, acute on the other, 3-plinerved, the margins in the lower one-fourth entire, otherwise rather coarsely dentate-serrate, usually 10 to 12 teeth on each side, the upper surface glabrous, with numerous, irregularly disposed, elongated cystoliths; petioles 2 mm long or less; stipules lanceolate, about 8 mm long. Staminate receptacles axillary, solitary, sessile, globose, 6 to 8 mm in diameter, the two external bracts orbicular, somewhat ciliate, broadly rounded, prominently corniculate, the appendage 2 to 3 mm long; bracteoles variable, oblong to oblanceolate, membranaceous, 4 to 5 mm long, prominently ciliate with long white hairs and with a very slender, ciliate, 2 to 3 mm long appendage from the back at or above the middle. Sepals of the staminate flowers 4, membranaceous, ciliate above, 2 to 2.5 mm long, two of them distinctly corniculate.

LUZON, Tayabas Province, Mount Tuloag, *Bur. Sci. 29129 Ramos & Edaño*, May 25, 1917, along small streams in damp forests at low altitudes.

The alliance of this species is not entirely clear, although, with the exception of the indumentum and its bract and floral characters, it resembles *Elatostema carinoi* W. R. Shaw. It is readily distinguished by its laxly reticulate leaves, the nerves and reticulations being dark brown in contrast to the green epidermis, and distinctly ciliate, as well as by its peculiarly appendaged bracteoles.

ELATOSTEMATOIDES C. B. Robinson

ELATOSTEMATOIDES SAMARENSE sp. nov.

Planta erecta, saltem 50 cm alta, sublignosa; foliis chartaceis vel subcoriaceis, inaequilateraliter oblongo-ovatis, circiter 15 cm longis et 6 cm latis, apice tenuiter acuminatis, margine distanter grosse dentatis, inferne plerumque integris vel subintegris, subtus ad nervis et nervulis perspicue molliter pilosis; cymis ♂ sessilibus, circiter 1.5 cm diametro, floribus numerosis, confertis, perianthii segmentis 5, bracteolis oblongo-lanceolatis, pubescentibus.

An erect, apparently unbranched, woody plant, at least 50 cm high, the stems nearly glabrous below, above more or less pilose with rather long spreading hairs. Leaves chartaceous or subcoriaceous, inequilateral, oblong-ovate, about 15 cm long and 6 cm wide, dark brown when dry, the upper surface with numerous, irregularly disposed, short cystoliths, the lower surface softly pilose with rather long spreading hairs on the nerves and reticulations, apex slenderly acuminate, base narrowed, inequilateral, rounded on the broader side, acute or somewhat rounded on the narrower side, the more prominent nerve on the narrower side leaving the midrib well above the base, margins distantly and rather coarsely toothed, at least in the upper part, below often entire or nearly so, nerves prominent, arched, anastomosing, the primary ones above the basal pair 3 or 4 on each side of the midrib. Staminate cymes axillary, sessile, about 1.5 cm in diameter, the flowers numerous, crowded, the subtending bracteoles oblong-lanceolate, 1.5 to 2 mm long, pubescent; pedicels pubescent, about 1.5 mm long. Perianth segments of the staminate flowers 5, oblong to oblong-elliptic, 2 mm long, somewhat ciliate, some of them distinctly corniculate or keeled-corniculate at the apex.

SAMAR, Yabong, *Bur. Sci. 17468 Ramos,* March 16, 1914, in damp forests near small streams at low altitudes.

The alliance of this is manifestly with *Elatostematoides manillense* C. B. Rob., from which it is especially distinguished by its prominently pilose midrib, nerves, and reticulations on the lower surface of the leaves.

BOEHMERIA Jacquin

BOEHMERIA ZOLLINGERIANA Wedd. in Ann. Sci. Nat. Bot. IV 1 (1854) 201, DC. Prodr. 16[1] (1869) 208.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33129 Ramos,* August, 1918; Bangui, *Bur. Sci. 27478 Ramos,* March, 1917: Pangasinan Province, Umingan, *Bur. Sci. 18322 Otanes,* May, 1914, in ravines and on open slopes, ascending to an altitude of 550 meters.

Weddell's species was based on a Javan specimen. It has been also recorded from Formosa by C. H. Wright,[2] who, however, identified the Formosan material from the description alone. The Philippine specimens agree closely with our rather full series of Formosan ones.

ARISTOLOCHIACEAE

ARISTOLOCHIA Tournefort

ARISTOLOCHIA MEMBRANACEA sp. nov. § *Diplolobus.*

Frutex parvus, ut videtur erectus, ramulis 1 ad 2 mm diametro; foliis membranaceis, oblongis ad oblongo-lanceolatis, 8 ad 15 cm longis, acuminatis, basi cordatis, lobis rotundatis, utrinque ad costa nervisque leviter pubescentibus, nervis utrinque 8 ad 10, tenuibus; inflorescentiis axillaribus, paucifloris; floribus circiter 3 cm longis, leviter pubescentibus; capsulis obovoideis, 1 cm longis, glabris.

[2] Journ. Linn. Soc. Bot. 26 (1899) 488.

Slender, apparently erect, the branchlets somewhat zigzag, 1 to 2 mm in diameter, pubescent with short spreading hairs. Leaves membranaceous, oblong to oblong-lanceolate, 8 to 15 cm long, 3 to 5 cm wide, mostly equilateral, base broadly rounded and prominently cordate, the sinus up to 1 cm wide and deep, rounded, narrowed upward to the acuminate apex, olivaceous and shining when dry, both surfaces sparingly pubescent on the midrib and nerves; basal nerves usually two pairs, not however sharply distinguished from the lateral nerves, all of the nerves rather slender, distinct, curved, anastomosing, up to 10 on each side of the midrib; petioles 3 to 5 mm long, somewhat pubescent. Inflorescences axillary, about as long as the petioles, somewhat pubescent, few-flowered, but one flower developing at a time; bracts oblong to spatulate, 3 to 5 mm long. Flowers about 3 cm long, pubescent externally with scattered spreading hairs, the ovarian part of the tube about 4 mm long, the globose part about 4 mm long, somewhat curved above the globose part, the tube about 10 mm long, the short lobe broadly ovate, rounded, about 4 mm long, the long one about 15 mm in length, acute or acuminate. Stamens apparently 8. Column with 6 flattened lobes. Capsule glabrous, obovoid, about 1 cm long. Seeds triangular in outline, 3 mm long, concavo-convex; convex surface distinctly papillate.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33338 Ramos*, August 22, 1918, on dry slopes and ridges, altitude about 350 meters.

This species is allied to *Aristolochia sericea* Blanco (*A. imbricata* Mast.) from which it is distinguished especially by its prominently cordate, thinner, less pubescent leaves, its much less pubescent flowers, and its glabrous capsules.

CARYOPHYLLACEAE

STELLARIA Linnaeus

STELLARIA MEDIA (Linn.) Cyr. Char. Comm. (1784) 36; Edgw. & Hook. f. in Hook. f. Fl. Brit. Ind. 1 (1784) 230.

Alsine media Linn. Sp. Pl. (1753) 272.

LUZON, Benguet Subprovince, Baguio, *Merrill 9699*, May, 1914; Pauai, *Bur. Sci. 31861 Santos*, May 4, 1914, altitude 1,500 to 2,300 meters.

A universally distributed weed in the north temperate regions, a native of Asia; unquestionably a recently introduced plant in Benguet.

MENISPERMACEAE

HAEMATOCARPUS Miers

HAEMATOCARPUS SUBPELTATUS sp. nov.

Frutex scandens, glaber; foliis coriaceis, basi rotundatis et leviter peltatis, oblongis ad oblongo-ellipticis, 9 ad 14 cm longis, apice tenuiter acuminatis; inflorescentiis ♂ axillaribus, racemosis vel depauperato-paniculatis, 3 ad 8 cm longis; floribus circiter 8 mm diametro, sepalis plerumque 12, lineolatis, exterioribus minoribus; petalis 6, quam sepalis interioribus minoribus, basi inflexo-auriculatis.

A scandent woody vine, glabrous except the very slightly pubescent sepals, the branches up to 4 mm in diameter. Leaves coriaceous, oblong to oblong-elliptic, pale and shining when dry, 9 to 14 cm long, 3.5 to 5.5 cm wide, base rounded and slightly peltate, the petiole inserted 1 to 2 mm from the margin, the apex rather slenderly acuminate; basal nerves 2 on each side of the midrib, nearly as prominent as the midrib and extending nearly to the apex, the secondary nerves slender, spreading at nearly right angles and with the reticulations distinct on both surfaces; petioles about 2 cm long. Staminate inflorescences axillary, solitary, racemose or depauperate-paniculate, 3 to 8 cm long. Staminate flowers yellow, about 6 mm in diameter, their pedicels 2 to 5 mm long. Outer 2 or 3 sepals less than 1 mm long, broadly ovate, the next three sepals ovate, obtuse, about 1.2 mm long, the inner six elliptic, rounded, 3 to 3.5 mm long, all of the sepals prominently lineolate, their margins slightly ciliate. Petals 6, somewhat thicker than the sepals, broadly elliptic to elliptic-obovate, rounded, 2.5 to 3 mm long, base inflexed-auriculate, stamens 6, free, their filaments 1 mm long; anthers broadly ovate, acuminate, 1 to 1.2 mm long, the connectives broad, produced.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33750 Ramos & Edaño,* December 22, 1918, in forests along streams at low altitudes.

This is the first representative of this small genus to be found in the Philippines; its alliance is with *Haematocarpus comptus* Miers, from which it is distinguished by its much shorter racemose, axillary inflorescences, and its smaller leaves which are rounded and slightly peltate at the base.

ANNONACEAE

ARTABOTRYS R. Brown

ARTABOTRYS MONOGYNUS sp. nov.

Frutex scandens, inflorescentiis exceptis glaber; foliis subcoriaceis, oblongo-ellipticis, nitidis, usque ad 18 cm longis, obtuse acuminatis, basi acutis, nervis utrinque circiter 12, patulis, distinctis, anastomosantibus; inflorescentiis usque ad 5 cm longis, paucifloris; petalis omnibus aequalibus, linearis, basi inflatis, circiter 1.6 cm longis, pubescentibus; carpellis solitariis, glabris.

A scandent shrub, glabrous except the inflorescence. Branches and branchlets terete, smooth, dark reddish-brown when dry. Leaves subcoriaceous, rather pale when dry, of the same color and shining on both surfaces, oblong-elliptic, 15 to 18 cm long, 5 to 5.7 cm wide, subequally narrowed to the acute base and to the shortly blunt-acuminate apex; lateral nerves about 12 on each side of the midrib, spreading, distinct, anastomosing, the primary reticulations lax; petioles dark-colored and rugose when dry, 5 to 8 mm long. Inflorescences leaf-opposed, up to 5 cm long including the flowers, few-flowered, stout, the peduncle 3 to 4 mm in diameter, sparingly pubescent, ultimately glabrous, strongly hooked, slightly compressed. Flowers white, their pedicels usually about 1 cm long, thickened upward, slightly pubescent. Sepals broadly ovate, thickly coriaceous, black when dry, prominently acuminate, about 3.5 mm long, very slightly pubescent with widely scattered hairs. Petals all similar, the inflated basal portions broadly ovate, 3.5 to 5 mm in diameter, rather densely pubescent, the linear limb up to 16 mm long, about 1.5 mm wide, somewhat pubescent, blunt. Stamens numerous, nearly 2 mm long. Carpel solitary, broadly ovoid, narrowed upward, glabrous, somewhat angled, 1-celled, 2-ovuled. Fruit ellipsoid, brown, about 2 cm long.

LUZON, Zambales Province, Mount Canayayan, near Castillejos, *Bur. Sci. 26826 Edaño*, December, 1916, in forests, altitude about 50 meters.

A species manifestly in the alliance with *Artabotrys suaveolens* Blume, but with larger leaves. It is readily distinguished from all described species by its solitary carpels.

ARTABOTRYS CAGAYANENSIS sp. nov.

Frutex scandens, floribus exceptis glaber; foliis oblongis ad oblongo-oblanceolatis, usque ad 20 cm longis, subcoriaceis, in siccitate pallidis, basi acutis, apice distincte acuminatis, nervis utrinque 12 ad 14, distinctis; floribus solitariis, flavidis, circiter 5 cm diametro, petalis utrinque dense pubescentibus, interioribus obovatis, circiter 2.5 cm longis et 1.5 cm latis, exterioribus ovatis ad elliptico-ovatis, 3 cm longis et 2 cm latis, obtusis; carpellis circiter 14, pubescentibus, 2 mm longis.

A scandent shrub, glabrous except the flowers. Branches terete, rugose, brownish or reddish-brown. Leaves oblong to oblong-oblanceolate, subcoriaceous, rather pale and shining when dry, 16 to 20 cm long, 3.5 to 7 cm wide, base acute, apex distinctly acuminate, the acumen 1 cm long or less, blunt; lateral nerves 12 to 14 on each side of the midrib, distinct, curved, anastomosing, the reticulations slender; petioles reddish-brown, about 8 mm long. Hooks rather stout, strongly recurved, about 2 cm to the bend, glabrous. Flowers yellow, solitary, about 5 cm in diameter, their pedicels densely pubescent, 2 to 2.5 cm long. Sepals coriaceous, narrowly ovate, obtuse, densely pubescent, about 11 mm long and 8 mm wide. Petals spreading above the united portions, the flowers about 5 cm in diameter, coriaceous, rather densely pubescent on both surfaces, the outer ones ovate to elliptic-ovate, obtuse, about 3 cm long and 2 cm wide, the inner ones obovate, about 2.5 cm long and 1.5 cm wide, obtuse or obtusely acuminate, the inflated base formed by the united lower parts of the petals about 8 mm in diameter. Stamens indefinite, 2 mm long. Carpels about 14, oblong, about 2 mm long, pubescent.

LUZON, Cagayan Province, Peñablanca, *Adduru 136*, May 28, 1917, *Bur. Sci. 22719 Castillo*, April 24, 1915, on forested slopes at low altitudes.

A species well characterized among the Philippine forms by its unusually large flowers and broad petals.

GONIOTHALAMUS Hooker f. and Thomson

GONIOTHALAMUS LANCIFOLIUS sp. nov.

Arbor circiter 7 m alta, novellis et floribus exceptis glabra; foliis lanceolatis, chartaceis, usque ad 33 cm longis et 5 cm latis, nitidissimis, acuminatis, basi acutis, nervis utrinque 25 ad 30, distinctis; floribus axillaribus et caulinis, solitariis, tenuiter pedunculatis, petalis exterioribus ovato-lanceolatis ad oblongo-lanceolatis, 7 ad 8 cm longis, acuminatis, extus ad basi dense fulvo-pubescentibus, interioribus circiter 1.2 cm longis, densissime pallide pubescentibus.

A tree, about 7 m high, entirely glabrous except the growing tips of the branchlets and parts of the flowers. Branches terete, pale brownish, glabrous. Leaves chartaceous, lanceolate, 19 to 33 cm long, 3 to 4 cm wide, the upper surface greenish olivaceous, very strongly shining, the lower somewhat brownish, the apex slenderly acuminate, base acute; primary lateral nerves 25 to 30 on each side of the midrib, slender, distinct, anastomosing, the reticulations lax; petioles about 8 mm long. Flowers 7 to 8 cm long, greenish-yellow, dark-brown when dry, odorless, solitary, axillary and from tubercles on the trunk, their pedicels 2.5 to 3 cm long, often appressed fulvous-pubescent at the base. Calyx about 1 cm in diameter, somewhat pubescent, the lobes short. Outer three petals ovate-lanceolate to oblong-lanceolate, 7 to 8 cm long, 2.5 to 3.5 cm wide, narrowed upward to the acuminate apex, glabrous except for the densely fulvous-pubescent basal portion outside; inner three petals about 1.2 mm long, conniving over the stamens, densely pale-pubescent externally.

LUZON, Pangasinan Province, Mount San Isidro, Labrador, *Bur. Sci. 29992 Fénix,* November 4, 1917, in forests near the summit, altitude about 400 meters.

This species belongs in the group with *Goniothalamus malayanus* Hook. f. & Th., but is well characterized by its elongated, narrow, strongly shining leaves, and its large, solitary, axillary and cauline flowers.

GONIOTHALAMUS LONGISTYLUS sp. nov.

Arbor parva, floribus exceptis glabra; foliis oblongis, in siccitate olivaceis, usque ad 16 cm longis, acuminatis, basi acutis, nervis utrinque 9 ad 11, patulis, tenuibus; inflorescentiis trunciflоris, floribus pedicellatis, fasciculatis, circiter 4 cm longis, petalis exterioribus glabris, oblongo-ovatis, acuminatis, interioribus late ovatis, 2 cm longis, extus leviter, intus densissime pubescentibus; carpellis numerosis, oblongis, pubescentibus, 2 mm longis, stylis valde elongatis, falcatis, acuminatis, 4 ad 4.5 mm longis.

A small tree, glabrous except the flowers and the slightly pubescent fruits. Branches and branchlets slender, terete, black when dry. Leaves oblong, olivaceous, chartaceous, 13 to 16 cm long, 3.5 to 4.5 cm wide, shining, of the same color on both surfaces, subequally narrowed to the acuminate apex and to the acute base; lateral nerves slender, 9 to 11 on each side of the midrib, spreading, anastomosing, the reticulations lax; petioles black when dry, about 1 cm long. Flowers black when dry, reddish-pink, fascicled on small tubercles on the trunk, about 4 cm long, their pedicels about 2 cm in length. Sepals glabrous, broadly ovate, obtuse, obscurely reticulate, about 8 mm long. Outer three petals submembranaceous, glabrous, oblong-ovate, prominently acuminate, about 4 cm long and 2 cm wide, narrowed upward; inner three petals thickly coriaceous, scarcely clawed, cohering, broadly ovate, acuminate, about 2 cm long and 1.3 cm wide, outside sparingly pubescent, inside very densely so. Stamens indefinite, about 2 mm long, the connectives rounded. Carpels many, oblong, pubescent, 2 mm long; styles simple, cylindric, falcate, 4 to 4.5 mm long, glabrous, acuminate. Fruits eight or more on each peduncle, the peduncles up to 6 cm in length, the fruits oblong or oblong-obovoid, 4 to 4.5 cm long, 2 to 2.5 cm in diamter, obtuse, base acute, glabrous, black or dark-brown when dry, 1- or 2-seeded.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26639 Ramos & Edaño,* August 24, 1916, on forested slopes.

This strongly marked species is not closely allied to any other known Philippine form. It is readily recognized by its cauline, fascicled flowers and its greatly elongated, falcate styles.

MITREPHORA Hooker f. and Thomson

MITREPHORA CAGAYANENSIS sp. nov.

Frutex vel arbor parva (4 m alta fide Castillo), plus minusve ferrugineo-pubescentibus; foliis chartaceis, oblongo-ovatis ad oblongo-ellipticis, usque ad 17 cm longis, basi acutis, apice obtuse acuminatis, nervis utrinque circiter 13, distinctis; floribus paucis, circiter 5 cm diametro, petalis exterioribus lanceolatis, acuminatis, patulis, leviter pubescentibus, circiter 3 cm longis, interioribus circiter 9 mm longis, longe unguiculatis, lamina latissime hastato-ovata, circiter 4 mm longa, intus densissime ciliato-hirsuta.

A shrub or small tree, 4 m high according to Castillo, the branchlets, inflorescences, and lower surface of the leaves on the midrib and nerves more or less ferruginous-pubescent or brownish-pubescent with short hairs. Branches slender, terete, glabrous, rugose when dry, brownish-gray. Leaves chartaceous, oblong-ovate to oblong-elliptic, olivaceous and somewhat shining when dry, 12 to 17 cm long, 5 to 9 cm wide, base acute, apex obtusely acuminate, the upper surface glabrous except the pubescent midrib; lateral nerves about 13 on each side of the midrib, distinct, curved; petioles pubescent, stout, 5 mm long or less. Inflorescences leaf-opposed, short, few-flowered, but a single flower developing at one time, ferruginous-pubescent, the simple axis 5 mm long or less, the pedicels shorter. Bracts ovate, densely pubescent, prominently acuminate, about 6 mm long. Flowers yellow, about 5 cm in diameter. Sepals similar to the bracts in size, shape, and appearance. Outer petals spreading, lanceolate, acuminate, dark-brown or nearly black when dry, appressed-pubescent on both surfaces with rather scattered hairs, the hairs much fewer on the inside, about 3 cm long and 8 mm wide. Inner petals erect, arched, about 9 mm long, their claws about 6 mm long and 1.2 mm wide, glabrous or slightly ciliate, the limbs broadly ovate-hastate, 3 to 4 mm long, 4 to 5 mm wide, externally pubescent with short hairs, inside densely ciliate with dark-brown hairs, acute, base lobed. Stamens indefinite, about 1 mm long. Carpels about 8, oblong, appressed-hirsute, about 1 mm long; ovules about 4.

LUZON, Cagayan Province, near Tuguegarao, *Bur. Sci. 22733 Castillo*, April 15, 1915, in thickets at low altitudes; Peñablanca, *Adduru 143*, sterile, June, 1917.

This species is well characterized by its lanceolate, elongated exterior petals and its long-clawed interior ones, the limbs of the latter being broadly ovate-hastate.

OXYMITRA Hooker f. and Thomson

OXYMITRA MULTINERVIA sp. nov.

Frutex scandens, partibus vetustioribus glaber vel subglaber; foliis ellipticis ad oblongo-ellipticis, subcoriaceis, in siccitate brunneis, nitidis, usque ad 20 cm longis, utrinque late rotundatis vel apice leviter retusis; nervis utrinque circiter 22, subtus valde prominulis; fructibus ellipsoideis ad obovoideis, 1 ad 1.5 cm longis, glabris.

A scandent shrub, in age nearly glabrous. Branches terete, brownish, nearly smooth, glabrous, the branchlets sparingly pubescent. Leaves elliptic to oblong-elliptic, subcoriaceous, brown when dry, shining, the lower surface a little paler than the upper, not at all glaucous, 13 to 20 cm long, 8 to 12 cm wide, broadly rounded at both base and apex, the lower surface very sparingly pubescent along the midrib and nerves; lateral nerves about 22 on each side of the midrib, very prominent on the lower surface, the reticulations subparallel, distinct; petioles 1 to 1.5 cm long. Fruits dark-brown when dry, glabrous, hard, ellipsoid to obovoid, 1 to 1.5 cm long, their pedicels 8 to 12 mm in length.

CATANDUANES, on forested slopes back of Calolbong, *Bur. Sci. 30456 Ramos*, December 10, 1917.

This species somewhat resembles *Oxymitra longiflora* Merr. and the very closely allied and perhaps identical *O. obtusifolia* Elm., but is readily distinguished by its much more numerous lateral nerves.

OXYMITRA PLATYPHYLLA sp. nov.

Frutex scandens partibus junioribus parce ferrugineo-pubescentibus; foliis obovatis ad ellipticis, usque ad 20 longis et 12 cm latis, basi cordatis, interdum leviter inaequilateralibus, apice late rotundatis, truncatis, vel obscure brevissime apiculatis, nervis utrinque circiter 13, subtus valde prominentibus, supra, costa exceptis, glabris, subtus ad costa nervisque leviter pubescentibus; fructibus numerosis, pedicillatis, subglabris, ovoideo-globosis, circiter 8 mm diametro, obscure apiculatis.

A scandent shrub, the younger parts, petioles, and leaves on the costa above and on the costa, nerves, and reticulations beneath more or less ferruginous-pubescent. Branches terete, slender, very dark-brown, somewhat rugose. Leaves obovate to elliptic, subcoriaceous, 14 to 20 cm long, 8 to 12 cm wide, base broadly rounded, distinctly cordate, sometimes slightly inequilateral, apex rounded, truncate, or shortly and obscurely apiculate, the upper surface olivaceous, shining, glabrous except the midrib, the lower surface brown, at times slightly glaucous; lateral nerves about 13 on each side of the midrib, very prominent on the lower surface, straight or slightly curved, anastomosing near the margins, the primary reticulations subparallel, prominent; petioles stout, about 4 mm long, more or less pubescent, ultimately nearly glabrous. Infructescences axillary, the peduncles 2.5 to 3 cm long, dark-brown, ultimately glabrous, each bearing 20 to 25 subglobose to ovoid-globose fruits, the infructescences rather dense, globose, about 3 cm in diameter; fruits red when mature, acid, about 8 mm in diameter, sparingly pubescent, apiculate, dark-brown when dry, their pedicels about 8 mm long.

LUZON, Laguna Province, Mount Maquiling, along Molauin River, *For. Bur. 26360 Mabesa*, in forests, altitude 400 to 500 meters.

The alliance of this species is with *Oxymitra obtusifolia* Elm. and *O. longiflora* Merr., from which it is distinguished by its much broader leaves and nearly globose fruits.

PAPUALTHIA Diels

PAPUALTHIA HETEROPETALA sp. nov.

Frutex erectus, ramulis floribusque exceptis glaber; foliis oblongis ad oblongo-lanceolatis, usque ad 11 cm longis, chartaceis, acutis vel acuminatis, basi angustatis, leviter inaequilateralibus et minute oblique cordatis, nervis utrinque 10, perspicuis; floribus extra-axillaribus, solitariis vel fasciculatis, pedicellis circiter 12 mm longis; sepalis ovatis, acuminatis, 4 ad 5 mm longis; petalis infra connatis, 3 ovatis, 8 mm longis, sursum angustatis, acuminatis, 3 oblongis, 9 ad 10 mm longis, plerumque acutis; carpellis circiter 5.

An erect shrub, glabrous, except the young branchlets and flowers, the branches slender, terete, nearly black when dry, sparingly lenticellate. Leaves oblong to oblong-lanceolate, chartaceous, pale and shining when dry, 7 to 11 cm long, 2 to 4 cm wide, apex usually acuminate, sometimes acute, base narrowed and slightly inequilateral, usually minutely and obliquely cordate;

lateral nerves about 10 on each side of the midrib, slender, prominent, anastomosing, the reticulations lax, distinct; petioles black when dry, about 2 mm long. Flowers yellowish, extra-axillary, solitary or few in a fascicle, but one flower developing at a time, their pedicels slender, about 12 mm long, appressed-pubescent, supplied with one or two, oblong, 2 mm long bracts below the middle. Sepals ovate, sparingly ferruginous-pubescent, 3 mm wide, 4 to 5 mm long, prominently acuminate. Petals united for the lower 2 to 3 mm, very unequal, three of the lobes ovate, about 5 mm long and 3 mm wide, much narrowed above to the acuminate apex, the three alternating lobes oblong, 6 to 7 mm long, 2 to 2.5 mm wide, sparingly appressed-pubescent outside, slightly narrowed upward, usually acute. Stamens indefinite, about 1.4 mm long. Carpels about 5, oblong, 1 mm long, appressed-pubescent; ovules apparently 3; stigma capitate.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32853 Ramos*, July 26, 1918, in dry forests at low altitudes.

In vegetative characters this species is very similar to *Papualthia lanceolata* Merr., but differs radically in its floral characters, notably in the ovate, very prominently acuminate sepals and the very unequal petals, three of which are ovate and prominently acuminate, the three alternating ones oblong, longer, narrower, and usually acute.

PHAEANTHUS Hooker f. and Thomson

PHAEANTHUS PUBESCENS sp. nov.

Arbor parva, ramulis cinereo-pubescentibus, novellis ferrugineo-pubescentibus; foliis lanceolatis ad oblongo-lanceolatis, chartaceis, usque ad 18 cm longis, plus minusve acuminatis, basi acutis, nervis utrinque circiter 10, curvato-adscendentibus, supra in siccitate atro-brunneis, nitidis, glabris, subtus perspicue pubescentibus; fructibus oblongo-ovoideis, nigris, glabris, circiter 1.7 cm longis.

A tree, about 5 m high, more or less pubescent, the younger parts densely so. Branches terete, brownish, rugose, glabrous, the branchlets rather prominently cinereous-pubescent, the very young parts densely ferruginous-pubescent. Leaves lanceolate to oblong-lanceolate, chartaceous, 10 to 18 cm long, 2 to 5 cm wide, narrowed upward to the usually blunt-acuminate apex, the base acute, upper surface glabrous, blackish-brown when dry, shining, the lower somewhat paler, rather prominently cinereous-pubescent, the midrib densely so; lateral nerves about 10 on each side of the midrib, slender, curved-ascending, distinct; petioles pubescent, 3 to 6 mm long. Fruits oblong-ovoid, glabrous, smooth, black when dry, about 1.7 cm long, apex very obscurely rostrate, the pedicels black when dry, 2 to 2.5 cm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27333 Ramos*, March 10, 1917, in forests near streams.

This species is manifestly allied to *Phaeanthus ebracteolatus* Merr.; it is distinguished especially by its indumentum.

PHAEANTHUS VILLOSUS sp. nov.

Frutex erectus, perspicue et molliter villosus; foliis chartaceis, oblongis, usque ad 22 cm longis, tenuiter caudato-acuminatis, supra glabris, subtus villosis, nervis utrinque circiter 20, perspicuis; pedicellis villosis, 7 ad 9 cm longis; floribus solitariis, circiter 4.5 cm longis, petalis interioribus caudato-acuminatis.

A shrub, the branches, lower surface of the leaves and the pedicels softly and densely villous. Leaves chartaceous, oblong, 16 to 22 cm long, 6 to 8 cm wide, the apex slenderly caudate-acuminate, base acute to somewhat rounded, the upper surface glabrous, shining, the lower surface densely and softly villous on the midrib and nerves; lateral nerves about 20 on each side of the midrib, distinct; petioles densely villous, 7 to 10 mm long. Flowers yellow, extra-axillary, solitary, their densely villous pedicels 8 to 9 cm long. Sepals and the three outer petals minute, pubescent, triangular-ovate, about 1 mm long. Inner petals coriaceous-fleshy, oblong-elliptic, about 4.5 cm long, to 2.3 cm wide, somewhat pubescent outside and with slender longitudinal nerves, base somewhat narrowed, apex subcaudate-acuminate. Anthers numerous, oblong, about 3 mm long, the connectives oblique, somewhat concave. Carpels numerous, oblong, about 3 mm long, somewhat pubescent; style club-shaped, pubescent, about 1.5 mm long.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30775 Ramos & Edaño*, April 23, 1918, along small streams in damp forests.

This species is well characterized by its rather dense soft indumentum, which is found on most parts of the plant. It is most closely allied to *Phaeanthus pubescens* Merr., from which it differs essentially in its much more numerous lateral nerves.

POLYALTHIA Blume

POLYALTHIA DOLICHOPHYLLA sp. nov. § *Eupolyalthia*.

Frutex subglaber; foliis brevissime petiolatis, chartaceis, oblanceolatis ad oblongo-oblanceolatis, usque ad 50 cm longis, 11 ad 18 cm latis, basi perspicue cordatis, subamplexicaulibus, nervis utrinque circiter 18, valde perspicuis; floribus axillaribus, pedicellatis, circiter 4 cm longis; calycis lobis 1.5 ad 2 cm longis; petalis crasse coriaceis, exterioribus circiter 1.5 cm latis, interioribus angustioribus, infra contractis, basi leviter inflatis; carpellis anguste oblongis, pubescentibus, ovulis 2, superpositis.

A shrub, 2 to 3 m high, glabrous except the petioles and the midribs on the lower surface toward the base. Leaves chartaceous, oblanceolate to oblong-oblanceolate, about 50 cm long, 11 to 18 cm wide, the upper surface grayish when dry, shining, the lower surface brownish, apex somewhat acuminate, narrowed below the middle to the abruptly rounded and prominently cordate base, the base 5 to 8 cm wide, the basal lobes somewhat amplexicaul; lateral nerves about 18 on each side of the midrib, very prominent on the lower surface, curved, arched, anastomosing; petioles very stout, 8 to 10 mm long, pubescent. Flowers yellow or reddish-yellow, axillary, solitary, at maturity about 4 cm long, their pedicels up to 1.5 cm long, each with an ovate, acuminate, basal bracteole about 1 mm long. Calyx-lobes ovate to oblong-ovate, acute or obtuse, chartaceous, 1.5 to 2 cm long. Petals about 3.5 cm long, thickly coriaceous, glabrous, the outer three about 1.5 cm wide, the inner three about 1 cm wide, acute or obtuse and distinctly narrowed below the middle and above the slightly inflated base. Stamens indefinite, the anthers oblong, 2.8 mm long. Carpels numerous, narrowly oblong, pubescent, the stigmas densely pilose; ovules 2, superposed.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 30983* (type), *36873 Ramos & Edaño,* April and May, 1918, along small streams in forests.

This remarkable species is prominently characterized by its unusually large leaves which are narrowed below to the abruptly rounded and prominently cordate, somewhat amplexicaul base; the petioles are unusually short, some of the leaves being subsessile. It has no close alliance among the Malayan species known to me.

PSEUDUVARIA Miquel

PSEUDUVARIA GRANDIFLORA sp. nov.

Arbor circiter 5 m alta, plus minusve cinereo-pubescentibus, novellis dense ferrugineo-pubescentibus; foliis oblongis, usque ad 20 cm longis, obtuse acuminatis, basi acutis ad subrotundatis, nervis utrinque 8 ad 11, curvato-adscendentibus, perspicuis; floribus axillaribus, numerosis, fasciculatis, longe pedicellatis, circiter 1.5 cm longis.

A tree, about 5 m high, the branches dark grayish-brown, rugose, glabrous, the branchlets rather densely cinereous-pubescent, the young tips ferruginous-pubescent. Leaves chartaceous, oblong, 13 to 20 cm long, 4 to 5.5 cm wide, pale-olivaceous and somewhat shining on the upper surface when dry, the midrib pubescent, the lower surface paler, pubescent on the midrib and lateral nerves, base acute, apex blunt-acuminate; lateral nerves 8 to 11 on each side of the midrib, curved-ascending, prominent, anastomosing; petioles pubescent, 5 to 7 mm long. Flowers numerous, axillary, fascicled, about 1.5 cm long, usually two or three in each fascicle, their pedicels pubescent, 1.5 to 2.5 cm long. Sepals reniform, rounded, pubescent, about 1.8 mm long and 2 mm wide. Outer three petals suborbicular-ovate, pubescent, rounded, 3.5 to 4 mm long; inner three petals arched, the claw about 9 mm long, pubescent externally, glabrous within, the limb rhomboid, about 10 mm wide, pubescent externally and on the margins, glabrous within. Stamens very numerous, about 1 mm long. Female flowers unknown.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27514 Ramos*, March 9, 1917, in damp forests at low altitudes, Ilocano name *apnit*.

This species is readily distinguished from the only other known Philippine species, *Pseuduvaria philippinensis* Merr., by its very much larger flowers.

UVARIA Linnaeus

UVARIA PANAYENSIS sp. nov.

Frutex scandens, floribus dense griseo-puberulis exceptis glaber vel subglaber; foliis oblongis, chartaceis ad subcoriaceis, usque ad 28 cm longis, tenuiter acuminatis, basi cordatis, nervis utrinque circiter 15, perspicuis; floribus pallidis, circiter 4.5 cm diametro; sepalis reniformibus; petalis coriaceis, utrinque dense cinereo-puberulis, late ovatis, 2.5 cm longis; carpellis lineari-oblongis, glabris, pauciovulatis.

A scandent shrub, nearly glabrous except the densely grayish-puberulent flowers. Branches glabrous, the branchlets with very few, scattered, ferruginous, scarcely stellate hairs. Leaves oblong, firmly chartaceous or subcoriaceous, 25 to 28 cm long, 8 to 9 cm wide, entirely glabrous, grayish on both surfaces when dry, the apex slenderly and sharply acuminate, base rounded and distinctly cordate; lateral nerves prominent, curved, anastomosing, about 15 on each side of the midrib, the reticulations lax; petioles 5 mm long or less, black when dry. Flowers about 4.5 cm in diameter, apparently pale or yellowish, their pedicels about 3 cm long, glabrous or with very few, short, ferruginous, obscurely stellate hairs, each with a broadly ovate, ferruginous-pubescent, 3 to 4 mm long bract at or below the middle. Sepals reniform, coriaceous, about 6 mm long, 9 mm wide, externally cinereous-pubescent. Petals coriaceous, densely cinereous-pubescent on both surfaces, the outer three broadly ovate, obtuse, about 2.5 cm long, 2 cm wide, the inner three somewhat smaller. Anthers very numerous, linear-oblong, 3.5 to 4 mm long, the connectives rounded-truncate, not oblique, very slightly produced. Carpels many, linear-oblong, glabrous, including the stigma 3 mm long; ovules few.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31367 Ramos & Edaño,* May 22, 1918, in forests along small streams.

This species is manifestly allied to *Uvaria leytensis* (Elm.) Merr., from which it is readily distinguished by its distinctly cordate leaves and its cinereous-puberulent flowers.

UVARIA MACGREGORII sp. nov.

Frutex scandens, inflorescentiis exceptis glaber; foliis chartaceis, oblongo-ovatis et ovato-ellipticis, usque ad 12 cm longis, griseo-olivaceis, apice obtusis, basi rotundatis et plerumque leviter cordatis, nervis tenuibus, utrinque circiter 10; floribus circiter 2 cm diametro, rubro-brunneis; sepalis margine ferrugineo-pubescentibus; petalis late ovatis, circiter 1 cm longis, margine ferrugineo-pubescentibus ceteroquin glabris; carpellis anguste oblongis, glabris.

A scandent shrub, glabrous except the axillary buds on the young branchlets, and parts of the inflorescences. Leaves firmly chartaceous, oblong-ovate to ovate-elliptic, 8 to 12 cm long, 3.5 to 6 cm wide, glabrous on both surfaces, grayish-olivaceous when dry, slightly shining, somewhat narrowed upward to the obtuse apex, base broadly rounded and usually slightly cordate; lateral nerves slender, not prominent, about 10 on each side of the midrib, anastomosing; petioles 5 mm long, black when dry, glabrous. Flowers dark reddish-brown, about 2 cm in diameter (somewhat immature) in short, usually 2-flowered, leaf-opposed inflorescences, the peduncles 3 mm long or less, the pedicels 5 to 10 mm long, rugose when dry, the subtending bracts oblong, 3 to 4 mm long, the bracts and pedicels with few, scattered, ferruginous hairs, the latter soon becoming glabrous. Sepals broadly ovate to reniform, about 4 mm long, rounded or subacute, coriaceous, rugose when dry, their margins ferruginous-pubescent. Petals broadly ovate about 1 cm long, obtuse to subacute, densely ferruginous-pubescent on the margins and toward the tip, otherwise glabrous. Anthers numerous, narrowly oblong, 1.5 mm long, the connectives oblique, slightly produced. Carpels numerous, narrowly oblong, glabrous, 1.5 mm long; ovules usually 4; styles 0.5 mm long.

PANAY, Antique Province, Batbatan Island, opposite Culasi, *Bur. Sci. 32249 McGregor*, June 29, 1918, fairly common in thickets at low altitudes.

This species rather closely resembles *Cuming 1607* from Misamis Province, Mindanao, which has been referred to *Uvaria ovalifolia* Blume but which apparently is not referable to Blume's species. Among the other characters the present species differs from *Uvaria ovalifolia* in its somewhat smaller, fewer-nerved leaves; in being nearly glabrous; and in its entirely glabrous carpels. It is well characterized by its sepals and petals being nearly glabrous except for their densely ferruginous-pubescent margins and apices.

LAURACEAE

CRYPTOCARYA R. Brown

CRYPTOCARYA RAMOSII sp. nov.

Arbor parva, ramulis inflorescentiisque exceptis glabra; foliis oblongis ad oblongo-lanceolatis, subcoriaceis, 6 ad 11 cm longis, acuminatis, basi acutis, nervis utrinque 7 vel 8, perspicuis, reticulis ultimis confertis, utrinque obscure foveolatis; fructibus ellipsoideis, 1.5 cm longis, nigris, nitidis, glabris, laevis, 1.5 cm longis.

A tree, 5 to 6 m high, glabrous, except the young branchlets and inflorescences which are ferruginous-pubescent. Branches reddish-brown, lenticellate. Leaves oblong to oblong-lanceolate, subcoriaceous, usually pale when dry, shining, 6 to 11 cm long, 1.5 to 4 cm wide, narrowed upward to the acuminate apex, base acute; lateral nerves usually 7 or 8 on each side of the midrib, rather prominent on the lower surface, pinnately arranged, curved, anastomosing, the ultimate reticulations very close, both surfaces very shallowly and minutely foveolate; petioles 5 to 8 mm long. Panicles in the uppermost axils, narrow, rather few-flowered, 6 to 8 cm long, the branches rather few, short, not exceeding 1.5 cm in length. Flowers subsessile, ferruginous-pubescent, about 4 mm long, the tube about 2 mm long. Perianth-lobes elliptic-ovate, as long as the tube. Fruit ellipsoid, black and shining when dry, 1.5 cm long, glabrous, smooth.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33071 Ramos*, August 30, 1918, in forests at low altitudes.

The description of the flowers is from *Bur. Sci. 33346 Ramos*, from Mount Palimlim, this specimen differing slightly from the type in its relatively somewhat shorter and slightly fewer-nerved leaves. The alliance of this species is manifestly with *Cryptocarya vidalii* Merr., from which it is easily distinguished by its much smaller fruits.

CRYPTOCARYA EUPHLEBIA sp. nov.

Arbor parva, ramulis et petiolis et inflorescentiis dense castaneo-pubescentibus; foliis oblongis ad oblongo-ellipticis, subcoriaceis, usque ad 10 cm longis, costa excepta glabris, olivaceis, nitidis, apice breviter acuminatis, basi acutis ad subrotundatis, utrinque, praesertim subtus, minute et dense foveolatis; nervis utrinque 6 ad 8, supra impressis, subtus valde priminulis, subadscendentibus, vix anastomosantibus; paniculis axillaribus terminalibusque sub fructu usque ad 10 cm longis; fructibus in siccitate nigris, depresso-globosis, laevis, glabris, 10 ad 12 mm diametro.

A small tree, the branchlets, petioles, and inflorescences densely and finely castaneous-pubescent. Branches terete, glabrous, lenticellate, smooth, brownish. Leaves subcoriaceous, oblong to oblong-elliptic, 6 to 10 cm long, 2.5 to 5 cm wide, olivaceous, shining, glabrous except for the somewhat pubescent midrib, the apex abruptly and distinctly acuminate, base acute to somewhat rounded, both surfaces, but especially the lower one, densely and shallowly foveolate; lateral nerves 6 to 8 on each side of the midrib, impressed on the upper surface, very prominent on the lower surface, somewhat ascending, slightly curved, not or but very obscurely anastomosing; petioles 8 to 10 mm long. Panicles axillary and terminal, in fruit up to 10 cm long. Fruits black, glabrous, smooth, shining, depressed-globose, 10 to 12 mm in diameter.

CATANDUANES, *Bur. Sci. 20576 Ramos,* November 20, 1917, on the forested slopes of Mount Mariguidon.

This species is well characterized by its shallowly and densely foveolate, glabrous, conspicuously nerved leaves and its depressed-globose fruits. In the latter character it differs especially from *Cryptocarya oblongata* Merr. It seems to be most closely allied to *Cryptocarya zamboanguensis* Merr. and *C. intermedia* Elm.

CRYPTOCARYA ELLIPTIFOLIA sp. nov.

Arbor parva, inflorescentiis exceptis glabra; foliis ellipticis ad elliptico-ovatis, chartaceis, subolivaceis, nitidis, usque ad 20 cm longis, apice perspicue et obtuse acuminatis, basi leviter decurrento-acuminatis, nervis utrinque 5, distantibus, distinctis, curvatis, vix elevatis; paniculis sub fructu axillaribus, circiter 7 cm longis; fructibus globosis, circiter 1.5 cm diametro, in siccitate nigris, nitidis, glabris, leviter longitudinaliter striatis.

A small tree, 6 m high *fide* Ramos, entirely glabrous except the inflorescences, which are apparently somewhat pubescent. Branches and branchlets smooth, terete, slender, smooth, brownish-olivaceous. Leaves elliptic-ovate to elliptic, chartaceous, subolivaceous, shining, 15 to 20 cm long, 7 to 9 cm wide, not at all foveolate, the apex prominently and obtusely acuminate, the acumen about 1.5 cm long, stout, the base somewhat decurrent-acuminate; lateral nerves 5 on each side of the midrib, prominent but scarcely projecting, somewhat curved, reticulations slender, distinct, rather close; petioles 1 to 2 cm long. Panicles in fruit axillary, about 7 cm long, the branchlets sparingly pubescent. Fruits globose, black when dry, shining, faintly ridged longitudinally, glabrous, about 1.5 cm in diameter.

CATANDUANES, *Bur. Sci. 30330 Ramos*, December 9, 1917, in forests along small streams back of Calolbong.

A species well characterized by its rather large, conspicuously acuminate leaves; lateral panicles; and rather large, globose, somewhat ridged, glabrous fruits.

CRYPTOCARYA DENSIFLORA Blume Bijdr. (1825) 556; Koord. & Val. Bijdr. Boom. Java **10** (1904) 213.

PANAY, Jamindan and Mount Macosolon, *Bur. Sci. 31317, 33435 Ramos & Edaño*, April and May, 1918 (leaves not glaucous beneath). NEGROS, *For. Bur. 23666 Hinolan,* March, 1915. MINDANAO, Lanao, *Mrs. Clemens 1001, s. n.,* April and July, 1907.

This species has previously been reported from Java, where it is common and widely distributed, and from the Malay Peninsula. The Philippine material cited above closely matches a series of specimens from Java and the Malay Peninsula, and also conforms to the descriptions of Blume's species. The specimens collected by Mrs. Clemens were described by me in 1908 as a new species of *Beilschmiedia,* but the description was fortunately never published. *Cryptocarya laevigata* Elm., the type of which is a specimen with very immature fruits, is scarcely to be distinguished from Blume's species.

NEOLITSEA Merrill

NEOLITSEA LANCEOLATA sp. nov.

Arbor circiter 6 m alta, ramulis junioribus et petiolis dense adpresse pubescentibus, ramis glabris, teretibus, ramulis et foliis verticillatis; foliis lanceolatis, chartaceis ad subcoriaceis, in siccitate brunneis, nitidis, usque ad 7 cm longis et 1.5 cm latis, basi acutis, apice tenuiter acuminatis, junioribus ad costa villosis, vetustioribus glaberrimis, penninerviis, nervis primariis utrinque circiter 10; fructibus axillaribus, fasciculatis, parvis, glabris, pedicellis adpresse pallide villosis, circiter 5 mm longis.

A tree, about 6 m high, the young branchlets and petioles densely pale or pale-ferruginous appressed-pubescent. Branches glabrous, terete, the branchlets verticillate, 3 to 6 at a node. Leaves verticillate, chartaceous to subcoriaceous, brownish when dry, lanceolate, 5 to 7 cm long, 1 to 1.5 cm wide, narrowed below to the acute base and above to the slenderly acuminate apex, shining, smooth, the older ones entirely glabrous, the younger ones pale appressed-villous along the midrib on both surfaces; nerves all pinnately arranged, the primary ones about 10 on each side of the midrib, slender, curved, somewhat ascending, obscurely anastomosing, the reticulations not prominent, the ultimate ones close and very obscurely foveolate; petioles 5 to 8 mm long, rather densely pubescent. Fruits fascicled on the ultimate branches below the leaves, 3 to 6 in a fascicle, the pedicels rather stout, somewhat thickened upward, pale appressed-pubescent, the persistent calyx-tube somewhat funnel-shaped, truncate, glabrous, about 5 mm in diameter.

CATANDUANES, Mount Mariguidon, *Bur. Sci. 30231 Ramos*, November 27, 1917, in forests near the summit of the mountain.

This species is well characterized by its verticillate branchlets and its small, lanceolate, penninerved leaves. It does not appear to be very closely allied to any of the previously described species of the genus.

NEOLITSEA PAUCINERVIA sp. nov.

Species *N. zeylanicae* affinis. Arbor circiter 7 m alta, ramis et foliis glabris, ramulis dense pubescentibus; foliis alternis, oblongo-lanceolatis, subcoriaceis, in siccitate brunneis, nitidis, usque ad 8 cm longis et 3 cm latis, tenuiter acuminatis, basi acutis, 3-plinerviis, nervis lateralibus utrinque circiter 3, distinctis, curvato-anastomosantibus, adscendentibus, obscure anastomosantibus; fructibus axillaribus, ovoideis vel subglobosis, in siccitate nigris, rugosis, nitidis, circiter 5 mm diametro, calycis lobis 4, lanceolatis, acuminatis, villosis, pedicellis nigris, decidue villosis.

A tree, about 7 m high, the branches smooth, terete, glabrous, the branchlets and petioles densely pubescent with short hairs. Leaves alternate, rather more numerous near the tips of the branchlets and here sometimes pseudo-verticillate, oblong-lanceolate, subcoriaceous, brownish and shining when dry, both surfaces densely and shallowly foveolate, not at all glaucous, entirely glabrous, 7 to 8 cm long, 2 to 3 cm wide, narrowed below to the acute base and above to the slenderly acuminate apex, the base 3-plinerved, the lateral basal nerves leaving the midrib about 5 mm above the base of the leaf and extending to or beyond the middle, the lateral ones above the base 2 or 3, slender, distinct, curved-ascending, obscurely anastomosing; petioles 5 to 8 mm long. Fruits axillary and in the axils of fallen leaves, fascicled, 5 to 12 in a fascicle, ovoid to subglobose, about 5 mm in diameter, black and shining when dry, somewhat wrinkled. Pedicels about 5 mm long, black, covered with a brownish, more or less deciduous, appressed, villous indumentum, the persistent calyx-lobes lanceolate, acuminate, villous, about 2 mm long.

LUZON, Sorsogon Province, Mount Kililibong, *Bur. Sci. 23316 Ramos*, August 17, 1915, in the mossy forest.

This species, among the Philippine forms, is probably as closely allied to *Neolitsea villosa* Merr. as any, but differs in its few-nerved, glabrous, not glaucous leaves. Its true alliance seems to be with *N. zeylanica* Merr., from which it is distinguished by its nonglaucous leaves and its villous pedicels. It also closely resembles some forms of the Javan *N. cassiaefolia* Merr.

SAXIFRAGACEAE

POLYOSMA Blume

POLYOSMA VILLOSA sp. nov.

Frutex, subtus foliis et ramis et inflorescentiis dense molliter villosus; foliis verticillatis, 4-natis, oblongis ad oblongo-ellipticis, chartaceis ad subcoriaceis, 7 ad 10 cm longis, apice acutis, margine distanter dentatis; nervis utrinque 12 ad 15, patulis, distinctis; petiolo 1.5 ad 2 cm longo; racemis axillaribus, 5 cm longis, paucifloris; fructibus ellipsoideis, 8 mm longis, plus minusve pubescentibus, bracteolis subaequalibus, circiter 1 mm longis.

A shrub, the branches, branchlets, petioles, inflorescences, and the lower surface of the leaves, especially on the midrib and nerves, densely and softly villous. Leaves verticillate, usually 4 at each node, oblong to oblong-elliptic, chartaceous to subcoriaceous, 7 to 10 cm long, 2.5 to 4 cm wide, dark-olivaceous and shining when dry, the base rounded to acute, apex acute, sometimes with a very short mucro, the margins conspicuously villous, coarsely and distantly toothed, the upper surface more or less pubescent on the midrib and nerves; lateral nerves 12 to 15 on each side of the midrib, spreading at right angles, distinct, anastomosing, the reticulations lax. Petioles 1.5 to 2 cm long. Racemes axillary, solitary, about 5 cm long, few-flowered, pubescent. Fruits ellipsoid, about 8 mm long, somewhat pubescent, their pedicels about 3 mm long, the subtending bracteoles subequal, oblong-ovate, pubescent, about 1 mm long. Persistent calyx lobes ovate, acute, 1 mm long.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33340 Ramos*, August 21, 1918, on forested slopes, altitude about 900 meters.

This species apparently belongs in the group with *Polyosma verticillata* Merr., from which it is specially distinguished by its dense indumentum and its lateral, not terminal, few-flowered racemes.

POLYOSMA LONGIPETIOLATA sp. nov.

Frutex, partibus junioribus inflorescentiisque exceptis glaber; foliis verticillatis, 4- vel 5-natis, oblongo-ellipticis ad anguste oblongo-obovatis, coriaceis, in siccitate nigris, 8 ad 13 cm longis, integris, basi acutis, apice breviter lateque acuminatis, nervis utrinque 8 ad 11, distinctis; petiolo usque ad 6 cm longo; racemis terminalibus, usque ad 20 cm longis; fructibus anguste ellipsoideis, 8 mm longis, bracteolis valde inaequalibus, interioribus quam lateralibus duplo longioribus, 3 ad 5 mm longis.

A shrub, about 5 m high, glabrous except the very young parts and the inflorescences. Branches terete, dark reddish-brown, smooth, glabrous, the branchlets more or less angled, the younger ones appressed-pubescent with very short hairs. Leaves verticillate, 4 or 5 at each node, oblong-elliptic to narrowly oblong-obovate, coriaceous, glabrous, the upper surface nearly black when dry, the lower surface dark-brown, 8 to 13 cm long, 2.5 to 5 cm wide, entire, base acute, apex very shortly and broadly acuminate, the acumen obtuse and with a blunt apiculus; lateral nerves 8 to 11 on each side of the midrib, spreading, distinct, anastomosing. Petioles unusually long, up to 6 cm in length, when young pubescent, soon becoming glabrous. Racemes terminal, in fruit up to 20 cm long, more or less pubescent; pedicels 3 to 5 mm long. Fruits narrowly ellipsoid, about 8 mm long, slightly pubescent, the subtending bracteoles very unequal, pubescent, linear-oblong, the middle one 3 to 4 mm long, at least twice as long as the two lateral ones. Persistent calyx-lobes triangular-ovate, acute, 1 mm long.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33259 Ramos*, August 20, 1918, on forested slopes, altitude about 1,000 meters.

Among those species with verticillate leaves *Polyosma longipetiolata* is strikingly characterized by its glabrous branches; unusually long-petioled, glabrous, entire leaves; and its very unequal bracteoles.

PITTOSPORACEAE

CITRIOBATUS A. Cunningham

CITRIOBATUS JAVANICUS Boerl. & Koord. in Ic. Bogor. 1 (1901) *t. 77.*

LUZON, Batangas Province, Mount San Pedro, *Bur. Sci. 22343 Ramos,* August 20, 1914, in thickets at low altitudes.

With the exception of this one species the small genus *Citriobatus* is confined to Australia. The Philippine specimens were distributed unidentified, as without flowers I could not determine the group to which they belonged. I am now, however, able to name the material by a direct comparison with a series of five specimens from Java, including duplicates of three numbers of Koorders's collection on which the species was based. The Philippine specimens agree with the Javan ones in all respects.

PITTOSPORUM Banks

PITTOSPORUM PSEUDOSTIPITATUM sp. nov.

Frutex glaber, ramulis tenuibus; foliis verticillatis, 3- vel 4-natis, anguste lanceolatis, 4 ad 6 cm longis, utrinque angustatis, apice tenuiter acuminatis, nervis tenuibus; fructibus terminalibus, fasciculatis, tenuiter pedunculatis, obovoideis, 2-valvis, basi tenuiter stipitatis, stipite circiter 4 mm longo, partibus seminiferis 6 ad 7 mm longis, 6 mm diametro.

A glabrous shrub, about 3 m high, the branches and branchlets slender, terete. Leaves verticillate, usually 3 or 4 at a node, coriaceous, narrowly lanceolate, 4 to 6 cm long, 6 to 13 mm wide, narrowed below to the acute or acuminate base and above to the very slenderly acuminate apex, the tip with a distinct cartilaginous mucro, the upper surface olivaceous to black when dry, shining; lateral nerves slender, scarcely more distinct than are the reticulations; petioles about 5 mm long. Fruits fascicled at the tips of the branchlets, 2 to 4 in a fascicle, their pedicels slender, about 1 cm long, the capsule obovoid, black when dry, 2-valved, the lower part narrowed into a distinct pseudostalk, the thickened portion of the capsule 6 to 7 mm long, about 6 mm in diameter, the entire capsule, including the pseudostalk, about 1 cm long.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33127 Ramos,* August 8, 1918, on dry slopes, altitude about 700 meters.

This species is readily distinguished by its narrowly lanceolate, very sharply acuminate and cartilaginous-mucronate leaves as well as by its terminal, fascicled fruits, these being obovoid and much narrowed below the middle to form a very distinct pseudostalk.

PITTOSPORUM ACUMINATISSIMUM sp. nov.

Frutex epiphyticus vel pseudo-epiphyticus, glaber, ramulis tenuibus; foliis chartaceis, oblongis ad oblongo-ellipticis, nitidis, tenuiter acute acuminatis, usque ad 8 cm longis, nervis utrinque 7 ad 9, tenuibus; inflorescentiis solitariis, lateralibus et terminalibus, brevibus, 3-floris; floribus circiter 12 mm longis, ovario dense villoso; fructibus leviter compressis, 2-valvis, ellipsoideis, circiter 23 cm longis, valvis crasse carnoso-coriaceis, in siccitate rugosis.

An epiphytic or pseudoepiphytic shrub, entirely glabrous except the densely pubescent ovaries, the ultimate branches slender, 2 to 3 mm in diameter. Leaves chartaceous, oblong to oblong-elliptic, brownish-olivaceous when dry, 5 to 8 cm long, 2 to 4 cm wide, the apex sharply and slenderly acuminate, base acute; lateral nerves 7 to 9 on each side of the midrib, slender as are the reticulations; petioles 2 to 3 cm long, slender. Inflorescences usually solitary, lateral, rarely terminal, usually 3-flowered, their peduncles 5 mm long or less, the pedicels 5 to 10 mm long. Calyx shallowly cup-shaped, about 4 mm in diameter, the lobes broadly ovate, obtuse, 1.5 to 1.8 mm long. Petals 5, narrowly oblong, 11 mm long, 3.5 mm wide, obtuse. Filaments 4 to 4.5 mm long. Ovary oblong-ovoid, densely villous; style glabrous, 1.5 mm long. Capsules ellipsoid, somewhat compressed, 2-valved, about 2.3 cm long, 1.8 cm wide, the valves thick, fleshy-coriaceous, rugose when dry.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30745 Ramos & Edaño*, April 21, 1918, on trees in forests.

This form has the same habit as *Pittosporum resiniferum* Hemsl. and is manifestly closely allied to that species. It differs in its smaller leaves and its usually solitary, lax, few-flowered inflorescences; in Hemsley's species the flowers are borne in dense fascicles, while in the present species they are in depauperate, 3-flowered, usually solitary cymes.

PITTOSPORUM GLABERRIMUM sp. nov.

Frutex glaberrimus, ramulis tenuibus; foliis verticillatis, 3- vel 4-natis, oblongo-lanceolatis, utrinque angustatis, acutis vel leviter acuminatis, nervis utrinque 6 vel 7, tenuibus, distinctis;

capsulis terminalibus, solitariis, ellipsoideis vel obovoideis, 2-valvis, 2.5 cm longis, pedicellis 1 cm longis.

An entirely glabrous shrub, about 3 m high, the ultimate branchlets slender, terete, about 1.5 mm in diameter. Leaves verticillate, usually 3 or 4 at a node, oblong-lanceolate, shining subcoriaceous, those of each whorl more or less unequal, 3 to 6 cm long, 1 to 2 cm wide, subequally narrowed below to the acute base and above to the acute or slightly acuminate apex; lateral nerves slender, distinct, 6 or 7 on each side of the midrib, anastomosing, the reticulations lax; petioles 3 to 5 mm long. Capsules terminal, solitary, ellipsoid to somewhat obovoid, 2-valved, about 2.5 cm long, 1.5 to 2 cm in diameter, black when dry, orange-yellow when fresh, their pedicels about 1 cm long.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33309 Ramos*, August 21, 1918, on forested slopes, altitude about 1,000 meters.

The alliance of this species is apparently with *Pittosporum odoratum* Merr., from which it is at once distinguishable by its solitary terminal fruits.

ROSACEAE

PHOTINIA Lindley

PHOTINIA SERRULATA Lindl. in Trans. Linn. Soc. 13 (1821) 103 (excl. syn. *Crataegus glabra* Thunb.); Hemsl. in Journ. Linn. Soc. Bot. 33 (1887) 263; Rehder & Wilson in Sargent Pl. Wils. 1 (1912) 184.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 4425 Mearns, Bur. Sci. 31560 Santos, Sandkuhl 258*, altitude about 2,300 meters, in flower May to July, in fruit in February, Igorot name *itangan*.

This species has not previously been reported from the Philippines. The specimens cited above conform very closely with our series from Formosa, and from Kwangtung, Fokien, and Yunnan Provinces, China.

CONNARACEAE

CONNARUS Linnaeus

CONNARUS CASTANEUS sp. nov.

Frutex scandens, perspicue castaneo-pubescentibus; foliis circiter 30 cm longis, foliolis plerumque 7, coriaceis, oblongo-ellipticis, leviter acuminatis, 11 ad 18 cm longis, subtus densissime ferrugineo-pubescentibus; infructescentiis paniculatis, terminalibus, usque ad 25 cm longis, folliculis obovatis, compressis, leviter inaequilateralibus, 6 cm longis, extus densissime castaneo-pubescentibus, intus leviter villosis.

A scandent shrub, the branchlets, petioles, infructescences, and fruits densely castaneous-pubescent, the leaflets beneath densely ferruginous-pubescent. Leaves about 30 cm long, the leaflets usually 7, alternate, coriaceous, oblong-elliptic, somewhat acuminate, base rounded, 11 to 18 cm long, 5 to 7 cm wide, the upper surface greenish, more or less pubescent with deciduous pale hairs; lateral nerves usually 7 on each side of the midrib, prominent on the lower surface, anastomosing, the reticulations rather lax; petiolules 5 to 8 mm long, densely castaneous-pubescent. Panicles terminal, in fruit up to 25 cm long, the primary branches up to 15 cm long. Fruits compressed, obovate, slightly inaequilateral, about 6 cm long and 4 cm wide, externally very densely castaneous-pubescent, inside sparingly villous with pale hairs.

LUZON, Camarines Province, Paracale, *Bur Sci. 33600 Ramos & Edaño*, November 30, 1918, in damp forests at low altitudes, the fruits red, the lower surface of the fresh leaves red.

A species strongly characterized by the dense castaneous indumentum on the branchlets, petioles, infructescences, and fruits; and by the leaflets being densely ferruginous-pubescent on the lower surface and reddish-brown in contrast with the green upper surface. The indumentum is composed entirely of simple hairs.

ROUREA Aublet

ROUREA LUZONIENSIS sp. nov.

Frutex scandens, glaber; foliis circiter 10-foliolatis, 8 ad 12 cm longis, foliolis 2 ad 4 cm longis, subcoriaceis, ovatis ad oblongo-ellipticis, obtusis vel obscure breviterque acuminatis, basi plerumque rotundatis; infructescentiis axillaribus, solitariis, racemosis, 8 ad 10 cm longis, fructibus paucis, tenuiter pedicellatis, subaequilateralibus, oblongo-ovoideis, 8 ad 10 mm longis.

A scandent glabrous shrub, about 3 m high. Leaves 8 to 12 cm long, about 10-foliolate; leaflets subopposite and alternate, subcoriaceous, ovate to oblong-elliptic, 2 to 4 cm long, 1.2 to 2.3 cm wide, base rounded, usually somewhat inequilateral, apex obtuse to shortly acuminate, both surfaces rather pale when dry, shining. Inflorescences axillary, solitary, racemose, 8 to 10 cm long, few-flowered. Fruits oblong-ovoid, nearly equilateral, acute or slightly apiculate, 8 to 10 mm long, their pedicels 6 to 10 mm long. Persistent sepals broadly ovate, glabrous, the outer ones acute or slightly acuminate, the inner ones broadly rounded, about 3.5 mm long.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33534 Ramos & Edaño,* November 29, 1918, in dry thickets at low altitudes.

This species is allied to *Rourea erecta* (Blanco) Merr., from which it is especially distinguished by its fewer, differently shaped, not slenderly acuminate leaflets; and its smaller, nearly equilateral, slenderly pedicelled fruits which are racemosely arranged.

LEGUMINOSAE

TRIFIDACANTHUS Merrill

TRIFIDACANTHUS UNIFOLIOLATUS Merr. in Philip. Journ. Sci. 12 (1917) Bot. 269.

Pods straight, about 2 cm long, usually composed of three or four 1-seeded joints, flat, thin, reticulate, sparingly pubescent, the upper suture nearly straight, slightly indented between the joints, the lower suture rather deeply indented; joints usually 6 to 7 mm long, about 4 mm wide, the valves chartaceous or thinly coriaceous.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32925 Ramos*, July 18, 1918, in dry thickets at low altitudes.

The original description of this new genus and species was based on flowering specimens, but the second collection, and this from the type locality, shows that I was correct in placing it in the *Papilionatae-Hedysareae-Desmodiinae*, the *Desmodiinae* being indicated in the original description with doubt. It is manifestly most closely allied to *Desmodium*, from which, among other characters, it is distinguished by its characteristic spines.

INDIGOFERA Linnaeus

INDIGOFERA HENDECAPHYLLA Jacq. Coll. 2 (1788) 359, Ic. Rar. 3 (1768–93) *t. 570;* Baker in Hook. f. Fl. Brit. Ind. 2 (1876) 98 (*endecaphylla*); Craib in Notes Bot. Gard. Edinb. 8 (1913) 68.

Indigofera pusilla Lam. Encycl. 3 (1789) 248.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32770 Ramos*, August 5, 1918, in open dry places at low altitudes.

India to southeastern China, tropical and South Africa, and Madagascar; not previously reported from the Philippines.

ORMOSIA Jackson

ORMOSIA ORBICULATA sp. nov. § *Toulichiba, Macrodisca.*

Arbor, ramulis inflorescentiisque ferrugineo-pubescentibus exceptis glabra; foliis usque ad 30 cm longis, rhachibus productis; foliolis 7, subcoriaceis, glabris, oblongis ad oblongo-ellipticis, 8 ad 15 cm longis, apice acuminatis, nervis utrinque circiter 8; paniculis circiter 16 cm longis; floribus numerosis, circiter 2 cm longis, calycis circiter 8 cm longis; ovulis 2; leguminis suborbicularibus ad ovatis, usque ad 7 cm longis, basi late rotundatis, apice apiculatis, valvis crassis, lignosis; seminibus solitariis, ellipsoideis, exarillatis, 2 cm longis.

A tree, attaining a height of at least 10 m, glabrous except the young branchlets, buds, and inflorescences, which are rather densely ferruginous-pubescent. Leaves up to 30 cm long, the rachis extended beyond the distal pair of leaflets; leaflets 7, subcoriaceous, oblong to oblong-elliptic, pale when dry, somewhat shining, 8 to 15 cm long, 3.5 to 7 cm wide, base acute to rounded, apex distinctly acuminate, the acumen usually blunt; lateral nerves about 8 on each side of the midrib, distinct on both surfaces as are the reticulations; petiolules about 5 mm long. Panicles about 16 cm long, densely ferruginous-pubescent, terminal, the primary branches few, the lower ones up to 6 cm long. Flowers white, about 2 cm long. Calyx externally densely ferruginous-pubescent, about 1.5 cm long, the tube broad, up to 8 mm long and 1 cm wide, the lobes oblong, usually obtuse, about 8 mm long, slightly pubescent inside. Standard broadly obovate, about 2 cm long, the claw stout, 4 to 5 mm long. Filaments glabrous. Ovary stipitate, oblong, very slightly pubescent with scattered hairs, soon becoming glabrous, the stipe stout, about 5 mm long; style glabrous, curved, about 1.3 cm long; ovules 2. Pod thick, woody, suborbicular to ovate, up to 7 cm long and 6 cm wide, base broadly rounded, apex prominently apiculate, the valves up to 1 cm in thickness. Seed solitary, ellipsoid, not arillate, red, shining, about 2 cm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32775 Ramos* (type), July 17, 1918; Pasuquin, *For. Bur. 22094, 25094 Paraiso*, July 24, 1914, and February 18, 1916, on forested slopes, ascending to an altitude of 300 meters. Ilocano name *panapotien*.

This species closely resembles *Ormosia macrodisca* Baker, of the Malay Peninsula, but the flowers are much larger and the single specimen that I have with seeds shows no basal aril. From *Ormosia paniculata* Merr. it is at once distinguished by its entirely glabrous leaves.

ORMOSIA CLEMENTIS sp. nov. § *Toulichiba, Macrodisca*.

Arbor circiter 10 m alta, glabra (inflorescentiis ignotis); foliis circiter 40 cm longis, foliolis 5, rhachibus productis, foliolis chartaceis ellipticis ad oblongo-ellipticis, usque ad 20 cm longis, abrupte acute acuminatis, basi acutis, nervis utrinque 8 ad 10, distinctis; leguminis ligneis, subellipticis, circiter 7 cm longis, apice rotundatis vel obscurissime et late apiculatis vel acutis; seminibus plerumque 2, exarillatis, coccineis, basi nigris, subellipticis, circiter 2 cm longis, 1.5 ad 2 cm latis, nitidis.

A tree about 10 m high, glabrous (inflorescences unknown). Leaves about 40 cm long, the rachis produced above the upper pair; leaflets chartaceous, rather pale when dry, elliptic to oblong-elliptic, 9 to 20 cm long, 3.5 to 8.5 cm wide, the apex rather abruptly and sharply acuminate, base acute; lateral nerves 8 to 10 on each side of the midrib, distinct, anastomosing. Pods woody, subelliptic, about 7 cm long, brown when dry, the valves recurved after dehiscence, base and apex rounded or the apex obscurely and broadly apiculate or merely subacute. Seeds usually 2, not arillate, crimson, with a black base, subellipsoid, about 2 cm long, 1.5 to 2 cm wide, hard, shining, slightly rugose when dry.

MINDANAO, Lanao District, Camp Keithley, *Mrs. Clemens 1139*, July, 1907, altitude about 900 meters.

This species is probably most closely allied to *Ormosia orbiculata* Merr., but the pods are usually 2-seeded and the seeds have a conspicuous black base.

ORMOSIA BASILANENSIS sp. nov. § *Toulichiba, Macrodisca.*

Arbor magna, partibus junioribus et inflorescentiis plus minusve ferrugineo-pubescentibus, ramis circiter 1 cm diametro; foliis circiter 40 cm longis, rhachibus et petiolis et subtus foliolis ad costa ferrugineo-pubescentibus, rhachibus productis; foliolis 9, oblongis ad oblongo-ellipticis, subcoriaceis, 12 ad 17 cm longis, basi acutis, apice acuminatis, nervis utrinque circiter 8; leguminis orbiculari-ovatis, leviter inaequilateralibus, circiter 7 cm longis, valvis crassis, lignosis, apice breviter crasseque acuminatis; seminibus solitariis, 3 cm longis, ellipsoideis, rubris, nitidis, exarillatis.

A large tree, the younger parts, inflorescences, and leaves more or less ferruginous-pubescent, the leaflets only sparingly pubescent beneath along the midrib, the branches rather stout, about 1 cm in diameter, dark colored when dry, glabrous. Leaves about 40 cm long, the rachis and petioles more or less ferruginous-pubescent with rather long hairs, the rachis prolonged beyond the distal pair of leaflets; leaflets 9, oblong to oblongo-elliptic, subcoriaceous, shining, 12 to 17 cm long, 4.5 to 7 cm wide, subequally narrowed to the acute base and the distinctly acuminate apex; lateral nerves about 8 on each side of the midrib, distinct, ascending; petiolules 5 to 7 mm long. Pods orbicular-ovate, slightly inequilateral, about 7 cm long and wide, base rounded, apex with a short stout acumen, the valves woody, much thickened, much swollen opposite the solitary seed. Seed about 3 cm long, ellipsoid, red, shining, not arillate.

BASILAN, Maluno, *For. Bur. 17893 Rafael,* November 13, 1912, *Hollier 508,* January, 1904, in forests, altitude about 140 meters.

This species like the others here described resembles *Ormosia macrodisca* Baker, but the seeds are not arillate. Among the Philippine species it is perhaps most closely allied to *Ormosia orbiculata,* but the leaflets are more numerous, subequally narrowed at both ends, acute at the base, and sparingly pubescent beneath along the midrib.

ORMOSIA GRANDIFOLIA sp. nov. § *Toulichiba, Macrodisca.*

Arbor circiter 10 m alta, inflorescentiis foliisque plus minusve pubescentibus; foliis circiter 50 cm longis, rhachibus productis; foliolis 7, terminalibus late obovatis, lateralibus ellipticis, 13 ad 17 cm longis, subcoriaceis, apice abrupte obtuseque acuminatis, basi rotundatis, vel terminalibus acutis, nervis utrinque circiter 8; leguminis ellipticis, 6 ad 7 cm longis, apice late rotundatis, valvis crassis, lignosis; seminibus solitariis ellipsoideis, coccineis, 3 cm longis, exarillatis.

A tree, about 10 m high, the inflorescences, petioles, and leaflets on the lower surface more or less pubescent, the indumentum on the leaflets obscure. Leaves about 50 cm long, the rachis extended beyond the distal pair of leaflets; leaflets 7, the terminal one broadly obovate, the lateral ones elliptic, 13 to 17 cm long, 8 to 10 cm wide, subcoriaceous, rather pale when dry, shining, the base usually rounded or that of the terminal leaflet acute, apex very abruptly and shortly acuminate; the lateral nerves about 8 on each side of the midrib, prominent; petiolules about 1 cm long. Pods elliptic, 6 to 7 cm long, about 5.5 cm wide, apex broadly rounded, scarcely apiculate, the valves thick, woody, recurved, apparently one-seeded. Seed solitary, ellipsoid, scarlet, shining, somewhat rugose when dry, 3 cm long, 2.2 cm wide, slightly compressed, not arillate.

LUZON, Camarines Province, Magdoronganon River, *For. Bur. 21172 Alvarez,* March 23, 1914, in forests near the river, altitude about 100 meters.

This species manifestly belongs in the same group as *Ormosia orbiculata,* but has much larger, differently shaped leaflets, which are somewhat pubescent beneath; differently shaped pods, which are broadly rounded and scarcely apiculate at their apices; and much larger seeds. The seed is not at all arillate. *Ormosia basilanensis* Merr. differs in its more numerous leaflets and its elliptic pods, which are broadly rounded at their apices.

DESMODIUM Desvaux

DESMODIUM ORMOCARPOIDES DC. Prodr. 2 (1825) 327; Gagnep. in Not. Syst. 3 (1916) 256; Merr. Interpret. Herb. Amb. (1917) 267, non auct. plur.

Desmodium ormocarpoides Desv. in Mém. Soc. Linn. Paris 1825 (1826) 307, non auct. plur.

Hedysarum adhaerens Poir. in Lam. Encycl. Suppl. 5 (1817) 15, non Vahl.

Desmodium dependens Blume ex Miq. Fl. Ind. Bat. 1[1] (1855) 248.

JOLO, Tagasip, *F. L. Rola 118*, May 27, 1917, in teak forests at low altitudes.

This Malayan species is new to the Philippines, the specimens agreeing perfectly with material from Celebes and Amboina. As Gagnepain notes all modern botanists have misinterpreted *Desmodium ormocarpoides* DC., an examination of the type showing that it is the form described by Blume as *Desmodium dependens. Desmodium ormocarpoides* of modern authors, including the Philippine specimens previously so named, is *Desmodium zonatum* Miq.

GERANIACEAE

ERODIUM L'Héritier

ERODIUM CICUTARIUM (Linn.) L'Hérit. ex Ait. Hort. Kew. 2 (1789) 414.

Geranium cicutarium Linn. Sp. Pl. (1753) 680.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31669 Santos*, May 9, 1918, in waste places, altitude about 2,300 meters. A weed of wide distribution in temperate regions, unquestionably an introduced plant here.

RUTACEAE

EVODIA Forster

EVODIA MELIAEFOLIA (Hance) Benth. Fl. Hongk. (1861) 58.

Megabotrya meliaefolia Hance in Walp. Ann. 2 (1851–52) 259.

Boymia glabrifolia Champ. in Hook. Kew. Journ. Bot. 3 (1851) 330.

Eurycoma dubia Elm. Leafl. Philip. Bot. 2 (1908) 481.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31968 Santos*, June, 1918, altitude 1,800 meters, with the local name *galiuyguiuan*. NEGROS, Cuernos Mountains, *Elmer 10120* (type of *Eurycoma dubia* Elm.).

The second collection of this species in the Philipines induced me to make a critical study of it, as it was perfectly evident that the form described by Mr. Elmer as *Eurycoma dubia* represented no simarubaceous plant. I cannot distinguish the Philippine form from *Evodia meliaefolia* Benth., which was previously known from southern Japan, the Liu Kiu Islands, Formosa, and southern China. It is the only pinnate-leaved *Evodia* known from the Philippines.

EVODIA SESSILIFOLIOLA sp. nov.

Arbor usque ad 10 m alta, partibus junioribus inflorescentiisque plus minusve villosis; foliis plerumque 3-foliolatis, interdum 1-foliolatis, foliolis chartaceis ad subcoriaceis, sessilibus, oblongo-obovatis, usque ad 20 cm longis, basi cuneatis, apice obtusis, subtus punctatis, nervis utrinque circiter 13, subtus perspicuis; inflorescentiis axillaribus, pedunculatis, usque ad 10 cm longis; floribus 4-meris, petalis circiter 2.5 mm longis.

A tree, 8 to 10 m high, the younger parts and the inflorescences more or less villous, the indumentum grayish, the older parts soon glabrous. Leaves mostly 3-foliolate, sometimes 1-foliolate ones on the same branchlets with the 3-foliolate ones, their petioles 5 to 7 cm long; leaflets sessile, chartaceous to subcoriaceous, brownish or rather pale when dry, somewhat shining, obovate to oblong-obovate, 9 to 20 cm long, 4 to 10 cm wide, the mature ones glabrous, beneath distinctly punctate, apex obtuse to rounded, base of the terminal leaflet usually cuneate, equilateral, of the lateral ones usually obtuse and distinctly inequilateral; nerves about 13 on each side of the midrib, prominent on the lower surface, anastomosing, the reticulations prominent. Inflorescences axillary, peduncled, up to 10 cm long, paniculate, rather many flowered. Flowers white, 4-merous, their pedicels up to 2 mm in length, densely villous. Sepals oblong, 0.5 mm long. Petals ovate, about 2.5 mm long. Disk densely villous. Fruit of 3 or 4 cocci, glabrous, the individual cocci about 3 mm in diameter.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31788 Santos* (type), April 22, 1913, altitude about 2,400 meters, with the Igorot name *itapan*, *Mrs. Clemens s. n.*, January, 1915; Baguio, *Williams 1531*, November 30, 1904, *Sandkuhl 86*, July, 1913.

Among the Philippine species the alliance of this form is with *Evodia semecarpifolia* Merr., and among the extra-Philippine forms with *E. lunur-ankenda* (Gaertn.) Merr. It is distinguished from both by its sessile leaflets. The combination of 3-foliolate and 1-foliolate leaves on the same branchlets is rather unusual in the genus.

MELIACEAE

AGLAIA Loureiro

AGLAIA DIFFUSIFLORA sp. nov. § *Euaglaia*.

Arbor parva, plus minusve brunneo- vel castaneo-lepidotis; foliis alternis, circiter 60 cm longis, 7-foliolatis, foliolis oblongo-ellipticis, circiter 25 cm longis, chartaceis, obtusis vel obtuse acuminatis, nervis utrinque circiter 16; paniculis diffusis, laxis, foliis subaequantibus, multifloris, ramis inferioribus usque ad 30 cm longis; floribus racemose dispositis, 5-meris, calycis lobis orbicularibus, petalis obovato-ellipticis, 1.4 mm longis, tubo stamineo libero.

A small tree, the branchlets and inflorescences densely covered with closely appressed brown or castaneous scales with similar scattered ones on the lower surface of the leaflets. Leaves alternate, about 60 cm long, 7-foliolate; leaflets alternate or the upper pair opposite, chartaceous, rather pale when dry, oblong-elliptic, somewhat inequilateral, about 25 cm long, 9 to 11 cm wide, the apex obtuse or somewhat obtusely acuminate, base usually rounded on one side and acute on the other; lateral nerves about 16 on each side of the midrib, prominent; petiolules 1.5 to 2.5 cm long. Panicles diffuse, about 50 cm long, the branches spreading, the lower ones up to 30 cm in length, many flowered, the flowers laxly and racemosely arranged on the ultimate branchlets, their pedicels 1 to 2 mm long. Flowers white, 5-merous. Calyx-lobes orbicular, rounded, 0.5 mm in diameter. Petals elliptic-obovate to broadly elliptic, 1.4 mm long. Staminal-tube turbinate, glabrous, about 1 mm long, crenulate, the crenulations minutely puberulent, free, glabrous. Anthers 5, inserted below the rim of the tube, about 0.5 mm long, their tips minutely exserted.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31098 Ramos & Edaño*, May 16, 1918, in damp forests.

This species is allied to *Aglaia pallida* Merr., from which it is distinguished by its larger leaflets, the lepidote indumentum not being at all stellate, and by its very much longer petiolules.

ANACARDIACEAE

SEMECARPUS Linnaeus f.

SEMECARPUS SUBSESSILIFOLIA sp. nov.

Species *S. gigantifoliae* affinis, differt inflorescentiis terminalibus, inflorescentiis hypocarpiisque cinereo-pubescens. Frutex vel arbor parva, simplex; foliis oblongo-oblanceolatis, usque ad 50 cm longis et 16 latis, acuminatis, deorsum longe angustatis, basi rotundatis vel obtusis, nervis utrinque 30 ad 35, perspicuis; paniculis circiter 20 cm longis; fructibus oblongis, circiter 1 cm longis.

A shrub or a small unbranched tree, glabrous except the inflorescences. Leaves oblong-oblanceolate, about 50 cm long, 12 to 16 cm wide, firmly chartaceous, shining, the upper surface olivaceous, the lower pale when dry, apex shortly acuminate, gradually narrowed in the lower two-thirds to three-fourths to the narrow and abruptly rounded or obtuse base, which is at most 2.5 cm wide; midrib very stout, the primary lateral nerves 30 to 35 on each side of the midrib, somewhat curved, anastomosing, prominent, the reticulations rather lax, distinct, the secondary nervules leaving the nerves at about right angles; petioles very stout, about 1 cm long or less, panicles terminal, about 20 cm long, more or less pubescent, the primary branches few, up to 8 cm long. Immature fruits oblong, about 1 cm long, glabrous; hypocarp somewhat turbinate, about 4 mm long, black when dry, cinereous-pubescent.

PANAY, Capiz Province, Mount Madiaas, *Bur. Sci. 30711 Ramos & Edaño*, May 12, 1918, in forests.

This species is manifestly allied to *Semecarpus gigantifolia* F.-Vill. and like that species is unbranched. It differs essentially in its terminal, not cauline, inflorescences which are more or less pubescent and in its distinctly pubescent hypocarps.

SEMECARPUS FERRUGINEA sp. nov.

Arbor parva, ramulis inflorescentiisque ferrugineo-pubescens; foliis oblanceolatis ad oblongo-oblanceolatis, coriaceis, nitidis, acuminatis, basi angustatis, subtus glaucis, nervis utrinque 12 ad 14, perspicuis; paniculis terminalibus, usque ad 28 cm longis; fructibus oblique ovoideis, glabris, 1.2 cm longis, hypocarpio ferrugineo-pubescens.

A small tree, the branchlets, inflorescences, and hypocarps more or less ferruginous-pubescent. Leaves oblanceolate to oblong-oblanceolate, coriaceous, 12 to 16 cm long, 3 to 4.5 cm wide, apex slightly acuminate, somewhat narrowed below to the cuneate or obtuse base, the upper surface brownish-olivaceous, shining, glabrous except the pubescent midrib, the lower surface glaucous, slightly pubescent along the midrib and nerves; lateral nerves 12 to 14 on each side of the midrib, curved, anastomosing, the reticulations rather lax, distinct, the primary nervules leaving the nerves at nearly right angles; petioles stout, 7 to 10 mm long, sulcate on the upper side, pubescent. Panicles terminal, in fruit up to 28 cm long, the rachis and branches densely ferruginous-pubescent, the primary branches few, scattered, the longer ones about 6 cm in length. Fruits obliquely ovoid, glabrous, black and somewhat shining when dry, about 1.2 cm long, the very young ones with a few ferruginous hairs; hypocarps 5 to 7 mm long, ferruginous-pubescent, the indumentum somewhat deciduous; pedicels 5 to 8 mm long.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30756 Ramos & Edaño*, April 22, 1918, on forested slopes.

This species resembles *Semecarpus philippinensis* Engl., to which it is manifestly allied, but from which it is easily distinguished by its ferruginous-pubescent panicles and hypocarps.

ONCOCARPUS A. Gray

ONCOCARPUS OBOVATA (Elm.) comb. nov.

Dichapetalum obovatum Elm. Leafl. Philip. Bot. 2 (1908) 483.

LUZON, Tayabas Province, Mount Banahao, *Elmer 7931* (type), May, 1907, in fruit; *Quisumbing 1346*, May, 1918, with staminate flowers.

While it has long been realized by me that the form described by Mr. Elmer could be no dichapetalous plant, no study of it was previously made on account of the incomplete material representing it. Staminate material from near the type locality shows that it is an anacardiaceous plant and is referable to *Oncocarpus*. It differs radically from the other Philippine species of this small genus in its very short inflorescences, the staminate ones being reduced to few-flowered, axillary fascicles; the staminate flowers are moreover 5- to 6-merous, with 5 calyx-lobes and 6 petals and stamens. The petals are oblong-lanceolate, reticulate, villous externally, about 3 mm long, 1 to 1.2 mm wide, obtuse or acute; the filaments are unequal in length and glabrous; the rudimentary ovary densely villous. In the type collection, which was distributed as *Pterospermum*, the single fruit I have seen is 1-celled and 1-seeded, although it is described as 2-celled with one seed in each cell. The pedicel is only slightly thickened in fruit. The alliance of this species is manifestly with *Oncocarpus densiflora* Merr.

PARISHIA Hooker f.

PARISHIA OBLONGIFOLIA sp. nov.

Arbor, inflorescentiis ferrugineo-tomentosis exceptis glabra; foliis usque ad 40 cm longis, foliolis 15 ad 17, coriaceis, aequilateralibus, oblongis ad oblongo-lanceolatis, acuminatis, usque ad 18 cm longis, nitidis, nervis utrinque circiter 20; infructescentiis quam foliis paullo longioribus, calycis accrescentibus usque ad 10 cm longis, ferrugineo-tomentosis, lobis anguste oblongis, obtusis, usque ad 9 cm longis et 1.5 cm latis, tubo inflato, in siccitate brunneis, fructibus densissime villosis.

A tree, with ultimate branches thickened, rugose, dark-brown, about 1.5 cm in diameter. Leaves up to 40 cm long; leaflets 15 to 17, coriaceous, oblong to oblong-lanceolate, 11 to 18 cm long, 8 to 6 cm wide, acuminate, base acute, shining, brown when dry, the lower surface paler than the other; lateral nerves about 20 on each side of the midrib, distinct; petiolules 7 to 10 mm long. Panicles equal to or longer than the leaves, ferruginous-tomentose. Accrescent calyx up to 10 cm in length, the lobes 4, narrowly oblong, up to 9 cm long, about 1.5 cm wide, obtuse, ferruginous-tomentose, at first membranaceous becoming coriaceous, the inflated base brown when fresh, the lobes more or less pink toward their tips, when dry uniformly brown. Young fruits ovoid, very densely ferruginous-villous with spreading hairs about 2 mm long.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31044 Ramos & Edaño*, May, 1918 (type); Antique Province, Culasi, *Bur. Sci. 32219 McGregor*, May 24, 1918, on forested hillsides, altitude 900 meters. The same species is represented by a sterile specimen from Sibuyan Island, *For. Bur. 27040 Sajor*, November 7, 1917, with the Visayan name *bulalog*.

This species is the second one of the genus to be found in the Philippines and is readily distinguished from *Parishia malabog* Merr. by its narrower, differentially shaped, equilateral, more numerously nerved leaflets and by its ferruginous-tomentose inflorescences and accrescent, much larger calyces, the lobes of which are much wider than are those of *Parishia malabog*.

ICACINACEAE

VILLARESIA Ruiz and Pavon

VILLARESIA PHILIPPINENSIS sp. nov.

Arbor parva, inflorescentiis exceptis glabra; foliis crasse coriaceis, rigidis, ellipticis ad elliptico-oblongis, olivaceis, nitidis, usque ad 11 cm longis, integris, acuminatis, basi plerumque leviter inaequilateralibus, acutis, nervis utrinque circiter 4, perspicuis, petiolo 2 ad 3 cm longo; inflorescentiis terminalibus, 5 ad 8 cm longis, solitariis vel binis, ramis brevissimis; floribus circiter 6 mm longis, confertis; fructibus ovoideis, 2.5 ad 3 cm longis, inaequilateralibus.

A small tree, 4 to 5 m high, entirely glabrous except the inflorescences. Leaves thickly coriaceous, rigid, elliptic to elliptic-oblong, olivaceous and shining on both surfaces when dry, 6 to 11 cm long, 3 to 6.5 cm wide, entire, the apex rather prominently acuminate, base usually slightly inequilateral, acute; lateral nerves usually 4 on each side of the midrib, curved-ascending, arched-anastomosing, prominent on the lower surface, the reticulations lax, distinct; petioles black when dry, 2 to 3 cm long. Inflorescences terminal, 5 to 8 cm long, solitary or sometimes in pairs, narrow, more or less hirsute with short, somewhat ferruginous hairs, the branches numerous, rather crowded, racemosely arranged, 1 cm long or less, each bearing at the apex 5 to 8, densely crowded, cymosely arranged, sessile flowers. Sepals 5, subelliptic, rounded, imbricate, 1.5 to 2 mm long, sparingly hirsute. Petals 5, narrowly oblong, white, glabrous, 5 to 6 mm long, the tip inflexed, the margins slightly imbricate throughout, prominently keeled inside along the median portion. Filaments free, 5 mm long; anthers broadly ovoid, 1 mm long. Ovary glabrous, ovoid, 1-celled; ovules 2, pendulous; style glabrous, about 3 mm long; stigma minute, obscurely 2-lobed. Fruit ovoid, glabrous, shining, 2.5 to 3 cm long, distinctly inequilateral, black, the pericarp 1 to 1.5 mm thick. Seed deeply sulcate.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33267* (type), *33308 Ramos*, August 20, 1918, on forested slopes, altitude about 1,000 meters.

This species is apparently allied to *Villaresia suaveolens* (Blume) Val., the type of the genus *Pleuropetalon* Blume and of the genus *Chariessa* Miq., from which it is perhaps best distinguished by its long petioles; I have seen no specimen of Blume's species and all of the published descriptions are incomplete.

VILLARESIA LATIFOLIA sp. nov.

Arbor alta, inflorescentiis exceptis glabra; foliis crasse coriaceis, nitidis, obovatis ad oblong-obovatis, usque ad 18 cm longis et 11 cm latis, integris, abrupte et brevissime acuminatis, basi acutis ad decurrento-acuminatis, nervis utrinque 5 vel 6, petiolo 1 ad 1.5 cm longo; infructescentiis anguste pyramidatis, 10 ad 15 cm longis, ramis inferioribus usque ad 5 cm longis; fructibus ovoideis, aequilateralibus, 2 cm longis.

A large tree, glabrous except the somewhat hirsute inflorescences. Leaves thickly coriaceous, shining, obovate to oblong-obovate, 12 to 18 cm long, 6 to 11 cm wide, entire, the apex broad, abruptly and shortly acuminate, base acute to decurrent-acuminate, equilateral; lateral nerves 5 or 6 on each side of the midrib, curved-ascending, anastomosing, the reticulations lax; petioles 1 to 1.5 cm long. Infructescences terminal, solitary, narrowly pyramidal, 10 to 15 cm long, tripinnately paniculate, the primary branches racemosely arranged, numerous, rather crowded, the lower ones up to 5 cm in length, the uppermost ones simple, about 1 cm long. Fruits (not quite mature) ovoid, equilateral or nearly so, brown and shining when dry, about 2 cm long. Seed deeply longitudinally sulcate.

SAMAR, Catubig River at Pinipisakan, *Bur. Sci. 24557 Ramos*, March 21, 1916, in damp forests near the river at low altitudes, with the Visayan name *malaampipi*, distributed as an unidentified representative of the *Menispermaceae*.

The type of the genus *Villaresia* is a tropical American plant, and after a critical study of the two Philippine forms I am in entire agreement with Bentham and with Valeton in reducing to it the genus *Chariessa* Miquel, which was based on *Pleuropetalon* Blume (non *Pleuropetalum* Hook.), the type of which was a Javan specimen. Engler maintains *Chariessa* as a genus distinct from *Villaresia* chiefly on the basis that the petals of the latter are imbricate and those of the latter are valvate. Blume described the petals of the Javan form as imbricate, while in *Villaresia philippinensis* the petals are distinctly although not prominently imbricate throughout. There appears to be no other character by which the two genera can be distinguished. The genus *Villaresia* has about ten known species in tropical America, one in tropical Africa, one in Java, two in Australia, one in Polynesia, and two in the Philippines.

MIQUELIA Meissner

MIQUELIA PHILIPPINENSIS sp. nov.

Frutex scandens, ramulis junioribus hirsutis; foliis membranaceis, ovatis, 7 ad 11 cm longis, basi late rotundatis et plus minusve cordatis, apice acuminatis, margine integris vel repandis; inflorescentiis ♀ axillaribus, pedunculatis, floribus umbellatim dispositis; fructibus immaturis oblongo-ellipsoideis, 1 ad 1.3 cm longis, longe stipitatis.

A scandent shrub, the young branchlets hirsute. Leaves membranaceous, ovate, olivaceous, 7 to 11 cm long, 5 to 9 cm wide, base broadly rounded and usually shallowly cordate, apex somewhat acuminate, margins entire or somewhat repand; lateral nerves 5 or 6 on each side of the midrib, slender, distinct, the basal ones scarcely distinguishable from the others, reticulations lax; petioles pubescent when young, soon becoming glabrous, 3 to 7 cm long. Pistillate inflorescences axillary, their peduncles about 3 cm long, each bearing usually about 7 umbellately arranged flowers, their pedicels 5 mm long, each subtended by a lanceolate, acuminate, sparingly hirsute bracteole, 1 to 1.5 mm long. Sepals oblong, obtuse, 2.5 mm long. Fruits (immature) slightly pubescent, oblong-ellipsoid, 1 to 1.3 cm long, narrowed below into a pseudostalk as long as the fruit proper.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32885 Ramos*, August 6, 1918, in rocky forests at low altitudes.

This is the second species of the genus to be found in the Philippines and differs from *Miquelia cumingii* notably in its umbellately arranged, not capitate, pistillate flowers.

SAPINDACEAE

ALLOPHYLUS Linnaeus

ALLOPHYLUS STENOPHYLLUS sp. nov.

Frutex erectus, ramulis foliisque plus minusve pubescens, ramis glabris, lenticellatis; foliis 5-foliolatis, foliolis chartaceis, angustissime lanceolatis, 5 ad 10 cm longis, 1 ad 1.5 cm latis, tenuiter acuminatis, margine distanter serratis, supra subglabris, subtus ad costa nervisque leviter pubescentibus, axillis dense barbatis; racemis axillaribus, 7 ad 5 cm longis; fructibus subellipsoideis, circiter 5 mm longis.

A small erect shrub, the branches glabrous, brownish, distinctly lenticellate, the branchlets paler and somewhat appressed-pubescent. Leaves palmately 5-foliolate, their petioles 4 to 6 cm long, appressed-pubescent with short hairs; leaflets chartaceous, very narrowly lanceolate, 5 to 10 cm long, 1 to 1.5 cm wide, slenderly acuminate, base decurrent-acuminate, margins rather distantly serrate, the upper surface pale-olivaceous, shining, glabrous or very slightly pubescent especially on the midrib, the lower surface paler, sparingly pubescent on the midrib and nerves, densely bearded in the axils; petiolules of the central leaflets 5 to 10 mm long, the lateral leaflets subsessile. Racemes axillary, solitary, sparingly pubescent, 5 to 7 cm long. Fruits rather numerous, subellipsoid, brown when dry, very slightly pubescent, about 5 mm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32839 Ramos*, August 29, 1918, in dry thickets at low altitudes.

This species manifestly belongs in the group with *Allophylus dimorphus* Radlk., from which I do not consider that *A. quinatus* Radlk. can be specifically distinguished. *Allophylus stenophyllus* differs from all forms of the above species in its very narrowly lanceolate leaflets, which are nearly glabrous on both surfaces and which attain a length of 10 cm but do not exceed 1.5 cm in width.

GUIOA Cavanilles

GUIOA PARVIFOLIOLA sp. nov.

Frutex, partibus junioribus foliisque plus minusve pubescens; foliis 10 cm longis, foliolis plerumque 6, anguste oblongis, obtusis, coriaceis, 2 ad 4 cm longis, 6 ad 15 mm latis, basi angustatis, apice obtusis, vetustioribus supra glabris, nervis utrinque

8 ad 10; capsulis late obovatis, 3-lobatis, circiter 1 cm longis et 1.3 cm latis, lobis late rotundatis, apice retusis apiculatisque.

A shrub, the younger parts and the young leaves more or less pubescent, the older leaves glabrous or nearly so, at least on the upper surface. Leaves 10 cm long or less, the rachis and petiolules puberulent; leaflets usually 6, narrowly oblong, coriaceous, 2 to 4 cm long, 6 to 15 mm wide, obtuse, narrowed below to the somewhat decurrent-acuminate base, the upper surface dark-olivaceous, glabrous, the lower surface much paler and, at least when young, more or less pubescent with scattered short hairs; lateral nerves 8 to 10 on each side of the midrib, prominent on the lower surface; petiolules 2 to 5 mm long. Infructescences axillary, 3 to 5 cm long, pubescent, the branches few. Capsules broadly obovate, 3-lobed, apex more or less retuse and distinctly apiculate, about 1.3 cm wide and nearly 1 cm long, the lobes broadly rounded, red, glabrous. Seeds obovoid, smooth, shining, about 6 mm long.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33187 Ramos*, August 8, 1918, on dry slopes, altitude about 700 meters.

The alliance of this species is manifestly with *Guioa obtusa* Merr., from which it radically differs in its very much smaller, relatively much narrower leaflets.

ELAEOCARPACEAE

ELAEOCARPUS Linnaeus

ELAEOCARPUS ILOCANUS sp. nov. § *Dicera*.

Arbor parva inflorescentiis densissime ferrugineo-pubescens; foliis ellipticis ad obovato-ellipticis, glabris, olivaceis, nitidis, 4 ad 7 cm longis, basi acutis, apice breviter obtuse acuminatis, margine distanter apiculato-crenatis, nervis utrinque circiter 7, distinctis; racemis numerosis, solitariis, plerumque e axillis defoliatis, 5 cm longis; floribus 5-meris, 8 mm longis; sepalis lanceolatis, pubescentibus; petalis glaberrimis, usque ad $\frac{1}{2}$ laciniatis, laciniae circiter 20; staminibus circiter 25, antheris oblongis, obtusis, apice parce ciliatis; ovario pubescente, 3-loculare; fructibus ellipsoideis, 2.5 cm longis, 1-locellatis.

A tree, about 5 m high, the inflorescences very densely ferruginous-pubescent, the branches terete, glabrous, the very young branchlets either more or less pubescent or glabrous. Leaves elliptic to obovate-elliptic, olivaceous and shining on the upper surface, the lower surface paler, 4 to 7 cm long, 2 to 3.5 cm wide, base acute, apex shortly and obtusely acuminate, margins distantly apiculate-crenate; lateral nerves about 7 on each side of the midrib, prominent; petioles glabrous, 1 to 1.3 cm long, racemes numerous, solitary, chiefly from the axils of fallen leaves, about 5 cm long, usually 6- to 10-flowered. Flowers pink, about 8 mm long, 5-merous, their pedicels 5 to 6 mm long, densely pubescent. Sepals lanceolate, 7 mm long, densely pubescent. Petals entirely glabrous, 7 to 8 mm long, cuneate, split to about the middle into three primary divisions, these again divided, the ultimate laciniae about 20, slender. Stamens about 25, filaments 1 to 1.5 mm long, anthers narrowly oblong, 1.5 to 1.8 mm long, minutely scabrid, the cells slightly unequal, obtuse, sparingly ciliate at their tips. Ovary ovoid, densely pubescent, 3-celled. Fruit ellipsoid, about 2.5 cm long, black when dry, one-celled.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33271 Ramos*, August 21, 1918, on forested slopes near the summit, altitude about 1,000 meters.

This species somewhat resembles both *Elaeocarpus cumingii* Turcz. and *E. forbesii* Merr., differing radically from the former in its very densely pubescent racemes and sepals and from the latter in its much longer racemes and entirely glabrous petioles.

SLOANEA Linnaeus

SLOANEA JAVANICA (Miq.) Szyszyl. ex K. Schum in Engl. & Prantl. Nat. Pflanzenfam. 3 [6] (1890) 5; Koord. & Val. Bijdr. Boom. Java 1 (1894) 239, Atlas Baumart. Java 3 (1914) *f. 433* (after Miquel).

Phoenicospermum javanicum Miq. Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 68, *t. 3*.

LUZON, Cagayan Province, Pamplona, *For. Bur. 14713 Darling*, March 17, 1909; Pamplona, *For. Bur. 16988 Bacani*, March, 1907: Laguna Province, Cavinti, *For. Bur. 19665 Racelis*, August, 1912, with mature fruits. MINDORO, Ibolo River, *For. Bur. 11482 Merritt*, May, 1908, sterile. A tree, 10 to 25 m high, in forests up to an altitude of 600 meters.

This species has previously been known only from Java, where it is apparently very rare, as until recently it was known only from trees cultivated in the botanical garden at Buitenzorg; it is now known from Depok, near Buitenzorg, *Koorders 42807*, a duplicate of Koorders' specimen being before me. The Philippine specimens have somewhat larger and more prominently acuminate leaves than the Javan material, while the fruits are a little larger. In the absence of flowers I can detect no differential characters of sufficient importance to warrant the separation of the Philippine form from the Javan one. The genus is new to the Philippines.

Szyszylowicz does not make the transfer of *Phoenicospermum javanicum* Miq. to *Sloanea* in his paper "Zur Systematik der Tiliaceen" [3] as indicated by Koorders and Valeton, but merely reduces the genus *Phoenicospermum* to *Sloanea*.

STERCULIACEAE

PTEROSPERMUM Schreber

PTEROSPERMUM MEGALANTHUM sp. nov.

Arbor parva, subtus foliis et ramulis et inflorescentiis densissime ferrugineo-stellato-tomentosis; foliis oblongis, inaequilateralibus, integris, acuminatis, supra glabris, nitidis, usque ad 15 cm longis; inflorescentiis plerumque 2-floris, floribus longe pedicellatis, circiter 6.5 cm longis; sepalis anguste lanceolatis, 6 cm longis et 1 cm latis; petalis oblique obovatis, 3 cm latis, quam sepalis paullo longioribus.

A tree, 7 to 8 m high, the branchlets, petioles, inflorescences, and the lower surface of the leaves densely stellate-tomentose with ferruginous hairs. Branches at first stellate-pubescent, soon becoming glabrous, nearly black when dry. Leaves inequilateral, oblong, chartaceous to subcoriaceous, 9 to 15 cm long, 3 to 6.5 cm wide, entire, or the margins obscurely undulate, rather sharply acuminate, the upper surface olivaceous, glabrous and shining when dry, the basal lobe of the broader side broadly rounded, of the narrower side rounded to acute, the leaf somewhat obliquely cordate; lateral nerves about 6 on each side of the midrib, excluding those extending into the broader basal lobe; petioles densely ferruginous-stellate-pubescent, 5 to 10 mm long. Inflorescences in the uppermost axils and subterminal, usually 2-flowered, the peduncles 1.5 cm long or less, the pedicels in anthesis 3 to 4 cm long, densely ferruginous-pubescent; bracts linear-lanceolate, entire, deciduous. Flowers white, fragrant, about 6.5 cm long, 5-merous. Sepals coriaceous, narrowly lanceolate, about 6 cm long, 1 cm wide, slightly acuminate, externally densely ferruginous-stellate-pubescent, inside densely subappressed fulvous-hirsute. Petals obliquely obovate, membranaceous, glabrous, about 6.5 cm long, 3 cm wide. Staminal column glabrous, 1.5 cm long. Staminodes 3 cm long. Filaments and anthers each 1.5 cm long, sometimes 2, sometimes 3 between each pair of staminodes. Ovary ovoid, densely ferruginous-villous; style glabrous, 3 cm long.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31269 Ramos & Edaño* (type), April 28, 1918; Ibahay, *For. Bur. 25359 Achacoso*,

[3] Engl. Bot. Jahrb. 5 (1885) 427–457.

April 7, 1916, along streams in open forests, altitude about 100 meters.

This species has almost exactly the vegetative characters of *Pterospermum blumeanum* Korth. (*P. javanicum* Jungh.) and the second specimen cited above, which has only immature buds, was originally so identified. While it is manifestly closely allied to Korthals's species, it differs remarkably in its larger flowers, somewhat longer and much broader sepals, and in its much larger petals, which exceed the sepals in length.

DILLENIACEAE

DILLENIA Linnaeus

DILLENIA MEGALOPHYLLA sp. nov. § *Wormia.*

Arbor, inflorescentiis exceptis glabra, ramulis ultimis 1.5 ad 2 cm diametro; foliis coriaceis, ovatis ad elliptico-ovatis, usque ad 1 m longis, apice rotundatis, basi angustatis, margine undulatis vel obscure dentatis, nervis utrinque 15 ad 18, perspicuis, lamina decurrente, basi conduplicatis; inflorescentiis axillaribus, longe pedunculatis, paucifloris, circiter 40 cm longis, dense pubescentibus; sepalis coriaceis, obovatis ad late ellipticis, 3 cm longis, extus molliter dense fulvo-pubescentibus; carpellis plerumque 8.

A tree, about 7 m high, nearly glabrous except the inflorescences, the ultimate branches 1.5 to 2 cm in diameter. Leaves coriaceous, ovate to elliptic-ovate, up to 1 m long and 60 cm wide, apex rounded, base gradually narrowed, margins somewhat undulate and obscurely toothed, glabrous on both surfaces, what is apparently the petiolar part of the leaf with the lamina continuous but with much slenderer nerves than the leaf proper, extending to the very base of the petiole, conduplicate, the upper surface for a distance of about 2.4 cm on each side of the midrib closely appressed and with a modified, brown, apparently absorbent epidermis, this region in some leaves inhabited by colonies of ants, the lower surface of this conduplicate area rather softly pubescent; lateral nerves above the modified petiolar part of the lamina very prominent, 15 to 18 on each side of the midrib. Inflorescences in the uppermost axils, long-peduncled, few-flowered, sparingly branched above, about 40 cm long, densely and softly pubescent; pedicels 3 to 5 cm long. Sepals coriaceous, obovate to broadly elliptic, rounded, concave, about 3 cm long, softly and densely fulvous-pubescent externally. Petals not seen. Stamens apparently equal or subequal. Carpels usually 8, glabrous, not twisted, the styles up to 3 cm long. Immature carpels coriaceous, about 3 cm long, apparently purplish, dehiscent; ovules about 11 in each carpel; immature seeds with a small basal aril.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33034 Ramos,* August 21, 1918, in forests near the sea at low altitudes.

This species is remarkable for its exceedingly large leaves, which attain at least 1 meter in length. It belongs in the group with *Dillenia suffruticosa* Grieff. and like that species has a portion of the upper surface of the decurrent basal part of the lamina conduplicate and supplied with a modified, apparently absorbent, epidermal tissue. Among the Philippine species it is most closely allied to *Dillenia papyracea* Merr., of Basilan, from which it is readily distinguished by its very much larger leaves, softly pubescent inflorescences and sepals, and fewer carpels.

SAURAUIA Willdenow

SAURAUIA SANTOSII sp. nov.

Arbor 7 ad 9 m alta, *S. eleganti* affinis, differt floribus majoribus, 1.5 ad 2 cm diametro, confertis, foliis subtus densissime fulvo-ferrugineo-lanatis.

A tree, 7 to 9 m high, the branches brown, setose, and densely ferruginous-tomentose, the setae comparatively few, filiform, 4 to 7 mm in length, ascending. Leaves thickly coriaceous, rigid, oblong, 13 to 18 cm long, 5.5 to 7 cm wide, obtuse, the base rounded, cordate, often somewhat oblique, the margins with small, thick, rounded teeth, these often terminating in filiform, deciduous setae, the upper surface brown, glabrous, shining, rugose-pustulate, the nerves impressed, the lower surface very densely fulvous-ferruginous-lanate, the indumentum covering the whole surface, midrib, and nerves, the midrib and nerves also with few, scattered, filiform setae; lateral nerves 25 to 30, prominent, projecting; petioles 2 to 4 cm long, setose and tomentose. Inflorescences axillary, long-peduncled, cymose, the flowers crowded, the peduncles 10 to 12 cm long, densely tomentose and rather sparingly setose, the cymes compact, 4 to 5 cm in diameter. Flowers white, 1.5 to 2 cm in diameter, their pedicels up to 5 mm in length, setose and tomentose. Sepals broadly ovate, obtuse or rounded, 5 mm in diameter, the outer ones thickly coriaceous, densely villous and setose, the setae slender, up to 2 mm in length, the inner ones thinner, rather sparingly villous and not setose. Petals oblong-obovate, rounded, about 11 mm long and 7 mm wide. Ovary glabrous; styles 2, free to the base, 4 mm long.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31937 Santos,* May 16, 1918, on slopes, altitude about 2,200 meters.

This species is manifestly allied to *Saurauia elegans* (Choisy)

F.-Vill., from which it is readily distinguished by its dense indumentum, its compact cymes, and its much larger flowers. The two styles are constant in all the flowers examined, *Saurauia elegans* normally having three styles, although in some flowers they are reduced to two.

FLACOURTIACEAE

HOMALIUM Jacquin

HOMALIUM RAMOSII sp. nov. § *Myriantheia.*

Arbor, inflorescentiis exceptis glabra; foliis oblongis ad oblongo-ellipticis, subcoriaceis, integris nitidis, 6 ad 10 cm longis, basi acutis, apice obtuse acuminatis, nervis utrinque circiter 7; inflorescentiis axillaribus terminalibusque, racemosis vel depauperato-paniculatis, usque ad 10 cm longis; floribus fasciculatis, 5-meris, 6 ad 7 mm diametro, petalis oblongis ad oblongo-obovatis; staminibus 15.

A small tree, glabrous except the inflorescences, the branches terete, brownish. Leaves oblong to oblong-elliptic, subcoriaceous, shining, entire, 6 to 10 cm long, 3 to 4.5 cm wide, subequally narrowed to the acute base and acuminate apex, the acumen blunt, short; lateral nerves about 7 on each side of the midrib, arched, anastomosing, distinct as are the reticulations; petioles 5 to 8 mm long. Racemes axillary and terminal, solitary or forming sparingly branched inflorescences, the individual ones up to 10 cm long, cinereous-pubescent, the flowers mostly fascicled at the nodes, usually 2 or 3 in a fascicle, their pedicels 3 to 4 mm long, jointed with the calyx; bracteoles narrowly lanceolate, about 2 mm long. Flowers white, 5-merous, 6 to 7 mm in diameter. Sepals and petals about 2.5 mm long, pubescent, rather densely so inside, oblong to narrowly oblong-obovate. Stamens 15, three opposite each petal, their filaments about 2 mm long, glabrous. Ovary very densely pubescent, styles about 1.8 mm long, villous below.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 32985 Ramos*, August 12, 1918, on slopes, altitude about 450 meters.

This species has much the vegetative characters of *Homalium multiflorum* Merr. but belongs in a different section of the genus and is most closely allied to *H. samarense* Merr., from which it differs in its much shorter indumentum on its inflorescences; its smaller flowers, which are fascicled and not solitary along the racemes; and its entire leaves. In the present species occasional leaves are found presenting very few greatly reduced marginal teeth, but most of the leaves are quite entire.

BEGONIACEAE

BEGONIA Linnaeus

BEGONIA COLLISIAE sp. nov. § *Diploclinium.*

Herba, pedunculis foliisque utrinque ad nervis plus minusve ferrugineo-villosis; foliis longe petiolatis, in ambitu late ovatis, usque ad 20 cm longis, inaequilateralibus, basi lateraliter cordatis, apice leviter acuminatis, profunde subpalmatim lobatis, lobis numerosis, oblongis, 2 ad 5 cm longis, irregulariter et grosse dentato-serratis vel lobulatis; inflorescentiis longe pedunculatis, dichotome ramosis, parce glandulosis, paucifloris; floribus circiter 3 cm diametro; sepalis late ovatis, circiter 11 mm latis; petalis sepalis aequantibus, 6 ad 7 mm latis.

An herb, from short, rather stout, prostrate rhizomes about 1 cm in diameter. Leaves long-petioled, in outline broadly ovate, 15 to 20 cm long, 10 to 15 cm wide, when dry submembranaceous, the upper surface olivaceous, somewhat shining, the lower brownish, both surfaces more or less ferruginous-villous on the nerves, when fresh the nerves beneath red, inequilateral, subpalmately and conspicuously lobed, the lobes oblong, 2 to 5 cm long, 2 to 3 cm wide below, all acute or acuminate and irregularly and coarsely dentate-serrate or lobulate, the primary lobes usually about 10, the base of the leaf laterally cordate, the sinus narrow, 2 to 4 cm deep, the basal lobes broadly rounded, often overlapping; petioles brown when dry, ferruginous-villous. Peduncles nearly glabrous, up to 20 cm in length, the younger parts sparingly glandular, dichotomously branched at the apex, the primary branches about 4 cm long, few-flowered. Staminate flowers pink and white, about 3 cm in diameter. Sepals broadly ovate, about 14 mm long, 11 mm wide, rounded, with few, small, widely scattered, brown glands. Petals oblong-obovate, as long as the sepals, 6 to 7 mm wide. Stamens many, the anthers narrowly obovoid, 0.8 mm long, equaling or shorter than the filaments. Pistillate flowers and fruits unknown.

PANAY, Capiz Province, Libcacao, *Bur. Sci. 31469 Ramos & Edaño*, May 5, 1918, on stream banks in forests.

This species is remarkably distinct from all previously described Philippine ones in the section *Diploclinium*, and is strongly characterized by its deeply lobed leaves, the lobes being usually about 10 in number, up to 5 cm in length, and coarsely and irregularly toothed and lobulate.

BEGONIA LANCILIMBA sp. nov. § *Diploclinium.*

Herba glaberrima; foliis longe petiolatis, membranaceis, oblongis ad oblongo-lanceolatis, sub-aequilateralibus, usque ad

13 cm longis, basi rotundatis, leviter cordatis, apice tenuiter caudato-acuminatis, margine irregulariter dentatis; petiolo 15 cm longo; inflorescentiis foliis subaequantibus, paucifloris; floribus ♂ circiter 3 cm diametro.

An entirely glabrous herb, the rhizomes creeping, simple, about 5 mm in diameter, supplied with numerous, lanceolate, caudate-acuminate, brown stipules, 1 to 1.5 cm in length. Leaves pale-green on both surfaces when fresh, when dry membranaceous, somewhat shiny, oblong to oblong-lanceolate, nearly equilateral, 7 to 13 cm long, 2.5 to 4 cm wide, base rounded and very slightly cordate, narrowed upward from the lower one-third to the slenderly caudate-acuminate apex, the margin irregularly toothed, a few of the teeth rather large, most of them small; basal nerves about 8 ascending, a few lateral nerves leaving the midrib at and above the middle; petioles about 15 cm long. Peduncles of the staminate inflorescences 19 to 24 cm long, usually with 2 short branches at the apex, each bearing about 2 relatively large white flowers about 3 cm in diameter. Sepals 2, oblong-elliptic rounded, about 1.8 mm long, 10 mm wide. Petals narrowly oblong, equaling the sepals, 3 to 3.5 mm wide, rounded. Stamens about 35, the anthers oblong, about 1.5 mm long; filaments about 1 to 2 mm long.

PANAY, Antique Province, Culasi, *Bur. Sci. 32232* (type), *32570, 32286 McGregor*, June 14 and July 14, 1918, on forested slopes, altitude 900 to 1,000 meters.

This species is not closely allied to any previously described Philippine form and is very strongly characterized by being entirely glabrous; by its nearly equilateral, oblong-lanceolate to lanceolate, caudate-acuminate leaves which are slightly cordate at the base; by its long peduncles; and its few, comparatively large, white flowers.

BEGONIA OBTUSIFOLIA sp. nov. § *Diploclinium*.

Herba prostrata, petiolis et subtus foliis ad nervis adpresse ferrugineo-pubescentibus; foliis longe petiolatis, oblongis, inaequilateralibus, 7 ad 10 cm longis, apice obtuse rotundatis, basi leviter oblique cordatis, margine late lobatis vel undulatis, lobis rotundatis; inflorescentiis quam foliis longioribus, paucifloris; floribus ♂ circiter 3 cm diametro; capsulis aequaliter 3-alatis, junioribus circiter 14 mm latis et 10 mm longis, apice subtruncatis, basi rotundatis.

Rhizomes slender, creeping, the petioles and nerves on the lower surface of the leaves appressed ferruginous-pubescent.

Leaves oblong to oblong-ovate, distinctly inequilateral, 7 to 10 cm long, 3.5 to 4.5 cm wide, the upper surface glabrous, somewhat shiny, somewhat narrowed upward to the obtusely rounded apex, the base somewhat obliquely cordate, the sinus shallow, narrow, the margin on the narrower side usually with 1 or 2 short obtuse lobes, on the broader side with from 2 to 4 similar lobes or undulations; basal nerves usually 6, slender, distinct; petioles slender, 10 to 13 cm long. Peduncles 18 to 24 cm long, glabrous, dichotomously branched at the apex, the primary branches up to 3 cm in length, few-flowered. Flowers pink, the sepals of the staminate ones broadly ovate, rounded, about 14 mm long, 11 mm wide. Petals equaling the sepals, narrowly oblong, 4 mm wide. Pistillate flowers as large as the staminate ones, the young capsules equally 3-winged, about 14 mm wide and 10 mm long including the wings, base rounded, apex somewhat truncate.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30803*, *Ramos & Edaño*, April 19, 1918, on stones in damp forests.

In the form and characters of its leaves this species is remote from all other described ones of the section and is easily recognized by its usually oblong, rounded, obtuse leaves, which have a few short rounded lobes or undulations on each side.

BEGONIA RUBRIFOLIA sp. nov. § *Diploclinium.*

Herba prostrata, rhizomate brevibus, petiolis et subtus foliis ad nervis plus minusve ferrugineo-lanatis; foliis integris, inaequilateralibus, late ovatis, chartaceis, in siccitate utrinque rubris, in vivo supra viridis, subtus rubris, usque ad 9 cm longis, basi lateraliter cordatis, palmatim 8-nerviis, nervis conspicuis, apice late acutis; infructescentiis 20 ad 30 cm longis, quam foliis multo longioribus, dichotome ramosis; capsulis paucis, inaequaliter 3-alatis, circiter 12 mm longis et 2.3 mm latis, apice truncatis, basi rotundatis.

A prostrate herb, the rhizomes short, stout, brown, glabrous. Leaves chartaceous, when fresh green on the upper surface, red beneath, when dry uniformly reddish-purple on both surfaces, the upper surface glabrous, the lower densely white- or grayish-punctate, rather densely ferruginous-lanate on the nerves, broadly ovate, inequilateral, entire, 8 to 10 cm long and nearly as wide, the apex broadly acute, base laterally cordate and palmately 8-nerved, the nerves conspicuous, margins ciliate, the sinus narrow, basal lobes broadly rounded; petioles sparingly ferruginous-lanate, 7 to 11 cm long; stipules oblong-ovate, somewhat ciliate, about 1 cm long, and with a few fimbriate-ciliate paleae. Infructescences long-peduncled, 20 to 30 cm long, nearly glabrous, dichotomously branched at the apex of the peduncle, the primary branches about 5 cm long. Capsules few, including the wings about 12 mm long and 23 mm wide, inequally 3-winged, one wing about twice as large as the other two, the apex subtruncate, base broadly rounded, the outer upper angles of the wings rounded or obtuse.

PANAY, Antique Province, Culasi, *Bur. Sci. 32430 McGregor*, June 7, 1918, altitude about 1,000 meters.

This species is allied to *Begonia copelandii* Merr. and *B. alvarezii* Merr., but its indumentum is very different from both. The leaves are characteristically reddish-purple on both surfaces when dry.

BEGONIA SERPENS sp. nov. § *Diploclinium*.

Herba prostrata, repens, leviter ciliatis, internodiis 1 ad 3 cm longis; foliis breviter petiolatis, irregulariter rhomboideis, inaequilateralibus, 1.5 cm diametro, basi leviter cordatis, apice acutis vel acuminatis, margine irregulariter lobatis; inflorescentiis paucifloris, circiter 3 cm longis; floribus ♂ circiter 1.5 cm diametro.

A very small, slender, prostrate, sparingly appressed-ciliate herb, the rhizomes 2 mm or less in diameter, attaining a length of at least 25 cm. Leaves irregularly rhomboid, inequilateral, base more or less cordate, apex shortly acuminate, 1.5 to 2.5 cm in diameter, margins shallowly and irregularly lobed, the upper surface usually mottled with gray, glabrous, the lower surface sparingly ciliate on the nerves with appressed brown hairs, the margins more or less ciliate with short spreading hairs; petioles 1 to 1.5 cm long, sparingly ciliate; stipules brown, 5 to 6 mm long, oblong-ovate, with a long slender tip. Peduncles slender, about 3 cm long, usually 2-flowered. Staminate flowers usually pink, about 1.5 cm in diameter. Sepals broadly obovate, rounded, 7 to 8 mm long, 6 to 7 mm wide. Petals equaling the sepals, oblong-obovate, rounded, 4 mm wide. Stamens about 35; anthers oblong-obovoid, 0.8 mm long; filaments 1 mm long or less.

PANAY, Antique Province, Culasi, *Bur. Sci. 32588* (type), *32541 McGregor*, May and June, 1918, on damp forested slopes, altitude 500 to 900 meters.

This species is as closely allied to *Begonia nigritarum* Steud. as to any other but is readily distinguished by its smaller leaves, short petioles, and short, very few-flowered inflorescences as well as by its very slender, greatly elongated rhizomes; the internodes vary from 1 to 3 cm in length.

BEGONIA PANAYENSIS sp. nov. § *Petermannia.*

Herba suffruticosa, erecta, ramosa, glabra, circiter 1.5 m alta; foliis in siccitate membranaceis, nitidis, oblongis, usque ad 20 cm longis, inaequilateralibus, apice angustatis, tenuiter acuminatis, basi rotundatis, haud cordatis, margine distanter et irregulariter dentatis; inflorescentiis terminalibus, cymoso-paniculatis, usque ad 17 cm longis; floribus ♂ numerosis, circiter 1.5 cm diametro; sepalis orbicularis, 7 ad 8 mm diametro; petalis 0; capsulis ellipticis vel obovato-ellipticis, circiter 2.5 cm longis et 2 cm latis, aequaliter 3-alatis, apice truncato-rotundatis, basi vix angustatis, rotundatis.

An erect, branched, glabrous, suffrutescent herb, about 1.5 m high, the stems and branches stout. Leaves when dry membranaceous, shining, inequilateral, oblong, 16 to 20 cm long, 4 to 6 cm wide, narrowed upward to the slenderly acuminate apex and somewhat narrowed below to the rounded base, or the narrower side of the lamina acute and the broader side rounded, not at all cordate, margins distantly and irregularly dentate, or that of the narrower side often nearly entire except near the apex; nerves prominent, ascending; petioles stout, 1 to 1.5 cm long; stipules membranaceous, oblong to oblong-lanceolate, acuminate, 1.5 to 2 cm long. Inflorescences terminal, cymose-paniculate, up to 17 cm in length, the staminate flowers numerous, the pistillate flowers apparently few and only at the base of the inflorescence, none present on the type, but represented by mature capsules. Staminate flowers pink, about 1.5 cm in diameter. Sepals orbicular, 7 to 8 mm in diameter. Petals none. Stamens about 35, the anthers narrowly oblong to oblong-obovoid, 1.2 to 1.5 mm long, longer than the filaments. Capsules one or two at the base of the inflorescence, including the three equal wings about 2.5 cm long, 2 cm wide, elliptic to obovate-elliptic, apex rounded-truncate, base scarcely narrowed, usually rounded; pedicels 1.5 to 2 cm long.

PANAY, Antique Province, Culasi, *Bur. Sci. 32309 McGregor*, June 8, 1918, in forests along cool mountain streams, altitude about 250 meters.

This unusually robust species is manifestly allied to *Begonia longistipula* Merr., from which it is distinguished by its larger leaves and flowers and by its much larger, differently shaped capsules.

THYMELAEACEAE

PHALERIA Jack

PHALERIA PLATYPHYLLA sp. nov.

Frutex glaber *Phaleria cumingiae* affinis differt foliis multo majoribus, circiter 25 cm longis et 9 ad 11 cm latis, floribus caulinis, fasciculatis.

An entirely glabrous shrub, the branches reddish-brown when dry. Leaves oblong to oblong-ovate, firmly chartaceous, about 25 cm long, 9 to 11 cm wide, brownish-olivaceous when dry, shining, apex slenderly acuminate, base broadly rounded; lateral nerves about 10 on each side of the midrib, distinct; petioles 1 cm long or less. Flowers white, 4-merous, in fascicles on the trunk, about 3 cm long. Perianth-lobes 4, elliptic, rounded, 8 to 9 mm long, 6.5 mm wide. Filaments 8, somewhat exserted. Immature fruit ovoid-ellipsoid, somewhat rostrate, 1.5 cm long.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30759 Ramos & Edaño*, April 22, 1918, in forests.

This species has the vegetative characters of *Phaleria perrottetiana* F.-Vill., but the flowers are entirely glabrous and are moreover borne in fascicles on the trunk. It is distinguished from *Phaleria cumingii* F.-Vill. by its much larger leaves and cauline inflorescences.

MYRTACEAE

CLOËZIA Brongniart and Gris

CLOËZIA URDANETENSIS (Elm.) comb. nov.

Photinia urdanetensis Elm. Leafl. Philip. Bot. 8 (1915) 2802.

MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 13694*, September, 1912, on exposed forested ridges in the mossy forest, altitude about 1,700 meters.

The genus *Cloëzia* has hitherto been known only from New Caledonia, where it is represented by six species. The discovery of a representative of it in the Philippines adds another genus to the now remarkable list of genera that are known only from the Philippines and the islands to the south and southeast of the Archipelago, including Celebes and the Moluccas generally, New Guinea, New Caledonia, and northeastern Australia. The present species was described by Mr. Elmer as a representative of the rosaceous genus *Photinia*, but a critical examination of the type collection shows that it agrees even to the most minute details with the myrtaceous *Cloëzia*.[4] In the original description

[4] Brongniart & Gris in Ann. Sci. Nat. Bot. V 2 (1864) 134.

of Mr. Elmer the stamens are described as "about 10," but I find them to vary from 15 to 20. The ovary is two-thirds to three-fourths superior, 3-celled, each cell with about 6 ovules ascending from the inner basal angle. The apical gland of the anthers, or continuation of the connective, is unusually conspicuous, being longer than the anther-cells. The fruits of the Philippine species are as yet unknown. The leaves are distinctly *Eugenia*-like and are glandular-punctate.

TRISTANIA R. Brown

TRISTANIA OBLONGIFOLIA sp. nov.

Species *T. decorticatae* similis, differt foliis junioribus utrinque dense ferrugineo-pubescentibus, inflorescentiis et floribus dense fulvo-pubescentibus, staminibus circiter 35. Arbor circiter 5 m alta, ramis teretibus, glabris; foliis coriaceis, oblongis, in siccitate brunneis, usque ad 9 cm longis, utrinque subaequaliter angustatis, basi cuneatis, apice leviter obtuse acuminatis, nervis primariis utrinque circiter 20, tenuibus; inflorescentiis axillaribus, corymbosis, circiter 3 cm longis; capsulis glabris, subovoideis, circiter 5 mm longis.

A tree, about 5 m high, the older parts glabrous, the younger leaves very densely ferruginous-tomentose on both surfaces, the inflorescences densely fulvous-tomentose. Branches brown, smooth, terete, glabrous, the younger branchlets dark-brown. Leaves oblong, coriaceous, brown when dry, shining, of about the same color on both surfaces, glandular beneath, 6 to 9 cm long, 1.8 to 2.4 cm wide, subequally narrowed to the cuneate base and to the slightly acuminate apex, the tip obtuse or subobtuse; primary lateral nerves about 20 on each side of the midrib, slender, about equally distinct on both surfaces, not much more prominent than are the secondary ones; petioles 5 mm long or less. Inflorescences axillary, about 3 cm long, rather stout, few-flowered, densely fulvous-pubescent. Flowers about 4 mm long, their pedicels stout, pubescent, 1 to 2.5 mm long, the buds ellipsoid. Calyx ovoid, the lobes 5, ovate, obtuse, 1.2 mm long. Stamens in 5 phalanges of about 7 each, inflexed in bud. Infructescences glabrous, 4 to 5 cm long. Capsules somewhat ovoid, dark-brown, glabrous, about 5 mm long.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28617 Ramos & Edaño*, May 28, 1917, on forested slopes, altitude at least 400 meters.

In the vegetative characters, other than the very densely ferruginous-tomentose young leaves, this species greatly resembles

Tristania decorticata Merr. It differs remarkably from that species in its densely pubescent, larger flowers and its stamens being arranged in phalanges of about 7 each, not in groups of threes.

MELASTOMATACEAE

MEDINILLA Gaudichaud

MEDINILLA OBLANCEOLATA sp. nov.

Frutex, ramulis et inflorescentiis et foliis subtus ad costa nervisque perspicue setoso-ciliatis; foliis ternatis, breviter petiolatis, chartaceis, oblongo-oblanceolatis, usque ad 38 cm longis, tenuiter acuminatis, deorsum valde angustatis, penninerviis, nervis utrinque circiter 6, perspicuis; inflorescentiis lateralibus, circiter 10 cm longis, pedunculatis, cylindraceo-paniculatis, ramis numerosis, circiter 2 cm longis, patulis, dichotomis; floribus 4-meris, petalis oblongo-obovatis, circiter 13 mm longis, staminibus aequalibus.

A shrub, the stems about 2 cm in diameter, the young branchlets, inflorescences, and the midrib and nerves on the lower surface more or less setose-ciliate with long, spreading, pale-brownish hairs, the ciliae up to 5 mm in length. Leaves verticillate, 3 at each node, chartaceous, oblong-oblanceolate, 35 to 38 cm long, about 10 cm wide, the apex slenderly acuminate, narrowed in the lower one-half or two-thirds to the abruptly obtuse base which is 1 cm wide or less; lateral nerves about 6 on each side of the midrib, distant, ascending, somewhat curved, the primary reticulations subparallel, distant, distinct; petioles very stout, 1 cm long or less. Inflorescences lateral from the trunks, about 10 cm long, solitary, peduncled, paniculate the primary branches numerous, densely arranged, spreading, about 2 cm long, dichotomous, sparingly ciliate, the bracteoles oblong, about 2 mm long. Flowers 4-merous, red, their pedicels about 5 mm long, petals oblong-obovate, 13 mm long. Stamens 8, equal, their filaments 8 mm long; anthers lanceolate-acuminate, 7 mm long, the dorsal appendage less than 1 mm long, the anterior ones short, curved. Fruit fleshy, glabrous, ovoid or obovoid, truncate, about 1 cm long.

PANAY, Capiz Province, Mount Madiaas, *Bur. Sci. 30703 Ramos & Edaño,* May 14, 1918.

This species is entirely distinct from all hitherto described forms and is strongly characterized by its elongated, ciliate-setose indumentum, which is dense on the young branchlets and scattered on the midrib and nerves; by its ternate, elongated, oblong-oblanceolate, slenderly acuminate leaves which are much narrowed below and very shortly petioled; and by its cauline, paniculate, rather dense inflorescences, the panicles being subcylindric in outline.

MEDINILLA HASSELTII Blume in Flora 14 (1831) 513; Cogn. in DC. Monog. Phan. 7 (1891) 586.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31215 Ramos & Edaño*, May 19, 1918, in forests.

Malay Peninsula, Sumatra, Borneo, and Java; not previously recorded from the Philippines.

MEMECYLON Linnaeus

MEMECYLON RAMOSII sp. nov.

Frutex glaber, circiter 2 m altus, ramis ramulisque teretibus; foliis distincte 3-nerviis, oblongis, chartaceis ad subcoriaceis, usque ad 20 cm longis, basi subacutis, apice tenuiter acuminatis; nervis lateralibus inter nervulos transversales plus minusve arcuatis, distinctis, nervis transversalis utrinque circiter 14; petiolo 1.5 ad 2 cm longo; infructescentiis axillaribus, cymosis, circiter 3 cm longis; fructibus ovoideis vel subglobosis, 6 ad 7 mm diametro.

An erect glabrous shrub about 2 m high, the branches and branchlets terete, the latter pale when dry, about 1 mm in diameter. Leaves oblong, chartaceous to subcoriaceous, 15 to 20 cm long, 4.5 to 6 cm wide, the upper surface olivaceous when dry, the lower surface pale; marginal nerves distinct, more or less arched between the tips of the transverse ones, the latter about 14 on each side of the midrib, prominent on the lower surface; petioles 1.5 to 2 cm long. Infructescences axillary, cymose, about 3 cm long, branched from the base or several cymes in a fascicle. Fruit ovoid to globose, 6 to 7 mm in diameter, umbellately arranged on the ultimate branchlets.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 32962 Ramos*, August 29, 1918, in forests at low altitudes.

This species belongs in the group with prominently nerved leaves, somewhat arched marginal nerves, and terete branches and branchlets. It is distinguished from all of the other Philippine species of this group by its unusually long petioles.

MEMECYLON STENOPHYLLUM sp. nov.

Frutex erectus, circiter 1 m altus, glaber, ramis ramulisque tenuibus, teretibus; foliis angustate-lanceolatis, subcoriaceis, usque ad 11 cm longis et 1.3 cm latis, acuminatis, basi abrupte rotundatis, sessilibus vel brevissime petiolatis, in siccitate bullato-rugosis, nervis utrinque circiter 25, patulis, supra leviter immersis, reticulis obsoletis; infructescentiis terminalibus, pedunculatis, 3 ad 4 cm longis, ut videtur paucifloris, fructibus globosis, circiter 7 mm diametro.

An erect glabrous shrub, about 1 m high, the branches and branchlets slender, terete, the latter about 1 mm in diameter, the internodes 2 to 4 cm long. Leaves coriaceous, greenish-olivaceous, shining, narrowly lanceolate, 7 to 11 cm long, 6 to 13 mm wide, narrowed upward to the somewhat acuminate apex, the base abruptly rounded, sessile or subsessile, the midrib and lateral nerves somewhat impressed on the upper surface, the former very prominent beneath, the upper surface especially somewhat bullate-rugose on account of the impressed nerves; lateral nerves slender, spreading, about 25 on each side of the midrib, the reticulations obsolete. Infructescences terminal, peduncled, 3 to 4 cm long, usually trichotomously branched, the ultimate branchlets 1 cm long or less. Fruits globose, black when mature, about 7 mm in diameter, their pedicels about 2 mm long.

LUZON, Bulacan Province, Angat, *Bur. Sci. 34101 Ramos & Edaño*, March 1, 1919, on dry forested slopes at low altitudes.

This species does not closely resemble any previously described form, being remarkably well characterized by its very narrow, sessile or subsessile leaves, which are gradually narrowed upward to the somewhat acuminate apex, the base being abruptly rounded; when dry the leaves are characteristically bullate-rugose by the more or less impressed lateral nerves.

OTANTHERA Blume

OTANTHERA STRIGOSA sp. nov.

Frutex erectus, circiter 1 m altus, ramis ramulisque teretibus, parce adpresse strigosus, ramulis tenuibus; foliis oblongis, usque ad 9 cm longis, chartaceis, utrinque subaequaliter angustatis, basi acutis vel acuminatis, apice acuminatis, supra perspicue adpresse strigosis, subtus, nervis parce strigosis exceptis, glabra; nervis 5; inflorescentiis plerumque 3-floris, bracteis lanceolatis, acuminatis, 5 ad 7 mm longis; floribus 5-meris, calycis perspicue penicellatis, setis patulis, 2 ad 3 mm longis, lobis anguste oblongis, tubo aequantibus; petalis circiter 1.5 cm longis, obovatis.

An erect shrub, about 1 m high, the branches and branchlets slender, terete, brownish when dry, sparingly appressed strigose.

Leaves oblong, chartaceous, 5 to 9 cm long, 1.5 to 2.5 cm wide, subequally narrowed to the acute or acuminate base and to the acuminate apex, chartaceous, the upper surface olivaceous when dry, conspicuously appressed strigose, the lower surface paler, glabrous except for the sparingly appressed strigose nerves, occasionally the primary reticulations with very few short processes; nerves 5, distinct, the inner pair reaching the apex, the marginal pair evanescent above the upper two-thirds. Inflorescences terminal, usually 3-flowered, the pedicels 1 to 1.5 cm long; bracts lanceolate, acuminate, strigose, 5 to 7 mm long. Calyx-tube ovoid, 7 to 8 mm long, conspicuously penicillate, the setae simple, spreading, 2 to 3 mm long, somewhat scattered; calyx lobes 5, as long as the tube, narrowly oblong, setose. Petals purplish, obovate, about 1.5 cm long, their apices sparingly penicillate. Stamens 10, equal; filaments 6 mm long; anthers lanceolate, 5 mm long, the anterior basal appendages nearly round, glandlike, the connectives not at all produced.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33079 Ramos*, August 29, 1918, on forested slopes near small streams at low altitudes.

This species is readily distinguished from its congeners by its appressed-strigose branches, branchlets, and leaves, the latter being nearly glabrous on the lower surface except for the sparingly strigose nerves.

ASTRONIA Noronha

ASTRONIA BRACHYBOTRYS sp. nov.

Frutex vel arbor parva, ramulis junioribus et inflorescentiis leviter castaneo-furfuraceis; foliis coriaceis, rigidis, viridibus, oblongo-ellipticis, minute verruculosis, 5 ad 6 cm longis, utrinque subaequaliter angustatis, basi 3-nerviis, apice acuminatis; paniculis brevissime pedunculatis, 2 ad 3 cm longis, paucifloris, ramis usque ad 1 cm longis; floribus ♂ urceolatis, calycis tubo 2.5 mm longo, lobis reniformibus.

A shrub or small tree, the very young branchlets and inflorescences somewhat castaneous-furfuraceous, otherwise glabrous, the branches and branchlets terete, rather slender. Leaves coriaceous, rigid, oblong-elliptic, green on both surfaces, usually brownish-olivaceous when dry and minutely verruculose, 5 to 6 cm long, 2 to 3 cm wide, subequally narrowed to the acute base and to the distinctly acuminate apex, base prominently 3-nerved and with an additional very slender marginal pair, the latter not more prominent than are the transverse nervules, the primary lateral nerves anastomosing with the midrib in the acumen, when young the nerves beneath with few, scattered, furfuraceous-castaneous scales, soon becoming glabrous; petioles 1.5 to 2 cm long, glabrous. Panicles terminal, shortly peduncled, rather few-flowered, 2 to 3 cm long, the primary branches few, 1 cm long or less, the flowers somewhat crowded at the apices of the branchlets. Perfect flowers shortly pedicelled, urceolate, the calyx-tube about 2.5 mm long, the limb spreading and about 4.5 mm in diameter, the lobes reniform. Petals obovate, about 3 mm long. Staminate flowers similar to the pistillate ones but the calyx-tube broadly cup-shaped.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33279* (type), *33278, 33266 Ramos,* August 21, 1918, in forests, altitude about 1,000 meters.

This species is allied to *Astronia pachyphylla* Merr., *A. verruculosa* Merr., and *A. pauciflora* Merr., being distinguished from the first by its smaller, differently shaped leaves and its castaneous-furfuraceous inflorescences and it further lacks the characteristic large bracts of *A. pachyphylla;* the leaves and flowers are much smaller than are those of *A. verruculosa;* while *A. pauciflora* is distinguished, among other characters, by its densely lepidote branchlets and inflorescences.

ARALIACEAE

SCHEFFLERA Forster

SCHEFFLERA OBTUSIFOLIA sp. nov. § *Euschefflera, Heptapleurum.*

Frutex erectus, ramulis inflorescentiisque exceptis glaber; foliis brevissime petiolatis, palmatim 7- ad 9-foliolatis, foliolis coriaceis, oblongo-obovatis, integris, 8 ad 15 cm longis, apice plerumque rotundatis, basi acutis; inflorescentiis breviter pedunculatis, ramis primariis racemose dispositis, 18 ad 24 cm longis, leviter pubescentibus; umbellulis numerosis, racemose dispositis, 8- ad 12-floris pedunculis usque ad 1 cm longis; floribus 5-meris; fructibus ellipsoideis ad oblongo-ellipsoideis, 5 mm longis, 5-sulcatis.

An erect shrub, about 2 m high, glabrous except the somewhat pubescent branchlets and slightly pubescent inflorescences. Leaves very short-petioled, 7- to 9-foliolate; leaflets coriaceous, shining when dry, oblong-obovate, entire, 8 to 15 cm long, 4 to 6.5 cm wide, the apex usually rounded, narrowed below to the acute base; primary lateral nerves 7 to 10 on each side of the midrib, the nerves and reticulations distinct on both surfaces; petiolules 3.5 to 8 cm long; petioles stout, 1 to 1.5 cm long. Inflorescence terminal, shortly peduncled, the peduncle and axis 4 to 7 cm long, the former glabrous or nearly so, the bracts subtending the branches deciduous; primary branches 8 to 15, racemosely arranged, 18 to 24 cm long, slightly pubescent, spreading-ascending; umbels numerous, racemosely arranged on the primary branches, 8- to 12-flowered, their peduncles up to 1 cm in length; the pedicels in flower, 2 to 3 mm long, in fruit somewhat longer. Flowers 5-merous, white. Calyx obconic, truncate, about 2.5 mm in diameter. Petals 5, ovate, acute, 2 mm long, somewhat 3-nerved. Filaments 3.5 to 4 mm long. Fruits ellipsoid to oblong-ellipsoid, about 5 mm long, 5-angled or sulcate, 5-celled.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32912* (type), *32901 Ramos,* July, 1918, on rocks in dry thickets at low altitudes. *Bur. Sci. 33207 Ramos* from Mount Nagapatan, Ilocos Norte Province, Luzon, perhaps represents a form of the same species but the leaflets are smaller, while the petioles vary from 2 to 6 cm in length; this number was collected at an altitude of about 800 meters, growing on tree trunks.

This species is most closely allied to *Schefflera brevipes* Merr. and is one of the very few Philippine species with short petioles. It is distinguished from *S. brevipes* by its smaller and much fewer-nerved leaflets; its much shorter inflorescence-axis, and rather long-pedicelled, never subsessile, umbels.

SCHEFFLERA ALVAREZII sp. nov. § *Euschefflera, Heptapleurum.*

Frutex scandens, glaber, ramulis tenuibus; foliis 6-foliolatis, foliolis oblongis ad oblongo-obovatis, integris, subcoriaceis, usque ad 9 cm longis, apice tenuiter acuminatis, basi acutis, nervis utrinque 6 ad 8, subpatulis, perspicuis; inflorescentiis terminalibus, ramis primariis circiter 4, usque ad 25 cm longis; umbellulis circiter 5-floris, racemose dispositis; floribus 5-meris.

An entirely glabrous vine, the ultimate branches 4 mm in diameter or less. Leaves palmately 6-foliolate; leaflets subcoriaceous, oblong to oblong-obovate, entire, pale when dry, shining, 6 to 9 cm long, 2 to 3.5 cm wide, the apex slenderly acuminate, base acute; lateral nerves 6 to 8 on each side of the midrib, spreading or only slightly ascending, prominent on the lower surface as are the reticulations; petiolules 1 to 2.5 cm long; petioles 6 to 7 cm long. Inflorescence terminal, the rachis 2 cm long or less, bearing usually 4 primary branches up to 25 cm long. Flowers 5-merous, about 5 in each umbel, their pedicels about 3 mm long, the umbels widely scattered and racemosely arranged on the primary branches, their peduncles 4 to 5 mm long. Calyx obovoid, truncate, about 1.2 mm long, petals oblong ovate, acute, 2.5 mm long, ovary 5-celled.

MINDANAO, Lanao District, on the Lanao–Cotabato trail, *For. Bur. 25240 Alvarez,* March 24, 1916, altitude 1,100 meters.

This species is manifestly allied to *Schefflera caudatifolia* Merr., from which it differs especially in its flowers being arranged in umbels rather than in fascicles; in its much shorter rachis and much longer primary branches; while the primary nerves of the leaves are spreading rather than ascending.

SCHEFFLERA GLOBOSA sp. nov. § *Euschefflera, Heptapleurum.*

Frutex scandens, ramulis et infructescentiis stellato-tomentosis, indumento brunneo, ramis incrassatis; foliis 6-foliolatis, longissime petiolatis, foliolis oblongis, firmiter chartaceis, integris, usque ad 44 cm longis, apice tenuiter acuminatis; inflorescentiis terminalibus, rhachibus leviter productis, ramis primariis 3 ad 5, usque ad 20 cm longis, racemose dispositis; fructibus globosis, esulcatis, 5-locellatis, 5 mm diametro, umbellulis racemose dispositis, breviter pedunculatis, fructibus confertis brevissime pedicellatis.

A scandent shrub, glabrous except the young branchlets, bracts, and infructescences, which are brown stellate-tomentose, the ultimate branches up to 1 cm in diameter. Leaves palmately 6-foliolate, their petioles inflated and clasping at the base, stout, 30 to 35 cm long; leaflets oblong, firmly chartaceous, entire, glabrous, shiny, 22 to 44 cm long, 7 to 10 cm wide, the base rounded to subacute, the apex slenderly acuminate; lateral nerves 15 to 20 on each side of the midrib, distinct as are the reticulations, anastomosing, petiolules 5 to 11 cm long. Inflorescence terminal, the rachis somewhat produced, the primary branches 3 to 5, 16 to 20 cm long, racemosely disposed, each subtended by an oblong-lanceolate, acuminate, subcoriaceous bract about 3 cm in length. Fruits globose, about 5 mm in diameter, very slightly furfuraceous, not sulcate, 5-celled, terminated by the 5 nearly sessile stigmas, arranged in short-peduncled, scattered umbels, 9 to 10 fruits crowded on each umbel, their pedicels 1 to 2 mm long, the peduncles 2 to 7 mm long, the pedicels and peduncles with the same type of indumentum as the rachis.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 30897 Ramos & Edaño,* May 21, 1918, on tree trunks in forests along streams.

This species in vegetative characters strongly resembles *Schefflera digitata* (Blanco) Merr. (*S. machranta* Merr.), but differs radically in its very short pedicels and 5-celled fruits. The brown stellate-tomentose indumentum on the inflorescences; the globose, nonsulcate, short-pedicelled, crowded fruits; and the very long petioles are characteristic.

SCHEFFLERA PLATYPHYLLA sp. nov. § *Euschefflera, Heptapleurum.*

Frutex scandens, inflorescentiis brunneo-tomentosis; foliis 5-foliolatis, late oblongo-ovatis, integris, usque ad 34 cm longis et 17 cm latis, apice abrupte acuminatis; inflorescentiis terminalibus, ramis primariis circiter 12, usque ad 40 cm longis, racemose dispositis; floribus minutis, 5-meris, numerosis, confertis, umbellulis globosis, circiter 6 mm diametro, valde numerosis, racemose dispositis, pedunculis 5 ad 10 mm longis.

A vine, glabrous except the rather densely brown-tomentose inflorescence, the indumentum obscurely stellate, the ultimate branches about 1 cm in diameter. Leaves palmately 5-foliolate, their petioles about 15 cm long; leaflets broadly oblong-ovate, coriaceous, entire, 30 to 34 cm long, 15 to 17 cm wide, the upper surface olivaceous, shining, the lower somewhat brownish when dry, the base broadly rounded, the apex rather abruptly acuminate, the acumen up to 2 cm in length; lateral nerves about 25 on each side of the midrib, distinct as are the reticulations; petiolules stout, 5 to 8 mm long. Inflorescence terminal, the rachis stout, up to 8 cm long, bearing about 12 elongated, racemosely arranged, primary branches up to 40 cm in length, the subtending bracts oblong-ovate, up to 2.5 cm long. Flowers minute, white, 5-merous, crowded in globose umbels about 6 mm in diameter, 30 to 40 flowers in an umbel, the umbels racemosely arranged on the primary branches, about 75 on each branch, their peduncles 5 to 10 mm long; pedicels 1 to 2 mm long. Calyx pubescent, turbinate, truncate, about 1.2 mm long. Petals 5, oblong-ovate, 1.2 mm long.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 30897 Ramos & Edaño,* April 17, 1918, on tree trunks in forests along streams.

This species has an indumentum similar to that of *Schefflera globosa* Merr. and is manifestly allied to that species, from which it differs radically in its much larger, wider leaflets; in the numerous, elongated, primary branches of the inflorescence; and in its very numerous, densely many-flowered, longer-peduncled umbels. Both species apparently belong in the group with *Schefflera clementis* Merr.

SCHEFFLERA SANTOSII sp. nov. § *Euschefflera, Heptapleurum.*

Frutex scandens (vel erectus ?), glaber, ramis in siccitate rugosis; foliis 3- ad 5-foliolatis, brevissime petiolatis, petiolo 1 ad 2 cm longo; foliolis subcoriaceis, in siccitate olivaceis, nitidis, ellipticis ad oblongo-ellipticis, breviter acuminatis, integris, 6 ad 9 cm longis, nervis utrinque circiter 12, perspicuis; inflorescentiis terminalibus, rhachibus elongatis, ramis primariis 4 ad 8, racemose dispositis, usque ad 20 cm longis; umbellis distantibus, racemose dispositis, 8- ad 12-floris; floribus parvis, 5-meris.

A scandent (or erect ?), glabrous shrub, 3 to 4 m in length, the branches grayish, when dry wrinkled, the ultimate ones 5 mm in diameter or less. Leaves 3- to 5-foliolate, their petioles relatively short, 1 to 2 cm long, inflated and clasping at the base. Leaflets subcoriaceous, entire, olivaceous, shining, elliptic to oblong-elliptic, 6 to 9 cm long, 3 to 5 cm wide, subequally narrowed to the acute base and to the shortly acuminate apex; petiolules 5 to 20 mm long; lateral nerves about 12 on each side of the midrib, distinct and somewhat projecting on the lower surface, anastomosing, spreading-ascending, the reticulations lax, distinct. Inflorescence terminal, the rachis 5 to 7 cm long, the primary branches 4 to 8, racemosely disposed, alternate, up to 20 cm in length. Umbels racemosely arranged on the primary branches, 8- to 12-flowered, their peduncles up to 12 mm in length, the pedicels 1 to 4 mm long. Flowers 5-merous, white or purplish, calyx about 2 mm in diameter. Petals 5, oblong-ovate, 2 mm long.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31722 Santos*, June 1, 1918, in thickets near streams, altitude about 2,000 meters.

This species is well characterized by its very short-petioled leaves, in this character resembling *Schefflera brevipes* Merr., but differing radically from that species in its much fewer and smaller leaflets.

SCHEFFLERA PANAYENSIS sp. nov. § *Cephaloschefflera*.

Arbor, partibus junioribus plus minusve furfuraceis, foliis junioribus dense stellato-tomentosis, cito glaberrimis, ramis incrassatis; foliis 10- ad 12-foliolate, longissime petiolatis, foliolis coriaceis, oblongis, usque ad 17 cm longis, tenuiter caudato-acuminatis, nervis utrinque 10 ad 12, perspicuis; capitulis racemose dispositis, globosis, immaturis 1 ad 1.5 cm diametro, fructibus sulcatis, 5-locellatis.

A tree, about 5 m high, the very young parts densely furfuraceous, the very young leaves densely stellate-tomentose, soon becoming entirely glabrous. Ultimate branches about 1.5 cm in diameter, rugose, marked with very large petiolar scars. Leaves 10- to 12-foliolate, their petioles about 25 cm long; leaflets oblong, coriaceous, shining, 10 to 17 cm long, 3 to 3.5 cm wide, entire, base rounded to obtuse, apex slenderly caudate-acuminate; lateral nerves 8 to 10 on each side of the midrib, anastomosing, distinct, as are the reticulations; petiolules 6 to 8 cm long. Branches of the inflorescence 40 to 45 cm long, stout, glabrous, bearing numerous, racemosely arranged, dense, globose, glabrous heads, which in young fruit are from 1 to 1.5 cm in diameter, their peduncles 1 to 1.5 cm long. Young fruits 5-sulcate, 3 to 4 mm long, 5-celled.

PANAY, Capiz Province, Mount Madiaas, *Bur. Sci. 30736, Ramos & Edaño*, May 12, 1918, in the mossy forest.

This species resembles *Schefflera catanduanensis*, but has longer inflorescence branches and is furthermore very easily distinguished by its peduncled heads.

BOERLAGIODENDRON Harms

BOERLAGIODENDRON CAUDATUM sp. nov.

Frutex circiter 2 m altus; foliis longe petiolatis, palmatim 7- ad 9-foliolatis, foliolis nitidis, lanceolatis, valde inaequalibus, 10 ad 23 cm longis, tenuiter caudato-acuminatis, basi decurrento-acuminatis, majoribus plerumque utrinque 1- vel 2-lobatis, margine irregulariter perspicue dentatis; petiolo circiter 40 cm longo, basi cristis pectinatis 2 vel 3 instructis, dentibus deflexis; inflorescentiis sessilibus, circiter 15 cm diametro, radiis primariis circiter 25; capitulis ☿ circiter 1 cm diametro, floribus confertis brevissime pedicellatis, 4-meris.

An erect shrub, about 2 m high, the leaf-bearing part of the stem at least 1 cm in diameter. Leaves long-petioled, palmately 7- to 9-foliolate; leaflets subcoriaceous, olivaceous and shining when dry, lanceolate, very unequal in size, 10 to 23 cm long, slenderly caudate-acuminate, base decurrent-acuminate, the larger ones usually deeply lobed, the lobes 1 or 2, rarely 3, extending nearly to the midrib, the margins with irregular, rather prominent, usually incurved teeth; petiolules of the larger leaflets up to 3 cm in length, the smaller leaflets sometimes nearly sessile; petioles about 40 cm long, 4 to 5 mm in diameter, the basal 1 cm supplied with 2 or 3 pectinate crests, their teeth deflexed up to 7 mm long. Inflorescence terminal, sessile, about 15 cm in diameter, composed of about 25 primary branches, each subtended by an oblong to oblong-ovate, coriaceous bract about 1.5 cm long, the primary branches about 4 cm long, glabrous, then dichotomously or trichotomously branched, the bracts subtending the branches oblong to oblong-lanceolate, about 1 cm long, somewhat setose-furfuraceous, central branch 1 to 1.5 cm long, glabrous, bearing a globose head of sterile flowers about 1 cm in diameter, the bracteoles subtending the sterile flowers oblong, acute to obtuse, 4 to 5 mm long, coriaceous, somewhat keeled, more or less furfuraceous; lateral branches about 4 cm long, straight or somewhat geniculate at the middle, here supplied with a pair of coriaceous, somewhat setose-furfuraceous bracts, 4 to 5 mm in length; heads ellipsoid, dense, about 1 cm long, many-flowered, each flower subtended by an obovate 3 to 4 mm long bracteole, which is thickened in the median portion and rather prominently brown fimbriate-ciliate on the back and margins, and more or less inclosing the flower; pedicels 1 mm long or less. Calyx obovoid, 2 to 2.5 mm long, truncate, narrowed below, obscurely 4-angled by compression, the angles rounded. Ovary 4-celled.

LUZON, Ilocos Norte Province, Mount Palimlin, *Bur. Sci. 33308 Ramos,* August 21, 1918, on forested slopes near the summit, altitude about 1,000 meters.

This strongly marked species is most closely allied to *Boerlagiodendron catanduanense* Merr., from which it is easily distinguished by its pectinate petiolar crests; its much longer petioles; and its few-lobed caudate-acuminate leaflets, the lobes extending nearly to the midrib and ascending rather than divaricate. The inflorescence is also much larger and further differs in its furfuraceous-setose bracts and very different sterile and fertile heads.

ERICACEAE

VACCINIUM Linnaeus

VACCINIUM ILOCANUM sp. nov.

Frutex epiphyticus, inflorescentiis exceptis glaber; foliis ellipticis, crasse coriaceis, nitidis, integris, 6 ad 8 cm longis, basi acutis, apice breviter abrupteque acuminatis, nervis utrinque circiter 4, tenuibus, inferioribus adscendentibus; racemis axillaribus, solitariis, 2 ad 4 cm longis, pubescentibus; bracteis persistentibus, ovatis ad elliptico-ovatis, 5 ad 6 mm longis, acutis vel acuminatis; corolla glabris, 6 mm longa; filamentis barbatis; antheris oblongis, 1.1 mm longis.

An epiphytic shrub, entirely glabrous except the inflorescences, the branchlets about 3 mm in diameter, reddish-brown when dry. Leaves elliptic, thickly coriaceous, olivaceous and shining when dry, entire, 6 to 8 cm long, 3.5 to 5 cm wide, margins somewhat recurved, the lower surface somewhat paler than the upper and distinctly glandular-punctate, the base acute, apex acute to shortly and abruptly acuminate; lateral nerves about 4 on each side of the midrib, slender, the lower two pairs from near the base ascending, reaching at least to the upper two-thirds of the leaf; petioles very stout, reddish-brown, 5 to 8 mm long. Racemes axillary, and sometimes terminating short lateral branches, 2 to 4 cm long, the rachis, bracts, pedicels, and calyces more or less pubescent with short spreading hairs; pedicels 3 to 4 mm long; bracts persistent, ovate to elliptic-ovate, 5 to 6 mm long, usually acute, sometimes slightly acuminate. Calyx-tube almost obsolete, the lobes triangular, acute, pubescent, 1.5 mm long. Corolla oblong-ovoid, glabrous, narrowed upward, about 6 mm long, 3.5 mm in diameter below the middle, red, the lobes short, broadly ovate, recurved. Filaments densely bearded, about 1 mm long; anthers oblong, about 1.1 mm long, the terminal tubes very short, not narrowed, opening by oblique pairs. Style stout, glabrous, 3 mm long. Top of the ovary very slightly pubescent.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33372 Ramos*, August 21, 1918, growing on trees on forested slopes near the summit, altitude about 3,100 meters.

The alliance of this species is manifestly with *Vaccinium platyphyllum* Merr., from which, among other characters, it is distinguished by its smaller, fewer-nerved leaves, shorter pedicels, and only slightly pubescent top of the ovary.

DIPLYCOSIA Blume

DIPLYCOSIA GLABRA sp. nov.

Frutex epiphyticus, glaber, vel ramulis junioribus parcissime setosis; foliis ellipticis ad oblong-ellipticis, acutis vel brevissime apiculatis, basi acutis, usque ad 6 cm longis, in siccitate olivaceo-brunneis vel pallidis, nitidis, nervis utrinque 2, tenuibus, supra leviter impressis, subtus obsoletis; floribus axillaribus, solitariis vel fasciculatis, pedicellatis, bracteolis late ovatis, 1.5 mm longis, margine leviter ciliatis, calycis circiter 2 mm longis, lobis late ovatis, obtusis, 1.5 mm longis.

A glabrous, erect, epiphytic shrub, attaining a height of from 3 to 4 m, the very young branchlets sometimes with a very few slender setae. Leaves coriaceous, elliptic to oblong-elliptic, 2 to 6 cm long, 1 to 2.5 cm wide, brownish-olivaceous or pale when dry, shining, the lower surface with small scattered, brownish glands, the base acute, the apex usually acute and ending in a short, stout, blunt apiculus; lateral nerves 2 on each side of the midrib, slender, slightly impressed on the upper surface, obsolete on the lower surface, curved, the upper pair leaving the midrib at or near the middle of the leaf, the reticulations obsolete; petioles about 2 mm long. Flowers axillary, solitary or few in a fascicle, their pedicels about 5 mm long, the apical bracteoles connate, broadly ovate, acute or slightly acuminate, margins sparingly ciliate, 1.5 mm long. Calyx about 2 mm long, the lobes broadly ovate, obtuse, 1.5 mm long, their margins slightly ciliate. Corolla not seen. Fruit soft, fleshy, bluish-black, when dry brownish or black, about 5 mm long.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31784 Santos* April 22, 1918 (type), *Bur. Sci. 8509 McGregor*, June, 1909, *For. Bur. 14434 Darling*, January, 1909, *Copeland, s. n.*, May, 1913, in the mossy forest, altitude about 2,300 meters. Igorot name *dugui-is*.

Among the Philippine species this is most closely allied to *Diplycosia calelanensis* Elm., from which it is readily distinguished by its nerves being obsolete on the lower surface of the leaves. Among the extra-Philippine species its alliance is manifestly with the Javan *Diplycosia heterophylla* Blume, but its leaves are different in shape, never acuminate, with shorter petioles, while the venation is distinctly different.

MYRSINACEAE

ARDISIA Swartz

ARDISIA ILOCANA sp. nov. § *Akosmos.*

Frutex, ramulis inflorescentiisque castaneo-pubescentibus exceptis glaber; foliis oblongis, membranaceis ad chartaceis, 6 ad 12 cm longis, basi acutis, apice leviter acuminatis, integris, utrinque glandulis perspicuis instructis, nervis utrinque 15 ad 20, tenuibus, subobscuris, reticulis obsoletis; inflorescentiis bipinnatim paniculatis, 8 ad 10 cm longis, pedunculatis, plerumque e axillis defoliatis; floribus racemose dispositis, circiter 8 mm diametro, calycis lobis orbicularibus, leviter ciliatis, petalis punctato-glandulosis, leviter acuminatis.

An erect shrub, the branchlets and inflorescences distinctly castaneous-pubescent, otherwise glabrous. Leaves oblong, membranaceous to chartaceous, 6 to 12 cm long, 2 to 3.5 cm wide, base acute, apex somewhat acuminate, somewhat olivaceous and slightly shining when dry, both surfaces with numerous, relatively large glands which are distinctly visible to the naked eye and which occur at fairly regular intervals on all parts of the leaf; lateral nerves 15 to 20 on each side of the midrib, very slender, not prominent, obscurely anastomosing, the reticulations obsolete or nearly so; petioles pubescent when young, soon becoming glabrous, 5 to 10 mm long. Panicles lateral, from the ultimate branchlets, axillary and in the axils of fallen leaves, peduncled, bipinnate, 8 to 10 cm long, the flowers racemosely arranged on the primary branches, their pedicels 3 to 4 mm long. Flowers white, about 8 mm in diameter. Calyx lobes orbicular, rounded, glandular-punctate, margins ciliate. Corolla lobes oblong-elliptic, glandular-punctate, glabrous, 4 mm long, somewhat acuminate. Anthers lanceolate, acuminate, 2.5 mm long, the connectives slightly glandular.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 32982 Ramos*, August 12, 1918, altitude about 500 meters.

This species is well characterized by its numerous, relatively large, regularly spaced glands, which are distinctly visible to the naked eye on both surfaces of the leaf. Its alliance is with *Ardisia racemoso-panniculata* Mez, from which it is distinguished not only by its very evident glands but also by its very slender obscure nerves and practically obsolete reticulations.

ARDISIA LONGIPETIOLATA sp. nov. § *Pyrgus*.

Frutex glaber, ramis 6 ad 8 mm diametro; foliis confertis, anguste oblongis ad oblongo-ellipticis, usque ad 30 cm longis, integris vel obscurissime denticulatis, obtusis vel acutis, perspicue glanduloso-punctatis, nervis utrinque circiter 12; petiolo 4 ad 7 cm longo; paniculis circiter 30 cm longis, ramis inferioribus 9 ad 12 cm longis, floribus subumbellatim dispositis, sepalis punctatis, margine ciliatis; fructibus circiter 1 cm diametro.

A glabrous shrub, the branches terete, reddish-brown, 6 to 8 mm in diameter. Leaves pseudoverticillate, usually about 6 crowded at the end of each branch, narrowly oblong to oblong-elliptic or oblong-oblanceolate, 23 to 30 cm long, 6 to 10 cm wide, entire, or very obscurely toothed, apex obtuse to acute, base rounded, acute, or somewhat acuminate, when dry grayish or greenish olivaceous, shining, the lower surface rather densely glandular-puncticulate with dark-colored glands; lateral nerves usually about 12 on each side of the midrib, prominent, curved, anastomosing, the reticulations distinct; petioles 4 to 7 cm long, somewhat triangular. Panicles terminal, peduncled, about 30 cm long, the lower primary branches 9 to 12 cm long, the flowers subumbellately arranged at the tips of the primary branches. Pedicels about 1.5 cm long, thickened upward. Persistent calyx about 7 mm in diameter, the lobes ovate, acute, about 3 mm long, glandular-punctate, the margins ciliate. Fruits glabrous, globose, slightly glandular, red when mature, about 1 cm in diameter.

LUZON, Camarines Province, *Bur. Sci. 33492* (type), *33554 Ramos & Edaño,* December, 1918, in damp forests at low altitudes between Paracale and Mambulao.

This species belongs in the group with *Ardisia perrottetiana* A. DC., from which it is readily distinguished by its larger leaves and elongated petioles.

AMBYLANTHOPSIS Mez

AMBYLANTHOPSIS CRASSIFOLIA sp. nov.

Frutex erectus, glaber, ramulis incrassatis, cylindricis, circiter 1 cm diametro, cicatricibus multis ornatis; foliis crassissime coriaceis, integris, oblongis ad anguste oblongo-obovatis, 10 ad 13 cm longis, minute punctatis, obtusis, nervis utrinque 10, haud perspicuis, admodum subobsoletis; inflorescentiis axillaribus, plerumque racemosis, usque ad 7 cm longis; floribus 4-5-meris, 6 ad 7 diametro, petalis ellipticis ad oblongo-ellipticis, filamentis petalis aequilongis.

An erect glabrous shrub, about 2 m high, the ultimate branchlets much thickened, cylindric, about 1 cm in diameter and marked with numerous, large, petiolar scars. Leaves very thickly coriaceous, entire, oblong to narrowly oblong-obovate, 10 to 13 cm long, 3.5 to 4 cm wide, obscurely and minutely glandular-punctate, the apex obtuse, narrowed below to the acuminate base; midrib very stout, the lateral nerves about 10 on each side of the midrib, not prominent, sometimes nearly obsolete; petioles stout, 6 to 15 mm long. Inflorescences in the upper axil, up to 7 cm in length, the flowers usually racemosely arranged, sometimes in very depauperate panicles. Flowers red, 4- and 5-merous, 6 to 7 mm in diameter, their pedicels about 2 mm long. Calyx about 4 mm in diameter, the lobes oblong-ovate, obtuse, somewhat glandular-punctate, glabrous. Corolla lobes elliptic to elliptic-oblong, obtuse, 4 mm long, somewhat punctate, united for the lower 1 mm. Filaments as long as the petals, the anthers longitudinally dehiscent. Ovary and style 2.5 mm long, the ovary ovoid, the style as long as the ovary.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33288* (type), *33381 Ramos,* August 21, 1918, on forested slopes, altitude about 1,000 meters.

This species is entirely different from the other described forms of the genus *Ambylanthopsis,* but by definition must be placed in this genus unless a new one be proposed for it. It cannot be placed in the genus *Discocalyx* on account of its elongated filaments, which equal the corolla lobes in length. In the type specimen the much thickened, prominently scarred, ultimate branchlets attain a length of at least 15 cm and are distinctly thicker than the smooth or nearly smooth branches which bear them. The species is otherwise very prominently characterized by its very thickly coriaceous, entire, obscurely nerved leaves, which are crowded toward the apices of the branchlets and by its usually racemose inflorescences.

SAPOTACEAE

PALAQUIUM Blanco

PALAQUIUM GLABRIFOLIUM sp. nov.

Arbor novellis et floribus exceptis glabra; foliis subcoriaceis, anguste oblongo-obovatis, usque ad 14 cm longis, apice perspicue acuminatis, basi angustatis, cuneatis vel decurrento-acuminatis, nervis utrinque circiter 20, tenuibus; floribus solitariis vel fasciculatis, sepalis coriaceis, exterioribus glabris, interioribus leviter pubescentibus, circiter 3.5 mm longis; ovario puberulo.

A tree, 6 to 8 m high, entirely glabrous except the growing tips of the branchlets, the inner sepals, and the ovary. Leaves subcoriaceous, rigid, dark-brown when dry, shining, the lower surface paler than the upper, narrowly oblong-obovate, 10 to 14 cm long, 3.5 to 5 cm wide, apex rather conspicuously acuminate, the acumen blunt, narrowed in the lower one-half to the cuneate or somewhat decurrent-acuminate base; primary lateral nerves slender, about 20 on each side of the midrib, anastomosing, slightly more conspicuous than are the secondary nerves and reticulations; petioles 1.5 to 2 cm long. Flowers solitary or fascicled, from the axils of fallen leaves, their pedicels about 1 cm long, in age entirely glabrous. Outer sepals glabrous, thickly coriaceous, somewhat rugose when dry, very broadly ovate, 2.5 to 3 mm long, about 4 mm wide, the inner sepals ovate, obtuse or acute, about 3.5 mm long, slightly pubescent on the median portion, the margins thin, glabrous. Stamens and corolla not seen. Ovary slightly puberulent, 6-celled; style about 9 mm long, glabrous.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30820 Ramos & Edaño,* April 22, 1918, on forested slopes.

This species is most closely allied to *Palaquium dubardii* Elm., from which it is distinguished by its conspicuously acuminate leaves, which are much narrowed below, and by its much more numerous nerves. The characteristic indumentum of the genus is entirely wanting except on the growing tips of the branchlets and on parts of the flowers. The fruits with the specimens are globose or ovoid, about 2.5 cm in diameter, but are abnormal in that when young some insect has deposited its eggs in them and the developing larvae have destroyed the seeds, the entire fruit, except the parts destroyed by the larvae, being filled with a dense, rather brittle, somewhat woody substance.

SYMPLOCACEAE

SYMPLOCOS Jacquin

SYMPLOCOS BRACHYBOTRYS sp. nov.

Arbor parva, glaberrima; foliis coriaceis, integris, oblanceolatis, 5 ad 8 cm longis, obtuse acuminatis, deorsum angustatis, basi cuneatis, nervis utrinque 15 ad 18, tenuibus; racemis axillaribus, 1 ad 1.5 cm longis; floribus brevissime pedicellatis, circiter 8 mm diametro, calycis tubo circiter 1 mm longo, lobis orbiculari-ovatis, quam tubo brevioribus; fructibus cylindraceis, oblongis, circiter 1 cm longis.

An entirely glabrous tree, about 5 m high. Leaves coriaceous, entire, oblanceolate, 5 to 8 cm long, 1.5 to 2.5 cm wide, blunt-acuminate, much narrowed below to the cuneate base, subolivaceous, shining; lateral nerves slender, 15 to 18 on each side of the midrib, anastomosing, the reticulations lax, distinct; petioles 1 cm long or less. Racemes axillary, few-flowered, black when dry, 1 to 1.5 cm long. Flowers about 8 mm in diameter, pedicels 1 mm long or less, the subtending bracteoles elliptic-ovate, deciduous, about 1 mm long. Calyx-tube somewhat narrowed below, cylindric, 1 mm long, the lobes 5, somewhat spreading, orbicular-ovate, rounded, about 0.8 mm long, the inner ones slightly smaller than the outer three. Petals oblong to oblong-elliptic, obtuse, about 4 mm long. Stamens numerous, free, as long as the petals. Fruit oblong, nearly terete, about 1 cm long and 5 mm in diameter.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33277 Ramos,* August 22, 1918, on forested slopes, altitude about 900 meters.

This species closely resembles *Symplocos purpurascens* Brand and is apparently closely allied to that species. It is, however, very easily distinguished by its very short inflorescences and its much more numerous lateral nerves.

LOGANIACEAE

GENIOSTOMA Forster

GENIOSTOMA PACHYPHYLLUM sp. nov.

Frutex vel arbor parva, glabra, ramulis et foliis in siccitate nigris; foliis coriaceis vel subcoriaceis, anguste oblongis ad oblongo-lanceolatis, 5 ad 8 cm longis, basi acutis, apice acutis vel obscure acuminatis, nervis utrinque 5 vel 6, tenuibus, reticulis subobsoletis; fructibus axillaribus, solitariis, ovoideis vel ellipsoideis, circiter 7 mm longis, breviter pedicellatis.

A glabrous shrub or small tree, the branches terete, straw-colored, the young branchlets black when dry as are the leaves and petioles. Leaves coriaceous or subcoriaceous, brittle, narrowly oblong to oblong-lanceolate, 5 to 8 cm long, 1.2 to 2.5 cm wide, subequally narrowed to the acute base and to the acute or slightly acuminate apex; lateral nerves slender, 5 or 6 on each side of the midrib, obscurely anastomosing, the reticulations obsolete or nearly so; petioles about 5 mm long; stipules short, truncate. Fruits axillary, solitary, ovoid or ellipsoid, about 7 mm long, black when dry, their pedicels about 5 mm long; persistent sepals broadly ovate, rounded, their margins slightly ciliate.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33316 Ramos*, August 21, 1918, on forested slopes, altitude about 1,000 meters.

This species is distinguished among the Philippine forms by its glabrous, slenderly nerved, brittle, coriaceous or subcoriaceous leaves, the reticulations being obsolete or nearly so, and by its solitary, axillary fruits. The whole plant, except the branches, is characteristically black when dry.

APOCYNACEAE

ALYXIA Banks

ALYXIA RETUSA sp. nov.

Frutex scandens, inflorescentiis leviter pubescentibus exceptis glaber, ramulis incrassatis, 5-angulatis; foliis verticillatis, 5-natis, crassissime coriaceis, obovatis ad oblongo-obovatis, 5 ad 8 cm longis, apice late rotundatis retusisque, margine revolutis, nervis tenuibus, indistinctis; cymis axillaribus, breviter pedunculatis, circiter 3 cm longis; fructibus usque ad 3 cm longis, partibus seminiferis solitariis vel binis, ellipsoïdeis, 10 ad 12 mm longis, 8 mm diametro.

A scandent shrub, glabrous except the sparingly pubescent inflorescence, the branches stout, up to 8 mm in diameter, rugose when dry, the younger ones distinctly 5-angled. Leaves verticillate, 5 at each node, very thickly coriaceous, obovate to oblong-obovate, 5 to 8 cm long, 2.5 to 4 cm wide, the apex broadly rounded and retuse, base acute to decurrent-acuminate, margins somewhat revolute, the midrib impressed on the upper surface, very prominent on the lower surface; lateral nerves numerous, slender, indistinct; petioles 1 to 2 cm long. Cymes axillary, somewhat pubescent, shortly peduncled, about 3 cm long, excluding the fruits. Flowers apparently few, the persistent sepals ovate to oblong-ovate, obtuse, slightly pubescent, coriaceous, about 2.5 mm long. Fruits shortly pedicelled, either 3 cm long and constricted in the middle, with two ellipsoid seed-bearing parts, or not constricted and consisting of a single seed-bearing part, the seed-bearing parts 10 to 12 mm long, about 8 mm in diameter.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33330 Ramos*, August 21, 1918, on forested slopes, altitude about 1,000 meters.

This species is strongly characterized among those with very thick coriaceous leaves by the leaves being broadly rounded and retuse at their apices.

RAUWOLFIA Linnaeus

RAUWOLFIA MEMBRANACEA sp. nov.

Frutex erectus glaber; foliis membranaceis, oblongis ad oblongo-lanceolatis, acuminatis, 7 ad 11 cm longis, nervis utrinque circiter 10, tenuibus; cymis axillaribus terminalibusque, paucifloris, 4 ad 6 cm longis, fructibus ellipsoideis, leviter compressis, 1 cm longis, in siccitate rugosis.

An erect glabrous shrub. Leaves membranaceous, olivaceous, oblong to oblong-lanceolate, slenderly acuminate, base acute, olivaceous and shining when dry, 7 to 11 cm long, 2 to 3 cm wide; lateral nerves slender, about 10 on each side of the midrib, petioles 7 to 12 mm long. Cymes axillary and terminal, peduncled, 4 to 6 cm long, apparently few-flowered, the persistent calyx-lobes lanceolate, acuminate, about 2 mm long. Fruits somewhat ellipsoid, slightly compressed when dry, about 1 cm long and 6 mm wide, somewhat narrowed to the acute base and usually obtuse apex, rugose when dry.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33214 Ramos*, August 9, 1918, on dry slopes, altitude about 700 meters.

This species is not closely allied to any previously described

Philippine form. It is well characterized by its membranaceous, slenderly acuminate, few-nerved leaves.

TABERNAEMONTANA Linnaeus

TABERNAEMONTANA ECARINATA sp. nov.

Frutex glaber; foliis charteceis, olivaceis, oblongis ad oblongo-ellipticis, 7 ad 14 cm longis, apice late obtuseque acuminatis, nervis utrinque 8 ad 10; infructescentiis circiter 6 cm longis, haud ramosis, folliculis 2 gerentibus; folliculis 2.5 ad 3 cm longis, inaequilateralibus, ecarinatis, apice rostratis; seminibus circiter 18.

A glabrous shrub, the branches slender, terete. Leaves chartaceous, olivaceous, shining, equal, oblong to oblong-elliptic or oblong-lanceolate, 7 to 14 cm long, 3 to 7 cm wide, base often slightly inequilateral, somewhat acuminate, apex broadly and obtusely acuminate; lateral nerves 8 to 10 on each side of the midrib, distinct, anastomosing, the reticulations slender, lax; petioles about 5 mm long. Inflorescences apparently very few-flowered, the peduncles in fruit up to 6 cm long, simple, each bearing a single pair of follicles but usually presenting one or two scars of fallen pedicels. Persistent sepals ovate, about 2.5 mm long. Corolla-tube about 12 mm long, the lobes spreading, narrow, about 1.5 cm long. Follicles yellow, 2.5 to 3 cm long, 1.5 to 2 cm wide, inequilateral, smooth, not at all keeled, somewhat compressed, one side nearly straight, the other semicircular, apex rather prominently rostrate. Seeds up to 18 in each follicle, irregular, 7 to 8 mm long.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33022* (type), *33082 Ramos*, August, 1918, in forests along small streams at low altitudes.

This species is strongly characterized by its rostrate, rather many-seeded follicles, which are not at all keeled. In vegetative characters it resembles some forms of *Tabernaemontana pandacaqui* Poir. but differs entirely in its fruit characters.

CONVOLVULACEAE

IPOMOEA Linnaeus

IPOMOEA POLYMORPHA R. & S. Syst. 4 (1819) 254.

> *Ipomoea heterophylla* R. Br. Prodr. (1810) 487, non Ortega, 1800.
> *Convolvulus brownii* Spreng. Syst. 1 (1825) 612.
> *Convulvulus robertianus* Spreng. op. cit. 5 (1828) 192.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32945 Ramos*, July 25, 1918, in open dry places at low altitudes: Union Province, San Fernando, *Lete 108, 175*, July and September, 1916, in open sandy places near sea level, with the Ilocano name *camarin.*

This species has been previously reported only from Australia and Formosa, but the Philippine specimens cited above agree very closely with the descriptions and with Australian material kindly supplied by Mr. J. H. Maiden. In vegetative characters the Philippine specimens present great variation, as do the Australian ones. I am further of the opinion that *Henry 1112* from Formosa represents a somewhat dwarfed form of the same species. My specimen of this, identified as *Ipomoea* sp., is but about 10 cm. high and has unusually narrow leaves. In floral characters, however, it closely approximates the Luzon form.

VERBENACEAE

CALLICARPA Linnaeus

CALLICARPA OBTUSIFOLIA sp. nov.

Frutex, ramulis et petiolis et inflorescentiis et subtus foliis uniformiter denseque cinereo-stellato-tomentosus; foliis ellipticis ad oblongo-ellipticis, supra glabris, subcoriaceis, usque ad 8 cm longis, apice rotundatis, obtusis, vel subacutis, margine denticulatis, nervis utrinque 5 ad 7, perspicuis; cymis pedunculatis, dichotomis, usque ad 2.5 cm latis; floribus numerosis, circiter 2.5 mm longis, calycis extus dense albido-stellato-tomentosis.

A shrub, the branchlets, petioles, inflorescences, and lower surface of the leaves densely and uniformly cinereous-stellate-pubescent, the indumentum covering the entire surface. Branches terete, pale-brownish, glabrous. Leaves elliptic to oblong-elliptic, subcoriaceous, 5 to 8 cm long, 2.5 to 4 cm wide, the apex rounded, obtuse, or sometimes subacute, base usually obtuse, margins entire below, in the upper part distinctly denticulate, the upper surface brownish-olivaceous, glabrous or when young stellate-pubescent along the midrib; lateral nerves 5 to 7 on each side of the midrib, curved, distinct as are the primary reticulations; petioles 5 to 10 mm long. Cymes axillary, peduncled, dichotomous, up to 2.5 cm wide, the peduncles about 1.5 cm long; bracts linear-lanceolate, acuminate, 2 to 2.5 mm long; pedicels 0.5 mm long or less. Flowers rather crowded, pink. Calyx cup-shaped to obconic, about 1.6 mm long, densely stellate-pubescent, the teeth 4, short. Corolla glabrous, 2.5 mm long, the lobes equal, orbicular-ovate, rounded, nearly 1 mm in diameter. Filaments and style 5 to 6 mm long. Fruit globose, dark-brown and rugose when dry, about 2 mm in diameter.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 32921 Ramos,* July 27, 1918, in dry thickets at low altitudes, Ilocano *anayop.*

The alliance of this species is manifestly with *Callicarpa blancoi* Rolfe, from which it is especially distinguished by its elliptic to oblong-elliptic, usually rounded or obtuse, never acuminate leaves.

GESNERIACEAE

CYRTANDRA Forster

CYRTANDRA ILOCANA sp. nov.

Frutex glaberrimus; foliis chartaceis, integris, oblongis ad oblongo-obovatis vel oblongo-oblanceolatis, 3 ad 7 cm longis, in siccitate castaneis, basi acutis, apice acuminatis, nervis utrinque 5 ad 7, tenuibus; inflorescentiis tenuibus 1- vel paucifloris, pedunculis capillaris, 3 cm longis; calycibus cupulatis, 3 ad 4 mm longis, lobis late ovatis, 1.5 mm longis, acuminatis.

An entirely glabrous shrub, the branches grayish, 3 to 4 mm in diameter, marked with large petiolar scars; the branchlets slender, smooth, dark reddish-brown. Leaves subequal or one of each pair slightly smaller than the other, chartaceous, entire, oblong to oblong-obovate, or oblong-oblanceolate, 3 to 7 cm long, 1.5 to 2.5 cm wide, the upper surface dark-castaneous when dry, the lower much paler, base usually acute, often slightly inequilateral, apex distinctly acuminate; lateral nerves slender, 5 to 7 on each side of the midrib, curved, anastomosing, close to the margins, the reticulations very lax; petioles 5 to 9 mm long. Inflorescences very slender, axillary, one- or at most few-flowered, the peduncles capillary, about 3 cm long, each bearing one fruit and also presenting one or two scars at the apex as if there might have been two or three umbellately arranged flowers; pedicels slender, up to 1 cm long. Calyx cut-shaped, 3 to 4 mm long, the lobes broadly ovate, 1.5 mm long, acuminate.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33370 Ramos,* August 21, 1918, on forested slopes near the summit, altitude about 1,050 meters.

This species is allied to Cyrtandra glabrifolia Merr. (*C. glabra* Kränzl., non Jack) but differs in its smaller entire leaves and shorter petioles.

CYRTANDRA PANAYENSIS sp. nov.

Frutex, ut videtur scandens, ramulis junioribus ferrugineo-villosis, ceteroquin glaber; foliis oppositis, aequalibus, coriaceis vel subcoriaceis, ellipticis ad oblongo-ellipticis, 7 ad 10 cm longis, breviter acuminatis, longe petiolatis, nervis utrinque 7 vel 8, perspicuis, margine distanter serratis; floribus axillaribus, fasciculatis, 2 cm longis, corollae tubo infra angustato, aequaliter 5-lobato, lobis circiter 2 mm longis; ovario glabro.

A shrub, apparently scandent, the young branchlets usually densely villous with brown or ferruginous hairs, the older parts entirely glabrous. Leaves opposite, equal, coriaceous or subcoriaceous, elliptic to oblong-elliptic, 7 to 10 cm long, 3.5 to 5 cm wide, dark-olivaceous and smooth above when dry, the lower surface paler, glabrous, apex shortly acuminate, base acute to decurrent-acuminate, the margins distantly serrate; lateral nerves 7 or 8 on each side of the midrib, very prominent on the lower surface, the reticulations lax, distinct; petioles at first ferruginous-villous, soon becoming entirely glabrous, 3 to 4 cm long. Flowers axillary, pink, about 2 cm long, fascicled, their ferruginous-villous pedicels about 1 cm long or less, subtended by a whorl of small, lanceolate bracts. Calyx about 10 mm long, 7 mm in diameter, ovoid or ellipsoid, black when dry, subcoriaceous, glabrous, the lobes 5, oblong-ovate, acute or slightly acuminate, 3 to 3.5 mm long. Corolla 2 cm long, the lower 12 mm slender, about 2 mm in diameter, then somewhat enlarged and 6 to 7 mm wide when flattened out, slightly pubescent externally or glabrous, the lobes 5, equal, broadly ovate, obtuse, about 2 mm long. Disk glabrous, truncate, about 1.5 mm high. Ovary and style glabrous. Fruit soft, fleshy, ellipsoid, about 12 mm long.

PANAY, Antique Province, Culasi, *Bur. Sci. 32241* (type), *32411 McGregor*, May 24, June 20, 1918, in the mossy forest, altitude about 1,000 meters.

This species is closely allied to *Cyrtandra tayabensis* Elm., from which it is distinguished by its smaller, fewer-nerved leaves and its entirely glabrous ovaries.

CYRTANDRA SANTOSII sp. nov.

Frutex 1 ad 2 m altus, partibus junioribus et inflorescentiis et subtus foliis dense et longe ferruginoso-villosis; foliis rigidis, coriaceis, oblongo-ovatis, usque ad 10 cm longis, longe petiolatis, acutis ad acuminatis, basi acutis ad subrotundatis, margine distanter et obscure serratis, supra laevis, nigrescentibus, vetustoribus glabris vel subglabris, subtus ferrugineis, ad costa et nervis et reticulis dense et longiter ferrugineo-villosis; inflorescentiis cymosis, paucifloris, pedunculatis, usque ad 6 cm longis, bracteis oblongis, circiter 2 cm longis; floribus circiter 18 mm longis, extus densissime villosis, calycis lobis longe caudato-acuminatis.

A shrub, 1 to 2 m high, the younger parts, inflorescences, and lower surface of the leaves, especially on the midrib, nerves, and reticulations, densely villous with long, soft, silky, ferruginous hairs. Leaves coriaceous, rigid, oblong-ovate, 7 to 10 cm long, 3 to 4.5 cm wide, often somewhat inequilateral, the apex acute to acuminate, base obtuse to acute, margins obscurely serrate, the upper surface smooth, blackish when dry, when young more or less villous, especially along the midrib, becoming glabrous, the lower surface ferruginous; lateral nerves about 8 on each side of the midrib, curved-ascending, prominent and projecting as are the rather dense reticulations; petioles up to 3.5 cm in length. Inflorescences axillary, solitary, peduncled, cymose, rather lax, densely ferruginous-villous, the peduncles up to 3 cm in length, the bracts membranaceous, oblong, villous, about 2 cm long. Pedicels, in anthesis, about 5 mm long, very densely ferruginous-villous, in fruit up to 1.5 cm in length. Flowers about 1.8 cm long. Calyx glabrous inside, densely villous outside, about 13 mm long, the tube 7 mm long, the lobes with a 4 mm long, stout, caudate acumen from a broad base. Corolla 1.8 cm long, densely villous externally, inside glabrous, the throat and lobes granular, the throat somewhat oblique, the lobes unequal, orbicular-ovate, about 4 mm in diameter. Disk truncate, glabrous; style 4 mm long, prominently capitate-glandular. Fruit white when fresh, brown when dry, oblong-elliptic, 1 to 1.5 cm long.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 32071 Santos*, May, 1918, on slopes, altitude about 2,000 meters.

This very characteristic species is perhaps as closely allied to *Cyrtandra hypochrysoides* Kränzl. as to any other described form, but differs remarkably from that species in numerous characters, especially in its entirely different inflorescence, longer petioles, coriaceous rigid leaves, its much denser and longer indumentum, and its very different flowers.

CYRTANDRA LANCIFOLIA sp. nov.

Suffrutex circiter 40 cm altus, e basi ramosus, ramis tenuibus; foliis lanceolatis, membranaceis, in paribus inaequalibus, 5 ad 13 cm longis, utrinque subaequaliter angustatis, acuminatis, margine leviter undulatis, nervis utrinque 4 vel 5, utrinque glabris vel junioribus subtus leviter pubescentibus; floribus axillaribus, subsessilibus, circiter 5 cm longis, plerumque solitariis, bracteis foliaceis, spathaceis, usque ad 1.5 cm longis, deorsum connatis, perspicue acuminatis; calycis oblongis, 7 mm longis, subaequaliter 5-lobatis.

An undershrub, up to 40 cm high, branched from the base, the stems terete, about 4 mm in diameter, the branchlets brownish, slender, somewhat pubescent with very short hairs. Leaves lanceolate, membranaceous, those of each pair similar in shape but unequal in size, one usually one-third to one-half smaller than the other, 5 to 13 cm long, 1 to 2.7 cm wide, subequally narrowed to the acuminate apex and base, the margins somewhat undulate, the upper surface glabrous, brownish-olivaceous, the lower pale, glabrous or when young very slightly pubescent on the midrib and nerves; lateral nerves 4 or 5 on each side of the midrib, curved-ascending, anastomosing, the reticulations very lax; petioles 3 to 10 mm long. Flowers axillary, solitary or in pairs, white, sessile or very shortly pedicelled, about 5 cm long, each subtended by a pair of foliaceous spathelike bracts which inclose the calyx, being united by their margins in the lower 4 mm, these bracts 1.5 to 1.7 cm long, glabrous or nearly so, prominently acuminate, up to 9 mm wide below. Calyx oblong, about 7 mm long, slightly pubescent, subequally 5-lobed, the lobes lanceolate, acuminate, 2 mm long. Corolla 4.5 to 5 cm long, pilose with long scattered hairs externally, the lower 1 cm of the tube very slender, not exceeding 2 mm in diameter, then broadened, the throat, when flattened, about 1.5 cm wide, subequally 5-lobed, the lobes ovate, rounded, about 1 cm long. Disk cylindric, glabrous, 2 mm long, somewhat crenate. Ovary glabrous. Stamens about 3 cm long.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33078 Ramos*, August 29, 1918, along small streams in forests at low altitudes.

This species belongs in the group with, and is closely allied to, *Cyrtandra livida* Kränzl. and *C. agusanensis* Elm., from both of which it differs notably in its very much larger flowers, while the leaves are merely undulate, not toothed.

ACANTHACEAE

HEMIGRAPHIS Linnaeus

HEMIGRAPHIS NUMMULARIFOLIA sp. nov.

Herba glabra, tenuis, ramosis, prostratis vel subprostratis; foliis orbicularis ad orbiculari-ovatis, integris, 5 ad 10 mm longis; floribus axillaribus, solitariis, ebracteolatis, circiter 1.3 cm longis, calycis segmentis lineari-lanceolatis, 6.5 mm longis; capsulis anguste oblongis, 9 mm longis.

A slender, much-branched herb, the main branches spreading or prostrate, up to 20 cm long, the secondary branches more or less ascending, glabrous or nearly so, none of the branches more than 1 mm in diameter. Leaves orbicular to orbicular-ovate, 5 to 10 mm long, rounded, entire, olivaceous, the upper surface with rather numerous, irregularly scattered cystoliths, the lower surface slightly hispid on the midrib and nerves; lateral nerves 2 or 3 on each side of the midrib, not prominent. Flowers axillary, solitary, ebracteolate, about 1.3 cm long, sessile. Calyx segments nearly free, about 6.5 mm long, 1.5 mm wide or less, linear-lanceolate, acuminate. Corolla white or faintly tinged with blue, the lower 6 mm of the tube slender, cylindric, then broadened; lobes 5, subequal, orbicular, about 3 mm in diameter. Filaments bearded; anthers 1 mm long. Capsules narrowly oblong, acute or slightly acuminate, glabrous, about 9 mm long, 1.5 mm in diameter. Seeds about 12, orbicular-elliptic.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33031* (type), *32974 Ramos*, August 30, 1918, on dry open banks, the leaves when fresh reddish-purple beneath.

This species belongs in the group with *Hemigraphis reptans* Nees and is most closely allied to *H. fruticulosa* C. B. Clarke. It is well characterized by its unusually small, orbicular, entire leaves; by its axillary, solitary, and ebracteolate flowers; and by being glabrous or nearly so throughout.

COMPOSITAE

VERNONIA Schreber

VERNONIA GLANDULIFOLIA sp. nov.

Frutex scandens, ramulis junioribus bracteisque exceptis glaber; foliis lanceolatis ad oblongo-lanceolatis vel oblongo-ellipticis, subcoriaceis, 4 ad 7 cm longis, basi acutis, apice acutis vel leviter acuminatis, subtus minute et dense glanduloso-punctatis, nervis utrinque 6 ad 8, distinctis; capitulis paucis, solitariis vel binis, circiter 2 cm longis, multifloris, bracteis pubescentibus, interioribus circiter 1 cm longis.

A scandent shrub, glabrous except the very young branchlets and the involucral bracts, the branches grayish-brown when dry, not lenticellate, the slender branchlets dark reddish-brown. Leaves lanceolate to oblong-lanceolate or oblong-elliptic, subcoriaceous, olivaceous when dry, entire, 4 to 7 cm long, 1 to 2 cm wide, subequally narrowed to the acute base and the acute or slightly acuminate apex, the lower surface rather densely and minutely glandular-punctate, the numerous glands sunk in minute pits; lateral nerves 6 to 8 on each side of the midrib, distinct, anastomosing; petioles 5 mm long or less. Heads few, solitary or in pairs at the tips of the branchlets, in fruit about 2 cm long, their peduncles about 1 cm long; involucral bracts more or less pubescent, the outer ones 2 mm long or less, the inner ones narrowly oblong-lanceolate, about 1 cm long, their margins ciliate. Achenes about 4 mm long; pappus hairs numerous, about 1 cm long, pale reddish-brown.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33374 Ramos,* August 21, 1918, on forested slopes, altitude about 1,000 meters.

This species is well characterized among the woody scandent forms by its small, densely glandular-punctate, glabrous leaves and its few heads. Its alliance is with *Vernonia pyrrhodasys* Schulz-Bip.

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THE PHILIPPINE
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VOL. XIV MAY, 1919 No. 5

SOME BACTERIOLOGIC PHASES OF THE CHOLERA-CARRIER PROBLEM

By JOHN A. JOHNSTON

(From the Biological Laboratory, Bureau of Science, Manila)

It has been tersely stated by Munson(3) that the dangerous nature of frank cases of cholera with diarrhœa, vomiting, and collapse is well recognized by the people and consequently would be avoided, reported, isolated, and followed by disinfection of their environment; in short, cases of this nature would not occasion a health department great anxiety. The cholera carrier, however, is to be regarded with concern by health officials as a dangerous source of infection; for, having no symptoms, he is not considered a menace, and may go about infecting privies, food, drinks, and those who come in contact with him.

The Sanitary Commissioner of India says:(6)

> The part played by the Kumbh fair at Hardwar in the dissemination of cholera infection in the United Provinces has already been referred to; in the Punjab this fair seems to have played an even more definite part in the spread of this disease. It is very significant that the year 1903 was the date of the previous Kumbh fair. Cholera was practically absent from the Punjab during the first three months of the year but in April pilgrims returning from Hardwar spread the infection far and wide and during the next six months most districts suffered more or less severely.

A few figures here may not be amiss: From July 1 to November 1, 1914, some 30,000 specimens of fæces from prisoners in Bilibid, not cholera suspects, were examined and 1.75 per cent found to be positive.

The fact that an individual is a cholera carrier does not give immunity. Prisoners 8617, 12765, and 30351 were found positive on September 10 and 11, 1914. They were isolated, and their fæces were examined every other day and found continuously positive. No. 8617, after having been a carrier for seventeen days, became ill with frank cholera; No. 12765 was a carrier for sixteen days before he came down with the disease, and No. 30351, for eighteen days; the last-mentioned individual died of the disease.

The question naturally arises: What is the cause of development of cholera in carriers? In so far as our present knowledge of the subject goes this is an unanswerable question. For want of anything more definite, it may be said in a general way that a lowering of vital resistance permits invasion. If this hypothesis be true, then we can easily understand how a carrier may become a victim to the disease at this time. But not everything is explained even by the theory of lowered vital resistance; it is still an open question. Some workers are inclined to believe that the organism itself, as occurring in persons of carriers, fluctuates in virulence; but this belief is scarcely tenable, and may be dismissed with scant discussion. However, it may be that the cholera vibrio requires passage through an intermediate human host before causing symptoms. My own observations are to the effect that the vibrios isolated from a carrier, either while living or after death, behave in exactly the same manner as do those obtained from a frank cholera case; there is absolutely no difference.

Once a cholera carrier, how long does this condition exist? This is a question of the greatest importance for the health officer. The answer can only be obtained from the laboratory, and unfortunately we are unable to answer definitely. We know that in the typhoid carrier the period of infection lasts for years, very likely for the life of the individual. Some observations made on prisoners in Bilibid would seem to indicate that very likely the cholera-carrier state may be of indefinite duration. Prisoner 8841 was positive on September 12, 1914, had seven negative examinations at intervals of four days, was released from quarantine, and was not reëxamined until July 15, 1916, when he was positive again; negative until September 10, when he was once more positive; negative until December 31; positive again January 13 and 18, 1917; negative on January 24, but a nonagglutinable vibrio was isolated; January 25, 27, 30, and February 3, respectively, a nonagglutinable vibrio was isolated; February 7 he was once more positive; February 10, 15, 17, 20, 22, 27, and March 1, respectively, a nonagglutinating vibrio was isolated; March 3 he was again positive; March 6 and 8, respectively, a vibrio was found; March 15 he was negative and remained so to December, 1917.

Prisoner 8472 was positive September 28, 1914, and then had eight negative examinations at intervals of four days; he was found positive again July 13, 1916.

No. 9638 was found positive January 17, 1915, followed by eight negative examinations at intervals of four days; he was again positive July 13, September 13, and December 1, 1916, and has not been positive again.

Is it not reasonable to suppose that these men harbored the cholera vibrio for periods of one and two years? If this be true, why not for longer periods of time?

No. 11040 was positive for the first time August 2, 1916; negative until September 22; again negative until October 19; negative again until November 25; negative, November 29; positive, December 3; negative, December 15 and 16; December 20 a nonagglutinable vibrio was isolated; negative, December 23 and 29; on January 8 and 11, 1917, respectively, a nonagglutinable vibrio; January 18, positive; January 20, 24, 25, and 27, respectively, a nonagglutinable vibrio; January 30, negative; February 3, a nonagglutinable vibrio; February 7, positive; February 10, 15, 17, and 27, respectively, a nonagglutinable vibrio; March 1, negative; March 3, positive; March 6 and 8, negative; April 3 and 4, positive; and since then, negative to December.

I have records of many other cases that I could cite, but these are sufficient to show the irregularity with which positive results occur. I believe this irregularity is more apparent than real; for I believe that, if a cholera carrier were kept under exactly the same conditions of temperature, humidity, and surroundings; given the same food and the same work; and if the specimens were taken at the same time of day, in the same way, and transmitted to the laboratory under exactly the same conditions, the number of positive results would be more than doubled.

The researches of Schöbl(7) and of Schöbl and Pañganiban(8) on cholera carriers in guinea pigs have shown that food plays an important rôle in the appearance and the disappearance of the vibrios in the fæces. The normal period for recovery of the cholera vibrios from artificially infected guinea pigs has been definitely established to be approximately fourteen days, after which time they can no longer be found. If bile is administered, however, these same animals continue to excrete the vibrios for indefinite periods, the exact length of time not having been determined definitely.

In 1916, in Bilibid Prison,(4) 600 carriers (8.2 per cent of the population) were found; a total of 112,577 stool examinations were made. A word as to the technic: A sterile swab was plunged into each man's fæces and thus inoculated; this swab was placed in a test tube containing about 2 cubic centimeters of plain agar of a reaction of —1.0 to phenolphthalein. The purpose of the agar is simply to prevent the drying out of the inoculum. Upon receipt at the laboratory, 10 cubic centimeters of a 2 per cent peptone solution were added, and the tubes incubated over night. In the morning hanging drops from these peptone tubes were examined for suspicious motility, and the tubes showing it were set aside for further culturing. Dieudonné plates were used and, after streaking, were incubated for a further twenty-four hours. All suspicious colonies were fished out, emulsified in a sterile salt solution, and tested for agglutination. For the latter test an immune serum having a titer of 1 to 4,000 was used in a dilution of 1 to 500. The cholera vibrio agglutinates promptly with this, and nothing but the true cholera vibrio will give a positive reaction. There are vibrios, however, that correspond with the true organism in every way except agglutination; these may or may not be true cholera vibrios. The majority of these vibrios are hæmolytic; that is, in blood-agar plates a clear zone of hæmolyzed blood is produced about the colony. Some authors have reported strains of cholera vibrios producing hæmolysis also. In the light of our present knowledge, however, it may be safely accepted that any vibrio that does not agglutinate promptly on being brought into contact with a drop of a 1 to 500 dilution of a known cholera-immune serum of high titer is not a true cholera vibrio.

That these nonagglutinating vibrios bear some more or less intimate relation to cholera seems to be borne out by the following, from O'Connell:(1)

> These choleroid organisms are an extremely interesting phenomenon. Their relationship to true cholera may be said to have been established but not defined. Bacteriologists in service in the Far East have noted their appearance in specimens subjected to microscopical examination immediately before and during cholera epidemics. They are not known where cholera is not or has not been recently. Their morphology and biological characteristics are such that it is impossible to distinguish them from true cholera organisms by microscopic examination.

Greig,(2) working in India, has made an intensive study of these choleralike vibrios, and he classifies them according to their serological reactions with each other. He makes arbitrary division into six groups. During the past year thirty strains of nonagglutinating vibrios have been studied at the Bureau of Science. These strains were obtained from cholera cases, from carriers, and from presumably normal individuals who were contacts of cases of cholera. After obtaining a strain in pure culture, 0.1 cubic centimeter of a suspension of a twenty-four hour culture was injected into the gall bladders of a number of guinea pigs under strict asepsis. The animals were sacrificed from ten to twelve days subsequent to injection, and the contents of the gall bladder were used to inoculate peptone tubes; direct plates on Dieudonné were made also. The supply of animals being short it was decided to use bile, and transfers were made every three days. After forty such transfers eight of these previously nonagglutinable strains gave prompt agglutination in 1 to 500 dilution. Of these eight strains five held the acquired property for approximately three months. Three lost it after two months, and none held it for longer than four months. These facts were reported at the time as showing that the property of agglutination might be acquired, but my belief now is that these strains were true cholera that had lost the agglutinability.

TREATMENT

In Bilibid the carriers were given urotropin and, following Schöbl's experiments with ox bile in guinea pigs, 0.65 cubic centimeter of ox bile three times a day for two days; after an interval of five days the treatment was repeated. Those cases negative after the treatment were released from quarantine. The prison authorities at first, I believe, used sodium tauro cholate; but, the supply of this soon becoming exhausted, I suggested the use of inspissated beef bile. It was not supposed that the bile would cure the carrier condition, but that it would cause more vibrios to enter the intestinal tract from the gall bladder. The following is quoted from the Report of the Philippine Health Service for 1916:(5)

Results.—From 185 cases prior to the use of ox gall, 15 or 8 per cent became repeaters within 2 months. The first ox-gall period produced the following result:

Of 155 treated September 8, 9, 14 and 15, 5 were reported positive September 9, and 6 September 17; 84 of these 155 were discharged to brigades September 20, of whom 10 were returned positive on September 22; thus producing a total of 21 positives or 13.5 per cent of the 155 treated.

Of 529 prisoners receiving ox-gall treatment in the cholera brigade, 120, or 23 per cent, became repeaters. Of this number, 68, or 13 per cent, were returned as repeaters from the cholera brigade as follows:

Following first ox-gall treatment, 21 or 31 per cent.
Following second ox-gall treatment, 42 or 62 per cent.
Following third ox-gall treatment, 5 or 7 per cent.

It will be seen from this that the administration of bile would seem to be helpful in the detection of chronic carriers.

REFERENCES

(1) Annual Report of the Health Officer of the Port of New York. Albany (1915) 14.

(2) GREIG, E. D. W. Bacteriological studies of cholera like vibrios isolated from stools of cholera cases in Calcutta. *Indian Journ. Med. Research* 4 (1916–1917) 658–671.

(3) MUNSON, E. L. Cholera carriers in relation to cholera control. *Philip. Journ. Sci.* § B 10 (1915) 1.

(4) Report of the Philippine Health Service for the year 1916. Manila (1917) 25.

(5) Report of the Philippine Health Service for the year 1916. Manila (1917) 26.

(6) Report Sanitary Commissioner, India (1915) 62.

(7) SCHÖBL, OTTO. Experimental cholera-carriers. *Journ. Infect. Dis.* 18 (1916) 307–314.

IDEM. The relation between the amount of cholera culture injected into the gall bladder and the state of cholera carriers in experimental animals. *Philip. Journ. Sci.* § B 11 (1916) 153–155.

IDEM. The influence of bile upon the duration of the state of cholera carriers in experimental animals. *Philip. Journ. Sci.* § B 11 (1916) 157 and 158.

IDEM. The influence of bile upon the distribution of cholera vibrios in the digestive system of experimental cholera carriers. *Philip. Journ. Sci.* § B 12 (1917) 23 and 24.

IDEM. A survey of certain chemicals with regard to their bactericidal action on cholera vibrios within the body of experimental cholera carriers. *Philip. Journ. Sci.* § B 12 (1917) 215–231.

(8) SCHÖBL, OTTO, and PAÑGANIBAN, C. S. Experimental cholera carriers and immunity. *Philip. Journ. Sci.* § B 12 (1917) 43–49.

PHILIPPINE RAW MATERIALS FOR GLASS MAKING

By T. DAR JUAN and V. ELICAÑO

(*From the Chemical Laboratory and the Division of Mines, Bureau of Science, Manila*)

THREE TEXT FIGURES

Some years ago experiments were made by private concerns in the manufacture of glass from materials found in Pampanga and Tarlac, but the attempts were fruitless. At present there is a bottle factory at Santa Ana, Manila, that operates entirely with broken glass, or cullet; however, the operation of this factory is very intermittent, and its production does not meet the demand.

The imports of glass bottles and other ordinary glassware into the Philippine Islands have shown an almost constant increase since 1915, and have now reached a point where the establishment locally of a modern glass factory would appear to be justified. Information obtained by the Bureau of Science indicates that 15,000,000 split and pint bottles are used annually in the Philippines, 10,000,000 of which are returned empty to the soda-water and beer factories, leaving a probable market for not less than 5,000,000 bottles per year. Table I gives the value of Philippine imports from Japan of glass bottles, drinking glasses, and lamp chimneys for the last four years.

TABLE I.—*Philippine imports from Japan.*

[Numbers give values in pesos.]

	1918	1917	1916	1915
New empty bottles	440,090	193,093	158,419	129,197
Drinking glasses	95,057	142,076	60,268	52,859
Lamp chimneys	37,210	16,445	20,337	17,023
Total	572,357	351,614	239,024	199,079

Prices of bottles and other ordinary glassware have increased considerably during the past two years, and at present it is very difficult to secure them reasonably. In the Philippine Islands there are 12 soda-water factories (in Manila), 2 breweries, 440 drug stores, 81 alcohol distilleries, 17 repacking establishments, and a few other industries the operation of which depends entirely on the solution of the bottle problem. In view of the above considerations, we undertook this investigation in order to determine the suitability of Philippine materials for glass making.

Technically speaking, there are two general classes of glass recognized; namely, lime glass and lead glass. Lime glass is the material most commonly used for making the cheaper articles, such as ordinary bottles, demijohns, glass jars, drinking glasses, lamp chimneys, etc.; while lead glass is a more expensive product and is used chiefly in the manufacture of cut glassware and for optical purposes. The principal raw materials used in the manufacture of lime glass are lime, silica, and alkali.

LIME

Coralline and crystalline limestones of good quality occur throughout the Philippine Islands,[1] but the deposits most available to Manila are those of Montalban, Binangonan, and Tayabas. Both the Montalban and the Binangonan deposits are within the boundaries of Rizal Province; the limestone is of Miocene formation and is hard, crystalline, and of uniform chemical composition.

Montalban is located about 30 kilometers from Manila, on a line of the Manila Railroad. Binangonan is situated about 35 kilometers from Manila, with water transportation facilities via Pasig River and Laguna de Bay.

The Tayabas deposit is a metamorphosed coralline limestone and is located at Palsabangan, a barrio on the railroad and between the towns of Pagbilao and Malicboy. It is estimated that limestone may be obtained from any of these places at from 5 to 8 pesos[2] per metric ton, including cost of quarrying and transportation to Manila.

The Bureau of Science in its experimental kiln has manufactured from Montalban, Binangonan, Cebu, and Tayabas limestones over 100 tons of excellent lime, suitable for use in sugar centrals and in other industries; and there is no reason why these limestones cannot be used for glass making.

In this connection it would be of interest to note the composi-

[1] Cox, A. J., Philip. Journ. Sci. § A 4 (1909) 211; Cox, Reibling, and Reyes, Philip. Journ. Sci. § A 7 (1912) 332.

[2] One peso Philippine currency equals 50 cents United States currency.

tion of some Philippine limestones. The analyses given in Table II show that they are almost pure.

TABLE II.—*Analyses of some Philippine limestones.*

[Numbers give percentages.]

Constituent.	Cebu.	Binangonan, Rizal, 1912 [a]	Binangonan, Rizal, 1918.	Montalban, Rizal, 1912 [a]	Montalban, Rizal, 1918.	Palsabangan, Tayabas. [b]
Loss on ignition	43.45	43.31	43.49	43.04	43.98	43.48
Silica (SiO_2)	0.86	1.12	0.88	0.94	0.26	0.69
Iron and aluminium oxides (R_2O_3)	0.23	0.15	0.48	1.14	0.09	0.35
Lime (CaO)	54.67	53.78	54.39	54.61	54.97	54.68
Magnesia (MgO)	0.46	1.19	0.68	0.22	0.72	0.48
Alkalies (K_2O+Na_2O)		0.77		0.56		

[a] Analyzed by Forest B. Beyer. [b] Analyzed by F. D. Reyes, chemist, Bureau of Science.

SILICA

The principal source of silica is white sand or quartz. Sand deposits of good quality occur at Paracale, Camarines Province, and in the Mountain Province at Baguio; but the deposits of commercial importance are the extensive beaches of quartzose sand and the vein-quartz gravel and bowlders found in Lubang Island, Mindoro.

The quartzose sand is the rèsult of the disintegration of the intrusive granite that outcrops on the narrow isthmus at the south end of the island, between Looc and Tabahin Bays. This sand is composed mainly of quartz, orthoclase, and mica, with variable proportions of clay.

The sand deposits are found along the southern shore of Looc Bay, from the barrio of the same name to Balacbalac Point, and along the shores of Tabahin Bay, which lies between Caybanac and Natulo Points. Each of these extends both above and below the present beach and together make an area of about 2.5 square kilometers. Between the high- and the low-water marks the sand is subjected to the constant action of the waves, with the result that a gradual concentration takes place, leaving a product of almost pure quartz. The width of the area containing the clean quartz sand averages 2.5 meters, extending throughout the length of both the Looc and Tabahin shores. From the high-water mark to the foot of the hills, which apparently at one time was a water level, the sand is mixed with greater or less quantities of clay. Below the low-water mark the sand extends into the sea about 200 meters. The probable thickness and average width of the underwater deposit is not known, as no soundings were made. The depth of the concentrated sand between the high- and the low-water marks is over a meter, and there are wells above the shore line in the vicinity of Looc that have clean sand bottoms at a depth of from 2 to 3 meters. Insufficient data are at hand to make even an approximate estimate of the total amount of sand available.

The deposits of vein-quartz gravel and bowlders are found along the coast bordering the schist and gneiss formation at the north and the south sides of the intrusive granite mentioned above. The gravel has accumulated in great quantities in all the inlets, and the supply is fairly large. The principal areas of accumulation are the northern shore of Looc Bay toward Tumbaga Point, and from Antipolo Point to Pula Point near the town of Agcauayan. It is also found on the east shore of Lubang Island from Caybanac Point to Quebrada Point, and around the southern shore from Natulo Point to Balacbalac Point. Patches of accumulated quartz gravel are also to be found on the northern shores of Golo Island from Bulacan toward Caypandan Bay. This gravel ranges in size from that of a pea to more than 75 millimeters in diameter and is mixed with quartz bowlders weighing from a few kilograms to a ton or more. The gravel and the bowlders come from the fracturing of the segregated lenticular veins of quartz found in the schist and the gneiss. Some of the quartz lenses outcropping in Dilau Point measure approximately 6 meters in thickness. However, the main supply of these quartz veins is found around Agcauayan, where several lenticular veins outcrop, and floats of quartz breccias and bowlders cover the tops of Agcauayan, Puti, and Pula Hills (see fig. 1).

Besides the materials above described, the discharge slimes from the cyanide treatment of auriferous quartz of the Colorado Mining Company cyanide mill located at Aroroy, Masbate, and other such mills, may prove to be of value as a possible source of silica in glass manufacture. The utilization of this pulp has the advantage that, being already finely pulverized, it can be mixed directly with lime and alkali without preliminary treatment. Although no actual test has been made of this material, we are of the opinion, judging from its chemical composition, that it will make a good bottle glass.

Sand of lower purity, but useful as a fluxing material in glass making, is found in large quantities at Pasay Beach, Rizal Province, and in Tarlac River, Tarlac Province. Table III gives the analyses of silicious materials used in our experiments.

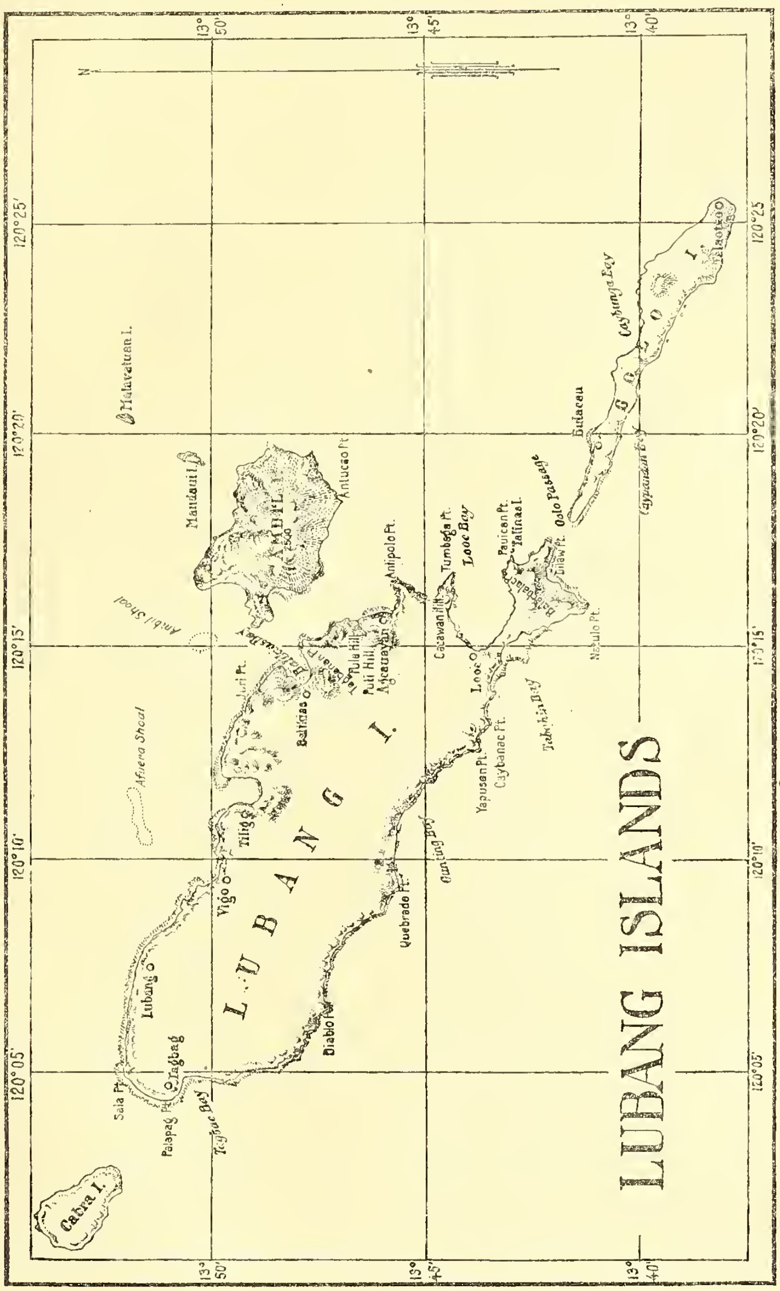


Fig. 1. Map of the Lubang Islands. Traced from a Coast and Geodetic Survey chart.

TABLE III.—*Analyses of silicious materials.*

[Numbers give percentages.]

Constituent.	Lubang quartz.	Lubang sand.	Pasay sand. [a]	Tarlac sand.	Slimes, C. M. Co. [b]
Loss on ignition	0.34	0.80	5.40	0.82	0.55
Silica (SiO_2)	97.49	86.60	56.00	57.54	84.85
Ferric oxide (Fe_2O_3)	trace	0.48	6.24	7.89	3.51
Aluminium oxide (Al_2O_3)	1.58	8.12	19.16	20.47	6.29
Lime (CaO)	trace	1.20	6.18	7.31	1.65
Magnesia (MgO)	trace	0.22	4.34	3.27	2.13
Manganese oxide (MnO_2)	trace	trace	trace	trace	----------
Alkalies ($K_2O + Na_2O$)	0.50	[c]2.58	2.66	[c]2.70	[c]1.02

[a] Analyzed by F. Peña, chemist, Bureau of Science.
[b] Analyzed by A. S. Argüelles, chemist, Bureau of Science.
[c] Determined by difference.

ALKALI

This material is derived from sodium carbonate or sulphate, which for glass making should be as nearly free from iron as possible. Sodium carbonate, or soda ash, fuses more readily with silicious material and lime than does sulphate; but, since the latter is a cheaper product, it is more generally used in glass making, especially in the production of cheap articles. If sodium sulphate is used, some form of carbon should be admixed to assist in its reduction. Sodium carbonate and sodium sulphate, which are intermediate products in the preparation of caustic soda, depending upon the process used, may be imported from the United States or may be prepared locally from common salt. During 1917 the Philippine Islands imported 1,423,532 kilograms of caustic soda, valued at the port of origin at 326,813 pesos. The establishment in the Philippines of a caustic soda factory, in connection with a glass factory or a paper-pulp plant, will save to the Islands the value of their imports of this commodity and will encourage the exploitation in the Philippines of such industries as the manufacture of paper pulp, glass, soap, etc., all of which use caustic soda or one or more of its intermediate products as raw material. In a soda factory the largest item is fuel, and the next, common salt. It is believed that, by establishing a factory in a place where there is an ample supply of firewood, and where at the same time climatic conditions are favorable for the solar evaporation of sea water, sodium carbonate can be produced locally at approximately 102 pesos per metric ton.

In addition to the materials already described cullet is invariably used in commercial glass factories. The object of mixing cullet with the batch is to utilize the fragments of glass left over during the process of manufacture, and to serve as a flux and to lower the temperature of reaction of the materials employed. Mixing the batch with cullet also considerably reduces the cost of production. However, since the main object of this investigation was to ascertain the suitability of Philippine materials for glass making, no cullet was used in our experiments.

PROPORTIONS OF CONSTITUENTS

The proportions in which the different ingredients of glass are mixed vary considerably, depending upon the quality and composition of the raw materials available, the quantity of broken glass mixed with the batch, the temperature, and the quality and color which it is desired to give the finished product.

Table IV gives the proportions of the materials used for the different batches, the percentage composition of glass materials in the mixture, and the percentage composition of the glass obtained.

The mixtures used in the first and second batches were rather difficult to melt and gave a glass that at white heat was not sufficiently fluid to expel all the gas bubbles. If to mixture 1 a small quantity of arsenious or manganese oxide is added, as shown in the table, a practically colorless glass is obtained. Tubing and bottles made from these mixtures are hard and strong, but they become cloudy after a few weeks. Mixture 3 is not difficult to melt, the gas bubbles are easily expelled, and the glass remains perfectly transparent. Mixture 4 gives a glass practically free from bubbles, and bottles made from it have an excellent appearance. Also in this case the addition to the mixture of a small amount of arsenious or manganese oxide decolorizes the product almost completely. Mixture 5 gives a greenish glass excellent for soda-water or beer bottles. The addition of small quantities of arsenious oxide (batch 6), or of manganese oxide (batch 7), produces a lighter-colored glass. Mixture 8 gives a green glass suitable for soda-water or beer bottles, and mixtures 9 and 10, a glass rather too dark for soda-water, but good for beer and wine bottles.

The furnace used in these experiments was built after the ordinary Japanese glass pot furnace and has over-all dimensions of 188 by 79 centimeters at the base and a height of 132 centimeters. Text figs. 2 and 3 give a general idea of the furnace construction. Its most important feature is the air passage, represented in fig. 2 by the letters 1*a*, 2*a*, and 3*a*, which

TABLE IV.—*Showing composition of mixtures and glass obtained.*

RAW MIXTURE IN PARTS BY WEIGHT.

Constituent.	Batch No. 1.	Batch No. 2.	Batch No. 3.	Batch No. 4.	Batch No. 5.	Batch No. 6.	Batch No. 7.	Batch No. 8.	Batch No. 9.	Batch No. 10.
Lubang quartz	100.0	100.0	100.0	100.0						80.0
Lubang sand					100.0	100.0	100.0	80.0	50.0	
Pasay beach sand								23.0	50.0	
Tarlac sand										81.0
Sodium carbonate	32.5	32.5	35.0	54.0	40.0	40.0	40.0	37.0	35.0	38.0
Limestone	38.8	38.8	25.0	23.0						
Hydrated lime					13.0	13.0	13.0	10.0	10.0	21.0
Arsenious oxide (As_2O_3)		0.2				0.3				
Manganese oxide (MnO_2)							0.25			
PERCENTAGE OF GLASS MATERIALS IN THE MIXTURE.[a]										
Silica (SiO_2)	71.51		75.00	70.52	67.60			65.63	58.87	64.31
Iron and aluminium oxides (R_2O_3)	1.15		1.18	1.16	6.75			10.07	14.05	12.51
Lime (CaO)	15.39		10.40	9.00	8.34			7.67	9.05	10.96
Magnesia (MgO)					0.17			0.93	1.88	1.37
Alkalies (K_2O+Na_2O)	11.95		13.42	19.32	17.14			16.30	16.15	10.85
Arsenic (As)										
Manganese (Mn)					trace			trace	trace	

PERCENTAGE COMPOSITION OF GLASS OBTAINED.

Silica (SiO_2)	70.14	70.20	74.55	70.80	[b]66.30	67.00	----------	[b]64.60	[b]60.00	64.08
Iron and aluminium oxide (R_2O_3)	1.65	1.63	2.20	1.21	7.40	7.45	----------	10.70	13.68	13.72
Lime (CaO)	16.90	16.84	10.50	9.55	8.50	8.40	----------	7.48	9.84	10.72
Magnesia (MgO)	----------	----------	----------	----------	0.38	0.32	----------	1.16	1.36	1.56
Alkalies (K_2O+Na_2O)	11.21	11.18	12.77	18.40	[c]16.92	16.80	----------	15.94	[c]15.12	9.96
Arsenic (As)	----------	nil	----------	----------	----------	nil	----------	----------	----------	----------
Manganese (Mn)	----------	----------	----------	----------	trace	trace	----------	trace	trace	trace

[a] Calculated from the analyses of the ingredients of the raw mixture. [b] Analyzed by F. Peña, chemist, Bureau of Science. [c] By difference.

1. Yellowish tinge. 2. Lighter than No. 1. 3. Yellowish tinge. 4. Yellowish tinge. 5. Greenish. 6. Lighter than No. 5. 7. Lighter than No. 5. 8. Green. 9. Dark green. 10. Dark green.

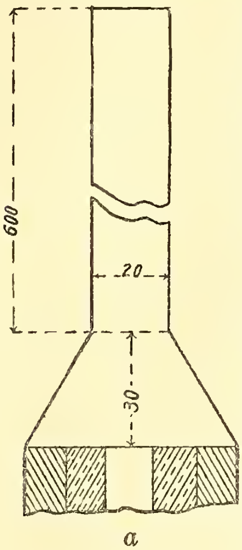
is built in a zigzag form below the hearth and extends across the width of the furnace. From the plan it may be seen that this furnace belongs to the gas-producer type, for the combustion in the fire chamber is incomplete. The heat radiating from the hearth preheats the air passing through the zigzag passage before it mixes with the hot gases in the combustion chamber. The result is that a more complete combustion of the gases takes place, and a higher temperature is obtained from the flame around the crucible. The peep hole *c*, which is covered with a sheet of mica, permits the operator to observe the temperature around the crucible and also enables the removal of any soot that may have accumulated along the passage from the crucible chamber to the chimney. When slot *b* is obstructed, the door *d* permits the cleaning of the passage from the fire grate to the combustion chamber.

The operation of this furnace is very simple. After the fire has been started, sufficient coal is piled in the fuel chamber to fill it to the door level. The height of the fuel bed is kept at a constant level by feeding the fire chamber with 1 to 2 kilograms of coal every fifteen to twenty minutes, and occasionally cleaning the grate to avoid accumulation of cinders. If the temperature around the crucible decreases, it is an indication that the quantity of coal burning in the fire grate is insufficient; that too much or too little air is being admitted through the air passage *a* or in the fire grate; or that the passage from the crucible chamber to the chimney is obstructed with soot. This furnace gives a temperature sufficiently high to expel the gas bubbles from the molten glass and, besides being economical in fuel, has the additional advantages of simple construction and easy operation.

If a glass factory is to be established in the Philippine Islands, the following facts should be taken into consideration:

The quality and price of fuel available are as important factors as are the raw materials to be melted. At present the market price of coal in Manila varies from 40 to 50 pesos per metric ton, depending upon the quality and the market conditions. With such a high price for coal, it may prove advantageous to use coconut shells when practicable. This fuel can be obtained in commercial quantities at from 8 to 10 pesos per metric ton.

Labor is also an important factor. Glass making is a new, or practically unknown, industry in the Philippines, and naturally there are few glass blowers in the Islands. If a factory with a capacity of from five to ten thousand bottles is to be operated, it will be unwise to depend entirely upon unskilled labor. In this connection it would be advisable to investigate the capacity limits to which machine blowers can be operated economically, and to draw conclusions from the results of this investigation as to whether it would be more economical for the present to contract expert glass blowers from Japan to train Filipino laborers or to operate an automatic machine blower.



As shown by the composition and the quality of the glass, there is not the slightest doubt that the raw materials are suitable for glass making. Furthermore, in order to determine whether or not they would stand the pressure and the sudden changes of temperature to which glass bottles are subjected in a factory under ordinary working conditions, a number of glass bottles made by the Bureau of Science were tested in local soda-water factories and breweries; the results were very satisfactory.

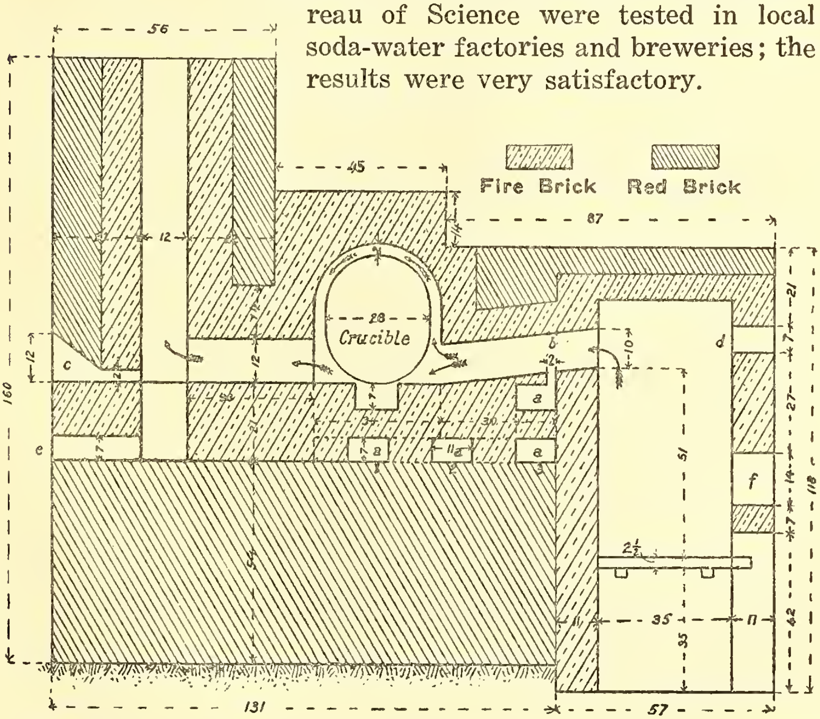


FIG. 2. Elevation of the experimental glass furnace. Section through *ABCD*. *a*, chimney, made of galvanized or plain sheet iron 1/16 inch thick.

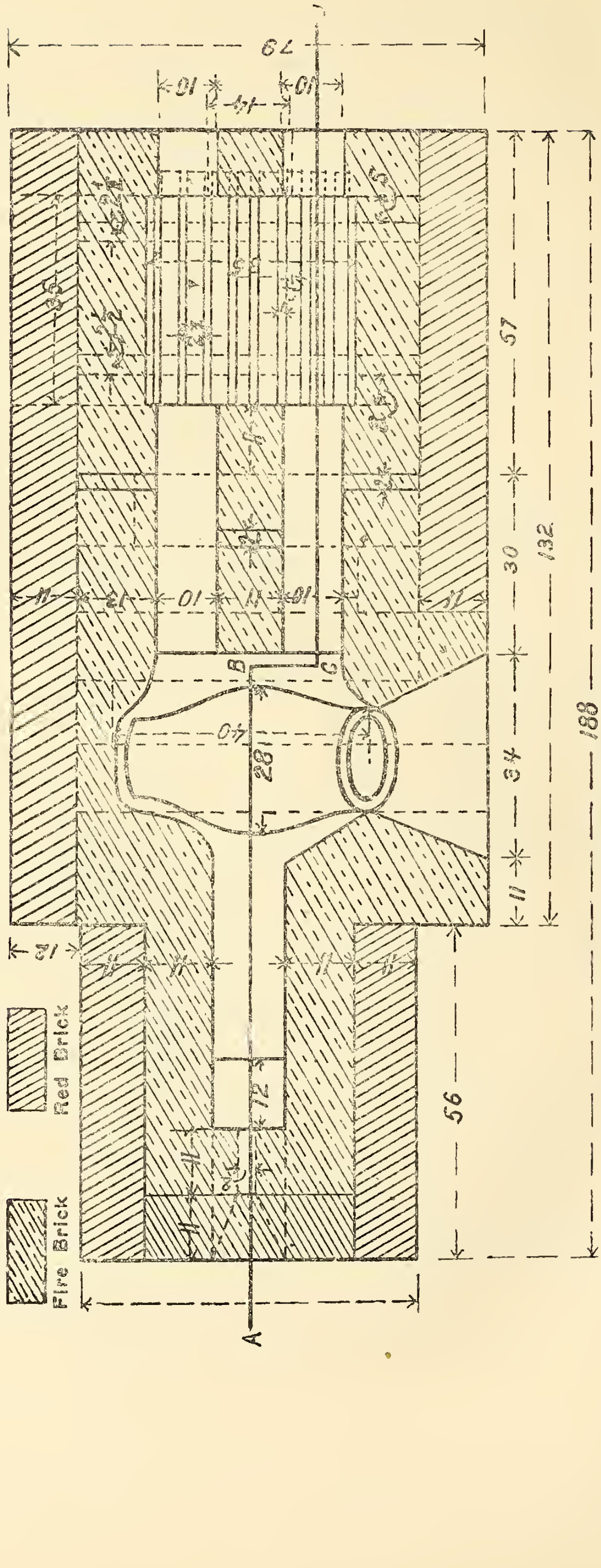


FIG. 3. Plan of the experimental glass furnace. Dimensions are given in centimeters.

In experimental tests made in the Bureau of Science, the quartzose beach sand and the vein quartz gave glass very similar in quality, except that that made from the vein quartz is of a lighter color due to a lower iron content, as shown in Table IV. The materials being of equal manufacturing suitability, the quartzose beach sand is preferable for the following reasons:

1. The quartzose sand already contains some feldspar, which lowers the melting point and supplies to the charge a certain amount of lime, alumina, and alkalies; while, if the vein quartz is used, all the fluxes have to be added.

2. The individual grains of the quartzose sand do not exceed 3 millimeters in diameter and thus, as a natural product, this sand can be readily charged into the furnaces. The vein-quartz gravel or bowlders, or the materials quarried from the veins, will necessarily have to be subjected to quenching, pulverizing, and sieving, which will increase the cost of manufacture.

3. The cost of mining sand is very much cheaper than vein quartz. The former can be readily dug from the beach and loaded into boats, while in the case of the vein quartz blasting and mucking will have to be done. The vein-quartz gravel of small size already mentioned as accumulated along the beach is not inexhaustible.

It has been stated above that a sand concentrate, averaging 2.5 meters wide and composed mainly of quartz grains, is found along the beach between high- and low-tide levels. It is considered that this supply of concentrate is inexhaustible on account of the continuous concentrating action of the waves on the adjacent deposit of impure sand, which readily and constantly supplies pure sand.

With an average width of 2.5 meters and a depth of 1 meter, extending 5 kilometers in length on both Looc and Tabahin Bays, there is ready on hand a supply of sand concentrate measuring 12,500 cubic meters. By actual test, a cubic meter of the sun-dried sand weighs approximately 1.5 metric tons. This indicates that there is available a supply of about 18,750 metric tons of sand, which will last a factory, with a daily capacity of 5 tons, twelve and one-half years of three hundred working days a year. It is presumed that after the twelfth year digging may again be done on the original place, and a concentrate be found of similar quality as before.

From data now on hand it is not possible to estimate accurately the cost of equipment for a glass factory of a given capacity, but any technical information or suggestions as to manufacture can be furnished to prospective investors.

ILLUSTRATIONS

TEXT FIGURES

CYSTOLITHIASIS AMONG FILIPINOS IN ASSOCIATION WITH DIETETIC DEFICIENCY

By Regino G. Padua

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ONE TEXT FIGURE

INTRODUCTION

Osborne and Mendel (19) in their series of dietetic experiments on lower animals found an incidence of phosphatic calculi in the urinary passages of rats that had been subjected to a ration of inadequate nutritional value. In their conclusion these authors say:

> We can not offer any rigid proof of the etiologic relationship between the ration deficient in fat soluble vitamine and the formation of phosphatic calculi. The impressive statistical fact that in every case where the calculi were observed the animals had existed for some time on a diet of the sort indicated, together with our failure to discover any other pathogenic factor common to all the affected animals, makes the hypothesis suggested above worthy of serious consideration.

Following this valuable suggestion, I attempted to carry on an investigation that has practically become twofold: (1) an attempt to show as far as lay in my power the possible application of the hypothesis to a people collectively noted for an unbalanced, essentially avitamine diet such as exists in the Philippines; (2) an investigation into the chemical composition of Filipino vesical calculi, which is interesting in itself and may prove valuable, considering the relative scarcity of similar investigations in foreign countries.

The consensus among various writers who have studied the nutritional condition of the Filipino people is that a large majority of them are not receiving sufficient nourishment for the maintenance of a stable physiological activity. The recent experiments of Concepcion (8) on the nutrition of normal Filipino subjects seem to confirm this opinion.

The ordinary daily ration of the Filipino masses, consisting principally of rice which is at times so improperly prepared that most of the pericarp where the vitamines are said to exist has been removed, vegetables of moderate amount, scarcely any meat or fish, and some other dietary articles of minor importance, is as a whole deficient from a nutritional standpoint. An almost exclusively vegetarian existence, low in phosphorus and protein (Aron and Hocson (2)), or a protracted consumption of a one-sided diet may result in diseases of metabolic or nutritional deficiency, exemplified in these Islands by the existence of beriberi, the theory of dietetic deficiency as the causation of which is apparently well established by the work of Andrews, (1) Chamberlain, Vedder, and Williams, (7) Fraser and Stanton, (11) de Haan, (9) Highet, (14) Gibson, (12) Williams and Saleeby, (26) and many others.

MATERIALS AND METHODS

In the museum of the surgical department of the Philippine General Hospital there were found, at the beginning of this work, forty-eight bladder stones from Filipino subjects, some of which were intact, while others were half-cut. These had been collected from the latter half of 1914 to almost the end of 1917. The incompleteness of the clinical histories of these forty-eight cases caused some difficulty in correlating the facts in the attempt to establish a relation between the nutritional state of the patient on admission and the character of the stone surgically removed. However, during the chemical analyses of these calculi, ten cystolithiasis cases were admitted to the surgical ward during the last two months of 1917, and these were thoroughly examined from a nutritional standpoint. Therefore, the present investigation is based on fifty-eight cases of vesical calculi with a view to correlating as far as practicable the clinical data with the chemical composition of the different layers of the individual stones.

To present a picture of the nutritional condition of the patients, it was planned to collect and condense all the essential points in the clinical-history record of the cases. All of the patients were Filipinos, of different age, sex, social condition, occupation, etc.—all of which factors must be considered in determining the relative frequency, and in tracing the nutritional etiology, of the disorder in each group. It must be emphasized that, except for the last ten cases, the history of beriberi as a whole was unreliable. Fortunately, however, most of the hospital records show, from objective examination of the patients, the degree of their body development and nutrition. The importance of considering the associated diseases, including intestinal parasitic infestation, lies in the fact that they tend to decrease the vital resistance of the body to the development of superimposing maladies. Diseases of the genito-urinary tract have been included in the case records to aid in explaining the formation of calculi. Whenever autopsy was performed on any of the cases, attempt was made to note the anatomical diagnosis for possible evidences of beriberi. Urine examinations have been made in most of the patients.

After weighing the stones, they were cut with a fine saw into two approximately equal parts, one of which was utilized in the analysis, while the other remained in the museum for further reference or subsequent study. Those that were cut were again divided into two, thus making the analyzed portion about one-fourth of the original stone. The layers of the portion analyzed were peeled off and weighed individually. Having determined by proportion the weight of the individual layers in toto, based on the weight of the whole or of half of the stone and that of the analyzed portion of the layer, the latter was subjected to a qualitative chemical analysis according to Heller's scheme.

Experience showed that the chemical phenomena were sometimes so misleading that the interpretation of results did not in some instances approach the desired accuracy. To check this error, I adopted the following modification in the analysis of each layer: The layer was ground to a powder and a small amount of the powder was dissolved by the aid of gentle heat in dilute hydrochloric acid; after filtering the solution, two drops of the filtrate were put on a slide and subjected to the action of ammonia vapor beneath a shallow glass container; about fifteen or twenty minutes were allowed for the reaction, and the crystals or sediments formed were examined and identified under the microscope.

In case of multiple calculi, the largest was weighed and analyzed in the same manner. The smaller ones were also cut and analyzed, but not recorded. The weight of the largest stone and that of the individual layers were calculated, as it was intended to determine or compute as far as practicable the rate of growth.

As a whole, the patients on admission were in a state of relatively low vitality, which is shown by the prolonged recovery after operation in the majority of the cases, sometimes three months as in case 25. Eleven of the cases gave a positive history or signs (or both) of beriberi. Eighteen were undernourished individuals with an unreliable history of beriberi, all of which belong to the first group of my clinical cases where the data were taken with very little or no stress on the nutritional bearing of the disease. Twenty-three of the series were determined as well-developed and well-nourished individuals, all of which except one pertain to the first group above mentioned. The rest of the cases (six in number) received no mention as to their nutritional condition. For the sake of clearness, the series may be divided into four groups as follows: I, cases which gave positive signs of beriberi; II, cases which indicated no reliable history of beriberi, but which were undernourished and belonged to the poorer class; III, cases which were well developed and nourished; and IV, cases regarding whose nutritional condition we have no data.

FINDINGS AND DISCUSSION

The fifty-eight cases studied, with their short clinical histories and the qualitative chemical analyses of their respective calculi, are too long for publication in full in this paper. Examples of the condensed case histories and chemical findings in only four cases, each representing a group, are given to show how the data were arranged for presentation in tabular form.

CASE 53 (GROUP I)

E. M. (55787), 25 years old, married, male, Filipino, fisherman; born and living in Taliptip, Bulacan, Bulacan; admitted to the hospital November 26, 1917, complaining of painful, frequent, and at times bloody urination of about one year's standing. Had measles while young, cholera at 10 years of age, and several attacks of rheumatic fever. Denies venereal diseases. He is well developed but poorly nourished. Signs of beriberi present and history of having had the disease is positive.

Clinical diagnosis.—Cystolithiasis, pulmonary tuberculosis, and trichuriasis.

Urine examination.—Reaction, slightly alkaline; sugar, negative; albumin, marked trace; microscopic, abundant red cells, occasionally casts, pus cells, and some squamous epithelial cells.

Cystolithotomy was performed November 30, 1917, and the patient died a few days afterward.

Calculus analysis (one yellowish stone).

	Grams.
Whole stone	26.5
Portion analyzed	14.0
First and second layers (inseparable)	6.0
Third and fourth layers (inseparable)	5.0
Fifth layer	2.0
Nucleus	1.0

Weight by proportion.

	Grams.
Cortex and second layer (inseparable)	11.4
Third and fourth layers (inseparable)	9.4
Fifth layer	3.8
Nucleus	1.9

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex and second layer	Amorphous and triple phosphate.	Calcium carbonate and trace of calcium oxalate.
Third and fourth layers	Amorphous phosphate	Calcium oxalate, calcium carbonate, and ammonium urate.
Fifth layer	Amorphous phosphate	Do.
Nucleus	Calcium oxalate	Amorphous phosphate and trace of uric acid.

CASE 9 (GROUP II)

E. M. (37388), 13 years old, single, female, Filipino, student; born and living in Santo Tomas, Batangas; admitted to hospital July 26, 1915, complaining of painful, frequent, difficult, and scanty micturition, and pus discharge occasionally. The condition is of about six years standing. No history of past diseases nor of beriberi. She is moderately developed but poorly nourished.

Clinical diagnosis.—Cystolithiasis, chronic cystitis, and prolapse of the rectum.

Urine analysis.—Reaction, alkaline; sugar, negative; albumin, a decided trace. Microscopic, abundant pus cells, some blood and mucus.

Cystolithotomy was performed August 3, 1915; the patient was discharged September 2, 1915.

Calculus analysis (one white irregular stone).

	Grams.
Whole calculus	31.5
Portion analyzed	15.1
Cortex, analyzed portion	5.5
Second layer	5.2
Third layer	4.0
Nucleus	0.4

Weight by calculation.

	Grams.
Whole cortex	11.5
Whole second layer	10.9
Whole third layer	8.3
Whole nucleus	0.8

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex	Triple and amorphous phosphate.	Calcium carbonate and ammonium urate.
Second layer (brownish white).	Amorphous phosphate and uric acid.	Ammonium urate and cystine.
Third layer (brown)	Calcium oxalate	Amorphous and triple phosphate.
Nucleus	Triple and amorphous phosphate.	Uric acid, ammonium urate, and calcium sulphate.

CASE 23 (GROUP III)

E. G. (44226), 26 years old, married, male, Filipino, laborer; born and living in Quingua, Bulacan; admitted to the hospital June 19, 1916, complaining of frequent and bloody urination of about one year's standing. He had fever of short duration during childhood and frequent attacks of malaria at the age of 15 years. He is well developed and nourished. No history of beriberi.

Clinical diagnosis.—Cystolithiasis, trichuriasis, and ankylostomiasis.

Urine examination.—Reaction, acid; sugar, negative; albumin, abundant; microscopic, very abundant pus.

Cystolithotomy was performed June 20, 1916. The patient was discharged fourteen days after the operation.

Calculus analysis (one yellow stone).

	Grams.
Whole calculus	97.0
Portion analyzed	43.6
Cortex, or first layer, analyzed	37.2
Second, third, fourth, and fifth layers (inseparable)	5.3
Sixth layer, analyzed	0.9
Seventh layer, or nucleus	0.2

Weight by proportion.

	Grams.
Whole cortex	82.8
Whole second, third, fourth, and fifth layers	11.8
Whole sixth layer	2.00
Whole seventh layer, or nucleus	0.4

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex of first layer (brownish).	Uric acid	Calcium oxalate.
Second layer (reddish)	do	Do.
Third layer (dark red)	Calcium oxalate	Uric acid.
Fourth layer (whitish)		
Fifth layer (dark red)		
Sixth layer (brownish)	Uric acid	Calcium oxalate.
Nucleus (dark red)	do	Some calcium oxalate.

CASE 31 (GROUP IV)

B. D. (47613), 4 years old, Filipino boy; born and living in Tondo, Manila; admitted to the hospital December 27, 1916, complaining of difficult and painful urination of about one month's standing. History of past illness and of beriberi unreliable. Nutritional condition undetermined.

Clinical diagnosis.—Cystolithiasis and acute abscess of abdominal wall.

Urine examination.—Reaction, alkaline; sugar, negative; albumin, an appreciable trace. Microscopic, numerous erythrocytes and a few degenerated epithelial cells.

Cystolithotomy was performed December 29, 1916, and the patient was discharged February 11, 1917.

Calculus analysis (one dull whitish stone).

	Grams.
Whole stone	5.5
Portion analyzed	2.0
Cortex analyzed	0.9
Medullary layer analyzed	0.8
Nucleus analyzed	0.3

Weight by proportion.

	Grams.
Whole cortex	2.5
Whole medullary layer	2.2
Whole nucleus	0.8

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex	Amorphous phosphate and calcium carbonate.	Calcium oxalate and trace of ammonium urate.
Medullary layer	Calcium carbonate	Amorphous phosphate, calcium oxalate, and ammonium urate.
Nucleus	do	Calcium oxalate, ammonium urate, and amorphous phosphate.

The analysis of each layer of an individual calculus is given as each may be regarded as a distinct stone formation. It should be recalled that a stone is formed, in the presence of a binding substance, around a nucleus, which may be a mass resulting from an inflammatory process of the vesical mucosa (pus, blood, or bits of necrotic tissue), or foreign bodies such as fragments of bougies, pins, silk sutures, or a previously formed stone which may have come from the kidney, or one that has been formed earlier in the bladder around which other layers of stone are formed with the same or different chemical composition.

The disposition of the bladder calculus in layers of different chemical substances may be the result of a change in the composition of urine secondary to a modified general metabolic process. Sondern,(22) in speaking of the increase of the calculus in size, says that—

> The abnormal condition during which the nucleus is found may be temporary and that the stone can continue to grow in size even if normal urine is excreted.

Once the nucleus of stone is formed around a mass of "foreign body" coated by the binding substance or albuminoid framework, the tendency is toward a more or less continuous deposit of practically the same chemical substances in almost the same proportions as in the original primary stone. It is possible that with the decline of health, usually secondary to faulty metabolism and nutrition, unfavorable fermentative changes may take place inside the bladder, which may subsequently give rise to the formation of a second layer of stone of distinct chemical composition, thereby making the primary calculus the nucleus of the second stone which Wells (25) considers a secondary calculus. Because of the injury produced by the resulting calculus, the condition may aggravate or the disease and general nutrition may improve as a result of treatment. In either case, a third layer of stone is formed with different chemical composition around the two-layered already existing calculus as a nucleus. This last layer may be considered as a third stone formation. Incidentally the analysis of several cases of multiple calculi removed (as in case 25) show that the medullary layer—that is, the layer outside of the nucleus—of the larger one is chemically almost indentical with the nucleus of the two-layered smaller one and the cortices, or the outside layers, of both are similar, as indicated in fig. 1.

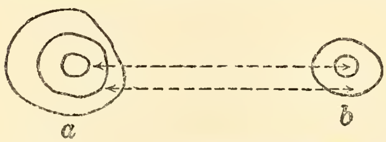

FIG. 1. Two- and three-layer calculi.

It is apparent that the first stone formation (primary stone) of *b* took place simultaneously with the second layer of *a* and that the two-layered calculus of *a* acted as a nucleus of the third layer, thus playing the rôle of the primary stone of *b*. Consequently, for a given stone there are as many stone formations as there are layers, which may or may not be physically and chemically distinct from one another.

From the fifty-eight cases examined there have been made out one hundred eighty-nine different layers or stone formations, the compositions of which are given in the following tables. In instances of multiple calculi the chemical composition of the largest stone is the only one considered.

In the beriberi cases, Group I, thirty-six layers, 66.67 per cent, were chiefly phosphatic; and in those cases, Group II, having histories of poor nutritional condition fifty-nine layers, 72.88 per cent, were phosphatic. In the group of well-nourished individuals, Group III, seventy-six layers, there were 40.79 per cent of uric acid and urates, against 36.84 per cent of chiefly phosphatic layers. In Group IV, where the nutritional condition was not noted in the clinical record, the incidence of phosphatic composition is also higher (nine layers or 50 per cent phosphate) against five layers or 27.77 per cent of uratic concretions.

TABLE I.—*Percentage of incidence of the chief constituents of the different layers.*

Chief constituents.	Group I.		Group II.		Group III.		Group IV.		Total.	
	Layers.	Inci-dence.	Layers.	Inci-dence.	Layers.	Inci-dence.	Layers.	Inci-dence.	Layers.	Inci-dence.
		Per cent.		*Per cent.*		*Per cent.*		*Per cent.*		*Per cent.*
Phosphates (amorphous, triple, and calcium)	24	66.67	43	72.88	28	36.84	9	50.00	104	55.03
Urates (uric acid and ammonium urate)	8	22.22	10	16.95	31	40.79	5	27.77	54	28.57
Oxalate (calcium)	2	5.56	4	6.78	12	15.79	1	5.56	19	10.05
Carbonate (calcium)	2	5.55	1	1.70	2	2.63	2	11.11	7	3.70
Mixed (phosphate and urate, phosphate and oxalate, phosphate and carbonate)			1	1.69	3	3.95	1	5.56	5	2.65
Total	36		59		76		18		189	100.00

TABLE II.—*Incidence of chief constituents in nuclei.*

Chief constituents.	Group I.		Group II.		Group III.		Group IV.		Total.	
	Number.	Inci-dence.	Number.	Inci-dence.	Number.	Inci-dence.	Number.	Inci-dence.	Number.	Inci-dence.
		Per cent.		*Per cent.*		*Per cent.*		*Per cent.*		*Per cent.*
Phosphate	5	45.4	13	72.2	7	30.4	2	33.3	27	44.6
Urates	3	27.2	3	16.7	10	43.5	2	33.3	18	31.0
Oxalates	2	18.2	1	5.55	4	17.4	1	16.7	8	13.8
Carbonates	1	9.1	1	5.55	2	8.7	1	16.7	5	8.6
Total	11	100	18	100	23	100	6	100	58	100

The totals for one hundred eighty-nine layers show one hundred four layers or 55.03 per cent with phosphates as the chief constituents, and fifty-four layers or 28.57 per cent of chiefly uratic composition. Oxalates occurred as chief constituents in nineteen or 10.05 per cent of the layers, carbonates in seven or 3.7 per cent, and there were five layers or 2.65 per cent with mixed phosphate and urate, phosphate and oxalate, and phosphate and carbonate as the chief constituents. Table II shows the chief constituents of the primary stones.

The percentage of primary phosphatic calculi is greatest in the individuals belonging to Groups I and II, in whom the nutritional condition was below par. In Group III, where the percentage of urates predominates, the affected individuals belong to a class with adequate food supply.

These findings are not in accord with the findings of foreign investigators. Wells(25) and others say that urate calculi exceed the rest in frequency. Ultzmann(24) found that out of five hundred forty-five cases of primary calculi 80.9 per cent were with nuclei consisting of uric acid (and urates), 5.6 per cent of calcium oxalate, 8.6 per cent of earthy phosphate, 1.4 per cent of cystin, and 3.3 per cent of some foreign body. Gordon's(13) statistics on his investigation of one hundred calculi which give a predominance of uratic stone in England may here again be recalled. Reed(20) reports a case in which the calculus was composed of urate and concentric rings of calcium oxalate with a colloid nucleus. Kahn and Rosenbloom(15) have analyzed a number of urinary calculi and in their conclusion they state:

1. The large majority of renal stones are composed of oxalate of lime.
2. Uric acid and the urates are found in all renal concretions, but it is rare to find a renal calculus that is mainly composed of the urates.

These same authors present analyses of two vesical calculi and both were made up almost exclusively of uric acid. Lastly Spiegel,(23) in an analysis of a large number of urinary stones, both renal and vesical, finds that only twenty of fifty stone formations contain phosphates, even as a minor constituent.

Oxalate stones which, according to Gordon and to Cabot,(6) may be derived from oxalate-containing vegetable foods, such as rhubarb and sorrel, are not common among Filipinos. While Spiegel and others believe that calcium carbonate calculi may originate from the excessive use of hard water (as is the common well water of the Islands), such stone formations are infrequent in this series. I have not found xanthine, urostealith, or fibrin calculi, which are occasionally mentioned in the literature.

, fibrin ; B, biliverdin.]

Other layers.			
ayer.	Weight.	Chief.	Minor.
	g.		

TABLE III.—*Classification of cases of cystolithiasis.*

[Pt, triple phosphate; Pa, amorphous phosphate; Pc, calcium phosphate; U, uric acid; Ua, ammonium urate; Uas, acid sodium urate; Oc, calcium oxalate; Cc, calcium carbonate; Cy, cystin; F, fibrin; B, biliverdin.]

Serial No.	Case No.	Sex.	Age.	Married or single.	Occupation.	Locality.	Duration of illness.		Weight of stone.	Chemical constituents of stone. Cortical layer.			Medullary layer.			Nucleus.			Other layers.			
										Weight.	Chief.	Minor.	Weight.	Chief.	Minor.	Weight.	Chief.	Minor.	Layer.	Weight.	Chief.	Minor.
GROUP I. CASES SHOWING POSITIVE HISTORY AND SIGNS OF BERIBERI OR OTHER NUTRITIONAL DISTURBANCES.																						
							Yrs.	mos.	g.	g.			g.			g.				g.		
1	19	M	35	M	Farmer	Rosario, Batangas	6		17.0	8.6	Pa	Oc	7.6	Pa	Oc	0.9	Pa	Oc				
2	25	M	8	S	None	Meycawayan, Bulacan	1		20.0	11.8	Pc	Ua, U, Cc	7.8	Pt	Ua, Cc	0.4	Pa	Ua, Cc				
3	49	M	63	M	Farmer	Malabon, Cavite	10		55.5	16.6	U	Oc, F	39.4	U	Oc, F	0.6	U	Oc, F				
4	61	M	25	M	Plumber	Apalit, Pampanga	2		16.0	11.0	Pt	Ua, Cc	17.0	Pt	Ua, Cc	2.0	Pa	Ua				
5	53	M	25	M	Fisherman	Bulacan, Bulacan	1		20.5							1.9	Oc	Pa, Ua	Cortex and second	11.4	Pa, Pt	Oc, Cc.
																			Third and fourth	9.4	Pa	Ua, Oc, Cc.
																			Fifth	3.8	Pa	Ua, Oc, Cc.
6	54	M	67	M	Ticket collector	Santa Cruz, Laguna	10		70.0	33.7	Pt	Ua, Cc				1.7	Pa, Pt	Oc, Cc	Second	9.7	Pt	Ua, Cc.
																			Third	24.9	Pa, Pt	Oc, Cc.
7	55	M	30	M	Seller	Taytay, Rizal	1		1.0	1.0	Pa	Cc					Oc					
8	56	M	30	M	Laborer	Lubao, Pampanga	2		15.0	6.0	U	Pa, Oc	7.4	U	Pa, Oc	1.6	U	Oc, Cc				
9	57	M	37	M	Farmer	Taal, Batangas	1		9.6	4.7	Pa	Cc	3.6	Cc	Pa, Oc	1.2	Cc	Pa				
10	58	M	60	M	Laborer	Binangonan, Rizal	1	2	23.5	9.1	Pt	Ua, Cc	11.7	Ua	Pt, U, Oc	2.7	Ua	Pt, U, Oc				
11	62	M	22	S	Soldier	Botolan, Zambales		2	30.0	11.0	Pt	Ua, Cc	17.0	Pt	Ua, Cc	2.0	Pa	Ua				
GROUP II. CASES NOT INCLUDED IN GROUP I, BUT WHO ARE UNDERNOURISHED INDIVIDUALS FROM THE LABORING CLASS.																						
1	1	M	16	S	Painter	Sampaloc, Manila			13.2	1.9	Pa	Oc, Cc				1.3	Pa	Ua, Oc	Second	7.4	Pa	Oc, Cc.
																			Third	2.6	Pa	Ua, Oc.
2	3	M	16	S	Student	Apalit, Pampanga	5		71.2							6.1	U	Pa, Oc	Cortex and second	28.6	U	Pa, Oc.
																			Third	16.3	U	Pa, Oc.
																			Fourth and fifth	20.3	U	Pa, Oc.
3	5	M	13	S	None	Binalonan, Pangasinan		2	37.0	27.4	Pa	Cc, Cy	7.7	Pa	Oc, Cc, Cy	1.9	Pa	Cc, Cy				
4	8	M	50	M	Farmer	Cabanatuan, Nueva Ecija			7.0	3.4	Pc	Ua, Oc	3.4	Pc	Ua, Oc	0.25	Pc	Ua, Oc				
5	9	F	13	S	Student	Santa Tomas, Batangas	6		31.5	11.5	Pt, Pa	Ua, Cc				0.8	Pt, Pa	Ua, U	Second	10.9	Pa, U	Ua, Cy.
																			Third	8.3	Oc	Pt, Pa.
6	11	F	16	S	Servant	San Jose, Nueva Ecija	2		26.0	13.5	Pt	Ua, Cc	11.4	Pa	Pt, U, Ua, Cc	1.1	Cc	Pa, Ua				
7	13	M	11	S	Student	Pulilan, Bulacan	5		27.0	13.6	Pt	Ua	12.5	Pt	Ua, Oc	1.0	Pt	Ua, Cc				
8	18	M	13	S	do	Balayan, Batangas	8		26.0	10.0	Pt, Pa.	Ua, Oc, Cc	16.0	Pt, Pa	Ua, Oc, Cc	1.0	Pa	Ua, Oc				
9	22	M	12	S	Laborer	Cabanatuan, Nueva Ecija	3		22.6	15.4	Pc	Ua	6.1	Pc	Ua	1.0	Pc	Ua, Oc, Cc				
10	26	M	8	S	None	Siniloan, Laguna	4		7.7	2.9	Pt, Pa	Ua, Oc, Cc	4.1	Pt, Pa	Ua, Oc, Cc	0.7	Pt	Ua, Oc, Cc				
11	27	M	46	M	Farmer	San Carlos, Pangasinan	1		11.5	0.7	Oc	Pa	9.0	Oc	Pa	1.8	Pa	U, Oc				
12	32	M	47	M	do	Lubao, Pampanga	3		8.5	3.2	Pt, Pa	Ua, Oc, Cc, Cy	4.7	Pt, Pa	Ua, Oc, Cc, Cy	0.6	Pt, Pa	Cc, Cy				
13	33	M	33	M	do	Tanawan, Batangas	8		55.0	15.0	Pt	Ua, Cc	37.9	Pc	Ua, Cc	2.1	Ua	Pc				
14	34	M	20	M	do	Apalit, Pampanga	1		20.0	6.4	Ua	Pa, Oc	11.8	U	Pa, Oc	1.8	U	Pa, Oc				
15	35	M	4	S	None	Tondo, Manila	1		11.0	6.4	Pt	Ua, Oc, Cc	37	Pt	Ua, Oc, Cc	19	Pa	Ua, Oc, Cc				
16	40	M	30	M	Shoemaker	Lucban, Tayabas	2		26.0							1.7	Oc	Pa, Ua	Cortex and medullary	24.3	Pt	U, Ua, Oc, Cc.
17	41	M	53	M	Carpenter	Calumpit, Bulacan	3		35.0	23.8	Pt, Pa	Ua, Oc, Cc	7.8	Pt, Pa	Ua, Oc, Cc	3.4	Pt, Pa	Ua, Oc, Cc				
18	46	M	17	S	Farmer	Cabanatuan, Nueva Ecija	1		55.0	32.6	Pa	U, Oc	18.3	Pa	U, Oc	4.1	Pa	U, Oc				
GROUP III. CASES OF HIGH SOCIAL STANDING OR THOSE WHO SHOULD HAVE ADEQUATE DIET.																						
1	2	M	30	M	Laborer	Calumpit, Bulacan	6		25.0	8.1	Pa	Oc, Cc	11.0	Pa	Oc, Cc	5.9	Cc	Pa, Oc				
2	4	M	68	M	do	Bacoor, Cavite	1		21.0	13.6	U	Pa,	6.4	U	Pa	1.00	U	Oc				
3	6	M	65	S	do	Baliwag, Bulacan	2		62.5	11.8	Ua	Pt, Cc, Uas				3.2	Ua	Pt, Oc	Second and third	47.5	Ua	Pt, Oc.
4	7	M	38	S	do	Apalit, Pampanga	12		181.0	81.6	U	Pa, Oc	100.0	Pa, U	Oc, Cc	2.4	Oc	U, Cc				
5	10	M	37	M	Farmer	Lipa, Batangas	1		8.0							0.5	Pa	Cc	Cortex and medullary	2.6	Pa	Cc.
6	14	M	10	S	Student	Ermita, Manila	6		38.0	13.9	Pt, Pa	Ua, Oc, Cc	21.0	Pt, Pa	Ua, Oc, Cc	2.2	Cc	Pt, U, Oc				
7	15	M	6-½	S	None	Agoo, La Union	2	6	6.0	4.5	Pa	Ua, Cc	1.0	Pa	Ua, Cc	0.5	Ua	Pa, Oc, Cc				
8	16	M	32	M	Laborer	Salinas, Cavite	3		98.0	60.6	Pt, Pa	Ua, Cc	35.4	Pt, Pa	Ua, Cc	2.0	Pt, Pa	Ua, Oc, Cc				
9	17	M	29	S	Farmer	Imus, Cavite		10	18.1	9.4	Pt	Ua, Cc	8.1	Pt	Ua, Cc	0.6	Pt	Ua, Cc				
10	20	M	53	M	Bookseller	Ermita, Manila			28.5	10.5	Ua	Pa, B	14.8	Ua	Pc, B	3.2	U	Pc, B				
11	23	M	26	M	Laborer	Quingua, Bulacan	1		97.0	82.8	U	Oc				0.4	U	Oc	Second		U	Oc.
																			Third	11.8	Oc	
																			Fourth			U.
																			Fifth			
																			Sixth	2.0	U	Oc.
12	24	M	40	M	Laborer	Tanay, Rizal	5		27.0	9.0	U	Pc, Ua, Oc	16.9	U	Pc, Ua, Oc	1.1	U	Pc, Ua, Oc				
13	28	M	42	M	Carpenter	Malate, Manila	1		28.5	11.4	Pt	Oc, Cc	5.8	Pt	Ua, Oc, Cc	1.3	Pt	Ua, Oc, Cc				
14	29	M	6	S	Student	Cabanatuan, Nueva Ecija	5		4.2	0.6	Oc	Pa	3.2	Oc	Pa, Ua	0.4	U	Pa				
15	36	M	25	M	Laborer	Mexico, Pampanga	2		6.7	4.2	Pa, Oc	Oc	1.7	Pa, Oc		0.8	Pa	Cc				
16	37	F	60	M	Housewife	Baliwag, Bulacan	1		23.0							14.5	U	Pa	Cortex and medullary	8.5	U	Pa, Ua, Oc.
17	38	M	28	M	Laborer	Tui, Bataan	1		25.0	16.3	Pa	Oc	7.7	U	Pa, Oc	1.0	Oc	Pa, U, Oc				
18	39	M	46	M	Farmer	Tanay, Rizal	4		54.0	25.8	Pa	Cc	24.5	Pa	Cc	3.7	Pa	Cc				
19	43	M	35	M	do	Antipolo, Rizal	2		23.5	6.2	U	Pa, Oc	17.0	U	Pa, Oc	1.3	Oc	Pa, U				
20	44	M	14	S	Helper	Ibaan, Batangas	1		10.9	3.5	Ua	Oc	6.1	Ua	Pa, Oc	1.8	Ua	Cc				
21	47	M	16	S	Laborer	Mariquina, Rizal			37.5	9.4	Pt	Cc				1.0	Pc	Ua	Second	16.7	Pa	Ua, Cc.
																			Third	4.2	Pa	Ua, Oc, Cc.
																			Fourth	6.2	Pa	Ua, Cc.
22	48	M	58	M	Farmer	Talisay, Batangas	1	6	11.0	7.0	Ua		3.3	Oc	Pc, Ua, Oc	0.7	Ua	Pc				
23	50	M	28	S	Laborer	Quingua, Bulacan	7		14.5	5.8	Oc	U, Ua	7.7	Oc	U	1.0	Oc	U				
GROUP IV. CASES WITH UNDETERMINED NUTRITIONAL CONDITION.																						
1	12	M	18	S	Laborer	Nakiilang, Tayabas	5		23.5	12.9	U	Pa	9.4	U	Pa	1.2	U	Pa, Oc				
2	21	M	12	S	None	Santa Maria, Bulacan	2		4.4	1.4	Pt	Ua, Oc, Cc	2.5	Pt	Ua, Oc, Cc	0.5	Pt	Ua, Oc, Cc				
3	30	M	60	M	Laborer	Iba, Zambales	1		16.5	8.7	Pa	U	5.0	U	Pa	1.2	U	Pa				
4	31	M	4	S	None	Tondo, Manila	1		5.5	2.5	Pa, Cc	Ua, Oc	2.2	Cc	Pa, Ua, Oc	0.8	Cc	Pa, Ua, Oc				
5	42	M	49	M	Laborer	Naangan, Batangas	3		20.0	7.0	Pa	Ua, Oc, Cc	10.0	Pa	Ua, Oc	3.0	Oc	Pa, Ua				
6	45	M	40	M	Farmer	Apalit, Pampanga	1		55.5	24.4	Pa	Ua, Cc	27.3	Pa	Ua, Cc	3.8	Pt, Pa	Ua, Cc				

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An inference might be drawn from comparison of my findings among Filipinos with those among Caucasians. The association of phosphatic calculi in the cases here classified as undernourished (with an unbalanced diet), and the frequency of urate stones among a class of people with nourishment sufficient for normal physiological processes are points that strongly agree with the incidental findings of Osborne and Mendel(19) in their experiments upon animals. As a whole, the total phosphatic estimates give an incidence of more than half of the total number of calculi among Filipinos. It is possible that quite a number of the cases at hand, although suffering from the so-called latent form of beriberi or other nutritional-deficiency disease, did not give any history nor present any suspicious sign of the disease at the time of admission, and in many instances the malady may have been entirely overlooked (Manalang,(17) Saleeby(21)). All but one of my cases (cases 49 to 58, Group I) gave a positive history of having had beriberi, and in this particular case the stone was essentially oxalate in composition. In only two of the beriberi cases were the calculi made up mainly of urates, and therefore the percentage of phosphatic stone formations in association with this disease is greatest.

The character of the stone deposit is partly dependent upon the influence of the urine reaction. Thus Ballenger and Elder,(3) in speaking of the cementing substance that holds the crystals together to form the calculus, say:

This doubtless varies with different stones according to the acidity or alkalinity of the urine. Stones composed of uric acid, urates, calcium oxalate, cystin and xanthin develop in acid urine while those consisting of calcium carbonate and acid phosphate of calcium arise in alkaline urine. Stones of ammonium or magnesium phosphate are precipitated from stagnant urine with local infection and inflammation.

Spiegel, in his series of chemical analyses, has corroborated this fact. Kahn and Rosenbloom, however, slightly differ from this view. These authors state:

While uric acid and acid salts are soluble in alkaline medium and insoluble in acids, the exact opposite holds good for calcium oxalate and calcium phosphate, which are deposited in alkaline medium and dissolved in acids.

Blatherwick(4) says:

High urinary acidity favors the formation of uric acid calculi, which comprise from 60 to 81 per cent of all urinary concrements.

Wells states that:

"Phosphate calculi are formed as a result of decomposition of the urine, with the formation of ammonia from the urea. In the ammoniacal solution thus formed the magnesium is precipitated as NH_4MgPO_4, the calcium as $Ca_3(PO_4)_2$ and calcium oxalate and ammonium urate are also thrown down, so that the concretions consist of a mixture of these substances, the magnesium salts being the most abundant." He then goes on to say that "the formation of phosphatic concretions is always a matter of urinary reaction and not of diet."

Due to lack of data as to the reaction of the urines before the onset of the disease, the present urine examinations are to be correlated with the chemical composition of the cortex or outside layer of the stones. In my series there are cases of alkaline urine where the stone is covered with uric acid or urate cortex. The latter phenomenon may be explained by the presence of inorganic phosphates, or by the fact that the alkaline fermentation has not yet been brought to completeness. The opposite condition may be true with the phosphate or carbonate stone in an acid medium. The neutral urine, on the other hand, may be a transitional stage in the process of ammoniacal fermentation in the urine brought about by infection, or may result from the so-called "alkaline tide." That food influences the reaction of the urine is shown by Blatherwick, who states:

In general, foods yielding an alkaline ash were found to decrease urinary acidity, while those yielding an acid residue increased it.

The urine of Filipinos is normally less acid than that of Americans or Europeans, owing chiefly to the low protein content of their diet, which consists chiefly of rice and a little fish among the poorer classes. The reaction of the urine from the cases on admission to the hospital may be compared with the composition of the cortices of the calculi in forty-nine cases of the series. Thus there were found in acid urines nine phosphate and nine urate or uric-acid cortices and one oxalate cortex; in alkaline or neutral urines, there were twenty-three phosphate and four uric-acid or urate cortices, one oxalate cortex, and one oxalate and phosphate cortex. The results show a tendency toward the formation of phosphate concretions in neutral or alkaline urines in accord with the literature.

Taking the composition of the nuclei of the stones for comparative reference in regard to the age when the first symptoms of cystolithiasis developed (which may not coincide with the exact date of the beginning of the formation of the urinary stone), we have Table IV.

We notice that among these fifty-eight cases there was a greater incidence of stone formation in children and young adults, contrary to the opinion of Bugbee,(5) who found a greater frequency of vesical calculi among patients past middle life. It is also to be noted that in the first four decades, and even among the undetermined cases, except one who is more than 50 years of age, the phosphatic calculi take the lead, while in the fifth and sixth decades of life, the urates predominate. This finding is contrary to that of Cabot who states that uric acid and calcium oxalate are often found in the urine of poorly nourished children due to imperfect oxidation of the tissues, and of old individuals who take food beyond their power of assimilation. Also Ellinger(10) considers stone in children to be almost always uratic in composition.

TABLE IV.—*Age incidence with reference to the composition of the nuclei.*

Chief constituents.	Age in years.						
	1 to 14.	14 to 20.	21 to 30.	31 to 40.	41 to 50.	51 to 60.	61 to 70.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Phosphates	52.9	100	35.3	50	66.7	20	
Urates	29.4		23.5	16.7	16.7	80	100
Oxalates			35.3	16.7	16.6		
Carbonates	17.7		5.9	16.6			
Total (cases)	17	1	17	6	6	5	2

Chief constituents.	Undetermined	Total.
	Per cent.	*Per cent.*
Phosphates	75	46.6
Urates	25	31.0
Oxalates		13.8
Carbonates		8.6
Total (cases)	4	58

The occupation of the patient at the time when the stone was removed may have a bearing on the composition of the latest stone formation, which is the cortical layer. Table V gives an idea of the chief constituents of cortex with reference to the latest occupation of the patient.

It is noticed that stone formation is of more frequent occurrence among ordinary laborers and farmers; and in all branches of occupation the phosphatic calculi are most frequent in incidence. Concepcion has pointed out the insufficiency of the earnings of the average unskilled laborer for the proper maintenance of a family under sanitary conditions. The general poverty of the laboring class naturally predisposes them to nutritional disorders. As a rule farmers are vegetarians, and their circumstances of living are such that they consume very little or no

TABLE V.—*Incidence of chief constituents of cortex of calculus as related to present occupation.*

Chief constituents.	Laborers.	Farmers.	Boys without occupation.	Students.	Miscellaneous.[a]	Total.
Phosphates	8	10	6	4	10	38
Urates	7	4		1	3	15
Oxalates	1	1		1		3
Phosphates and oxalates	1					1
Phosphates and carbonates			1			1
Total	17	15	7	6	13	58

[a] Carpenters, sellers, plumbers, fishermen, etc.

meat. Boys without occupation would naturally be dependent on the earnings of their parents, whose income is, in many instances, not sufficient for the maintenance of a normal physiological existence. Students in the public schools who come from the average family do not as a rule receive enough allowance to provide them with a wholesome and nutritious food on account of the high cost of living in the city. The remaining cases (included under miscellaneous) belong to a class of occupations with relatively low earnings and consequent low standard of living and probable deficiency in nutrition.

The distribution of cystolithiasis may be of some value in tracing the nutritional relations, particularly of the phosphatic calculi. Foreign authors attribute the irregularity of distribution to the habits of the people, their mode of living, selection of food and drink, and climatic conditions (Morton(18)). This investigator in his clinical lecture delivered at the Long Island College Hospital pointed out the prevalence in India of stones that are primarily uratic, infiltrated with oxalates and triple phosphates, and only found among the legumen eaters. Gordon also found a predominance of uratic stones in England, and says: "It has been attributed, we think erroneously to eating meats." The same author attributes the prevalence of stone in Holland to the hard-water supply, contrary to the opinion of Lewis(16) who maintains that:

The problem of oxalurics is not to prevent the introduction of calcium salts but the absorption of exogenous oxalic acid in the foodstuffs.

In the Philippines the phosphate stones predominate in almost all of the provinces concerned except Pampanga. Table VI gives this incidence, and the character of the stone here is determined by the chemical composition of the cortex, as this may be affected by the regional conditions under which the patient was living at the time immediately previous to the removal of the stone.

TABLE VI.—*Number of cases of cystolithiasis by provinces and by constituents of the stones.*

Province.	Phosphate.	Urate.	Oxalate.	Phosphorus oxalate.	Phosphorus carbonate.	Total.
Bataan	1					1
Batangas	7	2				9
Bulacan	6	3	1			10
Cavite	2	2				4
Laguna	2					2
La Union	1					1
Manila	4	1			1	6
Nueva Ecija	4		1			5
Pampanga	3	4		1		8
Pangasinan	1		1			2
Rizal	4	2				6
Tayabas	1	1				2
Zambales	2					2

The social condition and sex may here be disregarded because they would not have any influence in changing the dietetic condition of the patient.

SUMMARY AND CONCLUSIONS

The observations of Osborne and Mendel on rats indicate a possible association of dietetic deficiency with the formation of phosphatic urinary calculi. The Filipino diet is essentially of an insufficient and limited character, particularly in its vitamine content. Beriberi is still frequently encountered in these Islands, and Saleeby and others have indicated the frequency of the disease in a latent form which, with further limitation in diet, may become active and widespread. My personal experience in the Philippine General Hospital confirms this view. The results of the present investigation show that a relation apparently exists between the general dietetic inadequacy and deficiency among Filipinos and the incidence of phosphatic calculi, in contrast with the reported predominance of uric acid and urate calculi in Europe and the United States.

Of ten cases of cystolithiasis which I have particularly studied since this investigation was undertaken, nine not only gave a history of having had beriberi, but exhibited actual signs referable to the disease. Although the clinical data of all but two of the other forty-eight cases are, as a whole, obscure with respect to the history of nutritional disease, still they indicate that the majority of the patients were undernourished and underdeveloped. It is probable that among these forty-eight cases, there were many, besides the two, who were beriberic either in active or latent form, as the symptoms of beriberi were not especially looked for in preparation of their clinical histories from a purely surgical standpoint.

The cases studied have been classified into four groups; (I) eleven cases, nine of which were my own, giving positive history or signs of beriberi; (II) eighteen cases with an unreliable history of beriberi, but undernourished and from the poorer class; (III) twenty-three well-nourished and well-developed individuals; and (IV) six cases of uncertain nutritional condition.

The percentage of primary phosphatic calculi (nuclei), as determined by qualitative tests, is greatest in the individuals belonging to groups I and II, being 45.4 and 72.2, respectively. Primary urate calculi were most frequently found in the well-nourished cases (group III), occurring in 43.5 per cent of these cases.

Of the one hundred eighty-nine layers from fifty-eight stones examined, one hundred four layers or 55.03 per cent were phosphatic in composition; fifty-four or 28.57 per cent, uratic; nineteen or 10.05 per cent, oxalates; seven or 3.70 per cent, carbonates; five or 2.65 per cent, mixed phosphate and urate, phosphate and oxalate, and phosphate and carbonate.

A majority of the cases occurred in children and young adults. Uric acid or urate nuclei were found in six out of eight cases over 50 years of age, while phosphates predominated in the earlier decades.

The classification of the cases as regards occupation indicates the prevalence of stone formation chiefly among laborers and farmers. The provincial distribution of the cases is as follows: Bulacan, 10; Batangas, 9; Pampanga, 8; Rizal, 6; Manila, 6; Nueva Ecija, 5; Cavite, 4; other provinces, 10. Phosphate cortices predominated in all occupations and in all the provinces except Pampanga.

Among forty-nine cases the chief constituent of the cortices was phosphate in twenty-four cases, with a neutral or alkaline urine, and in nine cases with an acid urine. The reaction of Filipino urine is normally acid, but to a less degree than in the United States and Europe because of the low protein intake.

It is apparent, therefore, that the inadequate dietetic conditions among Filipinos and concomitant nutritional disorders such as beriberi favor the formation of phosphatic stones, owing to the low daily protein intake and the lessened acidity of the urine resulting therefrom.

I wish to extend my profound gratitude to Dr. Potenciano Guázon, chief of the department of surgery, College of Medicine and Surgery, University of the Philippines, for the exceptional opportunities he has given me to utilize the stones in the museum of the operating room of the Philippine General Hospital for chemical analysis. To Prof. Bowman Corning Crowell, chief of the department of pathology and bacteriology, University of the Philippines, I express my sincere appreciation for his strong encouragement in the present study. I acknowledge the valuable coöperation of my colleague, Doctor Aguilar, who has many times taken my place when on duty in the hospital. But above all, I wish to express my due acknowledgment and most hearty appreciation to Prof. Robert Banks Gibson, chief of the department of physiology, University of the Philippines, for his suggestions and priceless help in the preparation of this paper.

BIBLIOGRAPHY

(1) ANDREWS, V. L. Infantile beriberi. *Philip. Journ. Sci.* § B 7 (1912) 67.

(2) ARON, HANS, and HOCSON, FELIX. Phosphorus starvation with special reference to beriberi: II. *Philip. Journ. Sci.* § B 5 (1910) 98.

(3) BALLENGER, E. G., and ELDER, O. F. Stones in the urinary tract. *New York Med. Journ.* 105 (1917) 203–205.

(4) BLATHERWICK, N. R. Diet in the treatment of nephritis and urinary calculi. *New York Med. Journ.* 102 (1915) 362.

(5) BUGBEE, H. G. A clinical study of lithiasis based on a series of one hundred and ninety-eight cases. *Journ. Am. Med. Ass.* 69 (1917) 1492–1498.

(6) CABOT. Keen's Surgery. New York 4 (1914) 335.

(7) CHAMBERLAIN, W. P., VEDDER, E. B., and WILLIAMS, R. R. Etiology of beriberi. *Philip. Journ. Sci.* § B 7 (1912) 39.

(8) CONCEPCION, I. A study of the nutrition of the Filipinos. Read before the IV Asamblea Regional de Médicos y Farmacéuticos de Filipinas, February 4–8, 1918.

(9) DE HAAN, J. On the etiology of beriberi. *Philip. Journ. Sci.* § B 5 (1910) 65.

(10) ELLINGER, ALEXANDER. Harnsteine. Oppenheimer's Handbuch der Biochemie 3^1 (1910) 681.

(11) FRASER, HENRY, and STANTON, A. T. Etiology of beriberi. *Philip. Journ. Sci.* § B 5 (1910) 55.

(12) GIBSON, R. B. Influence of compensated salt mixtures on the development of polyneuritis gallinarum and beriberi. *Philip. Journ. Sci.* § B 8 (1913) 351.

(13) GORDON, G. S. Origin of the various constituents found in urinary stone. *Northwest Med.* n. s. 3 (1911) 110.

(14) HIGHET, H. C. Beriberi in Siam. *Philip. Journ. Sci.* § B 5 (1910) 73.

(15) KAHN, MAX, and ROSENBLOOM, JACOB. A report of some new chemical analyses of urinary calculi. *Journ. Am. Med. Ass.* 59 (1912) 2252.

(16) LEWIS, B. Multiple vesical calculi: over 1700 present. *Trans. Am. Urol. Ass.* 8 (1914) 310.

(17) MANALANG, C. Degeneration of peripheral nerves. *Philip. Journ. Sci.* § B 12 (1917) 169.

(18) MORTON, H. H. Stone in the bladder. *Medical Times* 45 (1917) 37–39

(19) OSBORNE, T. B., and MENDEL, L. B. The incidence of phosphatic urinary calculi in rats fed on experimental rations. *Journ. Am. Med. Ass.* 69 (1917) 32.

(20) REED, T. W. Vesical calculus: Report of a case. *U. S. Naval Med. Bull.* 10 (1916) 680.

(21) SALEEBY, N. M. The most important medico-economic problem of the Philippine Islands. *Philip. Journ. Sci.* § B 10 (1915) 88.

(22) SONDERN, F. E. Analysis of differentiated urine. *Post Graduate* 26 (1911) 64.

(23) SPIEGEL, L. Über die Zusammensetzung von Nierensteinen. *Ber. Deutsch. Pharm. Gesellsch.* 9 (1899) 318.

(24) ULTZMANN. Cited by Mandel, T. A., in Hammarsten, Olaf. Text Book of Physiological Chemistry 51 (1911) 616.

(25) WELLS, H. G. Chemical Pathology. W. B. Saunders Co. (1907) 380.

(26) WILLIAMS, R. R., and SALEEBY, N. M. Experimental treatment of human beriberi with constituents of rice polishings. *Philip. Journ. Sci.* § B 10 (1915) 99.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Diagrammatic representation of two- and three-layer calculi.

THE GROWTH OF HEVEA BRASILIENSIS IN THE PHILIPPINE ISLANDS

By Harry S. Yates

(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila)

ONE TEXT FIGURE

Probably no agricultural industry within the Tropics has undergone so remarkable a development during the past twenty years as has the plantation-rubber industry. *Hevea brasiliensis*, the principal source of plantation rubber, was first grown under cultivation when it was introduced into Ceylon about 1877.[1] Very little further planting was done until the experimental stage was passed and seed became available in quantity. The beginning of the cultivation of *Hevea* in Ceylon may be said to date from about 1890 to 1895 though for the first ten years development was comparatively slow. In Malaya *Hevea* attracted very little attention until about 1897, when, coffee becoming less profitable, planters saw the need of some product to supplement or replace it. However, when the Malayan planters did turn their attention to rubber, the development of the industry, stimulated by the high price prevailing for the product, took place very rapidly; and at present Malaya produces a very large share of the plantation rubber of the world. The cultivation of *Hevea* having proved successful and profitable in Ceylon and Malaya, many plantations have been started in other countries; more especially in Sumatra, Java, Borneo, India, Burma, Cochin China, New Guinea, and other places in the Asiatic Tropics, the Gold Coast and elsewhere in Africa, and in various parts of tropical America. The area planted to rubber in Malaya alone up to and including 1916 was 385,372 hectares (951,870 acres),[2] while the total area planted to rubber in the

[1] Those interested in an account of the early development of the industry are referred to Petch, Notes on the history of the plantation rubber industry of the East, *Ann. Roy. Bot. Gard. Peradeniya* 5 (1914) 433–520; and Burkill, The treatment to which the Para rubber trees of the botanic gardens, Singapore, have been subjected, *Gardens' Bull.* 1 (1915) 247–295.

[2] India Rubber Journ. No. 13, 55 (1918) 10.

Dutch East Indies in 1916 has been estimated at 209,312 hectares (517,000 acres).[3]

Although the United States takes considerably more than one-half [4] of the world's supply of crude rubber, very little is produced in American territory. Unmanufactured India rubber imported into the United States during the year ending December 31, 1917, amounted to 184,381,035 kilograms (405,638,278 pounds),[5] valued at 466,441,808 pesos. It is true that a part of this was wild rubber from South America, Africa, and elsewhere; but the imports of crude rubber in 1917 from the British and Dutch East Indies alone amounted to 115,915,868 kilograms (255,014,910 pounds), valued at 300,303,192 pesos. In view of this very large importation of rubber into the United States and the importance of the industries there dependent upon it, it would seem very desirable to develop a rubber-planting industry within American territory should land and climatic conditions suitable for the successful growth of *Hevea brasiliensis* be found.

There has long been a question as to the suitability of certain sections of the Philippines for the growth of *Hevea brasiliensis,* but notwithstanding its remarkable development in nearby countries the industry has received very little attention here. However, a small area of *Hevea brasiliensis* has been planted and is now producing rubber in profitable quantities; and, while it must be admitted that the industry has hardly passed the experimental stage, it has been demonstrated that rubber will grow and yield satisfactory returns in the Philippine Islands.

During the latter part of 1917 I had the opportunity of visiting the Basilan Plantation Company's estate on Basilan Island and while there made a number of girth measurments of trees of various ages. The results of these measurements are given in the present paper together with data regarding the climatic and soil conditions in the southern part of the Philippine Archipelago. The rate of growth of *Hevea brasiliensis* in the Philippines is compared with that recorded in other countries, and a comparison is made of the climatic conditions and soils of this part of the Philippine Archipelago with those in other countries, more especially in the Orient, where Para rubber is now being successfully cultivated.

[3] India Rubber World 54 (1916) 382.

[4] The India Rubber Journal No. 19, 55 (1918) 10 quotes a statement that in 1917 the United States took 71 per cent of the entire crude-rubber production of the world.

[5] India Rubber World 57 (1918) 384.

CLIMATIC CONDITIONS SUITABLE FOR THE GROWTH OF HEVEA

The original home of *Hevea brasiliensis* is in tropical South America along the Amazon and its tributaries, a region having a moist warm climate, and a fairly uniform distribution of rainfall. Meteorological data from the observatory at Belem (Para), located near the coast and slightly south of the mouth of the Amazon, indicate a climate with a rainfall averaging about 2,500 millimeters fairly evenly distributed throughout the year, though with a dryer season during September, October, and November. The temperature appears to be fairly uniform during the year; it averages about 25° C., and rarely falls below 20° C. or rises above 37° C. The distribution of rainfall by months and the number of rainy days in each month at Para are shown in Table I.

TABLE I.—*Rainfall at Belem (Para), State of Para, Brazil.*[a]

[Rainfall is given in millimeters.]

Month.	1907		1909		1910	
	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.
January	208.9	27	295.8	24	262.4	30
February	361.4	27	387.2	25	253.0	25
March	234.3	30	219.3	27	404.5	31
April	174.6	27	349.4	25	246.5	27
May	283.7	28	252.5	27	275.8	23
June	242.7	26	132.5	22	333.0	23
July	178.8	24	133.4	14	252.5	19
August	133.8	17	117.5	10	153.4	22
September	81.8	23	89.9	21	101.1	22
October	67.3	15	93.1	21	76.6	22
November	110.6	22	89.5	18	82.5	22
December	260.1	22	163.2	16	282.5	21
Totals	2,338.0	288	2,328.3	250	2,723.8	287

[a] From Bol. do Museu Goeldi 7 (1910) 48.

When a plant is introduced into new regions, it will usually be found to succeed best where the climate approaches that of its original habitat; and this rule has been found to apply to Para rubber. The successful growth of *Hevea* is not strictly limited to regions where conditions are precisely similar to those prevailing in the Amazon Valley; yet it certainly finds its optimum habitat in regions at comparatively low elevations, possessing a climate with a rainfall not much below 2,000 millimeters, evenly distributed throughout the year, and with a temperature rarely if ever falling much below 19° or 20° C., at least for any extended period. The

TABLE II.—*Rainfall at Isabela, Basilan, Philippine Islands.*[a]

[Rainfall is given in millimeters.]

Month.	1903		1904		1905		1906		1907		1908	
	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.
January	15.7	5	89.2	9	13.2	2	24.5	4	70.9	6	52.6	5
February	7.1	4	272.5	13	1.5	1	17.5	2	122.9	13	148.5	16
March	0.0	0	76.2	7	0.0	0	28.2	2	87.2	12	165.3	15
April	22.5	8	206.2	12	9.6	2	100.5	11	130.9	8	119.2	10
May	108.5	9	88.4	13	102.4	15	82.5	12	121.4	15	99.6	9
June	307.6	25	84.3	12	54.0	7	365.0	21	182.9	20	171.0	17
July	131.1	14	177.8	14	140.2	18	145.4	15	270.6	17	321.3	26
August	201.9	21	189.0	15	112.4	15	231.6	22	240.1	15	200.4	17
September	186.7	19	210.8	15	145.3	15	166.3	15	138.0	13	385.5	20
October	187.9	14	221.2	14	320.9	19	315.6	15	200.5	13	128.0	15
November	289.3	14	238.8	13	112.3	7	233.4	16	135.6	19	149.4	19
December	198.6	23	31.5	6	91.2	11	100.6	9	331.9	22	279.2	17
Totals	1,656.9	156	1,885.9	143	1,103.0	112	1,811.1	144	2,032.9	173	2,220.0	186

[a] From Saderra Masó, Annual amount and distribution of rainfall in the Philippines. Manila, Weather Bureau (1914) 28.

TABLE II.—*Rainfall at Isabela, Basilan, Philippine Islands*—Continued.

Month.	1909		1910		1911		1912		1913		Mean.	
	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.
January	56.7	16	43.9	11	68.9	7	108.3	5	54.4	7	54.4	7
February	142.7	12	56.6	9	152.2	9	28.8	4	31.3	4	89.2	7.9
March	25.4	5	130.0	11	0.0	0	1.8	1	126.4	14	58.2	6.1
April	29.9	8	105.7	14	173.5	4	32.3	7	50.4	10	89.2	8.5
May	142.8	21	41.1	17	224.8	19	62.1	11	114.6	15	108.0	14.2
June	163.1	18	334.6	25	65.5	13	329.3	23	258.9	23	210.6	18.5
July	369.4	18	121.0	18	116.9	9	314.7	20	184.0	13	208.4	16.5
August	283.1	23	319.6	23	212.6	14	96.5	14	176.1	12	205.8	17.4
September	155.4	15	368.2	27	138.9	16	104.6	10	217.9	11	201.6	16.0
October	364.3	17	215.6	17	275.8	12	369.0	17	280.3	15	261.7	15.4
November	178.1	19	335.1	22	13.3	3	48.6	8	118.7	9	168.4	13.5
December	59.7	12	155.8	11	97.2	7	33.0	9	146.1	6	138.6	12.1
Totals	1,970.6	184	2,227.2	205	1,539.6	113	1,529.0	129	1,759.1	139	1,794.1	153.1

humidity should also be fairly high. Such a climate is found only over limited areas within a few degrees on either side of the equator.

The amount and distribution of rainfall in the southern part of the Philippine Archipelago appears to be quite suitable for *Hevea brasiliensis*. Table II gives the rainfall at Isabela, Basilan Island, by months, with the number of rainy days in each month, over a period of eleven years.

During the period mentioned the average rainfall at Isabela has been 1,794.1 millimeters, with a minimum occurring in 1905 of 1,103 milimeters. During this time there have been but three months entirely without rain, though there is a dryer season during January, February, and March. The number of rainy days during the period under consideration has averaged 153.1, with a minimum of 112 in 1905.

In Table III are given the average rainfall and the number of rainy days at a number of other stations in the southern part of the Philippines.

TABLE III.—*Rainfall data for the southern Philippine Islands, 1903–1913.*

[Rainfall is given in millimeters.]

Month.	Jolo.		Davao.		Cotabato.		Zamboanga.	
	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.
January	89.1	7.4	110.2	5.9	98.8	12.6	37.2	4.9
February	122.4	7.4	141.6	7.5	88.8	10.1	62.0	5.1
March	85.2	8.1	164.2	7.5	68.1	7.8	21.0	2.5
April	118.2	7.3	190.3	9.2	164.9	12.7	38.2	5.5
May	160.2	13.5	252.8	11.6	218.5	14.7	72.0	7.6
June	203.3	15.0	234.2	11.0	237.3	17.2	88.8	10.6
July	172.0	12.2	208.9	10.2	292.0	18.4	99.0	10.6
August	170.4	13.9	207.4	10.1	271.8	18.4	95.0	10.9
September	184.4	12.5	203.6	9.8	248.6	16.7	106.3	9.5
October	222.9	16.1	242.3	11.6	255.1	15.3	116.1	10.1
November	193.0	14.5	176.4	9.2	231.7	15.9	106.5	9.4
December	144.8	14.4	208.8	10.1	133.5	13.0	84.3	8.1
Total	1,865.9	142.3	2,340.7	113.7	2,309.1	172.8	926.4	94.8

The rainfall at Zamboanga is the lightest recorded for any station in the Philippines and is given here solely for the purpose of showing the variation in rainfall that may occur within a comparatively short distance. Zamboanga is separated from Basilan by a strait but a few kilometers wide. In a range of hills only a few kilometers back of Zamboanga the rainfall is again much heavier. Davao has the heaviest and most evenly distributed rainfall of any of the stations listed. Cotabato is, however, a very close second.

Rainfall data from various localities in the East where Para rubber is being successfully grown are compiled in Table IV.

TABLE IV.—*Average rainfall in rubber-producing districts of the Orient.*

[Rainfall is given in millimeters.]

Month.	Ceylon, 1905–1908.[a]		Malaya.			Borneo, 1910–1913.[d]	
	Peradeniya.	Henaratgoda.	Kuala Lumpur, F. M. S. 1915–1916.[b]	Singapore. 1914–1916.[c]	Penang. 1914–1916.[c]	Sandakan.	Jesselton.
January	67.0	47.8	74.9	322.3	50.0	301.2	106.9
February	66.5	95.8	53.3	88.3	80.8	249.7	72.9
March	100.0	125.5	201.6	228.1	237.5	137.2	45.7
April	137.4	220.7	297.4	253.7	212.3	117.5	133.1
May	133.1	304.8	136.7	132.5	316.5	126.5	209.8
June	241.3	234.6	170.9	163.3	251.2	114.8	307.1
July	211.8	111.2	228.2	211.8	302.8	154.4	209.0
August	122.9	74.4	237.9	157.5	224.5	212.3	249.4
September	168.1	123.9	133.7	148.0	354.1	364.5	353.1
October	374.4	449.6	188.3	149.9	458.2	227.8	436.4
November	173.7	361.7	193.2	252.2	305.6	292.6	280.2
December	131.0	65.5	167.3	237.0	152.1	364.5	139.2
Total	1,927.2	2,215.5	2,083.4	2,344.6	2,945.6	2,663.0	2,542.8

[a] Report of the director, Royal Bot. Gardens of Ceylon (1906–1909).
[b] Supplement to the Official Gazette, F. M. S. Selangor Administrative report (1916–1917).
[c] The Gardens' Bulletin, Straits Settlements (1914–1916).
[d] Manual of Statistics of British North Borneo (1915).

TEMPERATURE

Hevea brasiliensis appears to reach its best development in regions having a comparatively high and uniform temperature throughout the year. At Belem (Para) near the mouth of the Amazon and about 1° south latitude the minimum temperature recorded during a period of three years was 20.2° C., and the maximum, 36.6° C.; the average yearly maximum for this period was 32.04° C., and the average yearly minimum, 22.23° C.

In the Philippines the lowest temperature recorded during a period of three years (1913–1915) at Davao was 19.0° C.; at Cotabato, 19.2° C.; and at Jolo, 20.2° C. During this period the maximum temperature at Davao was 36.0° C.; at Cotabato, 36.0° C.; and at Jolo, 33.4° C. In general the temperature in the Mindanao region appears to range between about 20° and 34° C. and is fairly uniform throughout the year, except for a somewhat warmer period during February, March, and April, when the temperature occasionally reaches 36° or 37° C.

SOIL

Hevea brasiliensis does not appear to be exacting in the quality or kind of soil necessary for its successful growth. Generally speaking, Para rubber may be said to do well on any soil that will support a heavy forest growth, provided drainage is good. *Hevea brasiliensis* is rather intolerant of excess of water in the soil, and very wet soils should be drained in order to obtain the best results. Heavy clay soil is not so suitable for the growth of rubber as are loamy or even sandy soils.

Cox [6] has shown that, in general, Philippine soils are good and contain ample quantities of the inorganic compounds necessary for plant growth. There are undoubtedly very large areas in the Mindanao region where the soils are suitable for the successful growth of *Hevea brasiliensis*. Table V gives the results of an analysis of five samples of soil taken on the Basilan Plantation Company's property on Basilan.

TABLE V.—*Soils from Basilan plantation.* [a]

	Sample No.—				
	1 [b]	2 [c]	3 [c]	4 [d]	5 [e]
Nitrogen (N_2)	0.093	0.119	0.108	0.127	0.134
Phosphoric anhydride (P_2O_5)	0.063	0.078	0.086	0.067	0.075
Lime (CaO)	0.10	0.27	0.11	0.22	0.14
Potash (K_2O)	0.077	0.083	0.064	0.089	0.119
Humus	1.18	1.40	1.16	1.29	1.22
Loss on ignition	13.80	13.92	14.16	14.60	13.72
Detritus, not passing 1 mm sieve	40.4	61.1	11.1	39.6	45.8
Coarse sand, 1.0 to 0.5 mm	4.8	2.8	2.2	4.1	1.7
Medium sand, 0.5 to 0.25 mm	4.7	2.9	2.5	3.9	1.4
Fine sand, 0.25 to 0.10 mm	4.0	3.6	4.2	4.4	7.2
Very fine sand, 0.10 to 0.05 mm	6.1	6.9	1.1	8.0	6.7
Silt, 0.05 to 0.01 mm	4.6	4.6	11.7	2.4	0.7
Fine silt, 0.01 to 0.002 mm	18.9	28.6	24.8	22.5	22.0
Clay, less than 0.002 mm	56.9	50.6	53.5	54.7	60.3
Total (except detritus)	100.0	100.0	100.0	100.0	100.0

[a] Analyzed by A. S. Argüelles, Bureau of Science, Manila, P. I.
[b] Rolling land; trees (*Hevea*) poor.
[c] Sandy loam; coconuts.
[d] Gently rolling land; trees (*Hevea*) good.
[e] Swampy land; *Hevea*.

[6] Philip. Journ. Sci. § A 6 (1911) 279–330.

The samples were taken at a depth of about 30 to 40 centimeters. Sample 1 was taken from a block planted to Para rubber in which the growth of the trees was very poor. The trees presented an unhealthy, ill-nourished appearance. It is interesting that analysis of the soil from this block showed it to be low in all inorganic substances necessary for plant growth.

In Table VI are given analyses of other soils from the Mindanao region of the Philippines, in Table VII analyses of Ceylon soils are tabulated for comparison, and in Table VIII analyses of soils from the Federated Malay States are given. The Malayan soils are characterized by their richness in nitrogen.

TABLE VI.—*Philippine soils.* [a]

	Cotabato.	Fort Pikit, 10 to 40 cm.	Lake Lanao, north side; 10 to 40 cm.	Lake Lanao, south side; 10 to 40 cm.	Sarangani, 10 to 40 cm.
Sample No	161	159	150	153	165
Moisture	8.35	18.47	16.61	3.56	4.48
Loss on ignition	10.16	11.39	19.47	7.30	5.58
Nitrogen (N)	0.207	0.184	0.216	0.173	0.115
Phosphoric anhydride (P_2O_5)	0.142	0.196	0.180	0.097	0.188
Lime (CaO)	0.87	1.92	0.37	2.24	3.18
Magnesia (MgO)	----------	2.31	0.26	----------	0.71
Potash (K_2O)	0.29	0.55	0.240	0.173	0.24
Soda (Na_2O)	0.76	----------	----------	----------	----------
Humus	----------	3.25	2.12	2.55	2.17
Soil acidity (per cent $CaCO_2$)	----------	0.0036	0.0022	0.0072	0.0000
Detritus—not passing 1 mm sieve	----------	small	small	2.29	small
Coarse sand, 1.0 to 0.5 mm	----------	0.99	2.61	3.81	5.76
Medium sand, 0.5 to 0.25 mm	----------	4.33	13.20	27.68	19.37
Fine sand, 0.25 to 0.10 mm	----------	7.11	18.80	24.81	25.84
Very fine sand, 0.10 to 0.05 mm	----------	13.81	13.82	18.09	18.08
Silt, 0.05 to 0.005 mm	----------	59.30	28.48	20.45	23.20
Clay, less than 0.005 mm	----------	14.11	23.61	5.35	7.89
	----------	99.65	100.52	100.19	100.14

[a] Cox, Philip. Journ. Sci. § A 6 (1911) 279–330, from Table VIII, p. 309, and Table IX, pp. 314 and 315.

TABLE VII.—*Ceylon soils.* [a]

	Cabooky soil.	Alluvial soil. Experiment station, Peradeniya.	Cacao land interplanted with rubber.	Tea land interplanted with rubber.	Swampy land, black soil.
Moisture	3.300	3.000	3.600	3.000	5.600
Organic matter and combined water	8.000	11.000	4.600	6.000	20.400
Oxide of iron and manganese	7.400	8.000	7.200	5.200	1.200
Oxide of alumina	8.200	9.717	6.786	13.049	5.232
Lime	0.060	0.130	0.160	0.160	0.050
Magnesia	0.054	0.259	0.216	0.490	0.115
Potash	0.085	0.162	0.077	0.401	0.061
Phosphoric acid	0.010	0.076	0.064	0.089	0.064
Soda	0.074	0.188	0.233	0.137	0.182
Sulphuric acid	0.008	0.054	0.048	0.068	0.048
Chlorine	0.003	0.014	0.016	0.006	0.048
Sands and silicates	72.806	67.400	77.000	71.400	67.000
	100.000	100.000	100.000	100.000	100.000
Containing nitrogen	0.128	0.230	0.100	0.162	0.448
Equal to ammonia	0.156	0.280	0.122	0.195	0.554
Lower oxide of iron	trace	much	trace	trace	much
Acidity	much	neutral	fair	much	much
Citric soluble potash	0.006	0.013	0.008	0.025	0.009
Citric soluble phosphoric acid	nil	trace	nil	trace	nil
Fine soil passing 90 mesh	11.50	53.90	48.00	34.00	59.00
Fine soil passing 60 mesh	9.50	43.00	42.00	25.00	36.00
Medium soil passing 30 mesh	4.00	3.00	8.00	10.00	1.00
Coarse sand and small stones	75.00	0.10	2.00	31.00	4.00
	100.00	100.00	100.00	100.00	100.00

[a] From Circulars and Agr. Journ. Roy. Bot. Gard. Ceylon 3 (1905) 67–72.

TABLE VIII.—*Soils of the Federated Malay States.*[a]

	Alluvial clays.			Sandy loams.						
		Subsoil.								
Moisture	6.920	5.560	5.000	4.200	2.000	1.400	4.000	2.200	2.600	1.800
Organic matter and combined water	24.080	16.640	8.000	9.000	4.400	3.000	9.600	5.600	6.000	9.200
Oxide of iron and manganese	1.120	1.200	3.000	1.500	2.400	0.300	8.240	0.700	0.300	4.000
Oxide of alumina	2.971	3.019	2.520	5.690	1.855	1.165	4.183	2.516	2.958	4.951
Lime	0.284	0.200	0.160	0.200	0.160	0.140	0.160	0.160	0.140	0.240
Magnesia	0.252	0.381	0.230	0.100	0.086	0.130	0.100	0.130	0.130	0.144
Potash	0.131	0.169	0.014	0.046	0.023	0.014	0.053	0.030	0.021	0.014
Phosphoric acid	0.025	0.012	0.076	0.064	0.076	0.051	0.064	0.064	0.051	0.051
Sand and silicate	64.200	72.800	81.000	79.200	89.000	93.800	73.600	88.600	87.800	79.600
Chlorine	0.017	0.019								
	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Containing nitrogen	0.667	0.425	0.403	0.392	0.425	0.492	0.386	0.403	0.369	0.464
Equal to ammonia	0.810	0.516	0.489	0.476	0.516	0.598	0.469	0.489	0.448	0.564
Lower oxide of iron	much	fair	good	good	good	good	good	good	good	good
Acidity			marked	marked	marked	marked	marked	marked	marked	marked
Fine soil passing 90 mesh	96.00	95.50	68.00	32.00	48.00	30.00	36.00	26.00	16.00	30.00
Fine soil passing 60 mesh	4.00	4.50	32.00	34.00	36.00	34.00	38.00	30.00	24.00	30.00
Medium passing 30 mesh				12.00	12.00	26.00	8.00	22.00	28.00	14.00
Coarse sand and small stones				22.00	4.00	10.00	18.00	22.00	32.00	26.00
	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000

[a] From Report of Director of Agriculture of F. M. S. for 1906, 3.

ELEVATION

Hevea brasiliensis appears to make its most rapid growth at low elevations. Though it has been grown in Ceylon and elsewhere at elevations up to 600 meters or more, the rate of growth is apparently much less rapid. It is probable that the retardative effect of altitude upon rubber is related to the lower temperatures prevailing at higher elevations. The extreme retarding effect of high elevations on the growth of trees in the Tropics is shown by the dwarfed condition of vegetation on mountain tops in these regions.

Table IX gives the results of an experiment in Malaya to show the effect of altitude upon the growth of *Hevea*. While the small number of trees observed, especially at the higher altitudes, renders the results somewhat inconclusive, yet the experiment indicates a considerable reduction in the rate of growth as elevation is increased. The trees in clearing 8 were, however, said to be as healthy as those in clearing 1.

TABLE IX.—*Experiment on Gunong Angsi.*[a]

Clearing.	Elevation.		Trees ready to tap.	Total trees.	Percentage.
	Feet.	*Meters.*			
1	300	91.44	365	529	69
2	600	182.88	32	180	18
3	1,000	304.80	321	665	48
4	1,200	365.76	(b)	(b)	(b)
5	1,600	487.68	24	90	27
6	1,800	574.84	17	91	18
7	2,100	640.08		66	
8	2,400	731.52	2	90	2

[a] From Agr. Bull. Straits & F. M. S. **10** (1911) 257. [b] Not planted.

GROWTH IN THE PHILIPPINES

It appears from the preceding discussion that climatic and soil conditions in the Mindanao region of the Philippine Islands compare well with those in regions in the eastern Tropics where plantation rubber is now being successfully produced. It remains to compare actual measurements of growth and yield of rubber of trees growing in the Philippines with those in other rubber-producing districts. In Table X a series of measurements is given of trees of various ages growing in the Philippines, and an attempt has been made to determine from these measurements the rate of growth of *Hevea* up to the age of about 10 years.

TABLE X.—*Growth of Hevea rubber trees in the Philippine Islands.*

Order No.	Girth of trees in block No.—									
	2[a]	2[b]	3[c]	5[d]	7[e]	9[f]	10[g]	10[h]	18[i]	25[j]
1	100.0	64.0	57.0	28.5	103.5	33.0	57.0	34.0	44.0	15.0
2	91.5	60.0	53.0	40.0	70.0	30.0	70.0	55.0	36.5	11.0
3	113.0	40.0	40.0	47.0	65.0	44.0	61.0	49.0	42.0	21.0
4	91.0	56.5	61.0	32.0	66.5	44.0	58.5	51.5	42.5	12.0
5	86.5	64.0	39.0	25.0	61.5	50.0	58.0	37.0	66.0	13.0
6	76.0	57.5	45.0	30.0	63.5	31.5	56.0	53.0	46.5	16.0
7	86.0	51.0	36.5	35.0	57.0	23.5	52.0	49.0	53.0	18.0
8	73.5	48.5	40.0	30.0	53.0	37.0	75.0	59.5	41.5	15.5
9	78.0	51.0	34.0	27.0	65.0	23.0	63.0	64.5	53.5	14.0
10	86.0	54.0	39.0	32.0	61.0	31.5	67.0	47.0	48.0	11.0
11	91.0	61.0	46.0	37.0	77.0	45.0	53.0	63.0	50.0	18.5
12	142.0	67.0	37.0	33.0	55.5	49.0	78.5	48.0	50.0	11.0
13	84.0	56.0	49.0	35.5	76.0	38.0	67.0	59.0	45.0	12.0
14	69.0	67.0	38.0	37.0	52.0	52.5	64.0	67.0	50.0	15.0
15	73.0	55.0	53.5	35.5	65.0	30.0	57.0	53.0	41.0	13.5
16	81.0	51.0	59.0	36.5	53.0	38.0	66.0	64.5	48.5	13.0
17	76.0	64.0	65.0	27.5	90.0	22.5	45.0	63.0	48.0	18.0
18	87.0	55.0	54.0	25.5	68.5	25.0	59.0	47.0	42.0	15.0
19	126.0	48.0	55.0	37.0	57.5	33.0	45.0	54.0	48.0	15.0
20	74.0	52.0	53.0	27.0	54.0	55.0	69.0	52.5	52.0	13.5
21	77.0	60.5	53.5	28.5	51.0	23.0	55.6	61.0	48.0	16.5
22	109.5	67.0	54.5	34.0	50.5	28.5	54.0	58.5	48.0	14.0
23	88.0	49.5	47.0	38.0	64.0	25.5	74.0	64.0	62.0	10.0
24	105.5	62.0	47.0	43.0	62.0	24.0	49.0	49.5	42.5	14.0
25	77.5	73.0	58.5	35.0	71.0	42.0	64.0	62.0	63.0	11.0
26	78.5	59.0	51.5	39.0	70.0	42.0	80.0	51.0	63.5	14.5
27	96.0	65.5	52.0	35.0	78.0	23.5	53.0	60.0	45.0	-------
28	78.0	60.0	65.0	35.0	63.0	28.0	73.0	55.0	49.5	-------
29	133.5	54.0	48.5	48.5	60.0	39.0	56.0	39.0	55.0	-------
30	87.5	59.0	49.5	34.5	-------	34.0	75.0	52.0	52.0	-------
31	73.5	64.0	77.0	38.0	-------	24.0	61.5	68.0	46.0	-------
32	74.0	64.0	45.5	35.5	-------	30.0	76.0	57.0	52.5	-------
33	97.5	51.0	45.0	30.0	-------	27.5	60.0	43.0	36.0	-------
34	102.5	53.5	45.0	32.0	-------	23.0	57.0	46.0	48.0	-------

[a] Planted in June, 1907; land flat; planting rather irregular but probably originally planted about 2.44 by 4.88 meters (8 by 16 feet); age, 124 months.

[b] Planted in June, 1910; 2.44 by 2.44 meters (8 by 8 feet) on a flat; age, 88 months.

[c] Planted in July, 1912; 5.49 by 5.49 meters (18 by 18 feet) on gently rolling ground; age, 63 months.

[d] Planted in May, 1913; 5.49 by 5.49 meters (18 by 18 feet); land slightly sloping; age, 53 months.

[e] Planted in August, 1910; originally interplanted with hemp at somewhat irregular distances, average about 4.57 by 5.49 meters (15 by 18 feet); land slightly sloping; age, 86 months.

[f] Planted in June, 1914; 5.49 by 5.49 meters (18 by 18 feet), on a steep hillside; age, 41 months.

[g] Planted in June, 1911, on a moderate slope, 4.88 by 4.88 meters (16 by 16 feet); age, 76 months.

[h] Planted in June, 1911, on a gentle slope, 5.49 by 5.49 meters (18 by 18 feet); age, 76 months.

[i] Planted in July, 1913, on practically level land, 5.49 by 5.49 meters (18 by 18 feet); age, 51 months.

[j] Planted in June, 1916, on slightly rolling land, 5.49 by 5.49 meters (18 by 18 feet); age, 17 months.

TABLE X.—*Growth of Hevea rubber trees in the Philippine Islands*—Ctd.

Order No.	Girth of trees in block No.—									
	2[a]	2[b]	3[c]	5[d]	7[e]	9[f]	10[g]	10[h]	18[i]	25[j]
35	77.0	56.5	46.0	39.0	------	34.0	59.0	51.5	44.0	------
36	89.0	68.0	59.0	38.0	------	24.0	58.0	61.0	47.0	------
37	77.5	56.0	52.0	41.0	------	39.0	53.0	62.0	53.0	------
38	75.0	65.0	41.5	38.0	------	34.0	76.0	58.5	45.5	------
39	111.0	53.0	50.0	30.5	------	------	70.5	49.0	41.0	------
40	80.0	60.5	63.0	42.0	------	------	56.0	61.5	39.5	------
41	83.0	59.0	33.0	46.0	------	------	50.0	45.5	53.0	------
42	84.0	68.0	51.0	42.0	------	------	56.0	63.0	41.5	------
43	98.5	65.0	50.5	37.0	------	------	58.5	52.0	53.0	------
44	105.0	54.5	47.0	41.4	------	------	63.0	51.0	49.0	------
45	84.0	56.0	48.0	38.0	------	------	63.5	55.0	44.0	------
46	85.5	59.0	58.5	43.0	------	------	65.0	52.0	47.0	------
47	101.5	58.0	60.0	33.0	------	------	68.0	65.5	37.0	------
48	86.0	67.0	46.0	23.5	------	------	59.5	66.0	35.0	------
49	89.0	60.0	34.5	34.0	------	------	59.0	66.5	47.0	------
50	93.5	59.0	47.0	35.0	------	------	60.0	63.0	43.0	------
51	92.0	60.0	33.0	28.0	------	------	61.0	60.5	45.5	------
52	76.0	56.5	43.0	34.5	------	------	------	61.0	52.0	------
53	83.5	74.5	50.0	40.5	------	------	------	58.0	51.5	------
54	83.0	------	34.0	33.0	------	------	------	58.0	36.0	------
55	86.5	------	46.0	32.5	------	------	------	------	46.0	------
56	98.0	------	52.5	32.5	------	------	------	------	56.0	------
57	80.5	------	51.5	50.0	------	------	------	------	39.0	------
58	124.0	------	35.0	------	------	------	------	------	49.5	------
59	91.0	------	51.0	------	------	------	------	------	46.0	------
60	78.0	------	52.0	------	------	------	------	------	46.0	------
61	101.0	------	53.0	------	------	------	------	------	44.0	------
62	109.5	------	------	------	------	------	------	------	52.0	------
63	77.0	------	------	------	------	------	------	------	35.0	------
64	86.5	------	------	------	------	------	------	------	60.0	------
65	83.5	------	------	------	------	------	------	------	48.0	------
66	93.5	------	------	------	------	------	------	------	34.0	------
67	91.5	------	------	------	------	------	------	------	45.0	------
68	105.5	------	------	------	------	------	------	------	49.0	------

[a] Planted in June, 1907; land flat; planting rather irregular but probably originally planted about 2.44 by 4.88 meters (8 by 16 feet); age, 124 months.

[b] Planted in June, 1910; 2.44 by 2.44 meters (8 by 8 feet) on a flat; age, 88 months.

[c] Planted in July, 1912; 5.49 by 5.49 meters (18 by 18 feet) on gently rolling ground; age, 63 months.

[d] Planted in May, 1913; 5.49 by 5.49 meters (18 by 18 feet); land slightly sloping; age, 53 months.

[e] Planted in August, 1910; originally interplanted with hemp at somewhat irregular distances, average about 4.57 by 5.49 meters (15 by 18 feet); land slightly sloping; age, 86 months.

[f] Planted in June, 1914; 5.49 by 5.49 meters (18 by 18 feet), on a steep hillside; age, 41 months.

[g] Planted in June, 1911, on a moderate slope, 4.88 by 4.88 meters (16 by 16 feet); age, 76 months.

[h] Planted in June, 1911, on a gentle slope, 5.49 by 5.49 meters (18 by 18 feet); age, 76 months.

[i] Planted in July, 1913, on practically level land, 5.49 by 5.49 meters (18 by 18 feet); age, 51 months.

[j] Planted in June, 1916, on slightly rolling land, 5.49 by 5.49 meters (18 by 18 feet); age, 17 months.

TABLE X.—*Growth of Hevea rubber trees in the Philippine Islands*—Ctd.

Order No.	Girth of trees in block No.—									
	2[a]	2[b]	3[c]	5[d]	7[e]	9[f]	10[g]	10[h]	18[i]	25[j]
69	84.5								55.0	
70	82.0								54.5	
71	84.0								59.5	
72	81.0								50.0	
73	104.5								44.0	
74	92.0								38.5	
75	87.0								58.5	
76	78.0								62.0	
77	75.0								49.5	
78	87.0								49.5	
79	104.0								63.0	
80	77.5								55.0	
81	93.0								55.0	
82	80.0								51.5	
83	91.0								43.5	
84	95.5								48.0	
85	82.0								44.0	
86									47.0	
87									48.0	
88									49.0	
89									36.5	
90									50.0	
91									43.5	
92									52.0	
93									40.0	
94									38.0	
95									54.0	
96									39.5	
97									44.0	
Average	89.4	58.4	46.3	35.4	64.9	33.9	61.7	55.5	47.8	14.2
Maximum	142.0	74.5	65.0	50.0	103.0	55.0	80.0	68.0	66.0	21.0
Minimum	69.0	40.0	33.0	23.5	50.5	22.5	45.0	34.0	36.5	10.0

[a] Planted in June, 1907; land flat; planting rather irregular but probably originally planted about 2.44 by 4.88 meters (8 by 16 feet); age, 124 months.

[b] Planted in June, 1910; 2.44 by 2.44 meters (8 by 8 feet) on a flat; age, 88 months.

[c] Planted in July, 1912; 5.49 by 5.49 meters (18 by 18 feet) on gently rolling ground; age, 63 months.

[d] Planted in May, 1913; 5.49 by 5.49 meters (18 by 18 feet); land slightly sloping; age, 53 months.

[e] Planted in August, 1910; originally interplanted with hemp at somewhat irregular distances, average about 4.57 by 5.49 meters (15 by 18 feet); land slightly sloping; age, 86 months.

[f] Planted in June, 1914; 5.49 by 5.49 meters (18 by 18 feet), on a steep hillside; age, 41 months.

[g] Planted in June, 1911, on a moderate slope, 4.88 by 4.88 meters (16 by 16 feet); age, 76 months.

[h] Planted in June, 1911, on a gentle slope, 5.49 by 5.49 meters (18 by 18 feet); age, 76 months.

[i] Planted in July, 1913, on practically level land, 5.49 by 5.49 meters (18 by 18 feet); age, 51 months.

[j] Planted in June, 1916, on slightly rolling land, 5.49 by 5.49 meters (18 by 18 feet); age, 17 months.

It is recognized that the results are subject to criticism from a scientific viewpoint, but it is believed definite data in regard to the girth of *Hevea brasiliensis* in the Philippine Islands are of sufficient practical importance to warrant their publication. It would undoubtedly have been desirable to remeasure the same trees through several successive years; but, since this has not been practicable, the results of the present series are given in the table to show the growth attained by trees at certain known ages. An attempt has been made, by averaging a number of measurements, to neutralize individual variation among trees of the same age as such variation in *Hevea* is well known to be considerable. Under apparently identical conditions certain individuals may attain as great a girth in five years as others do in seven or eight years.

Conditions of cultivation are approximately equal for all the trees considered. A strip about 3 meters wide is kept clean-weeded along the rows, and the remainder plowed about three times each year. The older trees were planted at various distances, but later plantings are all 5.49 by 5.49 meters (18 by 18 feet). In each case the planting distance is indicated. In the older blocks the retarding effect of close planting on the growth of the trees is very evident. The trees have practically all been tapped since they attained a diameter of 50.8 centimeters (20 inches) at 45.7 centimeters (18 inches) above the ground.

MEASUREMENTS OF TREES ON BASILAN ISLAND

In Table X the measurements of five hundred fifty-one trees of various ages are given. The age in months of each group is recorded, together with the planting distance and general character of the land. Measurements were made with a tape to the nearest 5 millimeters at 1 meter above the ground. For each group the maximum, minimum, and average girths are indicated. A certain error is caused by the fact that the measurements were necessarily made over the tapping surface, but this error is probably never very great and is in the direction of a reduction rather than an increase in the recorded girth of trees at the various ages. Most of the measurements of trees in other countries with which the Philippine trees are compared have been measured at 1 yard from the ground; and, since the trunks of *Hevea brasiliensis* taper rather abruptly, this difference in height of measurement has the result of reducing the girth of the Philippine trees when compared with others. This comparative reduction ranges from a few millimeters for the younger trees up to approximately 1 centimeter for trees 10 years of age. It has not been found practicable to apply any correction for this difference due to height of measurement; but when comparing the girth of trees measured at different heights, the fact should be borne in mind that such difference exists and that it increases with the size of the tree.

In fig. 1 is plotted the average circumference of trees of the various ages measured, and from this curve the average circumference of trees from 1 to 10 years old has been calculated. The results obtained in this manner are given in Table XI.

TABLE XI.—*Diameters attained by average trees in Basilan. From 1 to 10 years old with increment.*

Age in years.	Circumference.	Increment.
	cm.	*cm.*
1	10.3	10.3
2	18.7	8.4
3	27.2	8.5
4	35.6	8.4
5	44.0	8.4
6	52.4	8.4
7	60.9	8.5
8	69.4	8.5
9	77.9	8.5
10	86.5	8.6

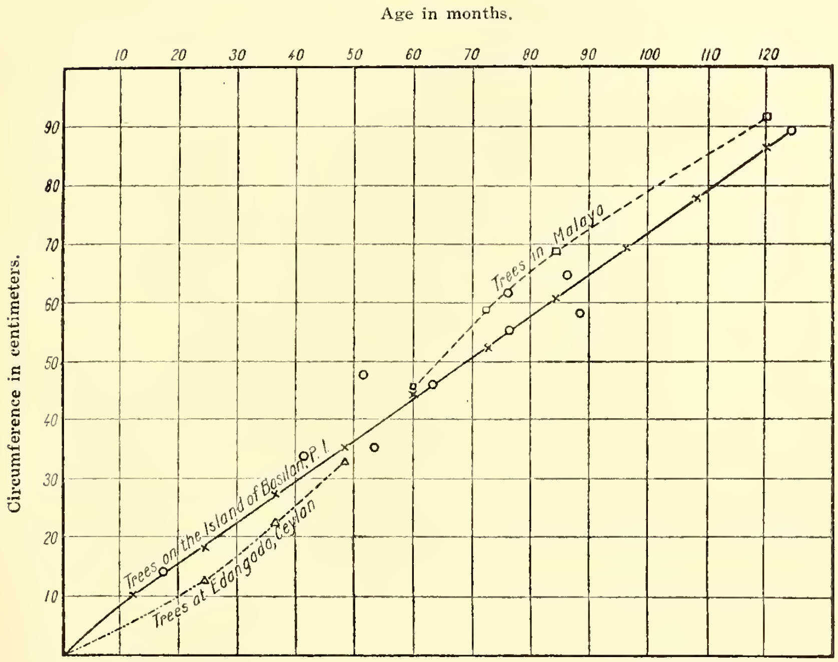

FIG. 1. Comparison of the growth of *Hevea brasiliensis* in the Philippine Islands with that in Ceylon and Malaya.

In the same figure are also plotted the figures given in Table XV for the growth of trees at Edangoda, Ceylon, and also the second of the two series of measurements of trees 5 to 9 years old given in Table XII.

From Table XI it appears that the annual increase in circumference of trees up to 10 years of age averages 8.6 centimeters. Ridley[7] gives measurements of trees in Malaya which approach very closely those recorded for trees in the Philippines. Table XII is copied from Ridley's paper, with the measurements reduced to centimeters.

TABLE XII.—*Growth of trees in Malaya.*[a]

Age in years.	1904		1905		1906		1909		Increment, six years.	
	cm.	*Inches.*	*cm.*	*Inches.*	*cm.*	*Inches.*	*cm.*	*Inches.*	*cm.*	*Inches.*
5	44.77	$17\frac{5}{8}$	54.61	$21\frac{1}{2}$	65.72	$25\frac{7}{8}$	89.85	$35\frac{3}{8}$	45.09	$17\frac{3}{4}$
5	45.88	$18\frac{5}{8}$	58.55	$23\frac{1}{2}$	68.80	$27\frac{7}{8}$	91.63	$36\frac{3}{4}$	45.75	$18\frac{1}{8}$
16	115.57	$45\frac{3}{4}$	120.97	$47\frac{5}{8}$	129.54	51	149.23	$58\frac{3}{4}$	33.02	13
28	278.13	$109\frac{1}{2}$	283.84	$111\frac{3}{4}$	288.92	$113\frac{3}{4}$	306.07	$120\frac{1}{2}$	27.94	11

[a] From Agr. Bull. Straits & F. M. S. 9 (1910) 257.

His measurements of trees from 5 to 9 years of age indicate a somewhat faster growth than is shown by trees in Basilan, but this may be due to the effect of close planting on the latter. In the same paper Ridley shows that in a block of closely planted trees the outside trees grew 20.3 centimeters in six years, while those inside grew only 10.3 centimeters during the same period. He also states that he considers a growth under fair conditions of 7.6 to 10.2 centimeters (3 to 4 inches) per year, for trees from 5 to 15 years of age, to be satisfactory. The average yearly increment of all trees measured in the Philippines appears to be about 8.6 centimeters (3.4 inches). An average of ninety-seven trees in block 18 indicates a growth of 47.8 centimeters (18.0 inches) in fifty-one months, which amounts to about 11.2 centimeters (4.4 inches) per year.

Ridley[8] gives the measurements of some trees growing under jungle conditions in the Singapore Botanic Gardens. A copy of his table appears in Table XIII with the measurements reduced to centimeters. The trees were planted about ten years before the first measurements were made. He states that they are fully twice as large as trees grown under cultivation.

[7] Agr. Bull. Straits and F. M. S. 9 (1910) 25.
[8] Agr. Bull. Straits & F. M. S. 7 (1908) 254.

TABLE XIII.—*Growth of trees in the Singapore Botanic Gardens.*[a]

[Age of trees, 14 years.]

Registered No. of tree.	Girth in—					Remarks.
	1904	1905	1906	1907	1908	
1272	97.8	102.9	108.5	113.6	121.9	Slope.
1273	78.7	81.3	88.3	93.3	96.5	Do.
1275	60.9	62.2	66.0	68.6	71.1	Do.
1276	136.5	147.0	147.3	151.1	152.4	Top of hill.
1277	153.7	159.7	166.1	174.0	182.9	Top of hill, 100 feet tall.
1278	86.4	88.9	90.5	93.7	96.5	Slope.
1279	87.0	92.7	96.5	101.6	104.1	Do.
1280	85.1	93.7	105.1	106.1	108.0	Do.
1281	158.4	173.0	181.3	191.8	200.7	Top of hill.

[a] From Agr. Bull. Straits & F. M. S. 7 (1908) 254.

The record extends over a period of four years and indicates an average growth during this period of 5.3 centimeters per year. The most rapidly growing tree, No. 1281, shows a growth of 10.5 centimeters per year, almost double that of the average.

In Table XIV are given measurements of trees up to 3 years old. The best growth indicated for that period is 23.9 centimeters, which is slightly less than that attained by trees of the same age at Basilan.

TABLE XIV.—*Open-planting experiments. Planted 7.5 by 3.75 meters (25 by 12.5 feet).*[a]

Seeds sown at stake, 1907.			Stumps 2 months from nursery. Seeds sown in nursery, October, 1907.			Stumps 6 months from nursery. Seeds sown in nursery, October, 1907.		
	cm.	*in.*		*cm.*	*in.*		*cm.*	*in.*
October, 1907	planted.	planted.	December, 1907	planted.	planted.	April, 1908	2.4	15/16
October, 1908	8.1	3 3/16	December, 1908	6.5	2 9/16	April, 1909	7.9	3 1/8
October, 1909	16.1	6 1/3	December, 1909	14.2	5 3/5	April, 1910	23.0	9 1/16
October, 1910	23.6	9 3/10	December, 1910	23.9	9 2/5			

[a] From Report of Director of Agriculture F. M. S. in Agr. Bull. Straits & F. M. S. 10 (1911) 255–256.

Other records from Malaya indicate in some cases more rapid growth than those cited. In measurements of certain trees on the Bukit Raja Estate in Selangor[9] in which five trees (Nos. 1, 3, 6, 7, 8), all approximately 4 years of age, attained an

[9] Agr. Bull. Straits & F. M. S. 1 (1902) 333.

average circumference of 47.8 centimeters at 1.36 meters (4.5 feet) above the ground. However, even this rate of growth is exceeded by certain selected trees in Basilan. The best group of three consecutive trees in block 18 (Nos. 79, 80, 81) shows an average girth of 57.7 centimeters (22.7 inches) at the age of 51 months, which is equivalent to about 54.24 centimeters (21.3 inches) at the age of 4 years.

Willis [10] presents the measurements of some trees in Ceylon. The original trees, planted at Henaratgoda in 1876 when probably about 1 year old, attained a girth of 35.6 centimeters (14 inches) two years later, and in 1882 the largest tree was 63.5 centimeters (25 inches) in circumference 1 yard from the ground. The girth of this tree was measured annually thereafter and in 1886, when 10 years of age, its girth was 124.5 centimeters (49 inches). Even this growth appears to be inferior to that attained by the best tree measured at Basilan, No. 12 in block 2, which attained a circumference of 142 centimeters (55.9 inches) at an age of 124 months.

In the same paper Willis gives the average measurements of trees at Edangoda and Yattipowa, Ceylon. Willis' figures are given in Table XV.

TABLE XV.—*Growth of trees in Ceylon.*

Locality.	Age.	Trees.	Circumference.	
	Years.		*cm.*	*in.*
Edangoda	4	100	32.9	12.96
Do	3	50	22.2	8.75
Do	2	20	12.6	4.96
Yattipawa	3	108	23.8	9.37
Do	3	108	23.2	9.13

The trees were measured 3 feet above the ground and so are closely comparable with measurements in the Philippines made at a height of 1 meter. These measurements indicate a decidedly slower growth than is shown by trees of the same age in Basilan. At an age of 4 years the circumference attained by trees at Edangoda was 2.7 centimeters (1.1 inches) less than that of trees of the same age in the Philippines. Other measurements of Para rubber trees recorded from Ceylon in-

[10] Circular and Bull. Roy. Bot. Gard. Ceylon 5 (1910) 17 and 18.

dicate that the rate of growth in that country, while rather variable, is in general considerably less rapid than in Malaya.

Johnson [11] gives girth measurements of trees in the Tarkwa Botanic Station, Gold Coast. Data from his table are presented in Table XVI. The rate of growth does not appear to differ greatly from that of trees of the same ages in the Philippines.

TABLE XVI.—*Growth of Para rubber at the Tarkwa Botanic Station, Gold Coast.*

Plot No.	Date of planting.	Distance planted.		Girth at 3 feet from ground.			
				December, 1905.		December, 1906.	
	1904.	*Feet.*	*Meters.*	*cm.*	*in.*	*cm.*	*in.*
I	June	15 by 15	4.5 by 4.5	17.78	7	30.48	12
II	do	12 by 12	3.6 by 3.6	15.24	6	25.40	10
III	July	15 by 15	4.5 by 4.5	15.24	6	25.40	10
IV	do	20 by 20	6.0 by 6.0	15.24	6	27.94	11
V	do	30 by 30	9.0 by 9.0	10.16	4	22.86	9
VI	do	40 by 40	12.0 by 12.0	10.16	4	22.86	9
VII	do	12 by 12	3.6 by 3.6	10.16	4	22.86	9
VIII	August and September	12 by 12	3.6 by 3.6	10.16	4	25.40	10

While much additional information in regard to the growth of *Hevea* is available, it is believed that sufficient material has been presented to indicate that the rate of growth of Para rubber in the Philippines compares favorably with that recorded elsewhere.

YIELDS OF HEVEA BRASILIENSIS

The yield obtained from Para rubber trees now being tapped in the Philippines is very satisfactory and seems to compare well with that obtained in other countries from trees of the same ages. The rubber obtained in 1916 from 20,510 trees in tapping by the end of the year was 14,991 kilograms (32,982 pounds), or an average of 0.73 kilograms (1.6 pounds) per tree. Almost 6,000 of these trees came into tapping during 1916 and 11,000 in 1915. The oldest trees were between 8 and 9 years of age at that time. Unfortunately no separate record has been kept of the yield from trees of different ages, and this renders difficult a comparison with the yields obtained in other countries.

[11] Johnson, The Cultivation and Preparation of Para Rubber, 2d ed. (1909) 25.

Records of yields from an estate in the Federated Malay States [12] indicate that trees 6 years old produced 215.5 kilograms per hectare (192 pounds per acre); trees 8 years old, a yield of 288.5 kilograms per hectare (257 pounds per acre); and trees 9 years old, 401.9 kilograms per hectare (358 pounds per acre). This yield may be compared with that at Basilan for trees (most of them only 4 to 6 years old) which, assuming there were 331 trees per hectare (134 per acre), amounts to about 241 kilograms per hectare (215 pounds per acre).

Carruthers [13] reports that in 1907 the average yield of dry rubber over the entire Malay Peninsula amounted to 0.79 kilogram (1 pound, 12 ounces) per tapped tree, and in Selangor 0.65 kilogram (1 pound, 7 ounces) per tapped tree. The average yield obtained in Malaya in 1907 compares perhaps most closely with the yields obtained in Basilan of any records available, since in both cases the trees were young and a very high percentage of the total number was tapped for the first time.

Johnson [14] gives records of the yield obtained on a number of Ceylon and Malayan estates. The average of yields from fourteen estates in 1905 was 0.61 kilogram (1.35 pounds) per tree. The total number of trees considered was 80,272. The greatest yield recorded was 1.47 kilograms (3.25 pounds) per tree but that was for only 100 trees. The greatest yield for a large number of trees was 1.32 kilograms (3 pounds) per tree for 10,000 trees. The average of the yields from twenty-two estates in 1906 was 0.67 kilogram (1.47 pounds). The greatest yield recorded was 3.23 kilograms (7.11 pounds) per tree for 807 trees. The average of yields from eighteen estates in 1907 was 0.83 kilogram (1.83 pounds) per tree. The highest yield was 1.49 kilograms (3.28 pounds) per tree for 68,236 trees.

A discussion of the records of yields obtained from Para rubber could be continued indefinitely, but it is believed that sufficient data have been presented to show that the yield obtained from *Hevea* on Basilan compare favorably with that obtained from young trees in Malaya and Ceylon.

[12] India Rubber Journ. No. 22, 53 (1917) 14.

[13] Agr. Bull. Straits & F. M. S. 7 (1908) 532.

[14] The Cultivation and Preparation of Para Rubber. London (1909) 149–152.

CONCLUSIONS

1. A comparison of rainfall, temperature, and soil conditions obtaining in the southern part of the Philippine Archipelago with those in countries where Para rubber is successfully cultivated indicates the suitability of the former region for *Hevea brasiliensis*.

2. Measurements of *Hevea brasiliensis* at present growing in the Philippines show a rate of growth comparing favorably with records of the growth of *Hevea* in Ceylon and Malaya.

3. Yields obtained from Para rubber trees now being tapped are satisfactory and compare well with those obtained in Ceylon and Malaya.

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ILLUSTRATION

TEXT FIGURE

FIG. 1. Chart, showing a comparison of the growth of *Hevea brasiliensis* in the Philippine Islands and in Ceylon and Malaya.

A BIOLOGICAL AND SYSTEMATIC STUDY OF PHILIPPINE PLANT GALLS [1]

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FIFTEEN PLATES

INTRODUCTION

Galls are abnormal growths on the stems, leaves, roots, or other parts of plants, caused by the action of insects, arachnids, or fungi, or by unknown agencies. Just how these peculiar structural developments are brought about is still open to discussion and speculation, experimental proofs being, up to the present, too deficient to warrant our drawing any definite conclusion. These malformations have been ascribed to various causes, the more commonly accepted, in the absence of more reasonable, explanations being the following:[2] 1, a severe mechanical injury to certain parts of the plant; 2, a continuous mechanical irritation; 3, secretion of chemical stimulus by the causal animal or fungus. One, or a combination of two or all, of these causes may give rise to the production of galls. In the formation of zoöcecidia, the third factor—that is, the action of the virus secreted at the time of oviposition or during the development of the parasite—is probably the most important, the first two being of minor or absolutely no use whatever. This fact was shown by Molliard in connection with his experiments on *Aulax papaveris* Perris, a cynipid gall maker on the pistil of *Papaver rhoeas* Pall.[3] From time to time he removed a small quantity of the virus secreted by the developing *Aulax* larva, and injected the fluid into the growing pistils of *Papaver*. This artificial treatment resulted in the formation of galls which resembled in all respects those formed in the presence of the larva itself. He was thus enabled to draw the conclusion that the virus alone, without the influence of mechanical irritation from the presence of the animal within, is sufficient to produce the characteristic *Papaver* gall. The importance of chemical stimuli, as related to gall formation, was recognized as early as 1686 by Malpighi,

[1] Thesis presented in partial fulfillment of the requirements for the degree of Master of Science, University of the Philippines, 1918.

[2] Cook, M. T., Insect Galls of Indiana. Dept. Geol. and Nat. Resources, Indiana, 29th Ann. Rep. (1904) 801.

[3] Compt. Rend. Acad. Sci. 165 (1917) 160.

a physician to Innocent XII, and professor of medicine at Bologna and, later, at Messina. In his De Gallis, which is the earliest systematic treatise on galls, he maintained that, at least in the case of *Cynips*, the galls formed on the plant were caused by a certain acid secreted by the insects.[4] A more recent paper by A. Cosens has the following to say in connection with these chemical secretions:[5]

> The larva secretes an enzyme capable of changing starch to sugar [and] which acts on the starchy constituents of the nutritive zone [of the gall] and accelerates the rate of their change to sugar. The material thus prepared supplies nourishment to both the larva and the gall.

Galls can be produced only "when the tissue of the plant is interfered with during, or prior to, the actual development of the tissue."[6] After the plant tissue has become fully matured, no amount of stimulus, whether physical or chemical, will lead to the formation of galls.

In the present work only galls caused by the action of animals, known as zoöcecidia, are taken into consideration. A zoöcecidium may be caused by the action of a member of either of two zoölogical classes—Insecta and Arachnida. Galls caused by the former vary in structure from a simple convolution in the leaf lamina or a swelling in the stem to a more or less complex formation on different parts of the plant. Insects that have the power of producing plant galls are confined to the following orders and families:

Order.	Families.
1. Rhynchota, or Hemiptera.	Psyllidæ, Aphididæ, and Coccidæ.
2. Diptera.	Itonididæ, or Cecidomyiidæ, and Trypetidæ.
3. Hymenoptera.	Cynipidæ and Tenthredinidæ.
4. Lepidoptera.	Gelechidæ.
5. Coleoptera.	Buprestidæ.[7]
6. Thysanoptera.	

Arachnid gall-makers are all mites, which are members of the family Eriophyidæ (formerly called Phytoptidæ). Galls caused by this family are called erinea[8] and are generally simple convolutions in the leaf lamina, with hairy outgrowth on the concave surfaces. When the gall is young, the gall-making eriophyids are found among these hair tufts.

[4] Cook, M. T., op. cit. 802.

[5] Trans. Canad. Inst. 9 (1912) 297–387; [Ent. News 24 (1913) 187–189.]

[6] Butler, F. H., Galls. Encycl. Brit. 11 (1910) 425.

[7] Cook, M. T., op. cit. 802.

[8] Banks, Nathan, Acarina or Mites, *Rep. U. S. Dept. Agr.* 108 (1915) 135.

OBJECT AND METHODS

Very little is known about Oriental galls, the only noteworthy treatise on the subject being the series of articles on Javanese, Sumatran, and Celebes galls by W. and J. Docters van Leeuwen-Reijnvaan. These publications are almost purely botanical in their nature, the causal animal being merely mentioned in passing in practically all cases. On account of the very close resemblance existing between the fauna and the flora of the Philippines and those of the Dutch East Indies, I found in the works of the authors just mentioned much valuable assistance in the preparation of the present paper.

In the Philippines the subject of plant galls is one which covers an absolutely virgin field, practically no attention having been paid to these curious abnormalities in this country. Although including many new and interesting species, the results of the present investigation do not pretend to be anything more than a mere breaking of ground for a future more thorough and comprehensive series of investigations along this line. This branch of research bids fair to be highly productive of results in the way of elucidating obscure facts relative to these interesting formations.

In gathering the materials for the study of galls, excursions were made to points in the vicinity of Los Baños, Laguna Province, Luzon, and especially to the thickets adjoining the college farm, the forests of Mount Maquiling, Balong Bulo Hill (near the college farm), the adjoining lowlands and valleys, and along the banks of Molauin Creek. The forests around Los Baños Falls and the thickets at the outskirts and in the barrios of Bay, Los Baños, Calamba, Cabuyao, Santa Rosa, and Biñan were visited several times and search made for galls. The materials were brought fresh into the laboratory and, as soon as possible, before the galls wrinkled up or otherwise became discolored or distorted, photographs were taken (to show the natural appearance of the galls on the parts of the plant attacked), preliminary descriptions made, and specimens saved in a medium of which the following is the formula:

	Parts.
Water	48
95 per cent alcohol	48
40 per cent formaldehyde (formalin)	4

Large-sized homeopathic vials or wide-mouthed dispensing bottles of convenient dimensions and with tight-fitting corks served as preserving vessels. Each bottle or vial had the accession number written on the cork and on the labels that accompanied the specimens in the preserving fluid, the galls and insects being given the same number in the accession record.

Longitudinal and cross sections were made of the mature galls, and these were drawn to show the details in structure and the mechanism peculiar to each case.

No hard and fast rule can be laid down as to the methods to be followed in breeding the insects from their galls. Conditions were different in each case, and laboratory methods had to be modified accordingly. In general, battery jars with fine muslin held on by elastic bands at the top proved to be the best form of breeding receptacle, a decided advantage in favor of these being that the green parts of the plants were kept adequately exposed to the light and that inspection and cleaning were easy. During dry months the materials had to be moistened at least once a day by spraying them with water from a small hand atomizer. Care was taken not to wet the plants too much, for then decay would set in, or the adult insects on emergence would be entrapped by the film of water on the plant surface or the inner wall of the jar and spoiled. The jars were inspected every morning and the adults caught by means of a short test tube. The removal of the adults as soon as they emerged was a necessary measure, because when allowed to stay in the vessel for a longer time many of them would be lost or badly mutilated among the moist plant materials.

Throughout the progress of the work precautions were taken against certain small spiders which, when accidentally introduced into the jar with the plant materials, would prey upon the gall insects as fast as the latter emerged. As a measure against this pest, the pieces of plants were thoroughly shaken, one by one, before being placed into the jars, and a constant watch was kept for the appearance of any of the spiders that might have hatched from eggs accidentally introduced.

Another piece of apparatus used consisted of a light-tight cardboard box with the mouth ends of test tubes or vials inserted into one side. This device was supposed to work on the principle that most insects are attracted to the light; and the interior of the box being dark, except at the insertion of the glass tubes, the insects on emerging were supposed to enter the latter. The apparatus had been used with good results and had been indorsed by the California Board of Horticulture and by the cotton-boll weevil investigators.[9] The results with this device in

[9] Banks, Nathan, Directions for Collecting and Preserving Insects, *Bull. U. S. Nat. Mus.* 67 (1909) 115, with figure.

the present experiments were most disappointing; in almost all trials the adult insects would not readily enter the test tubes, barely 5 per cent of those that emerged in the box having been captured in this manner.

With certain plants artificial breeding in the laboratory was found to be impracticable. The leaves of many species of *Ficus*, for example, dry up in less than an hour after being removed from the tree and placed under ordinary laboratory conditions; when confined in a vessel with a supersaturated atmosphere, decay readily sets in, or the material soon becomes moldy. The same is true with *Astronia* and certain other plants that grow at high altitudes. When the plant was conveniently near the laboratory, the galls were encased in muslin on the tree, so as to prevent the escape of the adults when they emerged; and daily inspection was made of these. However, in the case of the psyllid galls on the leaves of *Ficus ulmifolia* Lam., a badly infested plant of which happened to grow in close proximity to the entomological laboratory, the specimen was left without any cover. On examining the plant, it was found on January 25, 1917, after about two months' daily visits, that some of the galls were newly opened. On that day the plant was visited at frequent intervals, and it was discovered that the newly emerged adults, on growing stronger, had crawled over to the younger and softer tips of the branchlets, where they were easily caught in test tubes. For several days in succession captures were made in this manner.

The thysanopterous gall makers were easily secured from their galls. Provided the galls were not too old, the insects could always be found within in all stages of growth. They were scared out of the galls by gently tapping the latter, and could then be brushed off into a vial of 70 per cent alcohol. The eriophyids were not so easy to secure on account of their habit of clinging fast to the hair tufts of the galls and also because of their exceedingly minute size. Several methods were tried, but the simplest process was to brush the animals onto the surface of a mirror by means of a small camel's-hair brush, and then remove and mount them.

In the attempts to breed the gall insects from their galls, some other specimens—that is, parasites, inquilines, etc.—were often found. At times two or more species of a gall-making family were bred out, and in this case it was not easy to decide which was the gall maker and which the inquiline. There occurred a number of other instances where it was exceedingly difficult to arrive at a definite conclusion as to the real gall maker.

The adult gall insects were kept alive for from six to twelve hours in a cotton-plugged vial in order to give them time to dry and assume their normal color before they were killed. With the exception of the thrips and the eriophyids, two series of preserved specimens were prepared, one on small pins and the other on microscopical slides in Canada balsam or turpentine solution of colophony. If the specimens were scarce, only the former series was made of the adults. The thrips in all instars were always mounted on slides. When plenty of specimens of fresh insect galls could be secured, a number of these were carefully dissected, and the insects in their earlier stages removed and mounted on slides. In the case of transparent specimens, such as the earlier instars of psyllid nymphs and the larvæ of Itonididæ, which would be almost invisible when mounted on slides, resort was had to a previous staining in 0.5 per cent aqueous solution of magenta red for about twenty-four hours.

Drawings of anatomical parts of the gall insects were made with the aid of a camera lucida. Whenever practicable corresponding parts of different species of the same family were drawn to the same scale and in the same position, in order to facilitate comparison. Most of the gall sections were too large to be drawn conveniently by the aid of the microscope and camera lucida, so that practically all the drawings of these materials were made freehand.

RESULTS

Fifty-seven species of galls have been worked with. These are distributed among twenty-six plant families, as follows:

Apocynaceæ, 1.	Lecythidaceæ, 1.
Araceæ, 1.	Leguminoseæ, 2.
Araliaceæ, 2.	Loganiaceæ, 1.
Boraginaceæ, 1.	Melastomataceæ, 2.
Celastraceæ, 1.	Menispermaceæ, 3.
Combretaceæ, 2.	Moraceæ, 7.
Compositæ, 1.	Piperaceæ, 1.
Dilleniaceæ, 1.	Rubiaceæ, 1.
Dipterocarpaceæ, 4.	Sapindaceæ, 1.
Euphorbiaceæ, 10.	Tiliaceæ, 2.
Guttiferæ, 2.	Urticaceæ, 1.
Hernandiaceæ, 1.	Verbenaceæ, 3.
Lauraceæ, 2.	Vitaceæ, 3.

The present work has not been comprehensive enough to warrant our drawing very definite conclusions; but an examination of the above list tends to show that the Euphorbiaceæ have the greatest number of gall-making species, with the Moraceæ ranking second.

Classified as to causes, the following numbers of galls were obtained:

	Species of insects.
Itonidid galls	19
Psyllid galls	7
Thysanopterous galls	7
Eriophyid galls	7
Gelechid galls	1
Miscellaneous galls [a]	16

[a] "Miscellaneous galls" includes all the galls of which the causative agent is not definitely known.

Galls of the insects mentioned in the introductory paragraphs of this paper, other than those of the families enumerated above, have not been met with in the present investigation. Species of Cynipidæ [10] and Tenthredinidæ [11] have been reported from the Philippines, and the chances are that further work will lead to the discovery of the galls of the former, at least. The latter, *Selandria* (*Paraselandria*) *imitatrix* Ashm., according to Prof. C. S. Banks, the collector of the type, is an exophagous species and not a gall maker.

The Aphididæ and the Coccidæ are well represented in the Philippine fauna; but none of their galls have been found in connection with my work. It is not unlikely that their galls can be found here; for in Australia, a country that has many insects closely allied to Philippine species, among the largest and most remarkable galls are produced by some members of these families.[12]

The families Trypetidæ (Diptera) and Buprestidæ (Coleoptera) include many important pests of Philippine economic plants. Their work, however, has not been known to result here in the formation of galls.

In the various excursions made, it was noted that altitude influences the number of species of plant galls to a considerable

[10] See Kieffer, Nouveaux cynipides des Philippines, *Philip. Journ. Sci.* § D 9 (1914) 183; Neuer Beitrag zur Kenntniss der philippinischen Cynipiden, *Philip. Journ. Sci.* § D 11 (1916) 279.

[11] See Ashmead, Proc. U. S. Nat. Mus. 28 (1905) 971.

[12] Frogatt, Australian Insects (1907) 369, 370, and 380–383.

extent—the galls occurring most abundantly within a belt extending from sea level to an altitude of about 600 meters. Beyond that limit the galls are either very scarce or entirely absent. It was further noted that from sea level to an altitude of about 600 meters the greatest number of species occurred nearer sea level, their abundance diminishing with each 100-meter zone upward. This fact may be ascribed to at least two causes; namely, the prevalence or scarcity of the plant hosts in a given altitudinal zone; and the influence of temperature, moisture, pressure, absence or presence of natural enemies, and possibly other factors on the distribution of gall-making insects in different altitudinal zones. The following is the distribution of gall species, found by me, with respect to altitudes:

	Species.
Sea level to 100 meters	36
100 meters to 200 meters	31
200 meters to 300 meters	25
300 meters to 400 meters	23
400 meters to 500 meters	15
500 meters to 600 meters	9
600 meters to 900 meters	1
Above 900 meters	0

In the following pages the galls are divided into groups, according to their causative agents, which are indicated by the center heads; and each species is treated separately, with the specific name of the plant host as a side heading. Accounts of the causal insects, including descriptions of new species, will be given in later publications.

All of the specimen numbers cited in this paper refer to the collection of the department of entomology, College of Agriculture, Los Baños, Laguna, Philippine Islands.

GALLS CAUSED BY ITONIDIDÆ (CECIDOMYIIDÆ)

Acalypha stipulacea Klotz. Euphorbiaceæ.

Leaf galls caused by *Schizomyia acalyphæ* Felt.

Monothalamous; subcylindrical; red; basally yellowish or concolorous with leaf; covered all over with long, stiff, bristle-like hairs. Walls thin, fleshy; interior smooth. Opening apical; covered with a circular flap with edges confluent with the rest of the gall's surface, not visible until a few minutes previous to emergence of midges. Pupal exuviæ often found projecting half way out of opening.

Length of galls, 3.5 to 5.5 millimeters; diameter at base, 1.5 to 2.

On the nether surface of leaf, along principal veins or at points where two small nervules meet.

LUZON, Laguna, College of Agriculture, near lower nursery, Los Baños; at an altitude of about 45 meters. March 15, 1917. Type gall No. 18313, College of Agriculture collection.

Numerous specimens of these galls were found on several young leaves of a small *Acalypha* plant. A part of these materials was confined in Petri dishes. The day following, March 16, 1917, most of the adults emerged. An idea may be had of the habits of the insect during and after emergence from the following notes:

1.40 p. m.—A circular flap gradually separated from the apex of one of the galls, leaving a small part at the circumference attached to the gall. An adult midge, exposed from the pupal exuviæ to about the metathorax, wriggled its way out through the opening until about one-third the length of the exuviæ was exposed. The midge continued to wriggle, this time gradually withdrawing itself from the exuviæ.

1.57 p. m.—Legs completely exposed. With the legs anchored against the outer wall of the gall, the midge continued to struggle with a forward and backward motion, carrying the pupal exuviæ until about two-thirds the total length of the latter were exposed. Finally, with a sudden jerk, the insect completed its emergence.

1.58 p. m.—Wings fully expanded.

2.17 p. m.—Midge able to fly.

Summary.—The midge emerged seventeen minutes after the separation of the lid from the gall was first noted; the wings were fully expanded after another minute; and the insect was able to fly nineteen minutes later.

The galls are apparently scarce, as subsequent excursions resulted in the finding of only one or two isolated specimens.

Antidesma leptocladum Tul. Euphorbiaceæ.

Leaf galls caused by *Ctenodactylomyia antidesmæ* Felt.

Monothalamous; very acutely subconical; red; sometimes basally or wholly concolorous with the leaf; thickly but very briefly pubescent. Apex slightly curved toward one side; very acute. Wall thin; inner layer woody, faintly greenish white; outer, suffrutescent. Chamber following the general shape of the gall. Opening basal; situated at opposite surface of leaf; subcircular, with a close-fitting flap, detachable through the force of the emerging midge.

Length, 8.5 to 10.5 millimeters; diameter at base, 1.5 to 1.75.

On the upper surface of leaf, along the midrib or lateral nervules.

LUZON, Laguna, College of Agriculture, near citrus plantation, Los Baños, at an altitude of about 47 meters; Mount Maquiling, at an altitude of about 250 meters. March and September, 1917. Type gall No. 18157, College of Agriculture collection.

These galls are not very common and their makers are apparently restricted to certain periods of the year, within the dates given above. The leaves dry up in a day or two after being removed from the plant, and it was very difficult to secure the adults.

Barringtonia luzonensis Rolfe. Lecythidaceæ.

Leaf galls caused by *Kronodiplosis uichancoi* Felt.

Monothalamous; spherical; abruptly joined to the leaf by a very short, inconspicuous peduncle; glabrous; very finely punctate; almost concolorous with the leaf. Wall very thick; a thin, outer, succulent layer; the rest hard, ligneous. Chamber about one-tenth the size of the gall; subspherical. Opening subcircular; not visible until after the midge has emerged; without process; usually situated at one side of the gall.

Diameter of gall, 4.5 to 5.5 millimeters.

On nether surface of leaf, usually clustered together in irregular, longitudinal rows with respect to the midrib.

LUZON, Laguna, College of Agriculture, near Students' Campus, Los Baños, at an altitude of about 45 meters; barrio of Lalacay, Los Baños, at an altitude of about 40 meters. February, 1917. Type gall No. 18307, College of Agriculture collection.

These galls are common and are apparently present throughout the year.

Callicarpa erioclona Schauer. Verbenaceæ.

Leaf galls caused by *Asphondylia callicarpæ* Felt.

Polythalamous; consisting of an enlargement of the midrib, which forms with the atrophied leaf lamina a single mass of succulent tissue. Enlarged portion tomentose; concave above and convex on nether surface, petiole and apex usually, and a small portion at base sometimes, normal. Hair long; dark brown; concolorous with the normal short pubescence of the plant. Chambers subellipsoid; size very variable; arranged irregularly in close proximity to upper, concave surface. Opening without process.

Length, about 30 millimeters; width, 15; thickness, 16.

LUZON, Mount Maquiling, at altitudes of from 200 to 300 meters. August, 1917. Type gall No. 18147, College of Agriculture collection.

These galls were very abundant at the altitudes cited. The deformation is confined to the younger, subterminal leaves. Present during the greater part of the year.

Cissus adnata Wall. var. Vitaceæ.

Leaf galls caused by *Hyperdiplosis banksi* Felt.

Monothalamous; subconical; concolorous with leaf; slightly incurved basad; slightly curved subapically laterad; thickly but briefly pubescent. At base, on opposite surface of leaf, gall continued into a slightly raised, broadly subconical structure. Wall thick; succulent. Chamber subcylindrical, concave at base; broader apicad; a thin membranous cover at one-third the length of chamber from apex; inner wall of chamber beneath cover, smooth; above, lined with a thick mat of long hair. Opening apical.

Length, 11 millimeters; diameter at base, 5.5; mean diameter of chamber, 0.5.

On nether surface of leaf; rarely on upper surface.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters. Type gall No. 18306, College of Agriculture collection.

Very numerous on two isolated plants at the place cited; not found elsewhere.

Cissus trifolia (L.) K. Sch. Vitaceæ.

Stem galls caused by *Asphondylia vitea* Felt.

Polythalamous; very irregularly subfusiform or subellipsoid; unevenly tuberculated; consisting of enlargements at various parts of stem; concolorous with, and equally as pubescent as, the normal parts of the stem; succulent. Chambers subellipsoid; embedded irregularly within the succulent tissues of the gall; walls of chambers thin, more or less ligneous. Opening, an irregular tunnel made by the emerging midges through the gall tissues; without process.

Length, 15 to 60 millimeters; diameter, about 10.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of from 45 to 100 meters. August, 1917. Type gall No. 18342, College of Agriculture collection.

These galls were abundant from August to December, 1917, at the altitudes given above. As many as thirty insects have been found to inhabit one gall.

Diplodiscus paniculatus Turcz. Tiliaceæ.

Terminal stem gall caused by *Schizomyia diplodisci* Felt.

Polythalamous; subspherical; prevailing color green with a thin grayish coating; nonpubescent, consisting of enlargements at the ends of lateral branches of the plant. Walls thick; fleshy. Greenish flesh, turning brown after being cut and exposed to air. Chambers ellipsoid; arranged subcentrad in a more or less regular longitudinal bundle with the distal ends closer together than the proximal. Opening not visible until the midges are about ready to emerge; then a crack appears on the distal or lateral area of the gall, depending on the direction toward which the smaller end of the chamber bundle points; an irregular cavity forms thence and connects with the chambers within.

Average diameter of gall, 25.5 millimeters; of chamber, 0.75 to 1 millimeter.

LUZON, Mount Maquiling, at altitudes of 100 to 150 meters. March to August, 1917. Type gall No. 18314, College of Agriculture collection.

Fairly abundant during the months cited. The galls have the general appearance of fruits for which they are very often mistaken.

Grewia stylocarpa Warb. Tiliaceæ.

Leaf galls caused by *Asphondylia grewiæ* Felt.

Monothalamous; abruptly and thinly subreniform; yellowish green, changing to brown at maturity; nonpubescent. Wall thin; somewhat succulent; juice sticky. Chamber conforming with general outline of gall; inner wall smooth. Opening small; subcircular; without process; located at distal margin of gall plate.

Width, 5.5 millimeters; height, 6; thickness, 1.25 to 3.

On the upper surface of the leaf; arranged irregularly face to back in rows along the midrib.

LUZON, Mount Maquiling, at altitudes of 60 to 200 meters. March, 1917. Type gall No. 18137, College of Agriculture collection.

Occasional specimens were found near the trail leading from First Creek to Camp One. The causal midges are very difficult to breed, as the leaves and the galls wrinkle up and dry in less than one day after removal from the plant.

Illigera luzonensis (Presl) Merr. Hernandiaceæ.

Petal galls. Adult midges not collected.

Polythalamous; consisting of abnormal, irregular enlargement of petals; concolorous with corresponding parts of normal flowers; fleshy; nonpubescent. Chambers subellipsoid; embedded in the succulent tissue of the galls. Sepals of flowers affected by the gall abnormally enlarged but not swollen.

Diameter of infested flower, 16.5 millimeters; of normal flower, 4.5.

LUZON, Mount Maquiling, at altitudes of 100 to 300 meters (*C. Mabesa*). September, 1917. Type gall No. 18163, College of Agriculture collection.

Not common.

Leea manillensis Walp. Vitaceæ.

Leaf galls caused by *Lasioptera manilensis* Felt.

Monothalamous; irregularly and elongately subglobose; part of the gall appearing on upper surface of leaf and a corresponding inferior lobe on nether surface. Superior lobe smaller than inferior; the former sometimes flushed with carmine, otherwise uniformly lettuce green throughout; skin smooth, nonpubescent; the original puncture of the ovipositor usually marked by a small, infundibular, eccentric depression. Inferior lobe generally carmine, with a thin lettuce green border; general contour more or less wavy in outline; skin smooth, nonpubescent. Leaf lamina immediately adjoining gall convoluted circumferentially.

Interior fleshy; flesh light green, semitranslucent. Chamber located centrad along longitudinal axis of gall; about three-fourths the length of the gall; curved downward at one end; wall hard but brittle. Opening at inferior lobe; not visible until the midge is ready to emerge, when the part at which the opening should appear becomes darker than the rest of the gall surface; then the opening gradually becomes visible as the circular flap is pushed out.

Length of superior lobe, 7.5 to 9.5 millimeters; width, 5; thickness, 3 to 5; length of inferior lobe, 7 to 9.5; width, 5.5 to 7; thickness, 4 to 5.5.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 150 meters. March, 1917. Type gall No. 18318, College of Agriculture collection.

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These galls are apparently abundant during the greater part of the year, especially toward the close of the rainy season.

Mallotus moluccana (L.) Muell.-Arg. Euphorbiaceæ.

Leaf galls. Adult midges not collected.

Monothalamous; subconical; irregularly ribbed longitudinally; sparsely pubescent; light apple green, somewhat paler than leaf. Apex usually obtuse; sometimes produced to a tapering point. A slender projection generally present at opposite surface of leaf. Wall moderately and irregularly thick; succulent. Chamber conforming with general shape of gall. Opening small, circular; located at one side of the gall basad.

Average length, 10 millimeters; diameter, 3.

On the nether surface of the leaf; numerous.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 60 meters. March to September, 1917. Type gall No. 18312, College of Agriculture collection.

These galls are fairly abundant. Attempts at breeding the causal midges resulted, in all cases, in securing the chalcid parasites only. The causal larvæ found within the galls were typically itonidid larvæ; in all the specimens examined the *spathula sterni* was present. They were invariably parasitized.

Memecylon paniculatum Jack. Melastomataceæ.

Fruit galls. Adult midge not collected.

Infested fruit of irregular shape; more or less compressed proximodistad; pale greenish white, with a slight tinge of yellow; interior yellowish white; succulent. Chambers ellipsoid; numerous; irregularly arranged subcentrad; walls of chambers ligneous.

Average diameter of infested fruit, 16 millimeters.

LUZON, Mount Maquiling, at altitudes of 150 to 500 meters (*Mabesa*). October 15, 1917. Type gall No. 18169, College of Agriculture collection.

Rare.

Pæderia tomentosa Blume. Rubiaceæ.

Leaf galls caused by *Itonida pæderiæ* Felt.

Gall consists of a superior longitudinal infolding of both margins of leaf blade, with a consequent upward curvature of the affected leaf. Abnormal parts extending from base to about one-sixth of the leaf length from apex; the margins touch each other tangentially at sides along midrib. Apical and subapical portion of leaf lamina normal. Chambers formed by infolded parts of leaf thickly lined with long pubescence, the latter serving as support for the developing midges. Midrib and lateral nervules abnormally pubescent at nether surface of leaf. Adult midges make their exit either at distal or at proximal aperture of chambers.

Length of leaf, including petiole, 25 millimeters; length of affected part, about 19; thickness of chamber, from midrib of leaf to distal portion, 6.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 100 meters. October, 1917. Type gall No. 18165, College of Agriculture collection.

Not very common.

Parashorea plicata Brandis. Dipterocarpaceæ.

Leaf galls, probably caused by *Tricontarinia luzonensis* Felt.[13]

Monothalamous; green when young; castaneous when mature; glabrous; subconical; base somewhat peripherally incurved, the curvature thus formed continuing through the leaf lamina on to the other surface of the leaf and forming the more or less convex bottom of the gall. Apex generally acute; otherwise rounded off. Wall thick; hard and tenacious. Chamber spherical; inclosed by a moderately thick, ligneous wall. A secondary, inferior, subconical, empty chamber; apparently without function.

Diameter at base, 4.5 to 5 millimeters; height, 4 to 6.

On nether surface of leaf; often solitary but sometimes aggregate and fused together.

LUZON, Mount Maquiling, at altitudes of 50 to 500 meters. August, 1917. Type gall No. 18151, College of Agriculture collection.

These galls are fairly common. The leaves, as well as the galls, dry up very quickly when removed from the tree, thereby making it difficult to breed the midges. Further work may lead to the discovery of the actual cause of this interesting formation.

Shorea guiso Blume. Dipterocarpaceæ.

Leaf galls. Adult midges not collected.

[13] This species is believed by Dr. E. P. Felt to be predacious rather than phytophagous. See Felt, New Philippine gall midges, *Philip. Journ. Sci.* § D 13 (1918) 294.

Monothalamous; spherical; concolorous with leaf; somewhat thickly pubescent. Wall moderately thick; coriaceous. Chamber conforming with the general shape of the gall.

Average diameter, 2.5 millimeters.

On the nether surface of the leaf; submarginal, along principal lateral nervules.

LUZON, Mount Maquiling, at altitudes of 150 to 500 meters. September, 1917, and March, 1918. Type gall No. 18156, College of Agriculture collection.

Galls fairly common. Adult midges could not be obtained, as the leaves and the galls dry up very quickly when removed from the plant.

Siphonodon celastrineus Griff. Celastraceæ.

Leaf galls caused by *Kamptodiplosis reducta* Felt.

Monothalamous; subdiscoid. On upper surface of leaf, as an irregular, raised, subcircular spot, with the leaf cuticle forced open bordering the circumference; dark yellowish brown, more deeply so centrad. On nether surface of leaf, as irregularly raised papules, somewhat paler than leaf; border diffused ectad. Wall thick, ligneous. Chamber discoid. Opening circular, located centrally on the upper surface of the leaf.

Diameter on upper surface, 2.25 millimeters; on nether surface, 4.5; diameter of opening, 0.5 millimeter.

LUZON, Laguna, Balong Bulo Hill, near College of Agriculture, Los Baños, at an altitude of about 60 meters. March, 1917. Type gall No. 18319, College of Agriculture collection.

These galls were found on a single isolated tree. The same tree was visited a year later, and all the galls had disappeared. A search made in other places failed to disclose these galls on plants of the same species.

Spatholobus gyrocarpus (Wall.) Benth. Leguminoseæ.

Leaf galls caused by *Heliodiplosis spatholobi* Felt.

Monothalamous; abruptly and irregularly subconical; rugose; somewhat paler green than leaf; sparsely and briefly pubescent. On nether surface of leaf, subcircular; covered with a dense mat of light green to brown hair. Apex produced in a tapering projection, inclining over on one side. Wall slightly ligneous; thick. Chamber small; discoid. Opening a small, needle-hole-like aperture on nether surface of leaf.

Length of gall, 1.25 to 1.5 millimeters; diameter at base, 3 to 3.5.

On the upper surface of the leaf; very numerous.

LUZON, Mount Maquiling, at altitudes of 100 to 500 meters. July, 1917. Type gall No. 18341, College of Agriculture collection.

These galls are common during the rainy months, and the gall insects are fairly easy to breed out.

Symphorema luzonicum F.-Vill. Verbenaceæ.

Leaf galls caused by *Luzonomyia symphoremæ* Felt.

Monothalamous; spherical or nearly so; stramineous; covered with long, fine, dry, yellowish, nonglandular hairs; more densely pilose proximad than distad; sessile, and with base more or less sunken into the depression formed in the leaf lamina. Wall moderately thick; ligneous; of uniform thickness throughout. Chamber conforming with the general shape of the gall. Opening at distal end of gall; circular; covered with a close-fitting lid, which falls off when the midge emerges.

Diameter of gall, 1.7 to 2 millimeters.

Generally on the nether surface of the leaf; occasionally on the upper surface.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 45 meters; Mount Maquiling, at an altitude of 150 to 300 meters. Type gall No. 18315, College of Agriculture collection.

These galls are very common, and the causal midges are often easily bred out. From examination of the younger leaves, it appears that the galls begin with a puncture on either surface of the leaf, surrounded by a conspicuous, semitransparent, diffused area. As the gall grows, the epidermis of the leaf splits open and allows the deformity to continue its development.

Vernonia lancifolia Merr. Compositæ.

Leaf galls caused by *Diceromyia vernoniæ* Felt.

Polythalamous; gall consists of an abnormal contraction and incurving of midrib, with the leaf lamina much wrinkled inferiorly; no abnormal formation of hair or development of differential color. Chambers ovoid or ellipsoid; embedded in the succulent tissues of the abnormal midrib. Openings irregular; situated on concave, upper surface of gall.

Length of gall, 30 millimeters; thickness, 13.

LUZON, Mount Maquiling, at altitudes of 200 to 500 meters. August, 1917. Type gall No. 18143, College of Agriculture collection.

Galls fairly common. Insects easy to breed out.

GALLS CAUSED BY PSYLLIDÆ

Alstonia scholaris R. Br. Apocynaceæ.

Leaf galls[14] caused by *Pauropsylla tuberculata* Crawford.

Monothalamous; subcylindrical; concolorous with leaf, except at apex, yellowish; nonpubescent. Apex somewhat deeply cleft. Wall thick; succulent. Chamber subcuneate, with the sharp edge pointing distad; direction the same as the median depression at cleft of apex. Opening apical; subcircular; without process; not visible until the adult psyllids are ready to emerge. On the opposite surface of the leaf, a short, conical protuberance with apex broadly rounded.

Average length, 4 millimeters; broader diameter at apex, 3; narrower, 2.5; broader diameter at base, 3.75; narrower, 3.

On either surface of the leaf; more commonly on nether surface.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 50 meters. May, 1917. Gall No. 18322, College of Agriculture collection.

These galls are abundant but the adult insects are somewhat difficult to rear on account of the tendency of the leaves to dry in a couple of days after removal from the tree. The causal psyllid was first described from Pusa, Bengal, and reported as captured on *Alstonia* and also on "pumpkin."[15] The insect has never been recorded from the Philippines before.

Calophyllum inophyllum L. Guttiferæ.

Leaf galls. Adult psyllids collected but not identified.

One or both margins of leaf, except at apex and base, narrowly doubled up inferiorly, the fold forming the chamber wherein the insect passes its preimaginal stages. Older leaves more deeply concave longitudinally; a slight yellowing at different places on the folds.

Average diameter of fold, 2.5 millimeters.

LUZON, Laguna, School of Forestry, Los Baños, at an altitude of about 100 meters. March, 1918. Type gall No. 18348, College of Agriculture collection.

[14] Previously described by Rübsaamen from Bismarck Archipelago in Marcellia 4 (1905) 7. Also described and figured by Leeuwen-Reijnvaan from Java in Marcellia 9 (1910) 38. Figured by Leeuwen-Reijnvaan in Bull. Jard. Bot. Buitenzorg, II 3 (1912) 4. Described by Leeuwen-Reijnvaan from Celebes, Bull. Jard. Bot. Buitenzorg II 21 (1916) 24.

[15] Crawford, Indian Psyllidæ, *Rec. Ind. Mus.* 7 (1912) 430.

Galls common in the place cited; not found on the same plant elsewhere in Los Baños. Adults found only on March 11, 1918, after about one year's occasional observation on the nymphs within the galls.

Ficus nervosa Heyne. Moraceæ.

Leaf galls caused by *Dinopsylla cornuta* Crawford.

Fresh galls of these insects have never been obtained by me. A single infested leaf that had fallen from the tree was found; but the galls were too badly mutilated and shriveled up to furnish adequate material for description. Prof. C. F. Baker had previously bred this *Dinopsylla* from the same galls, and is my authority for the identity of the insect and its work. *Ficus nervosa* Hey. is fairly common in Mount Maquiling, at altitudes of 100 to 150 meters.

Ficus ulmifolia Lam. Moraceæ.

Leaf galls No. 1, caused by *Pauropsylla deflexa* sp. nov. (MS).

Monothalamous; very abruptly and irregularly subconical; lettuce green, lighter in color than leaf; pubescent, more thickly so than leaf. Apex usually obtuse; sometimes abruptly pointed. Bottom, at opposite side of leaf, subhemispherical; concolorous with and equally as pubescent as the rest of the gall. Chamber elongately subellipsoid; lining smooth. Wall thick; succulent. Opening apical; not visible until adults are ready to emerge; then wall splits open longitudinally from apex subbasad into several irregular lobes; each lobe deflected ectad.

Average length, 6 millimeters; diameter, 5; length of chamber, 3.5; diameter, 1.25.

Subconical portion on nether surface of leaf; subhemispherical, on upper surface. Usually aggregate and fused together, giving appearance of polythalamous galls.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 42 meters. January, 1917. Type gall No. 18309, College of Agriculture collection.

These galls are very common, but the adults are very difficult to breed. The leaves dry in less than half a day after removal from the tree. Numerous adult psyllids emerged from galls on a small *Ficus* tree in the nursery of the college, and were collected from the young shoots, up which the insects had crawled to feed.

Ficus ulmifolia Lam. var. Moraceæ.

Leaf galls No. 2. Adult psyllids not found.

Monothalamous; subconical; slightly curved subapicad toward one side; orange to red. Surface scabrous; nonpubescent; somewhat shiny. Wall moderately thick; succulent. Chamber conforming with the general shape of the gall; a tiny raised tubercle centrad at bottom.

Average length, 7.5 millimeters; diameter at base, 4.

On the upper surface of the leaf; usually solitary; occasionally aggregate, but only partially fused together and the individual galls are distinguishable.

LUZON, Mount Maquiling, at an altitude of 150 meters. March 16, 1918. Type gall No. 18401, College of Agriculture collection.

Apparently rare.

Ficus variegata Blume. Moraceæ.

Leaf galls caused by *Pauropsylla montana* sp. nov. (MS).

Monothalamous; subspherical; paler green than leaf; covered all over with long, succulent, slightly pubescent spines. A tiny, abrupt, acutely subconical projection centrad at bottom of gall on opposite surface of leaf. Wall thin; succulent. Chamber subspherical; abruptly produced obconically at bottom. Opening apical; not visible until adult is ready to emerge; then wall splits from apex longitudinally subbasad into usually five irregular lobes; each lobe deflected ectad.

Average diameter, 5 millimeters.

On the upper surface of the leaf; numerous; sometimes connivent, but never fused.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters; Mount Maquiling, at altitudes of 70 to 150 meters. January, 1917. Type gall No. 18310, College of Agriculture collection.

Galls fairly common; insects easy to breed.

Mallotus philippensis (Lam.) Muell.-Arg. Euphorbiaceæ.

Leaf galls caused by *Megatrioza pallida* sp. nov. (MS).

Shallow, concave depressions on nether surface of leaf, with the upper surface correspondingly convex. No abnormal growth of hair. Apex on concave surface yellowish to reddish brown; the rest unicolorous with leaf. Nymph fits in snugly on concave surface, the insect establishing itself there until ready to emerge.

Average diameter, 2 millimeters; average depth of concavity, 0.5.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 45 meters. January, 1918. Type gall No. 18174, College of Agriculture collection.

Galls very common; insects observed in the adult stage only in January.

GALLS CAUSED BY THYSANOPTERA

Dillenia reifferscheidia F.-Vill. Dilleniaceæ.

Leaf galls. Causal thrips collected but not identified.

Leaf margins wholly or partially involute toward nether surface of leaf; when partially so, the involution usually extends from apex, leaving a basal fraction of the leaf unaffected. Minute, red, irregular, hard papules more prominent on upper surface or at the continuation of the latter in the roll than on nether surface. Thrips in different stages found within the rolls of younger leaves.

Average diameter of roll, 8 millimeters.

LUZON, Laguna, College of Agriculture, lower nursery, Los Baños, at an altitude of about 43 meters. October, 1917. Type gall No. 18158, College of Agriculture collection.

These galls are apparently confined to a single isolated tree at the bank of Molauin Creek in the place cited. None of these materials was found elsewhere.

Ficus ulmifolia Lam. Moraceæ.

Leaf galls caused by *Gigantothrips elegans* Zimmerman.[16]

Part of leaf margin involuted or deflected. Small, irregular, reddish dots, bounded by irregular, yellow areas, visible on both surfaces. Insects found on nether surface of leaf.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 100 meters. January, 1918. Gall No. 18403, College of Agriculture collection.

These galls are abundant during the greater part of the year.

Garcinia venulosa (Blanco) Choisy. Guttiferæ.

Leaf galls. Thrips collected but not identified.

Open; a carinate structure formed by the superior involution of a part of submarginal portion of leaf; paler green than leaf;

[16] The insect has been reported from Java as making similar galls on the leaves of various other species of *Ficus*. See Leeuwen-Reijnvaan, Beitrage zur Kenntniss der Gallen von Java, Pt. V, *Bull. Jard. Bot. Buitenzorg* II 10 (1913).

nonpubescent. Wall thicker than leaf lamina; slightly rugose on both outer and inner surfaces. Opening, a longitudinal slit on nether surface.

Length, 60 millimeters; height, 5.5; thickness, 1.75.

On the upper surface of the leaf; solitary.

LUZON, Mount Maquiling, at an altitude of about 150 meters. March 16, 1918. Type gall No. 18402, College of Agriculture collection.

Apparently rare.

Mallotus philippensis (Lam.) Muell.-Arg. Euphorbiaceæ.

Leaf galls caused by *Neoheegeria mendax* Karny.[17]

Terminal and subterminal leaves with laminæ irregularly connivent superiorly; much wrinkled and aborted. Folds produced by wrinkles, pale lettuce green. Insects found between the apposing leaf blades.

Average length (wrinkled), 20 millimeters.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 47 meters. January, 1918. Gall No. 18175, College of Agriculture collection.

Fairly common.

Piper loheri C. DC. Piperaceæ.

Leaf galls caused by *Gynaikothrips chavicæ* Zimmerman.[18]

Irregular, roughened, pale greenish white depressions through leaf lamina, the concavity being on the upper surface; a corresponding convex portion on nether surface of leaf. Depressions more numerous submarginally apicad, and the margins at this portion of leaf involuted superiorly. Thrips found in depressions of younger leaves.

Average diameter of depressions, 2 millimeters.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 100 meters. October, 1917. Gall No. 18160, College of Agriculture collection.

Galls very common throughout the year.

[17] Gall and insect previously described from Java. See Karny, Gallenbewohnende Thysanopteren aus Java, *Marcellia* 11 (1912) 122. Karny and Leeuwen-Reijnvaan, Über die javanischen Thysanopteren und deren Bewohner, *Bull. Jard. Bot. Buitenzorg* II 10 (1913) 10 and 64.

[18] Previously reported from Java, Sumatra, and Celebes by Leeuwen-Reijnvaan as making galls on other species of *Piper*. See Marcellia 8 (1909) 113; Bull. Jard. Bot. Buitenzorg 10 (1913) 17, 21 (1916) 17 and 38.

Raphidophora perkinsiæ Engl. Araceæ.

Leaf galls. Thrips collected but not identified.

One or both margins of leaf inferiorly involuted; the rolls extending from base nearly to apex; rolls nearly meeting each other along midrib. Irregular, yellowish, convoluted markings visible from both surfaces.

Diameter of rolls, 4.5 millimeters.

LUZON, Mount Maquiling, at altitudes of 70 to 150 meters. October, 1917, and March, 1918. Type gall No. 18167, College of Agriculture collection.

Not very common.

Schefflera odorata (Blanco) Merr. et Rolfe. Araliaceæ.

Leaf galls [19] caused by *Gynaikothrips chavicæ* var. *heptapleuri* Karny.

Irregularly subcylindrical to subfusiform; elongate; noticeably curved at certain points, especially so subapicad; slightly paler green than leaf; somewhat rugose; nonpubescent. Wall not much thicker than leaf; succulent. Interior irregularly blotched with brownish markings. Opening subcircular; uncovered.

Average length of gall, 18 millimeters; diameter at largest point, 3.5; diameter of opening, 1.5.

On the upper surface of the leaf; numerous.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 45 meters. May, 1917. Gall No. 18136, College of Agriculture collection.

Not very common.

GALLS CAUSED BY GELECHIDÆ

Glochidion album (Blanco) Boerl. Euphorbiaceæ.

Leaf galls. Adult collected but not identified.

Monothalamous; subreniform; purplish red to reddish brown; basally concolorous with leaf; covered all over with short, stout pubescence. Wall thick; succulent; thicker distad than proximad. Chamber subfusiform; bottom broadly convex; one end produced into a long neck; neck guarded externally by a thin epidermis, concolorous and confluent with the rest of the outer

[19] Previously reported by Leeuwen-Reijnvaan from Java; see Bull. Jard. Bot. Buitenzorg II 3 (1912) 29.

Also, from Sumatra and Simaloer, and Celebes; see Bull. Jard. Bot. Buitenzorg II 21 (1916) 10 and 32.

gall surface until shortly before emergence of adult. A thin, whitish, membranous secondary flap near base of neck. Opening subcircular; at one end of gall.

Length of gall, 11.5 millimeters; thickness, 5.75; breadth, 4.5; length of chamber, including neck, 9.25; diameter at broadest point, 2.5.

On upper surface of leaf; numerous.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters (*Baker and Uichanco*); Mount Maquiling, at an altitude of about 150 meters. January, 1917. Type gall No. 18308, College of Agriculture collection.

Fairly common; but adults difficult to breed.

ERIOPHYID AND MISCELLANEOUS GALLS

The part of this treatise, involving galls caused by Eriophyidæ, is withdrawn for a later paper. Likewise, all other galls of which the insects have not been found are omitted here in the hope that further work on additional fresh materials, which are constantly coming in, may furnish some clue to the identity of the causative agents.

ACKNOWLEDGMENTS

I wish to express my hearty appreciation of the valuable assistance given me by Prof. Charles Fuller Baker, acting dean of the College of Agriculture, and Prof. Charles S. Banks, chief of the department of entomology, under whose joint direction the work was conducted. The work was begun under Professor Baker while Professor Banks was in America. I am also under great obligation to Prof. F. W. Foxworthy and Messrs. Calixto Mabesa and Nemesio Catalan, of the department of dendrology (forest botany), School of Forestry, for identification of most of the botanical material and for their kindly coöperation; to Prof. E. D. Merrill, botanist of the Bureau of Science, for identification of some botanical specimens; to Dr. E. P. Felt, state entomologist, Albany, New York, U. S. A., for determination of gall midges collected from my galls; and to Dr. W. Docters van Leeuwen-Reijvaan of Bandoeng, Java, for having very kindly furnished me with an almost complete set of his important papers on Dutch East Indian galls.

ILLUSTRATIONS

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Fig. 1. *Acalypha stipulacea* Klotz. Leaf gall caused by *Schizomyia acalyphæ.* Longitudinal median section. × 5.

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4. The gall shown in fig. 1. Lid, ental aspect. × 22.5.

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2. *Alstonia scholaris* R. Br. Leaf galls caused by *Pauropsylla tuberculata* Crawford. View from upper surface of leaf, showing bottoms of galls. × 1.5.

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7. *Piper loheri* C. DC. Leaf galls caused by *Gynaikothrips chavicæ* Zimmerman. View from upper surface of leaf; nether surface of leaf exposed at rolled-up margin. × 1.5.

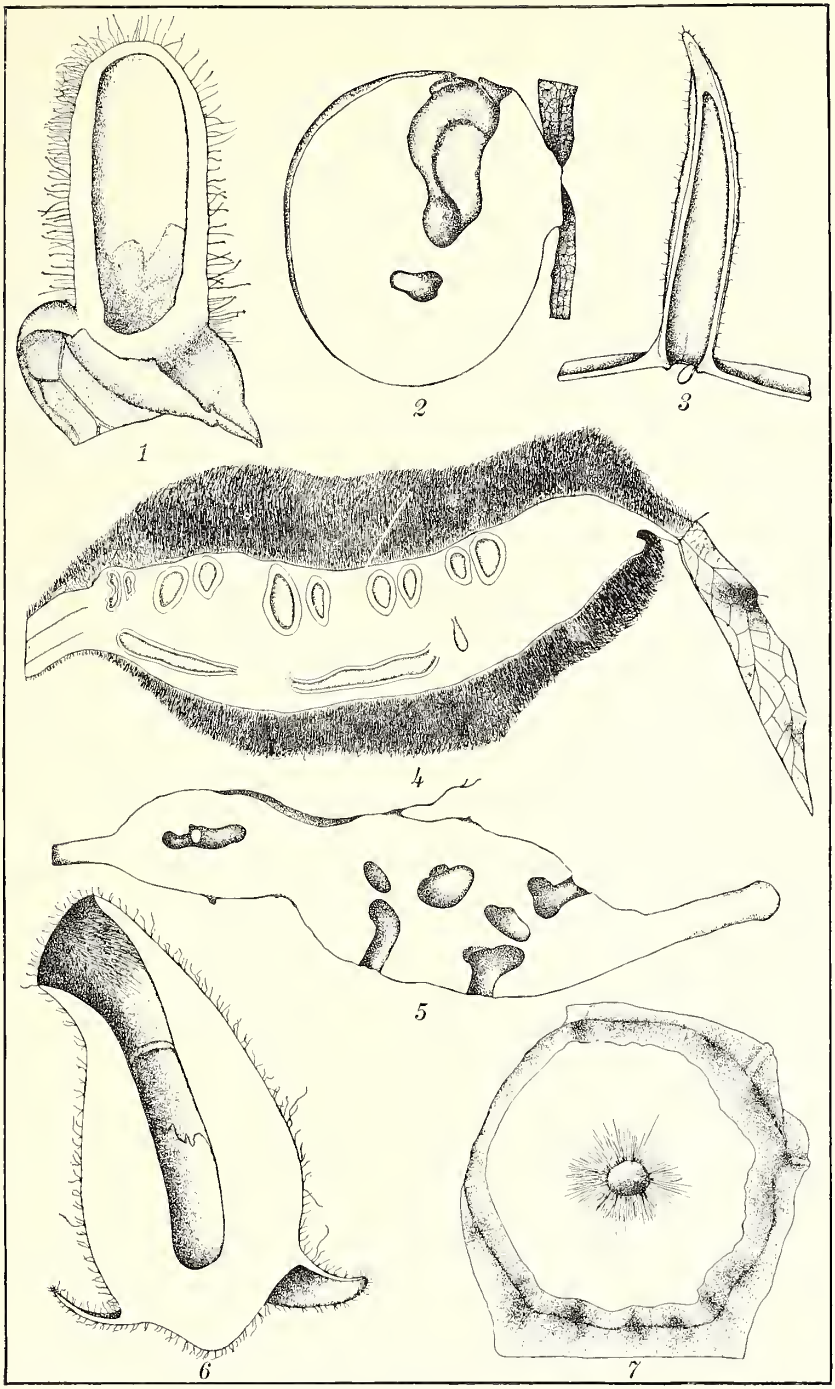


PLATE I. PLANT GALLS.

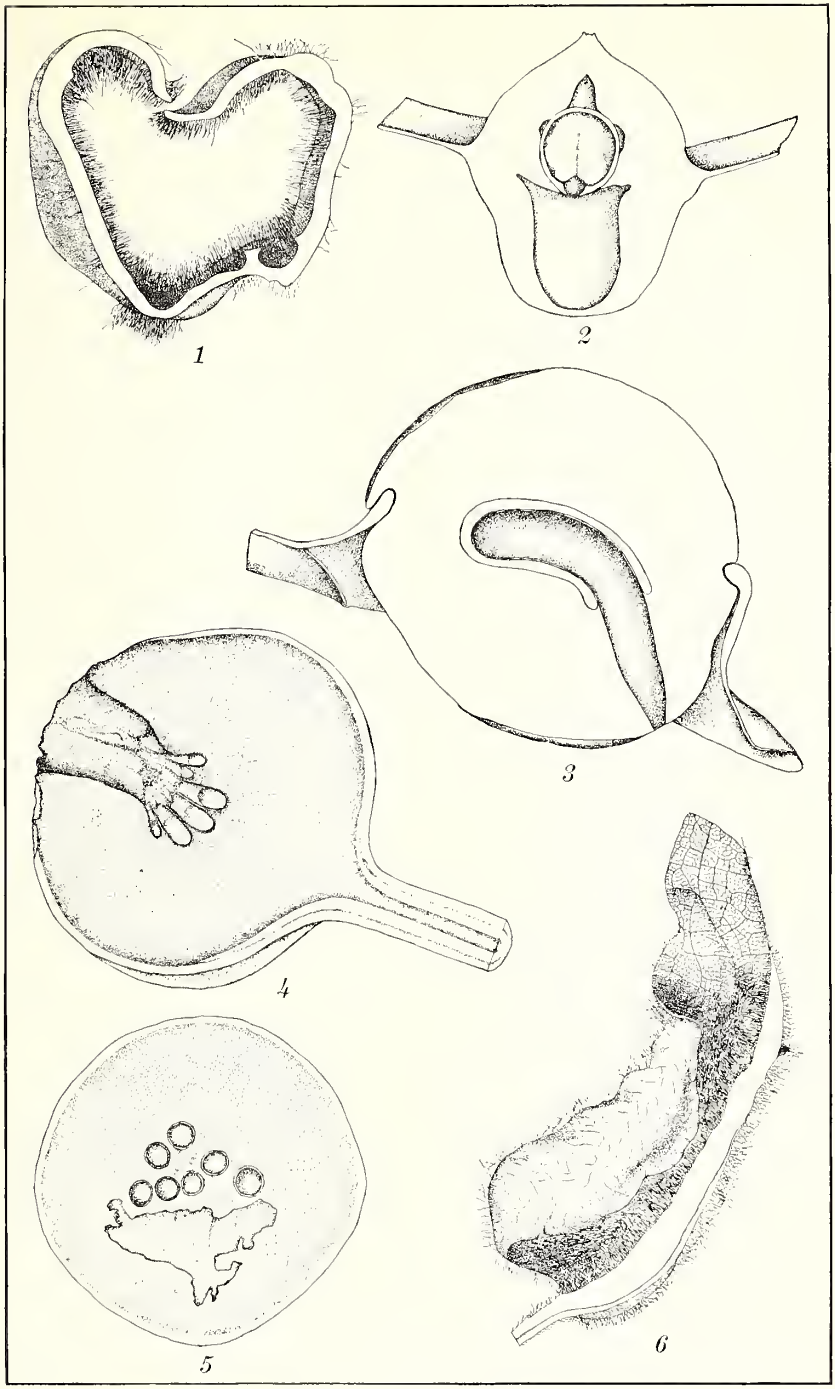


PLATE II. PLANT GALLS.

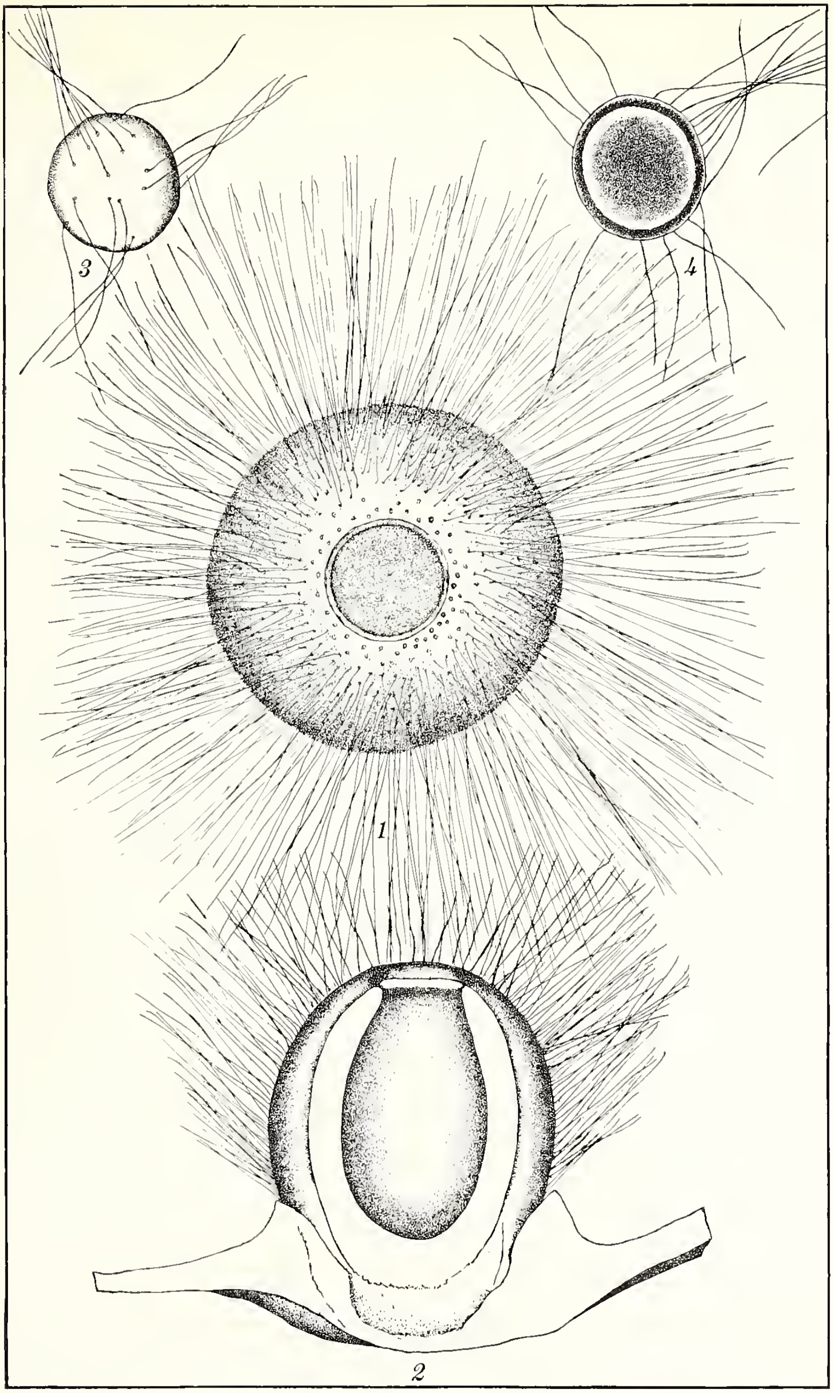


PLATE III. PLANT GALLS.

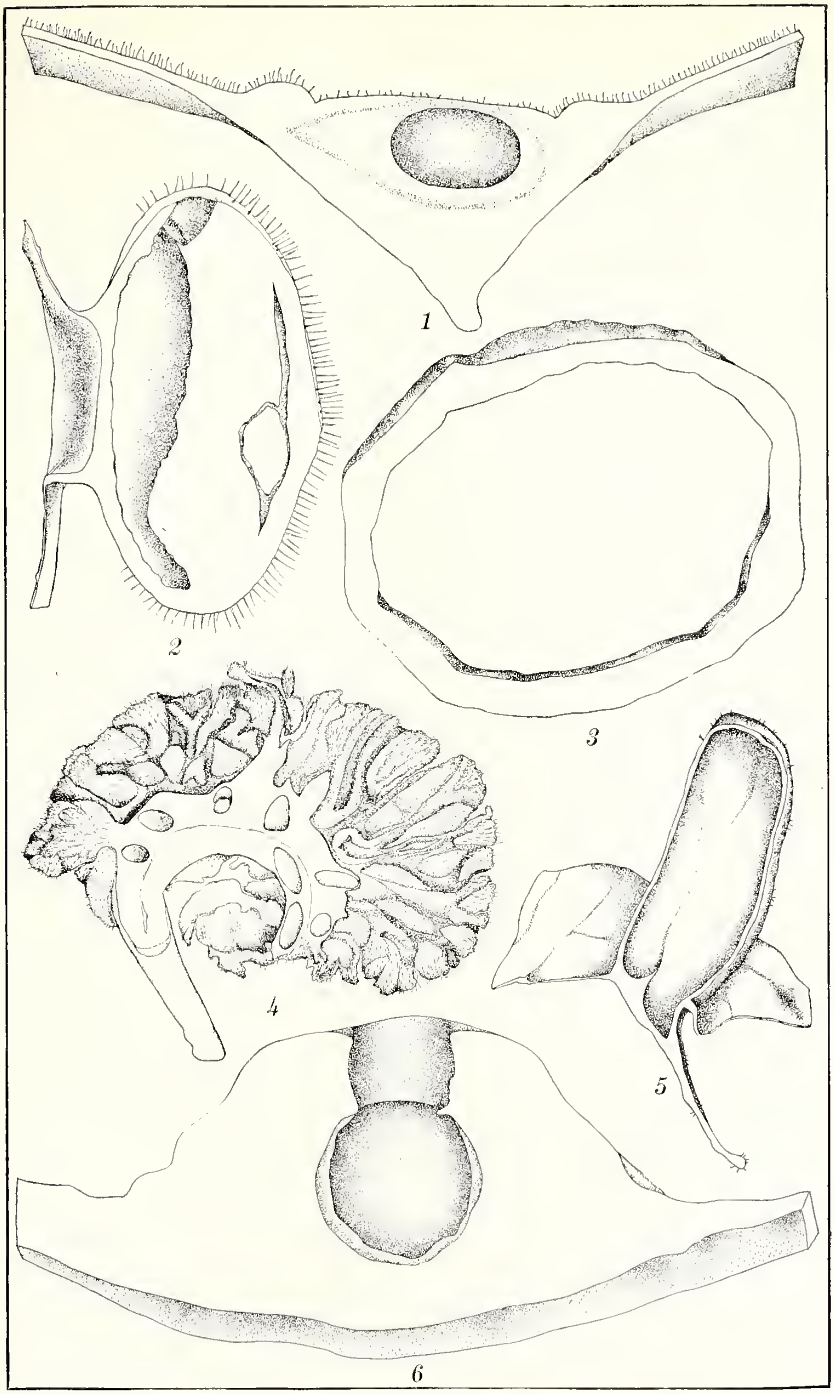


PLATE IV. PLANT GALLS.

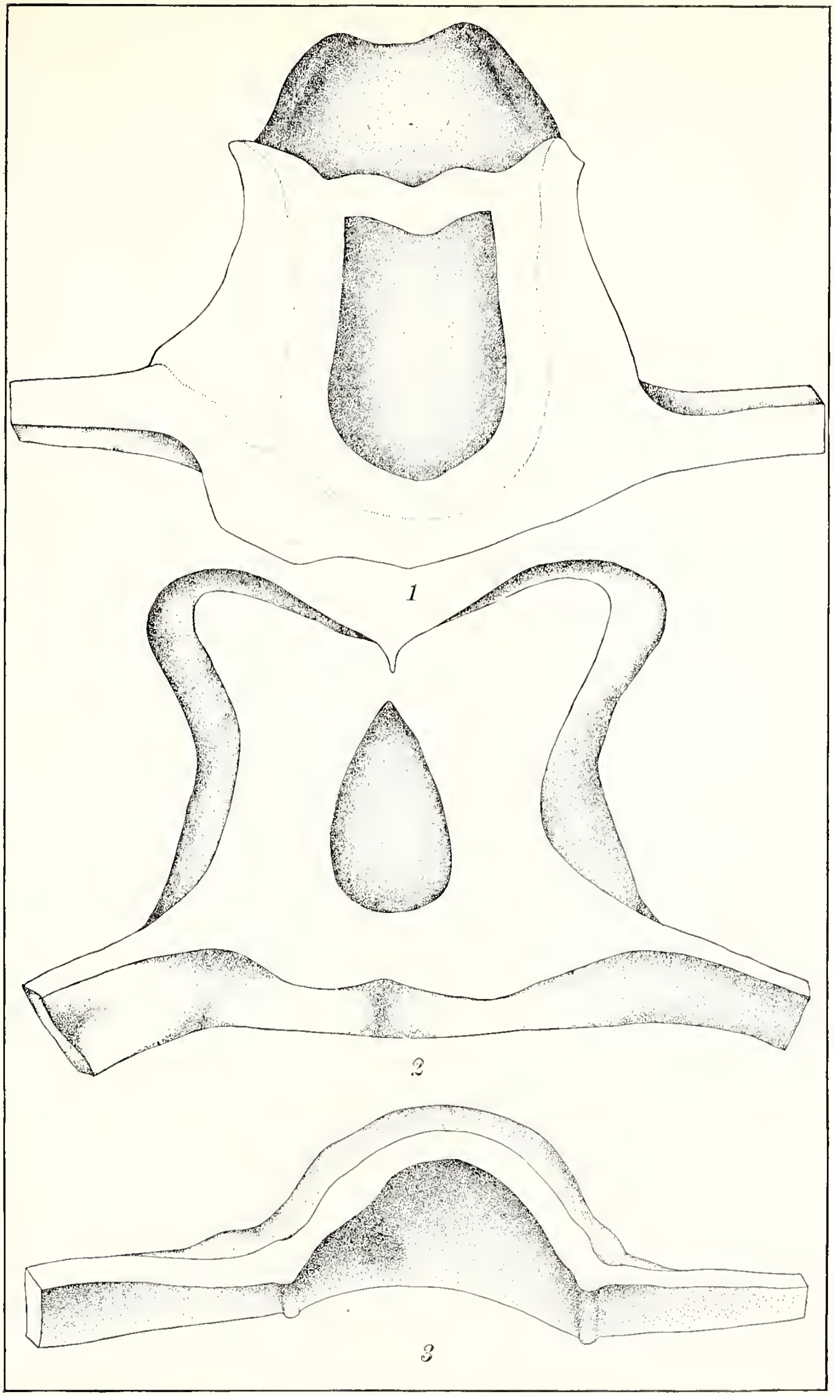
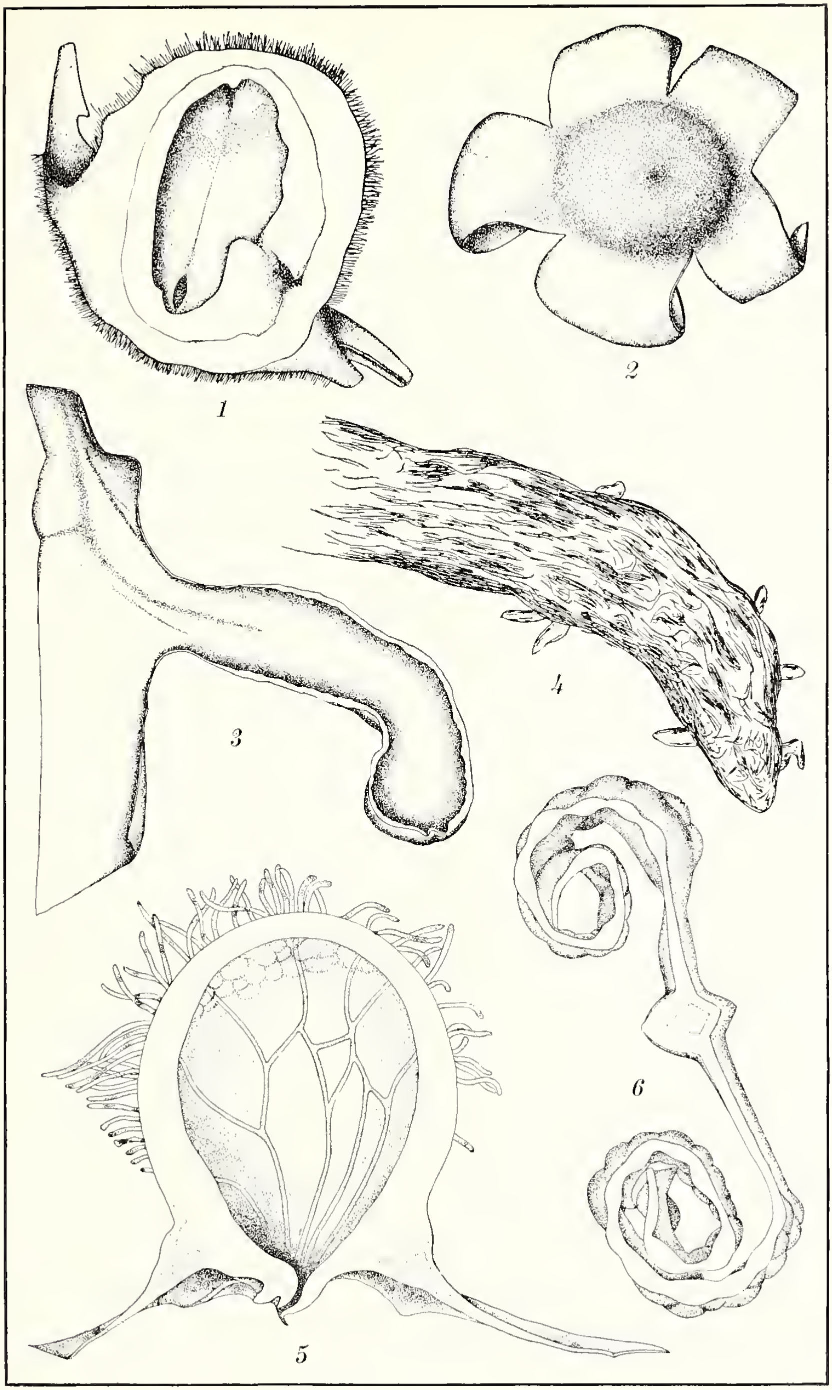


PLATE V. PLANT GALLS.



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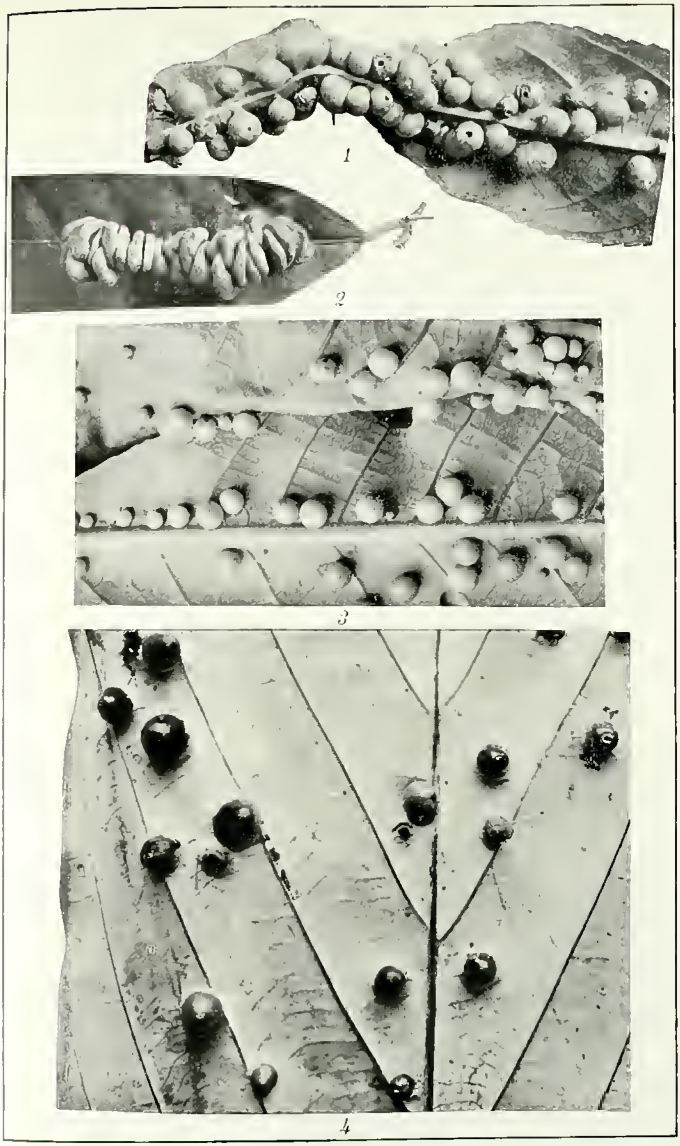

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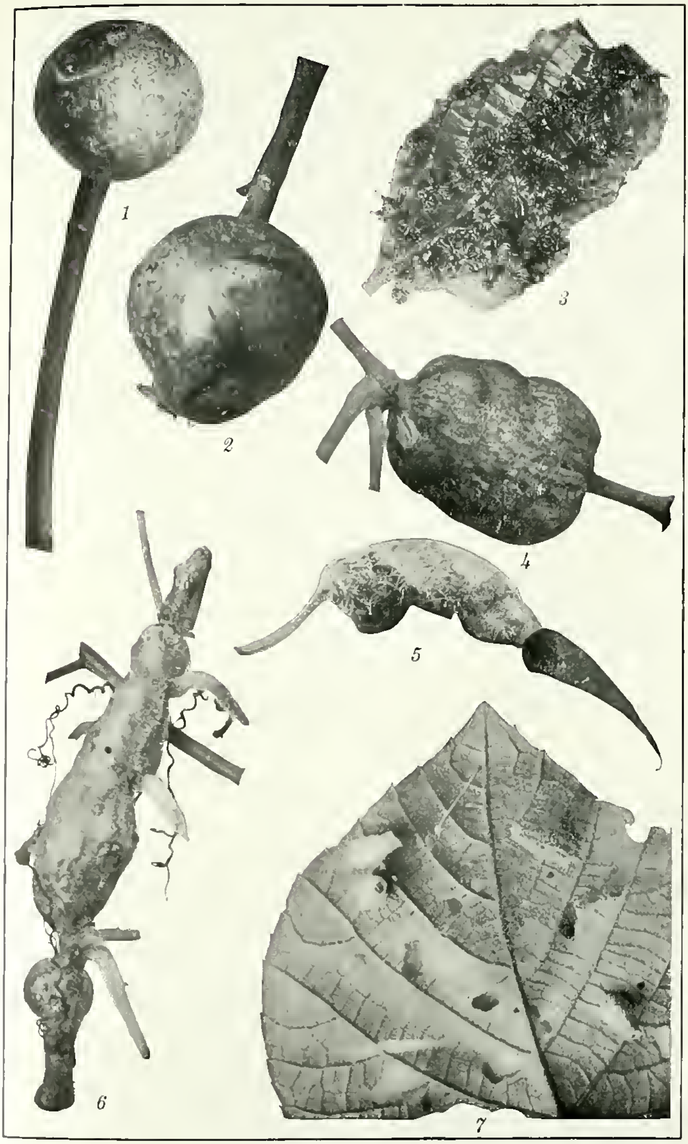

PLATE VIII. PLANT GALLS.

PLATE IX. PLANT GALLS.

PLATE X. PLANT GALLS.

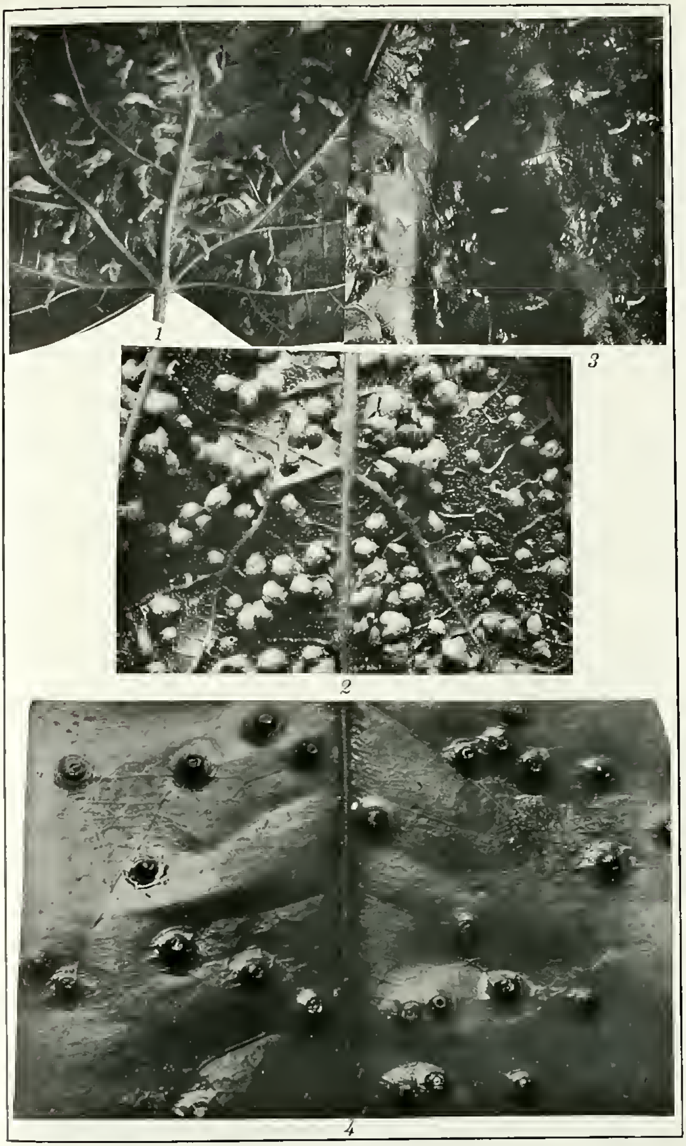

PLATE XI. PLANT GALLS.

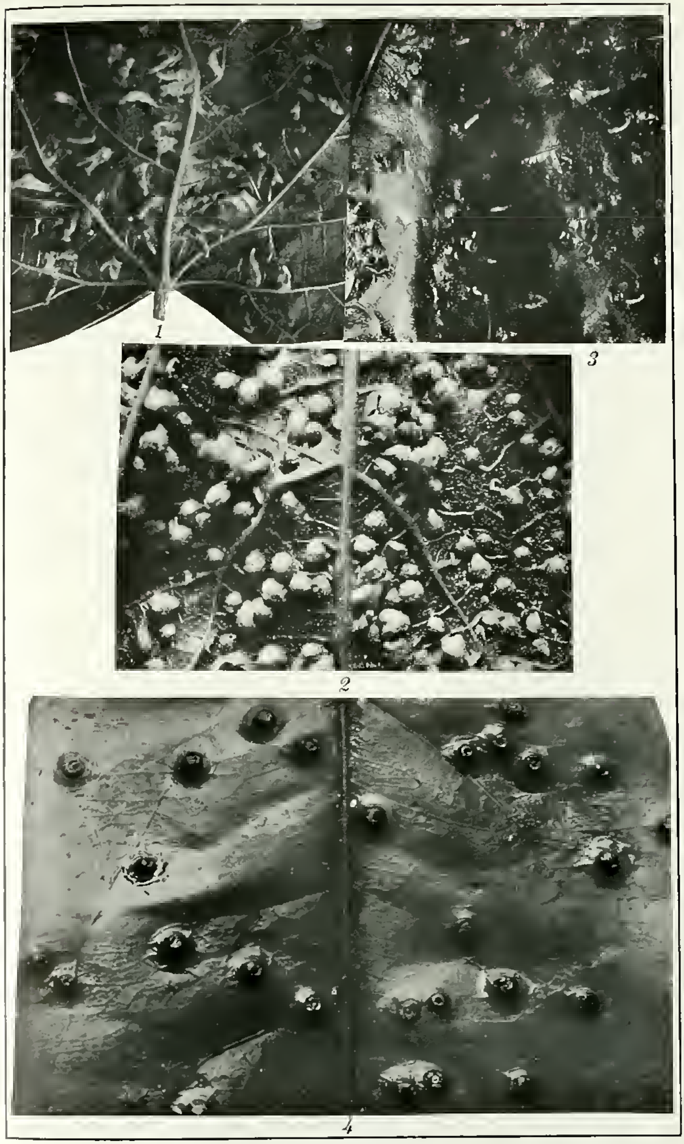

PLATE XI. PLANT GALLS.

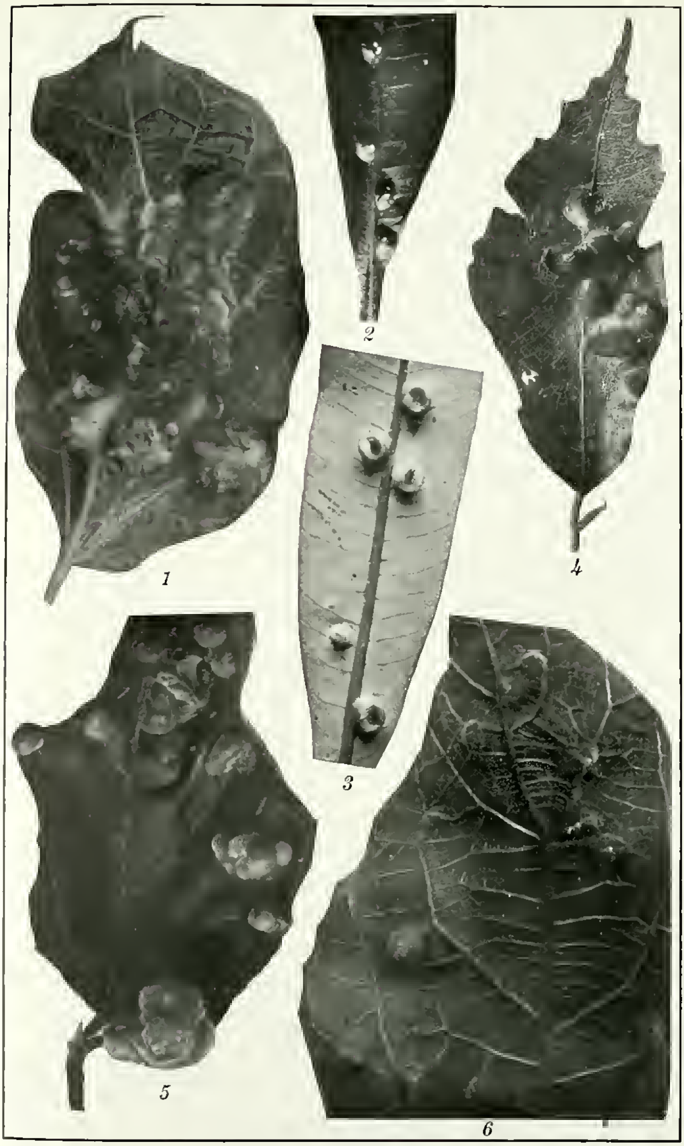

PLATE XII. PLANT GALLS.

PLATE XIII. PLANT GALLS.

PLATE XIV. PLANT GALLS.

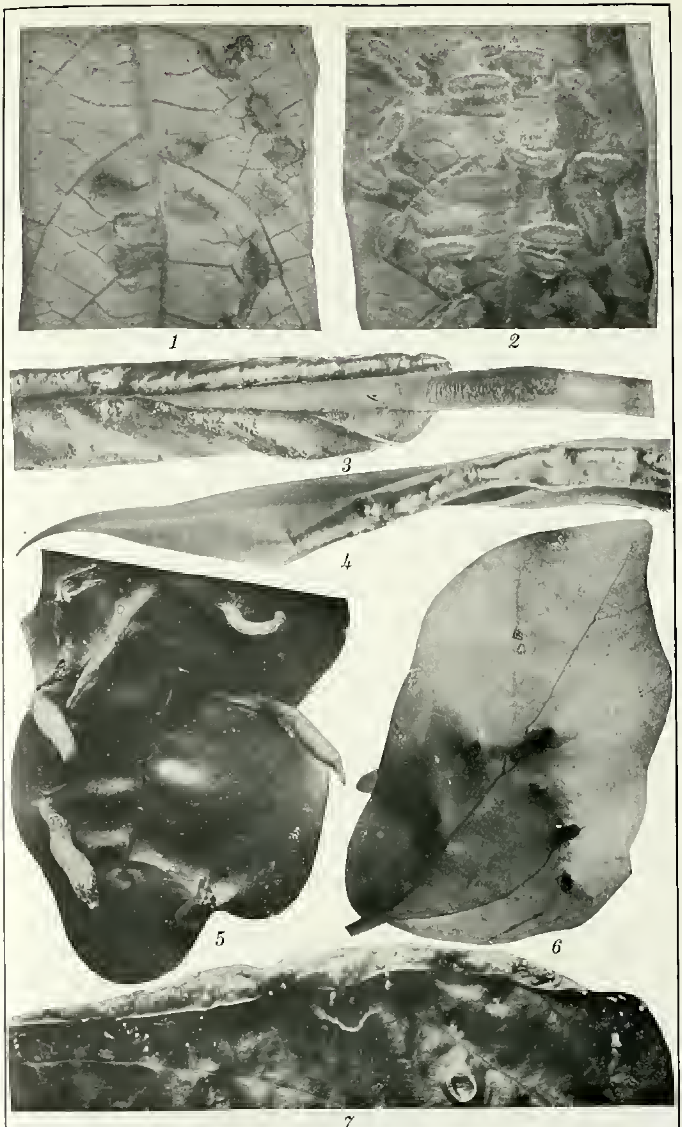

PLATE XV. PLANT GALLS.

THE SPHECODINE BEES OF THE PHILIPPINE ISLANDS

By T. D. A. Cockerell

(*University of Colorado, Boulder*)

The genus *Sphecodes* Latreille consists of small or medium-sized bees, usually with red abdomen, widely distributed over both hemispheres. The venation, with three submarginal cells, well-developed stigma, and arched basal nervure, is much like that of *Halictus*, but the end of the female abdomen is quite without the characteristic rima of that genus. The second submarginal cell is narrow, higher than broad. Sixteen species are known from India, three from Japan, one from Formosa, and three from Java. There are also a species in Celebes, one in New Guinea, and one in Australia. Up to the present time only one Philippine species has been known, but four others may now be added. They may be separated by the following table:

Females 1

Males (joints of flagellum swollen or knotlike) 3

1. Mesothorax rough and extremely densely punctured...... bakeri Cockerell.
   Mesothorax smooth and shining between the well-separated punctures 2
2. Larger; head subcircular.............................. rotundiceps sp. nov.
   Smaller; head transversely oval.............................. transversus sp. nov.
3. Larger; head very broad; middle of abdomen red........... latifrons sp. nov.
   Smaller; head not very broad; abdomen dark............... tristellus sp. nov.

Sphecodes bakeri Cockerell.

Sphecodes bakeri Cockerell, Ann. & Mag. Nat. Hist. VIII 16 (1915) 489.

Mindanao, Dapitan (type locality) and Davao. Both from C. F. Baker.

Sphecodes rotundiceps sp. nov.

Female.—Length, about 9 millimeters; anterior wing, 8; black; with the first three segments of abdomen dark red, the others black; tarsi ferruginous at apex; head and thorax with white hair, conspicuous on sides of face, tubercles, a band extending from tubercles down pleura and sides of metathorax; head subcircular; mandibles dark reddish apically and with a small inner tooth; clypeus short and convex, shining, with large irregular punctures; front very coarsely and closely punctured, but with a bow-shaped transverse smooth band; top of head elevated, very convex, all the ocelli above the level of top of eyes; mesothorax shining, with very strong irregular punctures, more or less in rows; scutellum similarly sculptured; base of metathorax shining, very coarsely cancellate; tegulæ piceous with a rufous spot; wings strongly brownish; stigma piceous; abdomen shining, the first two segments with scattered but very distinct punctures; a strong constriction between first and second dorsal segments.

LUZON, Laguna Province, Los Baños (*Baker*). Nearest to *S. fumipennis* Smith, but smaller, with darker abdomen.

Sphecodes transversus sp. nov.

Female.—Length, a little over 7 millimeters; anterior wing, a little over 6 millimeters; black, with the abdomen castaneous red, black beyond the extreme base of fourth segment; mandibles obscurely red apically, and with an inner tooth; head very broad, transversely oval, face with rather thin white hair; clypeus roughened, depressed in middle; region behind the summits of eyes smooth and polished; mesothorax and scutellum polished, with scattered distinct punctures; base of metathorax with a series of large inclosed spaces; pleura conspicuously hairy; tegulæ piceous, the outer margin partly pallid; wings brownish, stigma dark reddish; legs very dark reddish, with white hair; abdomen shining, without distinct punctures; constriction between first and second segments moderate.

LUZON, Mount Maquiling (*Baker*). By the broad head this recalls the smaller *S. biroi* Friese, from New Guinea.

Sphecodes latifrons sp. nov.

Male.—Length, about 6.5 millimeters; anterior wing, 5.5 millimeters; black, the abdomen red as far as the middle of the third segment, but the basal segment dorsally reddish black; head very broad; face and front densely covered with white hair; mandibles red in middle; occiput strongly elevated; mesothorax and scutellum shining, with large and strong, rather close punctures; base of metathorax very coarsely, irregularly cancellate; small joints of tarsi pale ferruginous; tegulæ piceous basally, the outer side broadly hyaline; wings dilute fuliginous, stigma dark reddish; abdomen shining, the first two segments with fine but distinct punctures.

LUZON, Baguio, Benguet (*Baker*). Closely allied to *S. transversus*, but surely not its male, on account of the punctured abdomen, the closer and larger punctures of mesothorax, and the irregularly sculptured base of metathorax. The scanty hair on apical half of abdomen is white in *S. latifrons*, yellowish in *S. transversus*.

Sphecodes tristellus sp. nov.

Male.—Length, about 5.5 millimeters; black, with the tarsi pale ferruginous apically; apical margin of first abdominal segment and extreme base of second narrowly chestnut red, and sides of first two segments broadly suffused with red; head subcircular; clypeus shining, but strongly and quite closely punctured, not at all hidden by hair; scape short; third antennal joint about one-third as long as fourth; surface of flagellar joints microscopically reticulate; front and sides of face with much white hair, not however hiding the surface; mesothorax with very large, rather dense punctures, partly confluent in rows; tegulæ rufotestaceous, with the margin pallid; wings hyaline, the apical field dilute brown; stigma ferruginous; base of metathorax very coarsely cancellate; abdomen delicately and sparsely but distinctly punctured. The type has the second submarginal cell extraordinarily narrow on one side, while on the other the second transversocubital nervure is lacking. There is a distinct dorsal constriction between the first and second abdominal segments.

LEYTE, Tacloban (*Baker*). Resembles *S. javanicus* Friese, from Buitenzorg, Java, but is considerably smaller, with less red on abdomen.

ADDITIONAL NOTE ON CERATINA

Ceratina humilior (Cockerell).

Ceratina philippinensis nigrolateralis humilior COCKERELL, Philip. Journ. Sci. § D 11 (1916) 305.

A second specimen from the original locality agrees, and I now believe that this is a quite distinct species. The first abdominal segment is reddish orange, with a black spot on each side.

REVIEWS

A text-book | of | Physiology | for | Medical Students and Physicians | by | William H. Howell, Ph. D., M. D., Sc. D., LL. D. | Professor of physiology in the Johns Hopkins University, Baltimore | seventh edition, thoroughly revised | Philadelphia and London | W. B. Saunders Company | 1918. Cloth, pp. 1–1059 + 1–13. 307 illustrations. $5 net.

PREFACE TO THE SEVENTH EDITION

In this, as in former editions, no fundamental change has been made in the contents, arrangement of material, or the general principles of presentation which were originally adopted. But in the three years that have elapsed since the sixth edition the natural expansion of physiological and medical research has yielded much new information. To incorporate the main features of this added knowledge it has been necessary to make many alterations. Throughout the work additions, substitutions, and omissions have been used freely in order to bring the book up to date as nearly as possible.

It is now thirteen years since the first edition appeared. During this period the author has tried faithfully in the successive editions to keep the book in line with our advancing knowledge. It is not probable that he has been wholly successful in these attempts, for the literature bearing upon the subject has increased steadily in volume and complexity, but certainly he has not altogether failed. The book has moved with the current of contemporary physiological thought, as a text-book must if it is to be useful to its clientele of students.

Pathological | Technique | A Practical Manual for Workers in | Pathological Histology and Bacteriology | including | Directions for the Performance of Autopsies and | for Clinical Diagnosis by Laboratory Methods | by | Frank Burr Mallory, A. M., M. D. | associate professor of Pathology, Harvard Medical School; pathologist | to the Boston City Hospital | and | James Homer Wright, A. M., M. D., S. D. | pathologist to the Massachusetts General Hospital; assistant professor of | pathology, Harvard Medical School | seventh edition | revised and enlarged | with 181 Illustrations | Philadelphia and London | W. B. Saunders Company | 1918. | pp. 1–55.

PREFACE TO THE SEVENTH EDITION

The book has been rearranged in this edition with the object of making it more useful. Among other changes the postmortem technique has been put at the end. The revision has been fairly thorough, but not so complete as could be wished owing to the war.

Of additions, the following deserve mention: Goodpasture's acid polychrome methylene-blue stain for frozen sections of fixed tissues and also for demonstrating meta-chromatically the different granules in the islet and acinar cells of the pancreas; Graham's oxidase stain for the granules in the myeloblastic series of cells and leukocytes; Benians' Congo red method for the demonstration of spirochetes; Claudius' stain for flagella; and the approved method of classifying pneumococci with reference to serum treatment.

As useful procedures which hitherto have not been generally recognized, attention is called to the use of the safety-razor blade in section cutting, the employment of benzene in paraffin embedding, and Rubaschkin's method of fixing celloidin and frozen sections to the slide for staining.

CONTENTS

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THE MECHANICAL PROPERTIES OF PHILIPPINE BAST-FIBER ROPES [1]

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FIVE PLATES AND TWO TEXT FIGURES

There are numerous uncultivated species of plants in the Philippine Islands, for the most part belonging to the families Sterculiaceae, Tiliaceae, Malvaceae, and Moraceae, that form an interesting group in the fiber series. The fibers produced by these plants, which range from large trees to small weedlike shrubs, are derived from the tough bast that is found in the inner portion of the bark of the stems and of the branches. At present these fibers, with perhaps the exception of the fiber obtained from *Abroma fastuosa,* have no commercial significance in the Philippines; but in the rural districts they constitute a cheap material for the manufacture of cordage that is sufficiently resistant and durable for agricultural and animal-husbandry purposes.

Abacá (Manila hemp), which is the strongest and most resilient of all cordage fibers, is one of the most valuable export products of the Philippine Islands. However, it is not grown generally throughout the Archipelago, and its cultivation is restricted to certain favorable districts where there are fertile, well-drained soil, freedom from winds, and an abundant rainfall uniformly distributed throughout the year. Abacá is an expensive fiber, and it is natural that the districts in which it is not grown use the numerous local bast fibers rather than import Manila hemp, especially when transportation is difficult.

[1] Received for publication January 24, 1919.

Therefore, in nearly all parts of the Philippines, outside of the abacá districts, the manufacture of cordage from the numerous bast fibers has developed into a common household industry.

Lamson-Scribner [2] has published a list of Philippine fiber plants comprising about one hundred seventeen species, among which are included many that yield basts. He gives their scientific and local names, with brief information regarding their distribution, the parts utilized, and their uses. Gilmore [3] also has given a list of some of the fibrous plants of the Philippines; he enumerates fifty-three species, some of which give basts, and gives their scientific and native names, occurrence, and their uses. Muller [4] devotes a chapter to fifteen of the most commonly used Philippine bast fibers and pays particular attention to the botanical descriptions and the distribution of the species. In three cases a description of the method of preparation of the fiber is included, but no data concerning the relative strengths of the basts are given.

Mendiola [5] has made a microscopical study of the ultimate fibers of thirteen Philippine bast-fiber plants. He also gives data on the tensile strength of "untwisted fibers and of cords," but their interpretation is difficult and is not at all clear. It would not be easy for another investigator to repeat the tests. No information is given as to the approximate size of the cords studied, their weight per unit length, their elongation, or the manner of testing; and "breaking load" is misnamed "breaking strain."

The present investigation was primarily undertaken for the purpose of securing quantitative results on the mechanical properties of bast ropes. A few short specimens of rope made of crude fiber already on hand, sufficient for about six tests each, were secured by me during a trip to the Ilocos Provinces and Abra in May, 1916, but most of the specimens were ordered in Abra and Benguet during November, 1916. In the household industry Filipinos mix the fibers from various species. There is little commercial demand for bast, so that in order to obtain specimens (and especially of a single species) these had to be

[2] Lamson-Scribner, F., List of Philippine Agricultural Products and Fiber Plants, *Bull. P. I. Bur. Agr.* ed. 2, 5 (1904) 36–47.

[3] Gilmore, J. W., Preliminary Report on the Commercial Fibers of the Philippine Islands, *P. I. Bur. Agr. Farmers' Bull.* 4 (1903).

[4] Muller, T., Industrial Fiber Plants of the Philippines, *Bull. P. I. Bur. Ed.* 49 (1913) 116–123.

[5] Philip. Agr. and Forester 6 (1917) 6–38.

made to order. Thirty-eight coils of rope were secured from material authentically identified in the Bureau of Science.[6] The ropes arrived at the Bureau of Science in March, 1917. By October of the same year, before there had been any insect infestation, the laboratory work in connection with this investigation had been completed. The length of the rope constituting a coil varied from about 25 to 60 meters. Thirty-two of the fibers used in fabricating the ropes tested were obtained from bast-plant species, and seven proved to be from species which gave nonbast fibers. In addition ropes from two standard cordage fibers, namely abacá and maguey, were used for the purpose of comparison. The species from which the fibers of the ropes tested were obtained are as follows:

SPECIES GIVING BASTS

STERCULIACEAE

Abroma fastuosa Jack.
Commersonia bartramia (Linn.) Merr.
Helicteres hirsuta Lour.
Kleinhovia hospita Linn.
Pterocymbium tinctorium (Blanco) Merr.
Pterospermum diversifolium Blume.
Sterculia crassiramea Merr.
Sterculia foetida Linn.
Sterculia oblongata R. Br.
Sterculia stipularis R. Br.

MALVACEAE

Bombycidendron vidalianum Merr. & Rolfe.
Malachra fasciata Jack.
Sida acuta Burm.
Thespesia lampas (Cav.) Dalz. & Gib.
Urena lobata Linn.

TILIACEAE

Columbia blancoi Rolfe.
Corchorus olitorius Linn.
Grewia bilamellata Gagnep.
Grewia eriocarpa Juss.
Grewia multiflora Juss.

MORACEAE

Allaeanthus glaber Warb.
Artocarpus communis Forst.
Ficus benjamina Linn.
Ficus forstenii Miq.
Ficus pachyphylla Merr.
Ficus palawanensis Merr.

BORAGINACEAE

Cordia cumingiana Vidal.
Cordia myxa Linn.

GNETACEAE

Gnetum sp.

BOMBACACEAE

Bombax ceiba Linn.

ULMACEAE

Trema orientalis Blume.

ANNONACEAE

Goniothalamus amuyon (Blanco) Merr.

[6] All botanical work in connection with this investigation, such as naming and identifying species, was done by E. D. Merrill, chief of the botanical section of the Bureau of Science, who also furnished the information regarding the habitat, etc., of the plants.

SPECIES GIVING NONBAST FIBER

GRAMINEAE

Dendrocalamus merrillianus Elm.

MENISPERMACEAE

Anamirta cocculus W. & A.

PALMAE

Cocos nucifera Linn.
Corypha elata Roxb.

ZINGIBERACEAE

Amomum sp.

SPECIES GIVING STANDARD CORDAGE FIBER

AMARYLLIDACEAE

Agave cantala Perrine.

MUSACEAE

Musa textilis Née.

Incidental to obtaining bast ropes for testing their physical properties, observations were made on the methods employed in extracting bast and its manipulation during the process of fabrication into cordage. The process of preparation varies in detail of technic, depending upon the locality, the kind of fiber, its age, and the quality of cordage desired. The procedure in the Ilocos Provinces may be conveniently divided into (1) the plain stripping process, and (2) the water-retting process; the two methods yield very different products.

(1) The plain stripping process is much simpler, and requires less time, than the other method, and gives a rough, crude product. The bark is stripped from the main trunk or branches of the tree; generally the branches are cut off for convenience in peeling. Herbaceous or semiherbaceous plants are usually cut down entirely or pulled up by the roots, and the trimmed twigs or branches stripped of their bark. At certain times of the year, particularly after the rainy season when the tree is full of sap, it is an easy matter to strip the bark. The bark at one end of the branch or twig is loosened by beating with the flat side of a bolo and then stripped off. Generally the bast or inner bark is attached to the outer bark, although sometimes it is removed after the outer bark has been peeled off. When they come off together the two are separated by a subsequent operation, the outer bark is rejected, and the inner dried in the sun. The bast is then torn into narrow ribbons which, without any other preparation, are first spun into strands and then laid into rope. The ropes are bulky, rough, and lacking in flexibility, due to the high percentage of woody tissue, but are generally good enough for ordinary purposes. All of the ropes made to order, except two, were fabricated of crude bast obtained by this process.

(2) The water-retting process is usually practiced on the fibers obtained from herbaceous plants. The twigs and branches or

the crude fiber strips are immersed in water for ten to fourteen days until the pulp in which the basts are embedded is sufficiently decomposed. The extraneous matter is then removed by various manipulations, such as kneading, beating, wringing, and washing in water. Ultimately the bast is disencumbered of most of the plant tissue which contains gums, resins, sugars, and starches, and which do not add to the strength of the filaments but, instead, shorten the life of the fiber by attracting insects and fungi. The product is a filamentous bast which has an aspect altogether different from the crude strips obtained by the former process and is a much better cordage material. The fiber is dried in the sun and is spun into strands and eventually laid into ropes, as in the former process. Only two of the ropes tested were made of water-retted fiber, which makes a strong, neat, smooth, and flexible rope.

FABRICATION OF ROPE

The bast in the form of narrow strips, ribbons, or filaments is spun manually (usually without the aid of any mechanical device) into a continuous strand, having a more or less circular section, and is wound on a simple reel. Generally speaking, it would be more correct to name this first combination of fibers a yarn, but in this case the yarn is at the same time the strand. The size of the strand is determined by the ultimate diameter desired for the rope. This procedure of making the strand is partly made necessary by the bulky, inflexible nature of the bast strips, which do not lend themselves to the process of small-yarn spinning as do fine filamentous fibers such as cotton, abacá, or maguey. Furthermore, simplicity requires that the same method of having one thick yarn per strand be used with the retted filaments.

Having decided upon the length of the rope, as many lengths of spun fiber are cut from the supply on the reel as there are to be strands in the rope, and of a length longer than the finished rope, in order to allow for the shrinkage incurred by the twisting of the laying process. Nearly all of the bast ropes used in the Philippines are laid with three strands; one of those tested had two strands.

In the process of making a three-strand rope the three strands cut from the reel are tied at one end to three hardwood cranks or twirlers, which are mounted between two upright posts, and yoked so that they can be revolved simultaneously. This is the forward laying apparatus and is fixed. Its details are clearly shown in Plate II, fig. 1. The strands are now stretched horizontally to their full length and the three free ends are united and jointly fastened to a single crank that turns in a vertical wooden pillar which is mortised in a sliding shoe resting on the ground. This is the rear laying appliance, details of which are shown in Plate I, fig. 1. In some localities the shoe is fitted with a

FIG. 1. Typical cross-sectional profiles of ropes tested. Actual size. *a*, rope made of *Cordia cumingiana* bast; *b*, rope made of *Kleinhovia hospita* bast; *c*, rope made of split bamboo (*Dendrocalamus merrillianus*); *d*, rope made of "F" grade abacá (machine laid).

wooden wheel, or caster, to facilitate its movement over the ground, while in others the wheel is lacking and the shoe with its upright is simply dragged.

After inserting a cylindrical block of wood with three grooves or flutes parallel to the long axis of the cylinder and at an angle of 120 degrees to each other, between the three strands just ahead of their point of juncture to the single twirler of the rear laying device, the strands are ready to be laid into rope. One man operates the three cranks of the forward laying device while another turns the single twirler at the rear in the opposite direction in order to give the rope the necessary twist. Meantime a third operator advances the grooved wooden block sufficiently slowly so that the strands may be twisted into a tight rope. Such a block is shown in place in Plate I, fig. 2. The twisting is continued until the grooved block is advanced to the three twirlers of the forward laying machine, at which point the operation is completed, and the rope is removed and coiled ready for use.

MECHANICAL TESTS OF BAST ROPE

Circumference and diameter.—The size of ordinary vegetable-fiber cordage of three or more strands is usually designated by its so-called circumference, which is actually its girth or perimeter. The girth of the test specimens was obtained by encompassing the rope with a strip of tough paper about two millimeters wide, and marking it at any convenient overlapping point. The paper was then straightened and the girth between the two marks measured. Due to the rough and nonuniform nature of the bast cordage the girth was not measured to fractions of a millimeter, but only to the nearest whole millimeter, which was sufficiently accurate for the purposes of this investigation. Each test specimen was measured close to each splice and in the middle, and the average of the three values used.

Diameters are not usually given in rope-test data. Direct diameter measurements would be very much more uncertain than girth measurements, especially if taken by inexperienced workmen, on account of the judgment required. To obtain such measurements numerous trials with the caliper must be made, and special care exercised to secure two diametrically opposite points, both in the boundary line of the strand and in the circumference of the circumscribing circle. The so-called "diameter" of the test specimens given in this paper was not measured directly and is not the true diameter, but was calculated upon the assumption that the girth measurement of the rope is a true circle. The relation of the girth to the true circumference and the relation of the so-called "diameter" to the actual diameter are discussed in a former paper.[7]

Actually, the diameter so calculated is a little less than the diameter of the circumscribing circle, but the difference is slight and the value is probably more accurate than could be obtained by direct measurement.

Cross-sectional areas.—Even with the most carefully machine-laid cordage, cross-sectional areas and values based on them are ambiguous unless accompanied by adequate explanations, and such data are very infrequently given in practice. The peculiarities of two- and three-strand cordage, shown in text fig. 1, more marked in the bast rope tested than in abacá or other filamentous fiber ropes, that make difficult the measurements of the actual solid, sectional area, are (1) the irregular trefoil shape of the rope section and (2) the appreciable void space in the strands themselves. The actual area contained within the three separate strands is much less than the area of a circumscribing circle, and the relation between the two is discussed in a previous paper.[8] There is an approximately constant ratio between these two factors, as is shown in Table I. In all of the tables in this paper the actual measurements of average girth were made in millimeters, of weight per meter in kilograms, and of breaking load in pounds, and the equivalents recorded are in round numbers, accurate to a fraction of a per cent.

[7] King, A. E. W., Philip. Journ. Sci. § A 13 (1918) 285–339.
[8] King, loc. cit.

The results in Table I show that the true sectional area of the ropes tested varies from 62 to 100 per cent of the calculated area, the mean being 86 per cent. For small ropes, this mean percentage of the calculated area will give a fairly accurate approximation of the true sectional area.

TABLE I.—*Relationship between the mean calculated and the true mean area of the ropes tested.*

ROPES MADE OF BAST FIBERS.

Fiber.	Calculated area.	True mean area.	True mean area÷calculated area.
	sq. mm.	*sq. mm.*	
Abroma fastuosa; rope made of crude bast strips	103.9	88.4	0.85
Abroma fastuosa; rope made of retted bast	28.7	24.4	0.85
Commersonia bartramia	115.0	97.5	0.85
Helicteres hirsuta	97.3	78.6	0.81
Kleinhovia hospita	120.8	116.6	0.96
Pterocymbium tinctorium	140.7	114.0	0.81
Pterospermum diversifolium	35.1	28.8	0.82
Sterculia crassiramea	126.7	121.3	0.96
Sterculia foetida	38.5	28.4	0.73
Sterculia oblongata	115.0	96.0	0.83
Sterculia stipularis forma	38.5	29.5	0.76
Bombycidendron vidalianum	38.5	31.6	0.82
Malachra fasciata	23.1	21.2	0.92
Sida acuta	45.8	40.8	0.89
Thespesia lampas	71.6	57.8	0.81
Urena lobata	35.1	30.3	0.87
Columbia blancoi	147.4	115.2	0.78
Corchorus olitorius	38.5	32.8	0.85
Grewia eriocarpa	31.9	25.9	0.82
Grewia multiflora	45.8	38.8	0.85
Grewia bilamellata	103.9	85.4	0.82
Allaeanthus glaber	120.8	100.2	0.83
Artocarpus communis	28.7	28.4	0.99
Ficus benjamina	42.0	32.5	0.77
Ficus forstenii	38.5	38.8	1.00
Ficus pachyphylla	38.5	32.3	0.84
Ficus palawanensis	28.7	20.5	0.72
Cordia cumingiana	115.0	86.8	0.76
Cordia myxa	49.7	44.5	0.90
Gnetum sp	25.5	21.5	0.84
Bombax ceiba	54.1	43.0	0.80
Trema orientalis	54.1	46.6	0.86
Goniothalamus amuyon	66.5	40.9	0.62
Average			0.84

TABLE I.—*Relationship between the mean calculated and the true mean area of the ropes tested*—Continued.

ROPES MADE OF MISCELLANEOUS FIBERS.

Fiber.	Calculated area.	True mean area.	True mean area ÷ calculated area.
	sq. mm.	*sq. mm.*	
Musa textilis; grade "F" fiber [a]	76.5	76.9	1.00
Do	18.0	15.5	0.86
Musa textilis; grade "G" fiber [a]	54.1	53.5	0.99
Do	20.4	14.1	0.69
Agave cantala; Cebu No. 2, maguey [a]	54.1	43.6	0.81
Cocos nucifera; salt-water retted, from Caoayan, Ilocos Sur	198.6	159.8	0.80
Cocos nucifera; machine cleaned, from Laguna husks	153.9	131.0	0.85
Do	45.8	38.9	0.85
Corypha elata; leaf	174.4	173.7	0.99
Corypha elata; vascular fibers from petioles; buntal	38.5	34.7	0.90
Amomum sp	31.9	25.7	0.79
Dendrocalamus merrillianus [b]	168.6	159.5	0.94
Anamirta cocculus; entire stem of vine twisted into three-strand rope	153.9	128.7	0.84
Average			0.87

[a] Machine-made rope, the test specimens of which were kindly furnished by Johnson-Pickett Rope Company, of Manila; all other ropes are handmade.
[b] Two-strand rope; all other ropes have three strands.

Twist and girth.—The maximum tensile strength of fibers is obtained when they are tested in their untwisted condition, but it is not practicable to make a long rope except by overlapping and twisting the fibers so that they are held in place by mutual friction. Short ropes without any twist were tested by Duhamel [9] over one hundred years ago. He found such ropes to be much stronger and more pliable than twisted ones, but less durable because the rope opened when bent, thereby allowing free entry of water into the interior where the fibers were soon decomposed. Hooke,[10] as far back as 1669, gives data showing the diminished strength of twisted fiber. Experiments performed by Réaumur [11] show that vegetable fibers lose anywhere from 14 to 39 per cent of their original strength after being twisted into rope. Investigations made by Duhamel [12] at the

[9] Duhamel-Dumonceau, Henri-Louis, cited by Forbes Royle, page 20, data evidently taken from Traité de la Fabrique des Manoeuvres pour les Vaisseaux, ou l'Art de la Corderie perfectionée. Paris (1747).
[10] Cited by Royle, page 22.
[11] Quoted by Royle, page 22.
[12] Op. cit. 23. Royle gives the detailed results of several of Duhamel's experiments.

time he was Minister of the French Marine show that the more tightly a rope was twisted the lower was its tensile strength. Rope that was comparatively loosely twisted was more pliable, less liable to run into kinks, and at least 25 per cent stronger than rope more tightly twisted.

The more tightly the fiber is twisted in making a rope, the harder and more rigid will the rope become. Excessive twisting is injurious, and the fiber may be so tightly twisted that it is stressed very nearly to the point of rupture, in consequence of which the rope is unable to bear much load. The twist that different fibers will stand without losing too much of their original strength varies with the material.

The twist in all the ropes tested, or the length of one complete turn of a strand, was measured by placing a scale parallel to the longitudinal axis of the rope. In fig. 2 the distance *T*

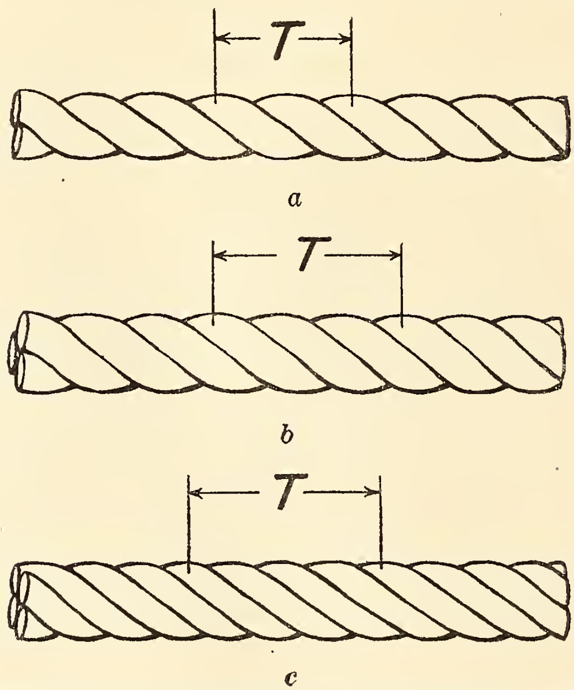

FIG. 2. Showing the twist of two-, three-, and four-strand ropes, respectively.

is considered the length of the twist. The values given in Table II are the means of five measurements, and show the relationship between the twist and the girth of the ropes tested. Fractions of a millimeter less than 0.5 have been dropped and those 0.5 or more have been counted as 1 millimeter.

The results show that in ordinary rope, whether hand- or machine-made, the degree of twist is remarkably uniform. In a few cases the strand makes one turn in a distance equal to the girth of the rope, but as a whole the rope is laid more tightly and averages 87 per cent of the girth.

Testing machine for determining elongation and tensile strength.—An automatic, four-screw, universal testing machine having a capacity of 30,000 pounds and direct driven by a 1 horse power electric motor was used for breaking the more

TABLE II.—*Twist of the ropes tested and the relationship of girth to twist.*

ROPES MADE OF BAST FIBERS.

Fiber.	Girth.	Length of twist.	Twist÷girth.
	mm.	*mm.*	
Abroma fastuosa; unretted fiber	36	29	0.81
Abroma fastuosa; retted fiber	19	18	0.95
Commersonia bartramia	38	30	0.79
Helicteres hirsuta	35	30	0.86
Kleinhovia hospita	39	32	0.82
Pterocymbium tinctorium	42	34	0.81
Pterospermum diversifolium	21	18	0.86
Sterculia crassiramea	40	36	0.90
Sterculia foetida	22	20	0.91
Sterculia oblongata	38	32	0.84
Sterculia stipularis forma	22	17	0.77
Bombycidendron vidalianum	22	19	0.86
Malachra fasciata	17	16	0.94
Sida acuta	24	20	0.83
Thespesia lampas	30	27	0.90
Urena lobata var. *scabruscula*	21	18	0.86
Columbia blancoi	43	32	0.74
Corchorus olitorius	22	22	1.00
Grewia eriocarpa	20	18	0.90
Grewia multiflora	24	21	0.88
Grewia bilamellata	36	39	1.08
Allaeanthus glaber	39	30	0.77
Artocarpus communis	19	18	0.95
Do	30	30	1.00
Ficus benjamina	23	19	0.83
Ficus forstenii	22	18	0.82
Ficus pachyphylla	22	18	0.82
Ficus palawanensis	19	14	0.74
Cordia cumingiana	38	27	0.71
Cordia myxa	25	22	0.88
Gnetum sp.	18	18	1.00
Bombax ceiba	26	26	1.00
Trema orientalis	26	21	0.81
Goniothalamus amuyon	29	23	0.79
Average			0.87

TABLE II.—*Twist of the ropes tested and the relationship of girth to twist*—Continued.

ROPES MADE OF MISCELLANEOUS FIBERS.

Fiber.	Girth.	Length of twist.	Twist ÷ girth.
	mm.	*mm.*	
Musa textilis; grade "F" fiber[a]	31	30	0.97
Do	15	13	0.87
Musa textilis; grade "G" fiber[a]	26	25	0.96
Do	16	15	0.94
Commercial unclassified fiber	45	45	1.00
Do	24	25	1.04
Agave cantala; maguey Cebu No. 2[a]	26	21.5	0.83
Agave cantala; maguey from Santo Domingo, Ilocos Sur	23	17	0.74
Agave cantala; maguey from Sulvec, Ilocos Sur	25	21	0.84
Cocos nucifera; salt-water retted, from Caoayan, Ilocos Sur	50	38	0.76
Cocos nucifera; machine cleaned, from Laguna husks	44	37	0.84
Do	24	20	0.83
Corypha elata; leaf	47	40	0.85
Corypha elata; vascular fiber from petioles; buntal	22	20	0.91
Amomum sp	20	18	0.90
Anamirta cocculus; entire stem of vine twisted into a three-strand rope	44	40	0.91
Dendrocalamus merrillianus[b]	46	31	0.67
Average			0.87

[a] Machine-made rope; all other ropes are handmade.
[b] Two-strand rope; all other ropes have three strands.

resistant rope test specimens. This machine is of the lever type in which the test piece is held in a vertical position. The beam is graduated in 1,000- and the dial in 5-pound intervals. For testing the smaller ropes, a Riehlé testing machine of the helical spring-scale type was used. This machine is hand operated, by means of a flywheel having a crank, and has a capacity of 600 pounds. The dial is graduated in 1-pound intervals.

Tensile-strength tests.—The test specimens were prepared with an eye-splice at each end, the eyes having an internal diameter of 4.5 centimeters, and the splices having three tucks. The clear length of rope between the splices was either 50 or 100 centimeters, with 3 or 4 centimeters extra for marking. Upon this clear length of the test specimen the gauge length used for determining the elongation was laid off. Except as indicated, five test specimens were broken to give each average result. Plate II, fig. 2, represents typical test specimens.

One series of experiments was conducted upon test pieces in an air-dry condition. The results obtained from these specimens are designated throughout this paper as dry tests. Table

III gives the tensile strength per unit area of the ropes when tested in an air-dry condition.

Another series of tests was made upon specimens that had been entirely immersed in tap water for twenty-four hours. In Table IV are given the tensile strengths of the ropes tested after such immersion. The test pieces were broken imme-

TABLE III.—*Ropes made of Philippine fibers arranged in the order of mean tensile strength when dry, beginning with the strongest. The same results, arranged in a different order, are given in Table XLII.*

ROPES MADE OF BAST FIBERS.

No.	Fiber.	Mean dry tensile strength.	
		Per sq. cm.	Per sq. inch.
		Kilos.	*Lbs.*
1	*Gnetum* sp	773	11,100
2	*Ficus palawanensis*	752	10,700
3	*Abroma fastuosa;* retted	643	9,100
4	*Malachra fasciata*	637	9,030
5	*Bombycidendron vidalianum*	630	8,940
6	*Abroma fastuosa;* crude strips	545	7,760
7	*Corchorus olitorius*	503	7,130
8	*Urena lobata*	482	6,850
9	*Ficus benjamina*	480	6,830
10	*Sida acuta*	475	6,760
11	*Ficus pachyphylla*	464	6,600
12	*Helicteres hirsuta*	438	6,230
13	*Bombax ceiba*	405	5,720
14	*Sterculia oblongata*	398	5,650
15	*Sterculia crassiramea*	398	5,660
16	*Grewia eriocarpa*	394	5,630
17	*Commersonia bartramia*	392	5,580
18	*Cordia cumingiana*	388	5,500
19	*Pterocymbium tinctorium*	381	5,420
20	*Grewia multiflora*	376	5,360
21	*Artocarpus communis;* old bast	367	5,220
22	*Artocarpus communis;* young bast	356	5,070
23	*Goniothalamus amuyon*	345	4,940
24	*Cordia myxa*	324	4,610
25	*Grewia bilamellata*	320	4,570
26	*Kleinhovia hospita*	309	4,370
27	*Columbia blancoi*	302	4,270
28	*Sterculia stipularis*	268	3,800
29	*Thespesia lampas*	268	3,800
30	*Pterospermum diversifolium*	263	3,740
31	*Allaeanthus glaber*	231	3,290
32	*Sterculia foetida*	200	2,840
33	*Ficus forstenii*	154	2,200
34	*Trema orientalis*	134	1,920
	Average	406	5,770

TABLE III.—*Ropes made of Philippine fibers arranged in the order of mean tensile strength when dry, etc.*—Continued.

ROPES MADE OF MISCELLANEOUS FIBERS.

No.	Fiber.	Mean dry tensile strength.	
		Per sq. cm.	Per sq. inch.
		Kilos.	*Lbs.*
1	*Musa textilis;* grade "G" abacá; rope, 16 mm. in circumference [a]	1,110	15,700
2	*Musa textilis;* grade "F" abacá; rope, 15 mm. in circumference [a]	974	13,800
3	*Musa textilis;* grade "F" abacá; rope, 31 mm. in circumference [a]	943	13,400
4	*Musa textilis;* grade "G" abacá; rope, 26 mm. in circumference [a]	744	10,600
5	*Agave cantala;* maguey; grade, Cebu No. 2 [a]	739	10,400
6	*Dendrocalamus merrillianus* [b]	237	3,380
7	*Corypha elata;* leaf of palm	232	3,300
8	*Corypha elata:* buntal; vascular fibers in petioles	222	3,150
9	*Cocos nucifera;* rope, 50 mm. in circumference [c]	185	2,640
10	*Cocos nucifera;* rope, 24 mm. in circumference [d]	176	2,490
11	*Cocos nucifera;* rope, 44 mm. in circumference [d]	170	2,420
12	*Anamirta cocculus* [e]	149	2,120
	Average	490	6,950

[a] Machine-made rope; all other ropes are handmade.
[b] This rope has two strands only; all other ropes have three strands.
[c] Rope made at Caoayan, Ilocos Sur, from salt-water retted coir.
[d] Rope made of coir that had been machine cleaned at the Bureau of Science from Laguna husks.
[e] Rope made of the entire stem of the vine.

diately at the end of this period, while still saturated, and are referred to as wet tests.

Elongation.—The test specimens were fixed in the testing machine in a vertical position by passing steel pins 40 millimeters in diameter through the eyes of the splices; they were subjected to an initial tension not exceeding 5 pounds, to facilitate marking the gauge length, which was either 50 or 100 centimeters, and were measured to an accuracy of 0.5 centimeter. The load was then applied at a uniform rate so that the specimens stretched 1.3 millimeters per second; therefore, the total elongation divided by 1.3 gave the duration of the test. During the time the load was being applied the zero of a scale graduated in 0.5 centimeter was constantly kept aligned with the lower gauge mark, the progress of the upper gauge mark was constantly noted, and the reading on the scale was recorded when the specimen broke. The difference between this reading and the gauge length gave directly the elongation which, when divided by the gauge length and multiplied by 100, gave the percentage of elongation. The elongations recorded are sufficiently accurate to give the percentages in the nearest whole per cent.

Breaking length.—Stresses of yarns, strands, and rope during tensile-strength tests are not distributed uniformly, but are more or less localized because of the heterogeneous nature of fiber bodies and the various mechanical defects. As a rule, nearly all vegetable-fiber ropes of three and four strands, including those here studied, break in one strand, seldom in two, and very

TABLE IV.—*Ropes made of Philippine fibers arranged in order of mean tensile strength when wet, beginning with the strongest. The same results, arranged in a different order, are given in Table XLII.*

ROPES MADE OF BAST FIBERS.

No.	Fiber.	Mean wet tensile strength.	
		Per sq. cm.	Per sq. inch.
		Kilos.	*Lbs.*
1	*Gnetum* sp.	1,000	14,500
2	*Ficus palawanensis*	766	10,900
3	*Ficus pachyphylla*	544	7,760
4	*Malachra fasciata*	543	7,700
5	*Sida acuta*	502	7,190
6	*Ficus benjamina*	471	6,700
7	*Bombycidendron vidalianum*	468	6,670
8	*Pterocymbium tinctorium*	435	6,180
9	*Helicteres hirsuta*	396	5,620
10	*Grewia eriocarpa*	381	5,450
11	*Urena lobata*	366	5,200
12	*Sterculia stipularis;* forma	366	5,200
13	*Cordia cumingiana*	364	5,160
14	*Corchorus olitorius*	360	5,100
15	*Bombax ceiba*	351	4,960
16	*Artocarpus communis;* bast from young tree	340	4,830
17	*Grewia multiflora*	332	4,730
18	*Abroma fastuosa*; unretted bast	319	4,530
19	*Sterculia crassiramea*	308	4,380
20	*Columbia blancoi*	306	4,340
21	*Goniothalamus amuyon*	293	4,180
22	*Thespesia lampas*	291	4,130
23	*Sterculia oblongata*	291	4,130
24	*Kleinhovia hospita*	286	4,070
25	*Commersonia bartramia*	266	3,780
26	*Cordia myxa*	263	3,730
27	*Trema orientalis*	262	3,720
28	*Pterospermum diversifolium*	261	3,690
29	*Allaeanthus glaber*	253	3,590
30	*Ficus forstenii*	222	3,160
31	*Sterculia foetida*	200	2,840
32	*Grewia bilamellata*	180	2,570
	Average	375	5,338

TABLE IV.—*Ropes made of Philippine fibers arranged in order of mean tensile strength when wet, etc.*—Continued.

ROPES MADE OF MISCELLANEOUS FIBERS.

No.	Fiber.	Mean wet tensile strength.	
		Per sq. cm.	Per sq. inch.
		Kilos.	*Lbs.*
1	*Musa textilis;* grade "G" abacá; rope, 16 mm. in circumference[a]	1,180	16,700
2	*Musa textilis;* grade "F" abacá; rope, 31 mm. in circumference[a]	946	13,500
3	*Musa textilis;* grade "F" abacá; rope, 15 mm. in circumference[a]	923	13,100
4	*Musa textilis;* grade "G" abacá; rope, 26 mm. in circumference[a]	759	10,800
5	*Agave cantala;* maguey; grade, Cebu No. 2[a]	651	9,220
6	*Amomum* sp	325	4,600
7	*Corypha elata;* buntal; vascular fibers in petioles	257	3,650
8	*Dendrocalamus merrillianus*[b]	179	2,540
9	*Cocos nucifera;* rope, 24 mm. in circumference[c]	148	2,100
10	*Cocos nucifera;* rope, 44 mm. in circumference[d]	146	2,070
11	*Cocos nucifera;* rope, 50 mm. in circumference[e]	136	1,940
12	*Anamirta cocculus*[f]	110	1,570
	Average	480	6,816

[a] Machine-made rope; all other ropes are handmade.

[b] This rope has two strands only; all other ropes have three strands.

[c] Immersed in stagnant tap water twenty-one days before testing; all other ropes were steeped in tap water only twenty-four hours before being tested. Rope made of fiber that had been machine cleaned at the Bureau of Science from Laguna husks.

[d] Rope made of fiber that had been macbine cleaned at the Bureau of Science from Laguna husks.

[e] Rope made at Caoayan, Ilocos Sur, from salt-water retted coir.

[f] Three-strand rope made of the entire stem of the vine.

rarely in three; this shows that the various strands are not equally taut in manufacture, and that the intensity of stress is greater in some fibers than in others.

As a substitute for stresses calculated on the basis of sectional areas of cordage and similar material (paper, leather, etc.), the computation of whose solid sectional area presents difficulties, Reuleaux[13] in 1861, and Rankine[13] in 1866, introduced the concept of breaking length. The breaking length of a rope is that length which when suspended at one end will cause the specimen to break of its own weight. It is computed by dividing the breaking load or tensile strength in pounds or kilograms by the weight in pounds per foot or in kilograms per meter, respectively, as follows:

$$\frac{\text{Breaking load}}{\text{Weight per unit length}} = \text{Breaking length.}$$

[13] Heermann, Paul, Mechanisch- und Physikalisch-technische Textile-Untersuchung. Julius Springer, Berlin (1912) 160–161.

Ropes made of the strongest and lightest fiber give the highest breaking length. However, a rope having a comparatively low breaking load (represented by the numerator of the equation) but having a relatively small weight per unit length (given by the denominator of the equation) would also give a high breaking length. Rope possessed of a very high breaking load and a relatively high mass per unit length might still give a high breaking length.

TABLE V.—*Breaking lengths of Philippine handmade bast-fiber ropes and miscellaneous hand- and machine-laid fiber ropes. The same results, arranged in a different order, are given in Table XLII.*

ROPES MADE OF BAST FIBERS.

No.	Fiber.	Mean breaking length.	
		Meters.	*Feet.*
1	*Gnetum* sp.	8,450	27,700
2	*Abroma fastuosa;* retted bast	7,740	25,400
3	*Malachra fasciata*	7,580	24,800
4	*Bombycidendron vidalianum*	6,950	22,800
5	*Ficus palawanensis*	6,230	20,400
6	*Urena lobata*	6,180	20,300
7	*Abroma fastuosa;* crude strips	5,770	18,900
8	*Sida acuta*	5,770	18,900
9	*Corchorus olitorius*	5,420	17,800
10	*Grewia eriocarpa*	5,050	16,600
11	*Sterculia crassiramea*	5,050	16,600
12	*Ficus benjamina*	5,030	16,500
13	*Ficus pachyphylla*	4,930	16,200
14	*Bombax ceiba*	4,620	15,150
15	*Artocarpus communis;* old bast	4,560	14,900
16	*Pterocymbium tinctorium*	4,560	14,900
17	*Sterculia oblongata*	4,490	14,700
18	*Artocarpus communis;* young bast	4,450	14,600
19	*Cordia cumingiana*	4,450	14,600
20	*Cordia myxa*	4,125	13,500
21	*Commersonia bartramia*	4,070	13,300
22	*Helicteres hirsuta*	3,950	12,950
23	*Kleinhovia hospita*	3,870	12,700
24	*Grewia bilamellata*	3,810	12,500
25	*Goniothalamus amuyon*	3,680	12,050
26	*Grewia multiflora*	3,660	12,000
27	*Columbia blancoi*	3,510	11,500
28	*Thespesia lampas*	3,180	10,400
29	*Sterculia stipularis*	2,980	9,780
30	*Pterospermum diversifolium*	2,620	8,620
31	*Allaeanthus glaber*	2,440	8,030
32	*Sterculia foetida*	1,964	6,450
33	*Ficus forstenii*	1,600	5,260
34	*Trema orientalis*	1,420	4,660

TABLE V.—*Breaking lengths of Philippine handmade bast-fiber ropes and miscellaneous, etc.*—Continued.

ROPES MADE OF MISCELLANEOUS FIBERS.

No.	Fiber.	Mean breaking length.	
		Meters.	*Feet.*
1	*Musa textilis;* grade "F" abacá; rope, 31 mm. in circumference [a]	12,300	40,400
2	*Musa textilis;* grade "F" abacá; rope, 15 mm. in circumference [a]	11,900	39,000
3	*Musa textilis;* grade "G" abacá; rope, 16 mm. in eircumference [a]	10,200	33,300
4	*Agave cantala;* maguey; grade, Cebu No. 2 [a]	9,350	30,700
5	*Musa textilis;* grade "G" abacá; rope, 26 mm. in circumference [a]	8,390	27,500
6	*Amomum* sp.	5,530	18,150
7	*Dendrocalamus merrillianus* [b]	3,800	12,450
8	*Corypha elata;* buntal	3,700	12,100
9	*Cocos nucifera;* rope, 24 mm. in circumference	3,550	11,650
10	*Anamirta cocculus* [c]	3,200	10,500
11	*Cocos nucifera;* rope, 44 mm. in circumference [d]	2,730	8,950
12	*Cocos nucifera;* rope, 50 mm. in circumference [e]	2,620	8,610

[a] Machine-made rope; all other ropes are handmade.
[b] This rope has two strands only; all other ropes have three strands.
[c] Rope made of the entire stem of the vine.
[d] Rope made of coir that had been machine cleaned at the Bureau of Science from Laguna husks.
[e] Rope made at Caoayan, Ilocos Sur, from salt-water retted coir.

In Table V ropes made of Philippine fibers are arranged in two groups.

The first group is devoted to handmade bast-fiber ropes and the second to hand- and machine-made ropes of miscellaneous fibers. The order of succession is not always the same, as will be seen by a comparison of the relative positions given to the various fibers in Tables IV and V; in the latter they are listed in the order of their breaking length, while in the former they are tabulated in the order of their dry tensile strength per unit area. The tensile strength per unit area does not take into consideration the actual weight of the fiber, and the two series must necessarily vary whenever there is a variation in the specific gravity of the materials. Rope made of the fiber of *Helicteres hirsuta* ranks ninth in tensile strength, but twenty-second when classified as to its breaking length. This irregularity is readily comprehended by reference to Table XLII, which shows that the rope made of this fiber is one of the heaviest tested.

Moisture.—Three pieces, each about 20 centimeters long, were cut from three different places in each coil of rope, and the samples were dried to constant weight at a temperature of 103° C. in a Freas electric oven. The dry weight was taken as the basis on which to compute the percentage of moisture. The figures given in Table VI show the mean of three closely agreeing determinations for each of the fibers tested.

TABLE VI.—*Percentage loss of moisture in ropes when dried at 103° C. to constant weight.*

ROPES MADE OF BAST FIBERS.

Fiber.	Moisture. Per cent.
Abroma fastuosa; unretted fiber	15.0
Abroma fastuosa; retted fiber	16.6
Commersonia bartramia	15.8
Helicteres hirsuta	14.6
Kleinhovia hospita	16.8
Pterocymbium tinctorium	13.5
Pterospermum diversifolium	10.7
Sterculia crassiramea	13.2
Sterculia foetida	9.7
Sterculia oblongata	15.0
Sterculia stipularis	9.0
Bombycidendron vidalianum	9.4
Malachra fasciata	9.3
Sida acuta	9.5
Thespesia lampas	8.9
Urena lobata var. *scabruscula*	10.8
Columbia blancoi	13.6
Corchorus olitorius	10.3
Grewia eriocarpa	9.1
Grcwia multiflora	15.1
Grewia bilamellata	9.8
Allaeanthus glaber	16.1
Artocarpus communis; young bast	10.2
Artocarpus communis; old bast	17.3
Ficus benjamina	9.2
Ficus forstenii	10.7
Ficus pachyphylla	10.0
Ficus palawanensis	10.0
Cordia cumingiana	14.5
Cordia myxa	9.3
Gnetum sp.	12.9
Bombax ceiba	18.8
Trema orientalis	9.8
Goniothalamus amuyon	9.5
ROPES MADE OF MISCELLANEOUS FIBERS.	
Agave cantala; maguey from Santo Domingo, Ilocos Sur	18.9
Agave cantala; maguey from Sulvec, Ilocos Sur	23.5
Cocos nucifera; retted fiber from Caoayan, Ilocos Sur	11.7
Corypha elata; leaf	14.7
Corypha elata; vascular fibers from petioles; buntal	10.6
Amomum sp.	9.8
Anamirta cocculus [a]	11.13
Dendrocalamus mcrrillianus [b]	13.6

[a] Entire stem of vine twisted into three-strand rope. [b] Two-strand rope.

Color.—In determining the color of the bast fibers discussed in this paper the color nomenclature of Ridgway [14] was used.

Length of bast strips.—In order to ascertain the average length of the bast strips, or ribbons, constituting the ropes tested, a 6-meter section was untwisted and measured. In Table VII are given the maximum, minimum, and mean lengths of the strips of bast from twenty-one species.

TABLE VII.—*Length of crude bast strips composing some of the ropes tested.*

Fiber.	Length.		Mean of five strips measured.
	Maximum.	Minimum.	
	mm.	*mm.*	*mm.*
Abroma fastuosa; unretted bast	912	356	675
Pterocymbium tinctorium	3,113	305	1,889
Sterculia crassiramea	3,010	277	1,890
Sterculia oblongata	3,066	184	2,111
Sterculia foetida	1,036	235	767
Sterculia stipularis; forma	1,248	206	980
Bombycidendron vidalianum	990	300	657
Thespesia lampas	1,555	542	1,203
Urena lobata	1,950	176	1,118
Corchorus olitorius	1,668	198	1,186
Grewia eriocarpa	1,592	290	1,004
Grewia bilamellata	1,343	346	1,060
Grewia multiflora	2,476	1,482	2,104
Artocarpus communis	927	160	610
Ficus benjamina	1,388	1,053	1,227
Ficus forstenii	1,095	346	738
Ficus pachyphylla	1,884	239	838
Ficus palawanensis	1,240	325	821
Gnetum sp	851	239	503
Bombax ceiba	1,595	303	967
Goniothalamus amuyon	1,063	295	794

The strongest rope, *Gnetum* sp., is made of bast strips having the shortest length, which shows that even with these lengths the resistance to slipping is greater than the actual strength of the fiber in the other cases.

LOCAL PHILIPPINE NAMES

Most of the local Philippine names of the species yielding bast fiber recorded in this paper were obtained from the descriptive labels accompanying botanical specimens in the Bureau

[14] Ridgway, R., Color Standards and Color Nomenclature. Published by the author in Washington, D. C. (1912).

of Science herbarium, and from Schneider.[15] Others were obtained while studying the bast-rope industry in the Ilocos Provinces.

Local Philippine names are given on account of their helpfulness in identifying plant species, but they must always be used with caution, because they are at times applied with extreme looseness. Several related species may all be known by one name; on the other hand, one species may be known by several different names in the same place and in the same dialect. For example, *Kleinhovia hospita* is called *marakapas* by the Ilocanos of Ilocos Sur, but the same term is also applied to a closely related species, *Pterocymbium tinctorium*, and to *Thespesia lampas*, which belongs to an entirely different family. In the same way *annabo* is applied to two species that belong to altogether different families; namely, *Malachra fasciata* and *Abroma fastuosa*. *Maratarong* is used to denominate both *Thespesia lampas* and *Cordia cumingiana*.

STERCULIACEAE

ABROMA FASTUOSA Jack. (*Abroma augusta* L.). Anabo.

Common names: Abroma, devil's cotton (English); *abrome* (French); *Kakaomalve, Abrome* (German).

Local names: *Ambong* (Tagalog); *an-nabó, anabó* or *annabó* (Abra, Apayao, Bataan, Benguet, Ilocos Norte, Ilocos Sur, Laguna, Manila, Negros, Rizal, Tayabas, Union); *anabong, labon, nabó, sayapo* (Visayan, Cotabato, Negros, Rizal); *anabú, pakalkal* (Pampanga); *anafu* (Nueva Vizcaya); *bago* (Sorsogon); *bodobodo* (Ilocos Norte); *nabu* (Bohol, Cagayan, Negros); *negegan* (Batanes); *sayapu* (Moro in Cotabato).

A shrub; the vegetative parts covered with stiff, somewhat irritating hairs; leaves heart-shaped, 10 to 30 centimeters long; flowers yellow, about 5 centimeters in diameter; capsules thin-walled, truncate, five-angled, five-winged, five-valved; widely distributed in the settled areas of the Philippines at low and medium altitudes; sometimes cultivated.

Various statements have appeared from time to time with regard to *Abroma fastuosa*—that it is more eaisly cultivated than jute, that it yields at least three crops of fiber yearly, etc. Although it is mentioned by Watt,[16] *Abroma fastuosa* bast can

[15] Schneider, E. E., Commercial Woods of the Philippines: Their Preparation and Uses, *Bull. P. I. Bur. Forestry* 14 (1916). Mr. Schneider, wood expert, has revised the local names used in this paper, in accordance with the spellings adopted by the Philippine Bureau of Forestry.

[16] Watt, G., The Commercial Products of India. John Murray, London (1908) 1.

hardly be considered to have attained commercial significance. Even in India, where the plant is very abundant and where, since its discovery by Roxburgh in 1801, the greatest efforts have been exerted to make it of commercial importance, the results have not been successful.

Cultivation experiments [17] with two lots of seed, performed at the Forestry School and on the farm of the College of Agriculture at Los Baños, Philippine Islands, were unsuccessful. The first lot gave a germination percentage of only 4, and the second, 20.5. At the end of a year the plants were 2.1 meters high and averaged 4.4 centimeters in diameter at the base. These plants were blown over during a storm eight days prior to their having attained an age of one year, but were subsequently righted. No details are given regarding the later progress of the plants or the quality and yield of the fiber produced. Mendiola [18] suggests the suitability of *Abroma fastuosa* for reforestation, since it grows on cogon areas and can check the growth of grass within a year. Aside from these experiments *Abroma fastuosa* has never been cultivated in the Philippines. It grows wild in at least fifteen provinces, and the fiber used locally is procured from this very uncertain and limited source. On one of the Bureau of Science herbarium sheets on which a specimen of *Abroma fastuosa* is mounted it is stated that this bast fiber is used in Cotabato as a substitute for abacá and that it sells for from 6 to 8 pesos per picul. It is stated also that in Cebu the fiber is quoted at 6.50 pesos and that it sometimes is sold for 10 pesos per picul, and that considerable quantities are brought to Cebu from Dipolog and Dapitan.

Tests and discussion of results.—Two samples of *Abroma fastuosa* rope were tested, photographs of which are shown in Plate III, figs. 1 and 2. Although these are from accurately identified plant specimens their physical appearance is sufficiently different to lead one to doubt their identity. That shown in fig. 1 was taken from a coil of rope collected by me at Sappaac, Abra Province, May, 1916. The fiber was prepared by retting for about ten days in fresh water with subsequent manipulation. It is sulphur yellow, soft and glossy, and makes a very pliable and attractive-looking rope. It has a high uniform tensile strength which compares favorably with machine-made abacá rope, and in breaking length it is only second to *Gnetum* sp.

[17] Mendiola, Nemesio Blanco, A study of Philippine bast fibers, *Philip. Agr. and Forester* 6 (1917) 6–38.

[18] Loc. cit.

Some of the strips of bast have been freed so thoroughly from the adherent cellular tissue that the individual filaments are easily discernible and present a silky appearance; in fact, Watt [19] states that the fiber might be considered a substitute for silk. The rope was made of fiber that was already on hand at the time of my visit, and therefore represents the bast as it is customarily used there for cordage manufacture. Plate II, fig. 1, shows the process of laying this retted-rope sample, together with details of the triple-crank end of the primitive wooden apparatus employed for the purpose. The other specimen, shown in Plate III, fig. 2, is cream buff and was collected at Disdis, Benguet Subprovince, for this particular work, by Eugenio Fénix, formerly botanical assistant, Bureau of Science. In this place the Filipinos did not take the trouble to clean the bast by retting or other process; they simply used the crude ribbon-like strips, which average 5 millimeters wide, 0.51 millimeter thick, and 675 millimeters long, in manufacturing the rope. Each strand is about seven strips thick. The result is a bulky, coarse, and rough-looking rope of erratic tensile strength when either wet or dry. Although inferior in strength to the retted-fiber rope, due to the large percentage of inert material encumbering its filaments, nevertheless it has more than average tenacity.

The retted bast-fiber rope has a uniformly high tensile strength, and breaks of dry specimens occurred at 147, 157, and 166 kilograms, respectively, a maximum variation of only 6 per cent from the mean. All three of the test specimens failed outside of eye-splices. On the other hand specimens of the uncleaned bast rope in a series of five tests gave a maximum tensile variation of 21 per cent from the mean value. Two of the specimens ruptured in eye-splices.

No tests were made of the wetted rope specimens fabricated of retted fiber. Wetting the rope made from crude strips of *Abroma fastuosa* bast lowered its mean tensile strength nearly 50 per cent, with a maximum variation in five specimens of 22 per cent from the mean. One specimen ruptured in an eye-splice. It would appear that this fiber is unsuitable for use in the wetted condition. Its unsuitability in wet places is appreciated by the Filipinos, who largely restrict its use to the dry season. When dry it is much valued and is preferred for hanging clothes because it is nonstaining.

[19] Watt, G., Dictionary of the Economic Products of India. Government of India Printing Office, Calcutta 1 (1885) 7 and 8.

TABLE VIII.—*Physical tests of rope made of Abroma fastuosa.*

	Crude fiber strips; not retted.[a]	Retted fiber; fairly clean.[b]
Mean diameter:		
Millimeters	11.5	6.1
Inches	0.45	0.24
Mean perimeter, or girth:		
Millimeters	36	19
Inches	1.42	0.75
True mean sectional area:		
Square millimeters	88.4	24.4
Square inches	0.137	0.037
Ultimate tensile strength (dry):		
Mean in kilograms	482	157
Maximum in kilograms	583	166
Minimum in kilograms	388	147
Mean in pounds	1,063	345
Maximum in pounds	1,285	365
Minimum in pounds	855	325
Ultimate tensile strength (wet):		
Mean in kilograms	282	([c])
Maximum in kilograms	336	([c])
Minimum in kilograms	220	([c])
Mean in pounds	621	([c])
Maximum in pounds	740	([c])
Minimum in pounds	485	([c])
Mean ultimate tensile strength per unit area (dry):		
Kilograms per square centimeter	545	643
Pounds per square inch	7,760	9,100
Mean ultimate tensile strength per unit area (wet):		
Kilograms per square centimeter	319	([c])
Pounds per square inch	4,530	([c])
Mean elongation at instant of rupture:		
Dry ... per cent	12	([c])
Wet ... do	13	([c])
Mean weight per unit length:		
Grams per meter	83.7	20.2
Pounds per foot	0.0562	0.0136
Average breaking length:		
Meters	5,770	7,740
Feet	18,900	25,400
Moisture ... per cent	13.67	14.3

[a] Made at Disdis, Benguet Subprovince. [b] Made at Sappaac, Abra Province. [c] No test made.

Comparative tests performed by Roxburgh[20] on the tensile strength of two "lines" made of *Abroma fastuosa* bast in the dry and wet condition, respectively, show an average gain of 12 pounds for the wetted line made from the fiber procured from

[20] Through Royle, Forbes, Fibrous Plants of India Fitted for Cordage, Clothing, and Paper. Smith, Elder and Co., London; Smith, Taylor and Co., Bombay (1855) 268.

young shoots cut before the blossoms appeared, and no gain in strength for the wetted line made from the bast obtained from old ligneous plants that had ripened their seed. The test specimens, which were apparently suspended at one end, had a length of 4 feet and were ruptured by the addition of weights; no mention is made of the rate of increment of load, the period of immersion, the kind of water used, the diameter or circumference of the test specimens, how the lines were made, or the percentage elongation. Consequently these tensile-strength data cannot be compared with those obtained in this investigation. Roxburgh's [21] data as published by Royle are in the following form; I have omitted the results given for twenty-seven lines made from other species:

Comparative strength of Fibres, both dry and wet, ascertained by weights suspended to four-feet lengths of the several lines.

No.	NAMES OF THE PLANTS, And brief Remarks on the various Materials employed in these Experiments.	Average weight each line broke when dry.	Average weight each line broke when wet.	Average of weight gained by wetting the lines.
15	Abroma augusta, young shoots cut before the blossoms appeared	100	112	12
16	The same, from old ligneous plants, that had ripened their seed	121	121	0

A summary of the tests made in the Bureau of Science is given in Table VIII.

COMMERSONIA BARTRAMIA (Linn.) Merr. Kakaag.

Local names: *Anitap* (Itneg, Benguet); *kakaag* (Ilocano, Benguet).

A small tree with heart-shaped, softly pubescent leaves; terminal panicles of small white flowers, the capsules five-valved, globose, densely covered with slender, hairy, soft processes; throughout the Philippines at low altitudes.

The color of the crude *Commersonia bartramia* bast strips constituting the sample of cordage examined varies from a light ochraceous salmon to a warm buff. Each strand averages five bast strips in thickness, the strips varying in width from 4 to 10 millimeters and in thickness from 0.28 to 0.74 millimeter.

The results of the tensile-strength tests of five dry specimens show medium tenacity although in poor agreement, with a maximum variation of 20 per cent from the mean. Four of the test pieces ruptured in eye-splices.

[21] Loc. cit.

Tensile-strength tests of five specimens that had been immersed in tap water for twenty-four hours showed a reduction of 32 per cent in strength, with a maximum variation from the mean of 26 per cent. Only one specimen broke in an eye-splice. Due to the marked impairment in strength occasioned by wetting, it would seem that cordage made of wetted *Commersonia bartramia* bast is unsuited for use. Nevertheless the residents of Benguet, where the rope was procured, state that during rainy weather it is more durable than the other commonly used basts, and that it is considered primarily a wet-weather rope.

A summary of the tests made in the Bureau of Science is given in Table IX.

TABLE IX.—*Physical tests of rope made from the bast of Commersonia bartramia.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	12.1
Inches	0.48
Mean perimeter, or girth:	
Millimeters	38
Inches	1.50
True mean sectional area:	
Square millimeters	97.5
Square inches	0.151
Ultimate tensile strength (dry):	
Mean in kilograms	382
Maximum in kilograms	458
Minimum in kilograms	306
Mean in pounds	843
Maximum in pounds	1,010
Minimum in pounds	675
Ultimate tensile strength (wet):	
Mean in kilograms	259
Maximum in kilograms	327
Minimum in kilograms	220
Mean in pounds	570
Maximum in pounds	720
Minimum in pounds	485
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	392
Pounds per square inch	5,580
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	266
Pounds per square inch	3,780
Mean elongation at instant of rupture:	
Dry (per cent)	14
Wet (per cent)	13

TABLE IX.—*Physical tests of rope made from the bast of Commersonia bartramia*—Continued.

Mean weight per unit length:	
Grams per meter	93.9
Pounds per foot	0.0632
Average breaking length:	
Meters	4,070
Feet	13,300
Moisture (per cent)	13.62

HELICTERES HIRSUTA Lour.

Local names: *Balibago bulbusin* (Pampanga); *buntot-usá, lailaiginan* (Rizal); *danglin aso* (Visayan); *danglin kalabau* (Abra, Pangasinan, Tarlac); *kakaab* or *kakaag* (Union, Pangasinan); *kakaag* (Abra, Pangasinan); *kol-lokol-lot ti bao* (Benguet); *kubal* (Pangasinan); *laginlaginan* (Manila and vicinity); *malamansanita* (Ilocos Norte, Tagalog); *malatakon* (Abra); *pakin bakit* (Ilocano); *saginsaginan* (Tagalog); *sarungas á dadakkel* (Ilocos Sur); *talakau* (Negrito); *talosan* (Tayabas); *tolosan* (Ilocano); *tongtongking* (Amburayan).

A shrub with soft, hairy, oblong, acuminate leaves which are obliquely cordate at the base; cymes axillary; flowers pink or purplish, slender, nearly 2 centimeters long, capsule oblong, cylindric, 3 to 4 centimeters long, beaked, very shaggy; throughout the Philippines at low altitudes, locally very abundant.

The fiber strips constituting this rope are light buff, harsh, and stiff. Some of the coarser ribbons have a decidedly woody appearance. The thicker ribbons are not so pliable as the thinner ones and are, moreover, marked with scars or perforations showing where twigs or branches grew from the stems. Each strand is from nine to eleven strips in thickness, the strips varying in width from 3 to 11 millimeters, and in thickness from 0.18 to 0.76 millimeter. It will be noticed that there is great variability in the dimensions of the strips.

Both the tensile strength and the breaking length of this rope are low. Twenty-four hours' immersion in water reduced the tensile strength only about 10 per cent. From field information it appears that rope made from this bast is durable during the rainy season. The individual breaks in both the dry and the wet series gave good agreement; the maximum variation from the mean tensile strength of the five dry test pieces was 17 per cent, and the corresponding value for the wet series was 11 per cent. All of the dry specimens failed outside of eye-splices, and two of the wet test pieces ruptured in eye-splices.

A summary of the tests made in the Bureau of Science is given in Table X.

TABLE X.—*Physical tests of rope made from the bast of Helicteres hirsuta.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	11.2
Inches	0.44
Mean perimeter, or girth:	
Millimeters	35
Inches	1.38
True mean sectional area:	
Square millimeters	78.6
Square inches	0.122
Ultimate tensile strength (dry):	
Mean in kilograms	345
Maximum in kilograms	404
Minimum in kilograms	306
Mean in pounds	761
Maximum in pounds	890
Minimum in pounds	675
Ultimate tensile strength (wet):	
Mean in kilograms	311
Maximum in kilograms	331
Minimum in kilograms	277
Mean in pounds	685
Maximum in pounds	730
Minimum in pounds	610
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	438
Pounds per square inch	6,230
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	396
Pounds per square inch	5,620
Mean elongation at instant of rupture:	
Dry (per cent)	13
Wet (per cent)	13
Mean weight per unit length:	
Grams per meter	87.4
Pounds per foot	0.0587
Average breaking length:	
Meters	3,950
Feet	12,950
Moisture (per cent)	12.71

KLEINHOVIA HOSPITA Linn. Tanag.

Local names: *Bafe n͠ga bunsung* (Nueva Vizcaya); *bantana* (Guimaras); *biknong* (Union, Zambales); *biluan, lapnis, malobago* (Negros); *biluan* (Occidental Negros); *binong* (Nueva Ecija, Pangasinan); *binunga* (Bataan); *bitanag* (Agusan, Surigao); *bitnong* (Ilocano); *bitonág* (Visayan); *bitonog* (Lanao); *butnong, taloktok* (Ilocos Norte); *hamitanago* (Visayan); *hunung* (Cagayan); *magindanau, tamanag* (Cotabato); *malibago* (Palawan); *marakapas* (Ilocos Sur); *pampar, panampat* (Pampanga); *tanág* or *tan-ag* (Bicol, Visayan, Ilocano, and Tagalog); *tanak* (Tayabas); *unapong* (Balabac); *unopong* (Moro).

A small or medium-sized tree with large, cordate, broadly ovate leaves, and ample terminal panicles of small pink flowers; capsules inflated, thin-walled, about 2 centimeters long, obovoid; throughout the Philippines at low altitudes; usually abundant.

According to Mendiola [22] *Kleinhovia hospita* can be made to produce at least two crops a year of shoots about 1 meter long. It is grown from seed, and all attempts to propagate it from cuttings have failed. The tree is found in Malacca, Singapore, Ceylon, Java, and tropical East Africa. It is grown as an avenue tree in India, especially in Calcutta.

In appearance and general structure the bast strips of *Kleinhovia hospita* are much like those of *Sterculia crassiramea;* the sample of rope made from the former also has the frayed and irregular characteristics of rope made from the latter. The strands average nine strips of bast in thickness, and the strips average 5 millimeters in width and vary from 0.43 millimeter to 1.75 millimeters in thickness.

The sample of rope when dry is low in tensile strength and in breaking length. Unlike some related species, the wetted fiber shows relatively little decrease in tensile strength; immersion in water for twenty-four hours reduced the mean tensile strength only 7 per cent. However, the maximum result in the two series was in that of a wet specimen. The Filipinos state that cordage made of this fiber is durable during rainy weather.

All ruptures of the dry specimens occurred outside, whereas two out of the five wet test pieces broke inside of eye-splices. The minimum as well as the maximum values in the wet series were obtained from test specimens that failed outside of eye-splices. The maximum variations from the mean tensile strength in the dry and the wet series were 17 and 30 per cent, respectively.

Like most of the ropes tested, this one is principally used for tethering carabaos and horses and for making halters. The individual ribbons of *Kleinhovia hospita* bast, after being torn into fine strips, are used as binder twine for tying rice stalks.

A summary of the tests made in the Bureau of Science is given in Table XI.

[22] Philip. Agr. and Forester 6 (1917).

TABLE XI.—*Physical tests of rope made from the bast of Kleinhovia hospita.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	12.4
Inches	0.49
Mean perimeter, or girth:	
Millimeters	39
Inches	1.54
True mean sectional area:	
Square millimeters	116.6
Square inches	0.181
Ultimate tensile strength (dry):	
Mean in kilograms	360
Maximum in kilograms	403
Minimum in kilograms	299
Mean in pounds	793
Maximum in pounds	890
Minimum in pounds	660
Ultimate tensile strength (wet):	
Mean in kilograms	334
Maximum in kilograms	435
Minimum in kilograms	272
Mean in pounds	737
Maximum in pounds	960
Minimum in pounds	600
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	309
Pounds per square inch	4,370
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	286
Pounds per square inch	4,070
Mean elongation at instant of rupture:	
Dry (per cent)	13
Wet (per cent)	13
Mean weight per unit length:	
Grams per meter	92.9
Pounds per foot	0.0625
Average breaking length:	
Meters	3,870
Feet	12,700
Moisture (per cent)	14.49

PTEROSPERMUM DIVERSIFOLIUM Bl. Bayok.

Local names: *Baloi* and *bároi* (Abra, Ilocos Sur, Pangasinan, Tarlac); *baroi* (Abra, Benguet, Ilocano, Itneg); *bayog-bayóg* (Zamboanga); *bayóg, bayók,* or *bayok* (Bataan, Batangas, Camarines, Catanduanes, Cavite, Cotabato, Laguna, Masbate, Mindoro, Negros, Nueva Ecija, Palawan, Pampanga, Rizal, Tayabas, Ticao, Zambales, and Zamboanga); *biyug, bayong* (Tayabas); *dibuál* (Basilan); *taliñgaan* (Ilocos Norte).

A small tree with large, oblong, irregular, pubescent leaves; in young plants the leaves usually palmately lobed; flower large, solitary; capsules large, up to 15 centimeters long, sharply five-angled; seeds winged; in second-growth forests throughout the Philippines.

Pterospermum diversifolium bast is pinkish cinnamon; the fiber strips average 3 millimeters wide and 0.54 millimeter thick. Rope made from it is very low in tensile strength and in breaking length, and because of its brittleness is not commonly used by Filipinos for rope making. Wetting does not affect its tensile strength. All of the dry, and one of the wet, test specimens failed in eye-splices. The values for the tensile strength given by the wet specimens show better agreement than those yielded by the dry ones, the maximum variations from the means in the dry and the wet series being 14 and 8 per cent, respectively.

A summary of the tests made in the Bureau of Science is given in Table XII.

TABLE XII.—*Physical tests of rope made from the bast of Pterospermum diversifolium.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	6.7
Inches	0.26
Mean perimeter, or girth:	
Millimeters	21
Inches	0.83
True mean sectional area:	
Square millimeters	28.8
Square inches	0.044
Ultimate tensile strength (dry):	
Mean in kilograms	75.7
Maximum in kilograms	81.6
Minimum in kilograms	65.3
Mean in pounds	167
Maximum in pounds	180
Minimum in pounds	144
Ultimate tensile strength (wet):	
Mean in kilograms	75.3
Maximum in kilograms	81.2
Minimum in kilograms	70.3
Mean in pounds	166
Maximum in pounds	179
Minimum in pounds	155

TABLE XII.—*Physical tests of rope made from the bast of Pterospermum diversifolium*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	263
Pounds per square inch	3,740
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	261
Pounds per square inch	3,690
Mean elongation at instant of rupture:	
Dry (per cent)	11
Wet (per cent)	15
Mean weight per unit length:	
Grams per meter	28.9
Pounds per foot	0.0194
Average breaking length:	
Meters	2,620
Feet	8,620
Moisture (per cent)	9.68

PTEROCYMBIUM TINCTORIUM (Blanco) Merr. Talúto.

Local names: *Abigon, taóto, taútu* (Bataan, Leyte); *abigón* (Bataan); *balulau* (Agusan); *bañgat* (Zambales); *bayau, takung* (Surigao); *duidui* or *duyduy* (Tayabas); *huligano* (Nueva Ecija); *libtúk* (Cagayan Province); *malasapsáp* (Pampanga); *marakapas* (Ilocano); *tagung-túñgan* (Cebu); *takong* (Surigao); *talóto* or *talúto* (Bataan, Camarines, Cotabato, Laguna, Mindoro, Negros, Nueva Ecija, Palawan, Tayabas).

A deciduous tree with broadly ovate, often lobed leaves; flowers appearing with or before the new leaves; fruit with a long boat-shaped appendage; throughout the Philippines at low and medium altitudes.

Pterocymbium tinctorium bast is pale yellow-orange. Each strand of the rope averages nine ribbons thick, and these vary in thickness from 0.28 to 0.89 millimeter and have a mean length of 1,889 millimeters. Dry rope made of this bast is low in tensile strength and breaking length. Immersion in water for twenty-four hours increased the tenacity of the fiber about 7 per cent. Wetting also caused the test specimens to break more uniformly. The maximum variation from the mean in the wet series of five tests was 18 per cent, whereas the corresponding value for the five dry specimens was 26 per cent. None of the test pieces saturated with water failed in eye-splices, but three out of the five dry specimens ruptured therein. One of the three specimens that ruptured in an eye-splice gave the maximum result.

A summary of the tests made in the Bureau of Science is given in Table XIII.

TABLE XIII.—*Physical tests of rope made from the bast of Pterocymbium tinctorium.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	13.4
Inches	0.53
Mean perimeter, or girth:	
Millimeters	42
Inches	1.66
True mean sectional area:	
Square millimeters	114.0
Square inches	0.177
Ultimate tensile strength (dry):	
Mean in kilograms	435
Maximum in kilograms	531
Minimum in kilograms	322
Mean in pounds	959
Maximum in pounds	1,170
Minimum in pounds	710
Ultimate tensile strength (wet):	
Mean in kilograms	496
Maximum in kilograms	587
Minimum in kilograms	424
Mean in pounds	1,093
Maximum in pounds	1,295
Minimum in pounds	935
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	381
Pounds per square inch	5,420
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	435
Pounds per square inch	6,180
Mean elongation at instant of rupture:	
Dry (per cent)	10
Wet (per cent)	12
Mean weight per unit length:	
Grams per meter	95.4
Pounds per foot	0.0642
Average breaking length:	
Meters	4,560
Feet	14,900
Moisture (per cent)	11.87

STERCULIA CRASSIRAMEA Merr. Tapinag.

Local names: *Adupong* (Benguet); *balínad* (Palawan, Ticao); *baníkad* (Mindoro); *baníl ad* (Guimaras, Mindoro, Rizal); *bannakalau* or *baniakalaw* (Abra, Benguet, Ilocos Norte, Ilocos Sur); *kalukalumpáñgan* (Rizal); *malakapai, malapapaya, tapinag* (Bataan); *palak-palak* (Bulacan).

A large deciduous tree with broadly ovate, cordate, entire, densely pubescent leaves; ample panicles of small flowers; and inflated capsules containing few seeds; ultimate branchlets much thickened; widely distributed in the forested areas of Luzon.

Sterculia crassiramea bast makes a rope which when dry has a medium tensile strength and breaking length. Wetting decreases the tensile strength about 23 per cent. The dry specimens gave uniform breaks with a maximum variation from the mean of 8 per cent. Only one test piece in the series of five dry specimens failed in an eye-splice, and the value given by this specimen is not the minimum. Whereas the tensile-strength results obtained from the dry test pieces show a maximum variation from the mean of only 7 per cent, the wet ones show a maximum variation of 16 per cent from the average. Three out of the five specimens failed in eye-splices.

The strands of the rope tested average six strips of bast thick. These strips vary from 5 to 15 millimeters in width and from 0.31 to 1.04 millimeters in thickness, and their mean length is 1,890 millimeters. The residents of Disdis state that this fiber is readily attacked by an insect called "bucbuc," which quickly destroys the rope by honeycombing it. Experience has shown that all bast-fiber ropes are extraordinarily susceptible to attack by insects and molds. Molds grow luxuriantly on these fibers if they are allowed to remain exposed, particularly during rainy and damp weather. The molds discolor the bast and in some cases permanently stain it by the secretion of pigments. It was necessary to preserve the museum specimens of bast rope in a large covered glass jar containing a wad of cotton saturated with formalin, in order to inhibit the growth of fungi and to prevent the attack of insects.

A summary of the tests made in the Bureau of Science is given in Table XIV.

TABLE XIV.—*Physical tests of rope made from the bast of Sterculia crassiramea.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	12.7
Inches	0.50
Mean perimeter, or girth:	
Millimeters	40
Inches	1.58
True mean sectional area:	
Square millimeters	121.3
Square inches	0.188

TABLE XIV.—*Physical tests of rope made from the bast of Sterculia crassiramea*—Continued.

Ultimate tensile strength (dry):	
Mean in kilograms	483
Maximum in kilograms	503
Minimum in kilograms	446
Mean in pounds	1,064
Maximum in pounds	1,110
Minimum in pounds	985
Ultimate tensile strength (wet):	
Mean in kilograms	373
Maximum in kilograms	435
Minimum in kilograms	315
Mean in pounds	823
Maximum in pounds	960
Minimum in pounds	695
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	398
Pounds per square inch	5,660
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	308
Pounds per square inch	4,380
Mean elongation at instant of rupture:	
Dry (per cent)	13
Wet (per cent)	14
Mean weight per unit length:	
Grams per meter	95.5
Pounds per foot	0.0642
Average breaking length:	
Meters	5,050
Feet	16,600
Moisture (per cent)	11.65

STERCULIA FOETIDA Linn. Kalumpáng.

Local names: *Bañgar* (Ilocano, Itneg); *bóbog, bo-bog, bubog, bobo* (Balabac, Iloilo, Negros, Palawan, Panay); *boñgog* (Cagayan); *bubur, bobor* (Ilocos Sur); *kalumpáng* (Apo Island, Bataan, Camarines, Cotabato, Iloilo, Laguna, Manila, Mindoro, Nueva Ecija, Palawan, Pampanga, Polillo, Rizal, Tayabas).

A large tree with palmately five-foliate leaves, the leaflets oblong-lanceolate, acuminate, entire, glabrous; flowers very fetid; capsules very large, bright red when mature, obovoid, splitting down one side, the oblong edible seeds persistent for some time after maturity; common and widely distributed in the Philippines.

With the exception of two other basts, *Sterculia foetida* is the weakest fiber tested. Immersion in water for twenty-four hours does not affect its tensile strength. The extremely low tenacity of this bast, together with its comparative scarcity, limit its usefulness as a cordage fiber.

Sterculia foetida bast is light salmon-orange. The strands of the rope tested are eight strips thick, and the latter average 4 millimeters wide, 0.30 millimeter thick, and 767 millimeters long. None of the five dry specimens ruptured in eye-splices; and the tensile-strength values are in close agreement, the maximum variation from the mean being only 4 per cent. Of the four wet specimens broken one failed in an eye-splice, giving the minimum value. There was a wide variation in the tensile strength of the wetted pieces, the maximum from the mean value being 28 per cent.

A summary of the tests made of this species in the Bureau of Science is given in Table XV.

TABLE XV.—*Physical tests of rope made from the bast of Sterculia foetida.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.0
Inches	0.28
Mean perimeter, or girth:	
Millimeters	22
Inches	0.87
True mean sectional area:	
Square millimeters	28.4
Square inches	0.044
Ultimate tensile strength (dry):	
Mean in kilograms	56.7
Maximum in kilograms	58.9
Minimum in kilograms	54.9
Mean in pounds	125
Maximum in pounds	130
Minimum in pounds	120
Ultimate tensile strength (wet):	
Mean in kilograms	56.7
Maximum in kilograms	72.5
Minimum in kilograms	48.1
Mean in pounds	125
Maximum in pounds	160
Minimum in pounds	106
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	200
Pounds per square inch	2,840
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	200
Pounds per square inch	2,840
Mean elongation at instant of rupture:	
Dry (per cent)	6
Wet (per cent)	10

TABLE XV.—*Physical tests of rope made from the bast of Sterculia foetida*—Continued.

Mean weight per unit length:	
Grams per meter	28.8
Pounds per foot	0.0194
Average breaking length:	
Meters	1,964
Feet	6,450
Moisture (per cent)	8.88

STERCULIA OBLONGATA R. Br. Malaboho.

Local names: *Bakan* (Mindoro); *banabá* (Ilocos Norte); *banílad* (Mindoro, Rizal); *búñga, malabúñga* (Tayabas); *hantak* (Batanes); *lapnít* (Calayan, Babuyanes); *malabóho* (Bataan); *malakakao* (Bataan, Laguna); *malabanilad* (Samar); *sinaligan* (Abra, Benguet); *uós* (Camarines).

A small or medium-sized tree with oblong, glabrous, entire leaves; terminal panicles of small flowers; and oblong, bright red, inflated capsules; widely distributed in the Philippines at low altitudes.

Most of the strips of *Sterculia oblongata* are salmon-buff, some are tawny, and others are salmon-orange. Each strand of the rope is from six to eight strips thick. Some strips are only 2 millimeters wide and 0.13 millimeter thick, and others are 14 millimeters wide and 0.77 millimeter thick; all are marked longitudinally with narrow elongated depressions that give them a grained surface not unlike wood. Some of the depressions extend through the bast.

Tests show that rope made of *Sterculia oblongata* bast when dry possesses only medium tensile strength and breaking length When wetted, the strength is markedly decreased; the mean tensile strength of specimens saturated with water showed an average reduction of 27 per cent. The tests indicate that rope made of this bast is not suited for use in water. However, the information obtained in the field is quite the contrary. The residents of Disdis, Benguet, state that rope made of *Sterculia oblongata* bast is preferably used during the rainy season. Two of the five dry, and three of the five wet, test specimens failed in eye-splices, the maximum and minimum values in both series of tests being obtained from specimens that ruptured outside of eye-splices. The maximum variations from the mean tensile strength in the dry and the wet series were 9 and 17 per cent, respectively.

A summary of the tests of this species made in the Bureau of Science is given in Table XVI.

TABLE XVI.—*Physical tests of rope made from the bast of Sterculia oblongata.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	12.1
Inches	0.48
Mean perimeter, or girth:	
Millimeters	38
Inches	1.50
True mean sectional area:	
Square millimeters	96.0
Square inches	0.149
Ultimate tensile strength (dry):	
Mean in kilograms	382
Maximum in kilograms	413
Minimum in kilograms	351
Mean in pounds	842
Maximum in pounds	920
Minimum in pounds	775
Ultimate tensile strength (wet):	
Mean in kilograms	279
Maximum in kilograms	327
Minimum in kilograms	241
Mean in pounds	615
Maximum in pounds	720
Minimum in pounds	530
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	398
Pounds per square inch	5,650
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	291
Pounds per square inch	4,130
Mean elongation at instant of rupture:	
Dry (per cent)	13
Wet (per cent)	14
Mean weight per unit length:	
Grams per meter	85.1
Pounds per foot	0.0572
Average breaking length:	
Meters	4,490
Feet	14,700
Moisture (per cent)	13.05

STERCULIA STIPULARIS R. Br. Bonotan.

Local names: *Bisong* (Nueva Vizcaya); *bonotan, rapok* (Ilocos Norte); *buñgat* (Cagayan); *labnai* (Abra, Itneg); *malagasáha* (Tayabas).

A medium-sized tree with oblong-ovate, rusty-pubescent, entire, acuminate leaves; flowers numerous, calyx-lobes elongated; capsules red, inflated; widely distributed in the Philippines at low altitudes.

The strips of *Sterculia stipularis* bast are lacelike and present a sievelike appearance. They are uniformly ochraceous buff. Some are 12 millimeters wide, though most of them vary between 4 and 5 millimeters. They are thin, fluctuate between 0.15 millimeter and 0.43 millimeter in thickness, and have a mean length of 980 millimeters. The strands of the rope are eight strips thick.

When dry, the rope is very low in tensile strength and in breaking length. Wetting raises the tensile strength about 37 per cent. Notwithstanding its low tenacity, the Filipinos frequently use this bast for making rope. They state that it is durable in the wet season. The rope finds special application for making hog traps.

All of the five wet specimens broke in eye-splices, whereas only two of the dry test pieces failed in this manner. The maximum variations from the mean tensile strength in the dry and the wet series were 29 and 22 per cent, respectively.

A summary of the tests of this species made in the Bureau of Science is given in Table XVII.

TABLE XVII.—*Physical tests of rope made from the bast of Sterculia stipularis.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	7.0
Inches	0.28
Mean perimeter, or girth:	
Millimeters	22
Inches	0.87
True mean sectional area:	
Square millimeters	29.5
Square inches	0.046
Ultimate tensile strength (dry):	
Mean in kilograms	79.4
Maximum in kilograms	102
Minimum in kilograms	59.4
Mean in pounds	175
Maximum in pounds	225
Minimum in pounds	131
Ultimate tensile strength (wet):	
Mean in kilograms	108
Maximum in kilograms	136
Minimum in kilograms	84.8
Mean in pounds	239
Maximum in pounds	299
Minimum in pounds	187

TABLE XVII.—*Physical tests of rope made from the bast of Sterculia stipularis*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	268
Pounds per square inch	3,800
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	366
Pounds per square inch	5,200
Mean elongation at instant of rupture:	
Dry (per cent)	7
Wet (per cent)	10
Mean weight per unit length:	
Grams per meter	26.6
Pounds per foot	0.0179
Average breaking length:	
Meters	2,980
Feet	9,780
Moisture (per cent)	8.26

MALVACEAE

BOMBYCIDENDRON VIDALIANUM Merr. and Rolfe. Lanutan.

Local names: *Lanótan* (Bulacan); *lanútan* (northern Luzon to Bulacan and Bataan); *losóban* (Abra); *lusúban, lusóban* (Ilocano, Itneg); *pañgar-dísen* (Cagayan, Ilocos Sur); *takúlau-blanco* (Ilocos Norte).

A medium-sized tree with oblong-lanceolate, acuminate leaves and large white flowers; capsules ovoid; widely distributed in Luzon at low altitudes.

The strands of the rope made of *Bombycidendron vidalianum* bast average sixteen strips thick, the latter varying in width from 2 to 8 millimeters, and in thickness from 0.13 to 0.31 millimeter. The dry rope possesses a high tensile strength and breaking length. Immersion in fresh water reduces the mean tensile strength by about 26 per cent. The Ilocanos consider this bast to be pliable, resistant, and durable, and fitted for service throughout the year. The tensile-strength tests showed an erratic tendency, the wet specimens showing poorer agreement than the dry ones. In the dry series of five tests the maximum variation from the mean tensile strength was 18 per cent, and that from the average value in the five wet specimens was 30 per cent. Four of the five dry, and three of the five wet, specimens ruptured outside of eye-splices, the other test pieces breaking in splices. In both series of tests the minimum values were given by specimens breaking in the unspliced portion of the rope.

A summary of the results of tests of *Bombycidendron vidalianum* bast rope made at the Bureau of Science are given in Table XVIII.

TABLE XVIII.—*Physical tests of rope made from the bast of Bombycidendron vidalianum.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.0
Inches	0.28
Mean perimeter, or girth:	
Millimeters	22
Inches	0.87
True mean sectional area:	
Square millimeters	31.6
Square inches	0.049
Ultimate tensile strength (dry):	
Mean in kilograms	199
Maximum in kilograms	223
Minimum in kilograms	175
Mean in pounds	438
Maximum in pounds	515
Minimum in pounds	386
Ultimate tensile strength (wet):	
Mean in kilograms	148
Maximum in kilograms	176
Minimum in kilograms	103
Mean in pounds	327
Maximum in pounds	389
Minimum in pounds	226
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	630
Pounds per square inch	8,940
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	468
Pounds per square inch	6,670
Mean elongation at instant of rupture:	
Dry (per cent)	12
Wet (per cent)	14
Mean weight per unit length:	
Grams per meter	28.6
Pounds per foot	0.0192
Average breaking length:	
Meters	6,950
Feet	22,800
Moisture (per cent)	8.56

MALACHRA FASCIATA Jack. Páang-balíwis.

Local names: *Annabo* (Union); *bakembákes* (Ilocano, Itneg); *malabitíspapa* (Bataan); *páang balíwis* (Manila and vicinity, Tagalog, Pangasinan).

A coarse, suffrutescent, weedy herb, introduced from tropical America, with coarsely hairy, palmately lobed leaves and axillary pink flowers; in and about towns as a weed in waste places at low altitudes; locally very abundant.

Unlike most of the bast tested in the form of rope, *Malachra fasciata* bast has more of a filamentous than a ribbon character due to the fact that the fiber is prepared by retting. The entire bush is cut and then steeped in fresh water for about ten days, at the end of which time the bast is easily stripped and washed free of the larger portion of nonfibrous material. Plate III, fig. 13, illustrates the filamentous nature of this bast; bundles instead of strips would be the more correct designation of the fiber elements constituting the strands. These bundles of filaments vary from fine hairlike fibrils with elliptical cross section to coarse polygonal bundles calipering about 0.76 millimeter in thickness. A few of the bundles are ribbon-shaped but narrow, and in no case exceed 2 millimeters in width. They have an average thickness of 0.46 millimeter. The strands are, roughly, ten bast bundles thick. *Malachra fasciata* bast is olive buff; owing to its nonstaining property, rope made from it is said to be used for hanging clothes in addition to serving as a general utility rope.

The dry rope has an excellent tensile strength and breaking length. Wetting decreases the mean tensile strength 15 per cent and also causes the specimens to break more uniformly. The maximum variation from the mean tensile strength in the five wetted specimens was only 6 per cent, whereas the maximum difference from the average value in the dry ones was 20 per cent. One of the wet, and two of the dry, test pieces were ruptured in eye-splices.

A summary of the tests of this species made in the Bureau of Science is given in Table XIX.

TABLE XIX.—*Physical tests of rope made from the bast of Malachra fasciata.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	5.4
Inches	0.21
Mean perimeter, or girth:	
Millimeters	17
Inches	0.67
True mean sectional area:	
Square millimeters	21.2
Square inches	0.033
Ultimate tensile strength (dry):	
Mean in kilograms	135
Maximum in kilograms	152
Minimum in kilograms	108
Mean in pounds	298
Maximum in pounds	335
Minimum in pounds	239

TABLE XIX.—*Physical tests of rope made from the bast of Malachra fasciata*—Continued.

Ultimate tensile strength (wet):	
Mean in kilograms	115
Maximum in kilograms	122
Minimum in kilograms	109
Mean in pounds	253
Maximum in pounds	268
Minimum in pounds	240
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	637
Pounds per square inch	9,030
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	543
Pounds per square inch	7,700
Mean elongation at instant of rupture:	
Dry (per cent)	8
Wet (per cent)	10
Mean weight per unit length:	
Grams per meter	17.9
Pounds per foot	0.0120
Average breaking length:	
Meters	7,580
Feet	24,800
Moisture (per cent)	848

SIDA ACUTA Burm.

Local names: *Attái-na-baka* (Ibanak); *basbasot* (Bontoc); *eskobilla* (Visayan); *eskuba* Davao); *eskubilla* (Laguna); *herbaka* (Ilocos Sur); *kastule* (Tagalog, Bulacan); *maratakkimbaka* (Ilocano in Tarlac); *salike* (Visayan, Basilan); *takkimbaka* (Abra, Ilocos Norte, Isabela, Pangasinan, Union); *takkinbaka*, *ualis-ualisan* (Tarlac); *uaualisin* (Bulacan); *ualis-ualisan* (Nueva Vizcaya); *ualis-ualisan* (Manila).

A slender, sparingly branched, shrubby or suffrutescent plant, a meter high or less, with elongated slender branches and lanceolate, glabrous, acuminate leaves; flowers yellow, axillary, short-pedicelled; in waste places in and about towns throughout the Philippines; abundant.

Species of *Sida* have been reported as common jungle plants in India,[23] but long-staple fiber is produced only by plants grown on well-drained land with plenty of moisture. In India (and this applies to the Philippines with greater force) there are difficulties still to be solved before any of the species of *Sida* can be cultivated profitably. Watt states: [24]

[23] Agr. Journ. India 4 (1909) 351.

[24] Watt, Geo., A Dictionary of the Economic Products of India. Government of India Central Printing Office, Calcutta 6 [2] (1893) 683.

* * * But the utilization of Sida will mainly depend on the particular form that will produce the tallest stems with the fewest branches, and the highest percentage of fibre to weight of stems. It may readily be admitted that the feature, on which the industry will fail to be established, will be the yield as compared with jute. Hitherto the few Reports that have appeared exhibit the yield as considerably lower than that of jute. Experimenters should, however, not be too easily disheartened on this score, for it must be borne in mind that Sida has never been systematically cultivated, while everything has been done that is possible to improve the yield and quality of jute. * * *

Sida fiber has been reported as weaker than jute, *Corchorus olitorius;*[25] the results obtained in this investigation also show that *Sida acuta* bast is less resistant than jute. *Sida* fiber is said to spin well, and it can be mixed with other fibers that are at present used on a manufacturing scale.

Sida acuta bast is one of the prettiest fibers tested. It is marguerite yellow, fine, filamentous, soft, lustrous, and silky. The particular sample had been retted for about ten days in fresh water and subsequently cleaned, so that its preparation is quite different from that of most of the other fibers tested. The fine filaments still held together slightly in bundles similar to the original ribbonlike form. Practically all of the gum and pulp had been removed by the retting and subsequent washing, making the fiber very pliable and altogether unlike the crude, harsh, and stiff strips characteristic of most of the other ropes tested.

Although *Sida acuta* makes a handsome, silky looking rope, it possesses only medium tensile strength and breaking length. Wetting increases its mean tensile strength about 6 per cent. The wet series of tests gave better agreement than the dry, the maximum difference from the mean tensile strength in the former being 7 per cent and in the latter 12 per cent. Three of the five dry specimens and three of the four wet test pieces failed in eye-splices. The Ilocanos consider rope made of *Sida acuta* a superior product because of its durability under both dry and wet conditions, its pleasing color, and its gloss. It is used for general purposes and is particularly suited for use where a nonstaining fiber is desired.

A summary of the tests of this species made in the Bureau of Science is given in Table XX.

[25] Bull. Imp. Inst. 10 (1912) 218.

TABLE XX.—*Physical tests of rope made from the bast of Sida acuta.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.6
Inches	0.30
Mean perimeter, or girth:	
Millimeters	24
Inches	0.95
True mean sectional area:	
Square millimeters	40.8
Square inches	0.063
Ultimate tensile strength (dry):	
Mean in kilograms	193
Maximum in kilograms	216
Minimum in kilograms	162
Mean in pounds	426
Maximum in pounds	476
Minimum in pounds	357
Ultimate tensile strength (wet):	
Mean in kilograms	205
Maximum in kilograms	213
Minimum in kilograms	190
Mean in pounds	453
Maximum in pounds	470
Minimum in pounds	418
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	475
Pounds per square inch	6,760
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	502
Pounds per square inch	7,190
Mean elongation at instant of rupture:	
Dry (per cent)	14
Wet (per cent)	18
Mean weight per unit length:	
Grams per meter	33.5
Pounds per foot	0.0225
Average breaking length:	
Meters	5,770
Feet	18,900
Moisture (per cent)	8.67

THESPESIA LAMPAS (Cav.) Dalz. & Gib. Marakapas.

Local names: *Amagóng* (Nueva Ecija); *bulakbulákan* (Tagalog); *dal-dal-upang* (Ilocano, Itneg); *kapas-kápas* (Union); *kastule* (Tagalog); *kastuli* (Rizal); *makakápas* (Zambales); *marakápas* (Abra, Amburayan); *maratarong* (Abra, Ilocano, Itneg).

An erect, slightly branched shrub, 2 to 3 meters high, with broadly ovate, usually three-lobed, leaves; flowers large, 6 to 8 centimeters long, yellow with a deep purple center, capsule ovoid, about 3 centimeters long, four- or five-valved; widely scattered in the settled areas of the Philippines at low altitudes.

The strips of *Thespesia lampas* bast composing this sample of rope are streaky cream, and average 0.51 millimeter thick, 5 millimeters wide, and 1,203 millimeters long. Each strand averages sixteen strips thick. Due to the large amount of woody material the strips of crude bast are stiff and hard. After exposure to the laboratory air for a day or so during the rainy season the fiber was covered with a growth of gray mold. Nearly all of the crude basts are susceptible to molds, but *Thespesia lampas* is apparently more readily infested than are the others. Retted fibers, like *Sida acuta* and *Abroma fastuosa*, are attacked little, if at all, when properly cleaned.

Rope made of this bast when dry is very low in tensile strength and in breaking length. The wetted specimens were about 8 per cent more tenacious than the dry test pieces. Both gave erratic results, the maximum differences from the mean tensile strength being 24 and 21 per cent, respectively. Two of the five dry, and four of the five wet, specimens ruptured in the unspliced sections of the test pieces, the remaining ones breaking in eye-splices. The minimum values in both the dry and the wet series were obtained from specimens that failed outside of eye-splices, whereas the maximum values in the respective series were given by test pieces ruptured in eye-splices.

A summary of the tests of this species made in the Bureau of Science is given in Table XXI.

TABLE XXI.—*Physical tests of rope made from the bast of Thespesia lampas.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	9.6
Inches	0.38
Mean perimeter, or girth:	
Millimeters	30
Inches	1.18
True mean sectional area:	
Square millimeters	57.8
Square inches	0.09
Ultimate tensile strength (dry):	
Mean in kilograms	155
Maximum in kilograms	192
Minimum in kilograms	121
Mean in pounds	341
Maximum in pounds	424
Minimum in pounds	267

TABLE XXI.—*Phsiycal tests of rope made from the bast of Thespesia lampas*—Continued.

Ultimate tensile strength (wet):	
Mean in kilograms	168
Maximum in kilograms	191
Minimum in kilograms	133
Mean in pounds	370
Maximum in pounds	421
Minimum in pounds	293
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	268
Pounds per square inch	3,800
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	291
Pounds per square inch	4,130
Mean elongation at instant of rupture:	
Dry (per cent)	9
Wet (per cent)	13
Mean weight per unit length:	
Grams per meter	48.7
Pounds per foot	0.0327
Average breaking length:	
Meters	3,180
Feet	10,400
Moisture (per cent)	8.22

URENA LOBATA Linn. Kollokollot.

Local names: *Afulut* (Gaddanes in Nueva Vizcaya); *anonongkot* (Bicol); *dalupang* (Visayan, Culion); *kol-lokollót* (Amburayan, Ilocos Sur, Nueva Vizcaya, Pangasinan, Tarlac); *kollolót* (Abra); *kolot-kolótan, kulut-kulútan* (Pampango, Tagalog, Visayan); *kulat-kulát* (Pangasinan); *kullu-kullúk* (Ilocano in Isabela); *kuluk* (Ibanak); *kulu-kulót* (Bontoc); *kulut-kulútang, dalupang* (Negros); *mangkit* (Tayabas); *puot-sinúang* (Isinai in Nueva Vizcaya); *puriket* (Abra).

An erect, branched, shrubby plant, 0.5 to 2 meters high, with ovate to orbicular, usually lobed, leaves; pink flowers; and small, globose, shiny fruits; a weed in the settled areas throughout the Philippines; abundant.

In India (Assam and Burma) *Urena lobata*, which is said to grow sometimes 8 feet high, is used as a cordage material. It is a fiber of the jute type and is said to be more easily extracted than jute. *Urena lobata* is one of the three important textile fibers known to the natives of Madagascar.[26] They make rope, twine, and mats from the bast. In the manufacture of coffee bags it is said to be an excellent substitute for jute because the fiber has no influence on the aroma of the coffee.[27]

[26] Der Tropenpflanzer 7 (1903) 451.

[27] The Useful Plants of Nigeria, Part 1 *Kew Bull.* add. ser. IX Part 1 (1908) 68–69.

The bark is used in Yoruba and Angola for making ropes, and also as a tying material in house building. When thoroughly cleaned the fiber is said [28] to be fine, white, and a meter in length, and to take color well. It is strong and makes good cordage. Experiments have also been conducted to determine its suitability for use as a paper stock, and it was found to be almost twice as strong as Bank of England note pulp. In another place a sample of this fiber from India [29] is reported as having uneven strength, and as having a filament length of from 7 to 9 feet. This particular sample of fiber was of good spinning quality, and could be spun in conjunction with the finest grades of Calcutta jute.

Numerous references [30] are found in the literature regarding the use, cultivation, and extraction of *Urena lobata* bast, and its possibilities as a substitute for jute. The most extensive attempts to extract this fiber on a large scale (and at the same time the most costly and perhaps most disastrous) were made in Brazil where the bast is commonly known as "aramina." In this connection the British Consul at Santos, Brazil, reports: [31]

> It was thought that a substitute for jute had been discovered in the aramina plant which grows wild, but under cultivation it lost a great part of the fibrous nature, and as the supply of the wild plant was wholly insufficient, a mill put up at a cost of some £24,000 [240,000 pesos] had to be shut down and after undergoing the necessary transformation is now used for the manufacture of hessians.

Unfortunately the sample of rope procured at Dolores, Abra, as having been made of *Urena lobata* was made of a mixture of *Corchorus olitorius* (jute) and *Urena lobata* basts, in about equal proportions. Apparently the manufacturer discovered that he would not have enough of the latter fiber to make the length of rope ordered, and he, therefore, made up the deficiency by using *Corchorus olitorius* bast, which is plentiful in the region and which has properties similar to those possessed by *Urena lobata*. The strips of *Urena lobata* bast used in the rope were cream buff and averaged about 2 millimeters wide, 0.41 millimeter thick, and 1,118 millimeters long. The strips of *Corchorus olitorius*

[28] Agr. Bull. Straits & Fed. Malay States, IV, n. s. 6 (1905).

[29] Bull. Imp. Inst. 12 (1914) 34 and 35.

[30] Abbey and Yates, Agr. Ledger 15 (1908–09) 51–62. This paper gives some sixty references.

[31] Agr. Ledger 15 (1908–09) 57. [Apparently taken from the report of H. B. M. Consul at Santos, Brazil, appearing in the Board of Trade Journal 62 (1908) 91.]

that were mixed in were mahogany red on the outer face and pinkish cinnamon on the inner. The strands of the rope spun were about eight strips thick.

When dry, the rope gives a medium tensile strength and breaking length. Rope made entirely of *Corchorus olitorius* gives about the same values. Wetting the rope made of the mixture of the two fibers decreases the mean tensile strength 24 per cent, and that made of jute is reduced 28 per cent. The tensile-strength values given by the five dry specimens showed much variation, the maximum from the mean being 34 per cent, but the five wet test pieces gave more concordant results, the maximum variation being only 11 per cent. Four of the dry, and two of the wet, test pieces failed in eye-splices. The Filipinos consider *Urena lobata* fiber to be fairly tenacious, but they say that it is not suitable for wet-weather use since it is unduly weakened when wetted and, besides, undergoes rapid deterioration.

A summary of the tests made in the Bureau of Science is given in Tables XXII and XXIV and shows that *Urena lobata* and *Corchorus olitorius* basts have similar properties.

TABLE XXII.—*Physical tests of rope made from the bast of Urena lobata.*

[Rope made at Dolores, Abra Province. This sample was made of a mixture of *Urena lobata* and *Corchorus olitorius* in about equal parts.]

Mean diameter:	
Millimeters	6.7
Inches	0.26
Mean perimeter, or girth:	
Millimeters	21
Inches	0.83
True mean sectional area:	
Square millimeters	32.3
Square inches	0.047
Ultimate tensile strength (dry):	
Mean in kilograms	146
Maximum in kilograms	195
Minimum in kilograms	120
Mean in pounds	322
Maximum in pounds	430
Minimum in pounds	264
Ultimate tensile strength (wet):	
Mean in kilograms	111
Maximum in kilograms	122
Minimum in kilograms	99.3
Mean in pounds	244
Maximum in pounds	270
Minimum in pounds	219

TABLE XXII.—*Physical tests of rope made from the bast of Urena lobata*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	482
Pounds per square inch	6,850
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	366
Pounds per square inch	5,200
Mean elongation at instant of rupture:	
Dry (per cent)	8
Wet (per cent)	11
Mean weight per unit length:	
Grams per meter	23.7
Pounds per foot	0.0159
Average breaking length:	
Meters	6,180
Feet	20,300
Moisture (per cent)	9.78

TILIACEAE

COLUMBIA BLANCOI Rolfe. Anilau.

Local names: *Aniláu, mamadlíng, mamaued* (Rizal); *keddéng* (Ilocano, Benguet).

A small tree, attaining a height of about 10 meters, with oblong-ovate, acuminate, toothed, hairy leaves, 10 to 20 centimeters long, their bases obliquely cordate; panicles terminal, many-flowered, flowers usually pink; capsules about 1 centimeter long, 3- or 4-winged, obovoid; throughout the Philippines at low and medium altitudes; common.

Columbia blancoi bast strips are salmon buff; they average 0.65 millimeter thick and vary from 2 to 13 millimeters in width. The strands average nine strips thick.

Dry rope made of this bast gives a very low tensile strength and breaking length. Wetting the rope increases the mean tensile strength about 1 per cent and also gives more concordant results. The maximum variation from the mean tensile strength in five tests of the dry rope was 16 per cent, while that shown by the five tests of wet specimens was 10 per cent. The inhabitants of Disdis, Benguet, who made the rope state that it is preferably used during wet weather on account of its durability when wetted. Two of the dry, and two of the wet, specimens broke in eye-splices.

A summary of the tests of this species made in the Bureau of Science is given in Table XXIII.

TABLE XXIII.—*Physical tests of rope made from the bast of Columbia blancoi.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	13.7
Inches	0.54
Mean perimeter, or girth:	
Millimeters	43
Inches	1.69
True mean sectional area:	
Square millimeters	115.2
Square inches	0.179
Ultimate tensile strength (dry):	
Mean in kilograms	347
Maximum in kilograms	402
Minimum in kilograms	281
Mean in pounds	765
Maximum in pounds	885
Minimum in pounds	620
Ultimate tensile strength (wet):	
Mean in kilograms	352
Maximum in kilograms	376
Minimum in kilograms	315
Mean in pounds	776
Maximum in pounds	830
Minimum in pounds	695
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	302
Pounds per square inch	4,270
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	306
Pounds per square inch	4,340
Mean elongation at instant of rupture:	
Dry (per cent)	13
Wet (per cent)	15
Mean weight per unit length:	
Grams per meter	98.7
Pounds per foot	0.0663
Average breaking length:	
Meters	3,510
Feet	11,500
Moisture (per cent)	11.96

CORCHORUS OLITORIUS Linn. Saluyut or Jute.

Common names: Calcutta flax, gunny, Indian grass, Jew's mallow, jute, melochia (English); *chanvre de Calcutta, fil de jute, jute, mauve de juif* (French); *Bengalhanf, Gemüsepappel, indischer Flachs, Judenhanf, Judenpappel, Jute, Kalkuttanhanf, Meluchia, Muskraut, Paathanf* (German); *yute* (Spanish).

Local names: *Pasau* (Tagalog), Zambales); *salúyot, salúyut* or *salóyot* (Ilocos Sur, Pangasinan, Union); *tagabang* (Visayan, Manila); *taka magindánau, yaka* (Cotabato).

An erect, glabrous, branched, suffrutescent herb, 1 to 1.5 meters high, the ovate-lanceolate leaves tailed at the base; flowers small, yellow, axillary; capsules cylindric, 10-ribbed, 3 to 3.5 centimeters long; a weed in damp places throughout the settled areas of the Philippines.

Corchorus olitorius is an annual herb that grows wild in nearly all islands of the Philippines. It is indigenous to India, where together with a closely related species, *Corchorus capsularis* Linn., it is cultivated on a large scale to furnish most of the jute of commerce. The plant is found in all tropical countries; but it is only in India, where next to rice it is the most important agricultural product, that the fiber is extracted in commercial quantities. In the Philippines, particularly among the Ilocanos, it is better known as a vegetable than as a source of fiber. The leaves and the tender shoots are stewed with *bagoong* (salty, fermented small fish or shrimp), cooked with bamboo shoots, or roasted or baked with fish. Among the Tagalogs the leaves are sold in the market with the name "pasau." In Sierra Leone, Nigeria, and Uganda parts of the plant are eaten as a vegetable. The plant is cultivated as a garden herb in France, and the tender shoots are used in salads.

Corchorus olitorius was known to the ancients. Watt states:[32]

> * * * It is well known that *Corchorus olitorius* has for centuries been cultivated near Aleppo as a pot herb, hence, says Rauwolf, the name *Olus judaicum* which the French translated *Mauve de Juif* and the English rendered as Jew's Mallow.

In India the total area under jute cultivation in 1916 was 2,702,700 acres, and the yearly exports[33] of Indian jute during the past two decades have been valued at more than 100,000,000 pesos. Of sacks alone more than 100,000,000 are exported annually, having a value of at least 14,000,000 pesos.

In the Philippines the fiber has no commercial importance, but small quantities are extracted for the manufacture of rope. Such cordage as a rule does not reach the market, but is used locally.

[32] Watt, Geo., A Dictionary of the Economic Products of India. Government of India Central Printing Office, Calcutta 2 (1889) 542.

[33] Agr. Journ. India III 13 (1918) 500. The export of raw jute and manufactures from India is given as follows:

	1915–16	1916–17
	£	£
Raw jute	10,428,024	10,858,736
Jute manufactures	25,318,934	27,769,725

Comparatively speaking, jute as it occurs in commerce is a very inferior fiber; in fact, it is the cheapest fiber used in the United States. It is only because of the facility with which it is cultivated, together with its adaptability for spinning, that it has such great importance in the present industrial economy. The fiber, which is initially relatively weak, soon deteriorates under the influence of moisture. It is produced in greater quantities than any other fiber except cotton and sisal and is principally used for making the burlap employed in the manufacture of gunny sacks. Jute is also used in the manufacture of cordage, twine, carpets, rugs, and cheap plushes and velvets. It is sometimes used as a cotton adulterant. Jute butts are excellent material for so-called "linen" paper. Watt states that jute is also used as a substitute for silk.

The fiber constituting the rope tested in this investigation is altogether different from the filamentous jute of commerce, to which reference is always made when speaking of jute in a technical sense. As Plate IV, fig. 3, shows, the fiber here tested is in the form of crude strips of bast that have not been subjected to the retting process and show little if any resemblance to the fiber as it is used in the textile industry.

Each strand of the rope averages eight strips thick. The strips have a mean width of 4 millimeters, vary in thickness from 0.23 to 0.41 millimeter, and average 1,186 millimeters in length. On one side the bast ribbons are mahogany red and on the other pinkish cinnamon, so that the rope has a mottled appearance, as Plate IV, fig. 3, clearly shows.

When dry, rope made of crude *Corchorus olitorius* bast strips has a medium tensile strength and breaking length. Wetting diminishes the tenacity of the fiber considerably. After twenty-four hours' immersion in fresh tap water, the mean tensile strength is reduced 28 per cent. Wetting also induces less concordant strength values. The maximum variation from the mean in the five wet specimens was 18 per cent. The five dry test specimens gave exceptionally good agreement, the maximum variation from the mean being only 7 per cent. Two of the dry, and three of the wet, test pieces failed in eye-splices.

A summary of the tests of this species made in the Bureau of Science is given in Table XXIV.

TABLE XXIV.—*Physical tests of rope made from the bast of Corchorus olitorius.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.0
Inches	0.28
Mean perimeter, or girth:	
Millimeters	22
Inches	0.87
True mean sectional area:	
Square millimeters	32.8
Square inches	0.051
Ultimate tensile strength (dry):	
Mean in kilograms	165
Maximum in kilograms	176
Minimum in kilograms	156
Mean in pounds	364
Maximum in pounds	388
Minimum in pounds	344
Ultimate tensile strength (wet):	
Mean in kilograms	118
Maximum in kilograms	139
Minimum in kilograms	97.9
Mean in pounds	260
Maximum in pounds	306
Minimum in pounds	216
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	503
Pounds per square inch	7,130
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	360
Pounds per square inch	5,100
Mean elongation at instant of rupture:	
Dry (per cent)	8
Wet (per cent)	10
Mean weight per unit length:	
Grams per meter	30.5
Pounds per foot	0.0205
Average breaking length:	
Meters	5,420
Feet	17,800
Moisture (per cent)	9.33

GREWIA BILAMELLATA Gagnep. Benglareng.

Local names: *Benglaleng or benglareng* (Ilocano and Itneg); *dongrareng* (Ilocano).

A shrub with oblong, nearly glabrous, green leaves, and small, glabrous, somewhat fleshy fruits; allied to *Grewia multiflora* Juss.

The bast strips constituting the rope tested are cream colored, are softer and thinner than most of the other basts, measure from 0.10 to 0.31 millimeter thick, average 4 millimeters wide, and have a mean length of 1,060 millimeters. The strands average fourteen strips thick.

When dry, rope made of this bast gives a very low tensile strength and breaking length. Wetting the rope causes an extraordinary reduction in tensile strength, amounting to 44 per cent, or nearly half its original strength. The five dry specimens gave more concordant results than the five wet ones, the maximum variations from the mean tensile strength in the two series being 11 and 29 per cent, respectively. None of the wet, and only one of the dry, test pieces ruptured in an eye-splice, and the latter did not give the minimum value. Filipinos say that rope made of this bast is durable during the dry season, but that the fiber quickly deteriorates when wetted. The high loss in strength upon wetting shows that the fiber is suited for use in the dry condition only. This fiber is said to be abundant.

A summary of the tests of this species made in the Bureau of Science is given in Table XXV.

TABLE XXV.—*Physical tests of rope made from the bast of Grewia bilamellata.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.6
Inches	0.30
Mean perimeter, or girth:	
Millimeters	24
Inches	0.95
True mean sectional area:	
Square millimeters	38.8
Square inches	0.060
Ultimate tensile strength (dry):	
Mean in kilograms	124
Maximum in kilograms	136
Minimum in kilograms	110
Mean in pounds	274
Maximum in pounds	300
Minimum in pounds	243
Ultimate tensile strength (wet):	
Mean in kilograms	69.8
Maximum in kilograms	85.6
Minimum in kilograms	49.4
Mean in pounds	154
Maximum in pounds	189
Minimum in pounds	109

TABLE XXV.—*Physical tests of rope made from the bast of Grewia bilamellata*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	320
Pounds per square inch	4,570
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	180
Pounds per square inch	2,570
Mean elongation at instant of rupture:	
Dry (per cent)	11
Wet (per cent)	11
Mean weight per unit length:	
Grams per meter	32.6
Pounds per foot	0.0219
Average breaking length:	
Meters	3,810
Feet	12,500
Moisture (per cent)	8.91

GREWIA ERIOCARPA Juss. Balitnong.

Local names: *Balibágo* (Batangas); *baria-an* (Union); *bariw-an* (Abra, Ilocano, Itneg, Nueva Ecija, and Pangasinan); *lanit, lapní, lapnít, lapí* (Cagayan).

A shrub or small tree with ovate, densely pubescent leaves, usually oblique, beneath white or nearly so; capsules densely hairy; widely distributed in the Philippines at low altitudes.

Grewia eriocarpa bast seems to be immune from the attack of the ordinary gray, green, and black molds that grow profusely on most of the other basts. The bast is wood brown; the strips vary from 2 to 5 millimeters in width and from 0.25 to 0.69 millimeter in thickness; they average 1,004 millimeters in length. Each strand of the rope averages nine strips thick. When dry the rope made of *Grewia eriocarpa* bast gives a medium tensile strength and breaking length. Wetting weakens the fiber about 3 per cent. The maximum variation from the mean tensile strength of the values obtained from the five wet specimens was 34 per cent, which indicates very poor agreement; whereas the corresponding value for the five dry test pieces was 19 per cent. Three of the five wet, and two of the five dry, test specimens failed in eye-splices. The minimum value in both series was given by test pieces rupturing in splices. Owing to its scarcity, the use of *Grewia eriocarpa* bast for the manufacture of cordage is infrequent.

A summary of the tests of this species made in the Bureau of Science is given in Table XXVI.

TABLE XXVI.—*Physical tests of rope made from the bast of Grewia eriocarpa.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	6.4
Inches	0.25
Mean perimeter, or girth:	
Millimeters	20
Inches	0.79
True mean sectional area:	
Square millimeters	25.9
Square inches	0.040
Ultimate tensile strength (dry):	
Mean in kilograms	102
Maximum in kilograms	121
Minimum in kilograms	83
Mean in pounds	225
Maximum in pounds	266
Minimum in pounds	183
Ultimate tensile strength (wet):	
Mean in kilograms	98.8
Maximum in kilograms	118
Minimum in kilograms	64.8
Mean in pounds	218
Maximum in pounds	261
Minimum in pounds	143
Mean ultimate tensile stregnth per unit area (dry):	
Kilograms per square centimeter	394
Pounds per square inch	5,630
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	381
Pounds per square inch	5,450
Mean elongation at instant of rupture:	
Dry (per cent)	6
Wet (per cent)	9
Mean weight per unit length:	
Grams per meter	20.2
Pounds per foot	0.0136
Average breaking length:	
Meters	5,050
Feet	16,600
Moisture (per cent)	8.31

GREWIA MULTIFLORA Juss. Danglin.

Local names: *Al-alinau* (Union); *alinau* (Amburayan, Ilocos Sur, Pangasinan, Sorsogon, Union, and Zambales); *aniláu* (Abra, Benguet, Ilocos Norte, Ilocos Sur, Union, and Pangasinan); *aplít* (Pampanga); *bagokon* (Guimaras, Mindoro); *benglaling* (Abra); *bulubukhón* (Guimaras); *dallag* (Gaddanes in Nueva Vizcaya); *danglí, kalitkalít* (Tayabas); *dangling*

(Bataan, Rizal, Tagalog); *danglog* (Cagayan); *durarong* (Ilocos Sur); *kanaroset* (Palawan); *lañgosig* (Bohol); *lanut* (Negrito in Pampanga); *lapnís, nagling* (Batangas, Cavite, Pampanga); *siapo* (Mindoro); *taroi* (Albay, Camarines); *umbubuyukan, imbubuykon* (Palawan).

A shrub or small tree, nearly glabrous; leaves oblong to oblong-ovate, up to 14 centimeters in length, often somewhat inequilateral, 3-nerved from the base; flowers in axillary umbels; fruit small, somewhat fleshy, obovoid, about 6 centimeters long, glabrous; common and widely distributed in the Philippines at low altitudes.

This bast is very common in the Ilocano provinces and is said to make a very durable rope for dry-weather use. *Grewia multiflora* is a pale yellow-orange, nonstaining fiber. The strips are soft; they average 6 millimeters wide, 0.46 millimeter thick, and 2,104 millimeters long. Each strand averages seven strips thick. *Grewia multiflora* makes a rope of more than average pliability, but of low tensile strength and breaking length. Immersion in water for twenty-four hours reduces the mean tensile strength 12 per cent. The five wet specimens gave more discordant strength values than the five dry ones, the greatest variation in the latter being 13, and in the former 29 per cent, from the mean. Three test pieces in each series failed in eye-splices, the maximum value in both series being given by specimens breaking in an eye-splice. The minimum value of the five dry specimens was obtained from a test piece that ruptured in the unspliced portion of the rope, whereas the minimum value of the five wet test pieces was given by a specimen that failed in an eye-splice.

A summary of the tests of this species made in the Bureau of Science is given in Table XXVII.

TABLE XXVII.—*Physical tests of rope made from the bast of Grewia multiflora.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	11.5
Inches	0.45
Mean perimeter, or girth:	
Millimeters	36
Inches	1.42
True mean sectional area:	
Square millimeters	85.4
Square inches	0.132

TABLE XXVII.—*Physical tests of rope made from the bast of Grewia multiflora*—Continued.

Ultimate tensile strength (dry):	
Mean in kilograms	321
Maximum in kilograms	363
Minimum in kilograms	299
Mean in pounds	708
Maximum in pounds	800
Minimum in pounds	660
Ultimate tensile strength (wet):	
Mean in kilograms	283
Maximum in kilograms	315
Minimum in kilograms	202
Mean in pounds	624
Maximum in pounds	695
Minimum in pounds	445
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	376
Pounds per square inch	5,360
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	332
Pounds per square inch	4,730
Mean elongation at instant of rupture:	
Dry (per cent)	10
Wet (per cent)	11
Mean weight per unit length:	
Grams per meter	87.9
Pounds per foot	0.0591
Average breaking length:	
Meters	3,660
Feet	12,000
Moisture (per cent)	13.12

MORACEAE

ALLAEANTHUS GLABER Warb. Malambiñgan.

Local names: *Alibabai* (Cagayan, Itneg); *alibakai* (Cagayan); *alitagtág* or *balitagtág* (Camarines); *alokon, baeg, boñgon* (Pangasinan); *babayan, imkabau* (Nueva Ecija); *buñgon* (Abra, Benguet, Ilocos Norte, Ilocos Sur); *kabag* (Mindoro); *karud* (Misamis); *liba* (Davao); *malakadiós* (Masbate); *malambiñgan* (Basilan).

A medium-sized tree with oblong, nearly glabrous leaves; the male flowers in long slender amentlike inflorescences; fruits fleshy, globose; of local distribution at low altitudes in northern Luzon.

The crude bast strips used in making this rope show great variation in color, structure, and size. Some of the strips are light yellow, soft, and thin. Others have a decided brownish tinge and are coarse and hard. The strands average five strips thick, and the strips vary from 2 to 12 millimeters in width and from 0.36 to 1.2 millimeters in thickness. This bast is characterized by a fine fuzz. Plate IV, fig. 7, shows its peculiar nature. Numerous ragged spots and irregularities occur in the rope that give it a rough appearance.

When dry, rope made of this bast is very low in tensile strength and breaking length, perhaps in part due to the ragged spots. Wetting increases the mean tensile strength about 10 per cent. Filipinos state that rope made from this bast is more durable during the rainy season than the average fibers used. The maximum variation from the mean tensile strength of the five dry test specimens was 15 per cent, whereas that from the mean of the five wet test pieces was 19 per cent. Four of the dry, and two of the wet, test pieces ruptured in eye-splices. Of particular interest is the extraordinary mean elongation of the wet specimens, 25 per cent, which is nearly double that given by the dry test pieces.

A summary of the tests of this species made in the Bureau of Science is given in Table XXVIII.

TABLE XXVIII.—*Physical tests of rope made from the bast of Allaeanthus glaber.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	12.4
Inches	0.49
Mean perimeter, or girth:	
Millimeters	39
Inches	1.54
True mean sectional area:	
Square millimeters	100.2
Square inches	0.155
Ultimate tensile strength (dry):	
Mean in kilograms	231
Maximum in kilograms	265
Minimum in kilograms	204
Mean in pounds	509
Maximum in pounds	585
Minimum in pounds	450
Ultimate tensile strength (wet):	
Mean in kilograms	253
Maximum in kilograms	302
Minimum in kilograms	209
Mean in pounds	557
Maximum in pounds	665
Minimum in pounds	460

TABLE XXVIII.—*Physical tests of rope made from the bast of Allaeanthus glaber*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	231
Pounds per square inch	3,290
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	253
Pounds per square inch	3,590
Mean elongation at instant of rupture:	
Dry (per cent)	13
Wet (per cent)	25
Mean weight per unit length:	
Grams per meter	94.4
Pounds per foot	0.0635
Average breaking length:	
Meters	2,440
Feet	8,030
Moisture (per cent)	13.86

ARTOCARPUS COMMUNIS Forst. Antipolo.

Local names: *Antipólo* (Bataan, Cagayan, Laguna, Manila, Mindoro, Palawan, Rizal, Union, Zambales); *antiponong lalaki* (Rizal); *kamansí* (Leyte); *pákak* (Cagayan, Ilocos Sur, Union, Zambales); *pasak* (Abra, Ilocos Sur, Union); *tipólo* (Camarines, Negros).

A tree with abundant milky juice; very large, pinnately lobed leaves; and large, globose, fleshy, many-seeded, rough fruits; the male flowers minute, very numerous, in large, dense, oblong-ovate, solid inflorescences; common and widely distributed in the Philippines, cultivated and wild.

This bast is a striking example of the different properties that a fiber may assume, depending upon the age of the plant from which it is taken, in contrast to variation in its appearance and properties due to the manner of its manipulation and preparation, as described under *Abroma fastuosa*.

Plate IV, fig. 9, shows a sample of rope made from bast from the trunk of an old tree obtained in April, 1916, at Sappaac, Abra Province. Plate I, fig. 1, illustrates this particular piece of rope in the process of manufacture. The strips of bast are chestnut in color, are about 1.5 meters long, and are exceedingly hard and stiff.

Owing to the excessive labor required in the preparation of the mature bast it is seldom used for making rope, though for some purposes it excels all other fibers in durability. After the old bast has been stripped, it must be beaten a long time in order to give it a small degree of pliability. The bast is first cut, or rather torn, into three ribbons, which are then tightly twisted, separately, to form the strands of a rope. These strands are then fastened in the crude wooden rope-laying apparatus shown in Plate I, fig. 1, and laid into rope. This sample of rope was just long enough to make one tensile-strength test, the results of which are recorded in Table XXIX.

The rope possesses little flexibility, and a piece 20 centimeters long held horizontally was not deformed by flexion; ordinary ropes of this size under similar conditions would show appreciable deflection. Plate VIII, fig. 4, shows that each strand is made of only one very rough strip of bast; it averages 1.68 millimeters thick and 18 millimeters wide.

In sharp contrast to this sample of hard dark bast is that illustrated in Plate IV, fig. 8, which was obtained from a young tree in Dolores, Abra Province, in 1917. It is of a salmon-buff color, is soft, and makes a rope that is pliable and far more uniform than that made of the chestnut-colored bast. The strands are from four to eleven bast strips thick; the latter vary in width from 1 to 4 millimeters, in thickness from 0.13 to 0.66 millimeter, and have a mean length of 610 millimeters. It will be noticed that the bast strips are comparatively short. When dry the rope made of the two basts is low in tensile strength and breaking length, although that from the old lignified bast is slightly stronger than that made of the young bast. The maximum variations from the mean tensile strength of the dry and the wet specimens of the young bast were 20 and 16 per cent, respectively. Three specimens in each series of five ruptured in an eye-splice. Wetting has little influence on the tenacity of the bast and causes a decrease in the mean tensile strength of only 2 per cent.

Filipinos emphasize the durability of rope made of *Artocarpus communis*, particularly that made of the old bast. It is said to withstand prolonged wetting and to give good service even when wetted and dried alternately. The rope is principally used in the form of traces, to yoke carabaos for field work. This service is severe; for, in addition to being alternately wet and dry, the rope is subjected to abrasion by being dragged in the gritty earth. The Ilocanos of Sappaac believe that old bast is more durable than rawhide.

A summary of the tests of this species made in the Bureau of Science is given in Table XXIX.

TABLE XXIX.—*Physical tests of rope made from the bast of Artocarpus communis.*

	From young bast.[a]	From old bast.[b]
Mean diameter:		
Millimeters	6.1	9.6
Inches	0.24	0.38
Mean perimeter, or girth:		
Millimeters	19	30
Inches	0.75	1.18
True mean sectional area:		
Square millimeters	28.4	60.8
Square inches	0.044	0.094
Ultimate tensile strength (dry):		
Mean in kilograms	101	[c] 222
Maximum in kilograms	121	----------
Minimum in kilograms	81.1	----------
Mean in pounds	223	490
Maximum in pounds	267	----------
Minimum in pounds	179	----------
Ultimate tensile strength (wet):		
Mean in kilograms	96.5	(d)
Maximum in kilograms	112	(d)
Minimum in kilograms	84.3	(d)
Mean in pounds	213	(d)
Maximum in pounds	246	(d)
Minimum in pounds	186	(d)
Mean ultimate tensile strength per unit area (dry):		
Kilograms per square centimeter	356	367
Pounds per square inch	5,070	5,220
Mean ultimate tensile strength per unit area (wet):		
Kilograms per square centimeter	340	(d)
Pounds per square inch	4,830	(d)
Mean elongation at instant of rupture:		
Dry ... per cent	11	(d)
Wet ... do	15	(d)
Mean weight per unit length:		
Grams per meter	22.8	48.8
Pounds per foot	0.0153	0.0328
Average breaking length:		
Meters	4,450	4,560
Feet	14,600	14,900
Moisture ... per cent	9.25	14.7

[a] Rope made at Abbualan, Dolores, Abra Province.
[b] Rope made at Sappaac, Abra Province, based on assumed true area.
[c] Only sufficient rope to make one test.
[d] No test made.

FICUS BENJAMINA Linn. Balete.[34]

Local names: *Auñgu* (Isabela); *baléte* (Ilocano); *baletéon, salisi* (Nueva Vizcaya); *balete-pulá* (Laguna, Tayabas); *baléti* (Abra, Bataan, Camarines, Cavite, Ilocos Norte, Laguna, Manila, Nueva Ecija, Pangasinan, Pampanga); *balíti* (Pampanga); *baliting-íbon* (Batangas, Rizal); *gisi* (Ibanak, Apayao Subprovince); *kolis* (Bataan); *kuliamat* (Negrito in Bataan); *sirisin* (Cagayan).

A strangling fig with coriaceous, glabrous, densely nerved, smooth, entire leaves and small, axillary, globose fruits; throughout the Philippines at low altitudes.

Ficus benjamina bast strips are salmon-buff and show considerable variation; some are soft and pliable, others are hard and stiff. They vary in width from 2 to 5 millimeters, their average thickness is 0.60 millimeter, and their mean length is 1,227 millimeters. The strands are about ten strips thick. When dry, rope made from this bast has a medium tensile strength and breaking length. Wetting the fiber reduces the tenacity by 2 per cent, which for practical purposes is negligible. All of the five wet test specimens ruptured in the unspliced portion of the rope, whereas two of the five dry ones failed in eye-splices. The maximum variations from the mean tensile strength in the dry and the wet series were 19 and 22 per cent, respectively. Immersion in water gives rise to a markedly higher mean elongation. In the Philippines bast from *Ficus benjamina* is not commonly used for rope making owing to its comparative scarcity.

A summary of the tests of this species made in the Bureau of Science is given in Table XXX.

TABLE XXX.—*Physical tests of rope made from the bast of Ficus benjamina.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.3
Inches	0.29
Mean perimeter, or girth:	
Millimeters	23
Inches	0.91
True mean sectional area:	
Square millimeters	32.5
Square inches	0.050

[34] "Balete" or "baliti," in the majority of Philippine dialects, is a broadly generic term used to designate all the "strangling" figs (*Ficus* spp.), and is rarely or never applied to any epiphytic or climbing plant of any other family.

TABLE XXX.—*Physical tests of rope made from the bast of Ficus benjamina*—Continued.

Ultimate tensile strength (dry):	
Mean in kilograms	156
Maximum in kilograms	176
Minimum in kilograms	126
Mean in pounds	343
Maximum in pounds	388
Minimum in pounds	277
Ultimate tensile strength (wet):	
Mean in kilograms	153
Maximum in kilograms	164
Minimum in kilograms	119
Mean in pounds	338
Maximum in pounds	362
Minimum in pounds	262
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	480
Pounds per square inch	6,830
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	471
Pounds per square inch	6,700
Mean elongation at instant of rupture:	
Dry (per cent)	9
Wet (per cent)	15
Mean weight per unit length:	
Grams per meter	31.0
Pounds per foot	0.0208
Average breaking length:	
Meters	5,030
Feet	16,500
Moisture (per cent)	8.41

FICUS FORSTENII Miq. Balete.

Local names: *Baléte, balíte* (Bataan, Mindoro, Rizal, Zambales); *basakla* (Abra, Ilocano); *dalákit* (Negros); *lañgaban* (Moro in Cotabato); *puos* or *puspus* (Ilocano, Itneg).

A strangling fig with oblong, distantly nerved, coriaceous leaves and ellipsoid, sessile, axillary fruits; throughout the Philippines at low altitudes.

Ficus forstenii bast is ochraceous salmon, and numerous fine fibrils protruding from the strips give the rope a ragged appearance. Plate IV, fig. 11, shows this hairy character and would seem to indicate that the fiber has been beaten to make it more pliable. The average length of the bast strips in the rope obtained for test is 738 millimeters. The strands are four strips thick. When dry, rope made of *Ficus forstenii* is very low in tensile strength and breaking length. However, immersion for twenty-four hours in water improves the tenacity

44 per cent. All of the wet specimens failed in the unspliced portion of the rope, and the maximum variation from the mean tensile strength in the five specimens tested was 21 per cent. Two of the dry specimens ruptured in splices, the greatest variation from the mean being 23 per cent. Wetting appreciably increases the mean ultimate elongation of the rope.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXI.

TABLE XXXI.—*Physical tests of rope made from the bast of Ficus forstenii.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	7.0
Inches	0.28
Mean perimeter, or girth:	
Millimeters	22
Inches	0.87
True mean sectional area:	
Square millimeters	38.8
Square inches	0.060
Ultimate tensile strength (dry):	
Mean in kilograms	59.8
Maximum in kilograms	70.3
Minimum in kilograms	46.3
Mean in pounds	132
Maximum in pounds	155
Minimum in pounds	102
Ultimate tensile strength (wet):	
Mean in kilograms	86.2
Maximum in kilograms	104
Minimum in kilograms	71.2
Mean in pounds	190
Maximum in pounds	230
Minimum in pounds	157
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	154
Pounds per square inch	2,200
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	222
Pounds per square inch	3,160
Mean elongation at instant of rupture:	
Dry (per cent)	11
Wet (per cent)	18
Mean weight per unit length:	
Grams per meter	37.3
Pounds per foot	0.0251
Average breaking length:	
Meters	1,600
Feet	5,260
Moisture (per cent)	9.71

FICUS PACHYPHYLLA Merr. Balete.

Local names: *Balíti* (Laguna); *lunug* (Occidental Negros); *pasakla* (Abra, Itneg).

A strangling fig with very coriaceous, glabrous, somewhat elliptic, rather densely nerved leaves and nearly globose axillary fruits; of local distribution at low altitudes and widely distributed in the Philippines.

Like *Ficus forstenii* bast, that from *Ficus pachyphylla* also is characterized by finely frayed filaments that cover the surface. The strips of bast are uniformly pecan brown; they average 2 millimeters wide, 0.28 millimeter thick, and 838 millimeters long. Each strand averages eight strips thick.

Rope made of *Ficus pachyphylla* has good strength, particularly when wetted. When dry it has a medium tensile strength and breaking length, but after immersion in water for twenty-four hours its tensile strength is increased 17 per cent. However, the results are discordant, the maximum variation from the mean of the five specimens being 25 per cent. The dry tensile-strength values showed better agreement, the maximum variation from the mean being 16 per cent. Four of the five dry, and three of the five wet, test specimens ruptured in eye-splices. Filipinos say that rope made of this bast is very durable.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXII.

TABLE XXXII.—*Physical tests of rope made from the bast of Ficus pachyphylla.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	7.0
Inches	0.28
Mean perimeter, or girth:	
Millimeters	22
Inches	0.87
True mean sectional area:	
Square millimeters	32.3
Square inches	0.050
Ultimate tensile strength (dry):	
Mean in kilograms	150
Maximum in kilograms	161
Minimum in kilograms	126
Mean in pounds	330
Maximum in pounds	355
Minimum in pounds	277

TABLE XXXII.—*Physical tests of rope made from the bast of Ficus pachyphylla*—Continued.

Ultimate tensile strength (wet):	
Mean in kilograms	176
Maximum in kilograms	209
Minimum in kilograms	132
Mean in pounds	388
Maximum in pounds	460
Minimum in pounds	290
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	464
Pounds per square inch	6,600
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	544
Pounds per square inch	7,760
Mean elongation at instant of rupture:	
Dry (per cent)	12
Wet (per cent)	17
Mean weight per unit length:	
Grams per meter	30.3
Pounds per foot	0.0204
Average breaking length:	
Meters	4,930
Feet	16,200
Moisture (per cent)	9.09

FICUS PALAWANENSIS Merr. Balete.

Local names: *Agamid, agamit* (Abra, Itneg); *baléte* (Cavite, Laguna, Lanao, Palawan, Tayabas); *tibíg* (Misamis).

A large strangling fig with coriaceous, oblong, glabrous, acuminate leaves and axillary ellipsoid fruits; found throughout the Philippines at low altitudes.

Like the other *Ficus* basts tested, the strips of *Ficus palawanensis* also are characterized by numerous fibrils that cover the surface. The bast strips are colored bittersweet pink; they average 0.41 millimeter thick, 3 millimeters wide, and 821 millimeters long. The strands average eight strips thick.

Of all the *Ficus* basts tested, *Ficus palawanensis* is the strongest, and it is one of the highest in tensile strength and breaking length. An examination of Table XLII will show that it is stronger than machine-laid rope made of maguey Government grade Cebu No. 2, and is nearly twice as strong as hand-laid maguey rope made of unclassified fiber extracted by the salt-water retting process in Ilocos Sur. In fact, *Ficus palawanensis* bast rope compares very favorably in strength with machine-made "G" grade abacá rope, and in one case exceeds the mean tensile strength of abacá rope 26 millimeters in circumference made of "G" grade fiber. When wetted for twenty-four hours, rope made of *Ficus palawanensis* bast is increased, and maguey is decreased, in tensile strength, and the former is 18 per cent more tenacious than the latter.

Four dry, and four wet, specimens ruptured in the unspliced portion of the rope, but the results obtained from the dry series of tests were much more uniform than those from the wet test pieces. The latter behaved erratically, and the maximum variation from the mean was 30 per cent, while the greatest variation from the average value in the dry series was 12 per cent. The mean elongation of the wetted specimens was considerably higher than that given by the dry test pieces.

Filipinos say that rope made of *Ficus palawanensis* bast is both stronger and more durable than that made of maguey. On account of its great strength, toughness, and durability the fiber is used for making wild-hog traps.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXIII.

TABLE XXXIII.—*Physical tests of rope made from the bast of Ficus palawanensis.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	6.1
Inches	0.24
Mean perimeter, or girth:	
Millimeters	19
Inches	0.75
True mean sectional area:	
Square millimeters	20.5
Square inches	0.032
Ultimate tensile strength (dry):	
Mean in kilograms	154
Maximum in kilograms	167
Minimum in kilograms	136
Mean in pounds	339
Maximum in pounds	368
Minimum in pounds	300
Ultimate tensile strength (wet):	
Mean in kilograms	157
Maximum in kilograms	195
Minimum in kilograms	110
Mean in pounds	346
Maximum in pounds	429
Minimum in pounds	243

TABLE XXXIII.—*Physical tests of rope made from the bast of Ficus palawanensis*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	752
Pounds per square inch	10,700
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	766
Pounds per square inch	10,900
Mean elongation at instant of rupture:	
Dry (per cent)	12
Wet (per cent)	19
Mean weight per unit length:	
Grams per meter	24.7
Pounds per foot	0.0166
Average breaking length:	
Meters	6,230
Feet	20,400
Moisture (per cent)	9.08

BORAGINACEAE

CORDIA CUMINGIANA Vid. Anonang-lalaki.

Local names: *Anónang-laláki* (Mindoro); *maratarong* (Ilocano, Benguet).

A small tree with broadly ovate, cordate, somewhat hairy leaves, many-flowered inflorescences, and small, ovoid, fleshy fruits; of local occurrence at low altitudes in Luzon.

The strips of this bast that constitute the strands of the rope procured for testing vary considerably in size and color; some strips are 15 millimeters wide and 1 millimeter thick, and are stiff and amber brown. Others are only 0.2 millimeter thick, 6 millimeters wide, soft, and buff. Plate V, fig. 1, shows that most of the *Cordia cumingiana* bast strips are broad and very coarse. The strands average seven strips thick.

When dry, rope made of this bast is low in tensile strength and breaking length. Wetting decreases the mean tensile strength of the fiber 6 per cent, but for all practical purposes does not affect the mean elongation. All of the wet specimens broke in the unspliced portion of the rope, whereas three of the five dry specimens ruptured in eye-splices. The latter tests showed more discordant results than the former, the maximum variations from the mean in the five dry, and the five wet, specimens being 20 per cent and 13 per cent, respectively.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXIV.

TABLE XXXIV.—*Physical tests of rope made from the bast of Cordia cumingiana.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	12.1
Inches	0.48
Mean perimeter, or girth:	
Millimeters	38
Inches	1.50
True mean sectional area:	
Square millimeters	86.8
Square inches	0.135
Ultimate tensile strength (dry):	
Mean in kilograms	337
Maximum in kilograms	383
Minimum in kilograms	270
Mean in pounds	743
Maximum in pounds	845
Minimum in pounds	595
Ultimate tensile strength (wet):	
Mean in kilograms	316
Maximum in kilograms	356
Minimum in kilograms	275
Mean in pounds	696
Maximum in pounds	785
Minimum in pounds	605
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	388
Pounds per square inch	5,500
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	364
Pounds per square inch	5,160
Mean elongation at instant of rupture:	
Dry (per cent)	16
Wet (per cent)	16
Mean weight per unit length:	
Grams per meter	75.6
Pounds per foot	0.0508
Average breaking length:	
Meters	4,450
Feet	14,600
Moisture (per cent)	12.61

CORDIA MYXA Linn. Anonang.

Local names: *Anónang* (Albay, Bataan, Batangas, Benguet, Camarines, Ilocos Sur, Laguna, Mindoro, Pampanga, Pangasinan, Rizal, Sorsogon, Tayabas); *bibíli* (Visayan); *gúma* (Balabac); *salóyong* (Tagalog); *sinalígan* (Ilocos Sur).

A tree, usually about 10 meters high, glabrous or nearly so; leaves ovate to elliptic-ovate, margins usually repand; inflorescences lax, axillary and terminal, 5 to 10 centimeters long; flowers white or yellowish-white, small; drupe fleshy, ovoid, about 1 centimeter long, yellowish white, the pulp scanty; common and widely distributed in the Philippines at low altitudes.

Cordia myxa bast is wood brown, and the strands of the rope used in the test are from eleven to fifteen strips thick. The strips average 3 millimeters wide and 0.10 millimeter thick. When dry, rope made of *Cordia myxa* bast is very low in tensile strength and breaking length. Wetting decreases the mean tensile strength 19 per cent. Filipinos say that the fiber is not suited for use in the wetted condition. Four of the five wet, and three of the five dry, specimens failed outside of eye-splices. The latter series of tests showed better agreement than the former, the maximum variation from the mean tensile strength being 15 and 34 per cent, respectively.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXV.

TABLE XXXV.—*Physical tests of rope made from the bast of Cordia myxa.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	7.96
Inches	0.31
Mean perimeter, or girth:	
Millimeters	25
Inches	0.99
True mean sectional area:	
Square millimeters	44.5
Square inches	0.069
Ultimate tensile strength (dry):	
Mean in kilograms	144
Maximum in kilograms	162
Minimum in kilograms	122
Mean in pounds	318
Maximum in pounds	357
Minimum in pounds	269
Ultimate tensile strength (wet):	
Mean in kilograms	117
Maximum in kilograms	157
Minimum in kilograms	101
Mean in pounds	257
Maximum in pounds	345
Minimum in pounds	222

TABLE XXXV.—*Physical tests of rope made from the bast of Cordia myxa*—Continued.

Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	324
Pounds per square inch	4,610
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	263
Pounds per square inch	3,730
Mean elongation at instant of rupture:	
Dry (per cent)	11
Wet (per cent)	14
Mean weight per unit length:	
Grams per meter	34.9
Pounds per foot	0.0235
Average breaking length:	
Meters	4,125
Feet	13,500
Moisture (per cent)	8.54

GNETACEAE

GNETUM sp. Kuliat.

Local names: *Kaliát* (Ilocano); *kaliát* or *kandiát* (Benguet); *kandiát* (Itneg); *kuliát* (Bataan).

A small tree with oblong, glossy, entire, acuminate, thin leaves; flowers minute, crowded in the points of the inflorescences; fruit ellipsoid, one-seeded, about 2 centimeters long, the seed edible; widely distributed in the Philippines at low altitudes; usually sylvan.

Gnetum sp. bast strips are rich brown, free from irregularities, and have a decidedly waxy touch and appearance. The waxy surface imparts a glossy sheen and, combined with the smoothness of the strips, assists them to slip over each other when strained. The strands of rope average ten strips thick. The strips vary in width from 1 to 3 millimeters, average 0.25 millimeter thick, and have a mean length of 503 millimeters. It will be noted that the strips are not only narrow and thin, but that they are shorter than those of any other bast measured.

Of all the bast ropes tested, that made of *Gnetum* sp. fiber is the most tenacious and has the highest breaking length; moreover, it is exceptionally pliable. *Gnetum* sp. rope is stronger than machine-laid maguey rope made of Government grade Cebu No. 2 fiber and in tenacity approaches closely cordage made of the most superior grade of abacá fiber. When wetted for twenty-four hours this bast rope increases 31 per cent in strength and is actually stronger than machine-laid abacá rope made of "F" grade fiber.

All test specimens of both the five dry, and the five wet, specimens, excepting one in the latter, ruptured outside of eye-splices. The maximum variation from the mean tensile strength of the dry specimen values was 29 per cent, and that of the wet specimens was only 11 per cent. Wetting not only greatly increases, but improves, their uniformity.

Rope made of *Gnetum* sp. bast is held in high esteem by Filipinos because of its great strength, pliability, and lightness, and is considered by Igorots and Ilocanos in Benguet, Abra, and Union superior to that made of any other local fiber. It is preferred for making wild-hog traps and for mounting seines and for trawl fishing. Fiber for these purposes is subjected to severe exposure and treatment and must be durable and reliable. When used for mounting nets and for fishing lines the bast meets with extraordinarily hard usage. It is customary to stretch a rope from one bank of a river to the other, and at regular intervals to suspend short lines to which hooks are attached. The rope of course is submerged, and frequently considerable débris becomes lodged against it. More than one instance is on record in which a man was saved from being washed away by grasping such a rope, of about the size of a lead pencil.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXVI.

TABLE XXXVI.—*Physical tests of rope made from the bast of Gnetum sp.*

[Rope made at Disdis, Benguet Subprovince.]

Mean diameter:	
Millimeters	5.7
Inches	0.23
Mean perimeter, or girth:	
Millimeters	18
Inches	0.71
True mean sectional area:	
Square millimeters	21.5
Square inches	0.033
Ultimate tensile strength (dry):	
Mean in kilograms	166
Maximum in kilograms	214
Minimum in kilograms	142
Mean in pounds	366
Maximum in pounds	471
Minimum in pounds	312

TABLE XXXVI.—*Physical tests of rope made from .the bast of Gnetum sp*—Continued.

Ultimate tensile strength (wet):	
Mean in kilograms	217
Maximum in kilograms	240
Minimum in kilograms	205
Mean in pounds	478
Maximum in pounds	529
Minimum in pounds	452
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	773
Pounds per square inch	11,100
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	1,000
Pounds per square inch	14,500
Mean elongation at instant of rupture:	
Dry (per cent)	10
Wet (per cent)	12
Mean weight per unit length:	
Grams per meter	19.7
Pounds per foot	0.0132
Average breaking length:	
Meters	8,450
Feet	27,700
Moisture (per cent)	11.45

BOMBACACEAE

BOMBAX CEIBA Linn. Malabulak.

Local names: *Bóboi* (Tagalog); *bobor* or *taroktók* (Abra, Ilocano); *bubui-gubat* (Mindoro, Rizal); *dǫ́ldol* (Ilocano); *kápas, kapói* (Jolo); *malabúlak* (Laguna, Nueva Ecija).

A very large deciduous tree, the trunk with large pyramidal spines; leaves palmately compound, leaflets oblong to lanceolate, 10 to 20 centimeters long; flowers very large, red, appearing before the leaves; capsules about 15 centimeters long; seeds hairy; throughout the Philippines at low altitudes.

Bombax ceiba bast is orange-buff. The strips of rope procured for the test average 6 millimeters wide, 0.38 millimeter thick, and 967 millimeters long. Each strand averages ten strips thick.

When dry, rope made of this fiber is medium in tensile strength and breaking length. Wetting diminishes its mean tensile strength 13 per cent. Three of the four dry, and one of the five wet, specimens broke in eye-splices. The maximum variation from the mean tensile strength of the dry test pieces was 9 per cent, and that shown by the wet series was 37 per cent.

This bast is rare and, therefore, is not commonly used for rope making. Filipinos say that it is suitable for wet-weather use.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXVII.

TABLE XXXVII.—*Physical tests of rope made from the bast of Bombax ceiba.*

[Rope made at Langiden, Abra Province.]

Mean diameter:	
Millimeters	8.3
Inches	0.33
Mean perimeter, or girth:	
Millimeters	26
Inches	1.02
True mean sectional area:	
Square millimeters	43.0
Square inches	0.067
Ultimate tensile strength (dry):	
Mean in kilograms	174
Maximum in kilograms	184
Minimum in kilograms	158
Mean in pounds	383
Maximum in pounds	405
Minimum in pounds	348
Ultimate tensile strength (wet):	
Mean in kilograms	151
Maximum in kilograms	176
Minimum in kilograms	94.8
Mean in pounds	332
Maximum in pounds	387
Minimum in pounds	209
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	405
Pounds per square inch	5,720
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	351
Pounds per square inch	4,960
Mean elongation at instant of rupture:	
Dry (per cent)	8
Wet (per cent)	10
Mean weight per unit length:	
Grams per meter	37.7
Pounds per foot	0.0253
Average breaking length:	
Meters	4,620
Feet	15,150
Moisture (per cent)	15.78

ULMACEAE

TREMA ORIENTALIS Blume. Anabiong.

Local names: *Agandung* (Cagayan); *alindagon* (Balabac, Moro); *anabion* (Visayan and Tagalog); *anabiong* (Mindoro, Negros, Rizal); *anagum* (Bicol); *anariong* (Batanes); *anarong* (Zambales); *andaluyong* (Bukidnon); *annadung, hubulos* (Bontoc); *dalunot maladurung* (Bataan); *hagod* (Laguna, Tayabas); *hanag-dúng, balibágo* (Rizal); *hanadióng, hinagdúng, inangdón, kungdón* (Mindoro); *hanagdóng* (Guimaras, Samar, Surigao, Tayabas); *hinagdúng* (Visayan); *inangdón* (Mindoro); *indai-luging* (Lanao); *lagod, balibágo, dalunot, hanadióng* (Tagalog); *lamai, arandóng* (Abra); *malarurung* (Igorot, Tagalog); *malasikongdúron, dalunit, hinlalaong* (Pampanga); *nagdón* (Occidental Negros); *pañgarandóngen* (Pangasinan); *pañgarandúñgin* (Benguet); *tatagtág* (Guimaras).

A small tree with oblong, ovate, somewhat harsh, oblique, acuminate leaves; small axillary inflorescences of very numerous minute flowers; and small, fleshy, ovoid drupes; very common and widely distributed in settled areas of the Philippines.

Trema orientalis bast strips are cinnamon in color. They average 3 millimeters wide and 0.38 millimeter thick. The strands average nine strips thick. Plate V, fig. 5, shows that the strips are very irregular and ragged looking.

When dry, rope made of *Trema orientalis* has the lowest tensile strength and breaking length of all ropes tested. However, when wetted, its resistance is nearly doubled. Even so, the tensile strength is low. Filipinos say that this bast is very weak, and that it makes a poor rope. For this reason it is not commonly used for the fabrication of cordage.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXVIII.

TABLE XXXVIII.—*Physical tests of rope made from the bast of Trema orientalis.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	8.3
Inches	0.33
Mean perimeter, or girth:	
Millimeters	26
Inches	1.02
True mean sectional area:	
Square millimeters	46.6
Square inches	0.072

TABLE XXXVIII.—*Physical tests of rope made from the bast of Trema orientalis*—Continued.

Ultimate tensile strength (dry):	
Mean in kilograms	62.6
Maximum in kilograms	79
Minimum in kilograms	46.7
Mean in pounds	138
Maximum in pounds	174
Minimum in pounds	103
Ultimate tensile strength (wet):	
Mean in kilograms	122
Maximum in kilograms	122
Minimum in kilograms	121
Mean in pounds	268
Maximum in pounds	269
Minimum in pounds	267
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	134
Pounds per square inch	1,920
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	262
Pounds per square inch	3,720
Mean elongation at instant of rupture:	
Dry (per cent)	7
Wet (per cent)	21
Mean weight per unit length:	
Grams per meter	44.1
Pounds per foot	0.0296
Average breaking length:	
Meters	1,420
Feet	4,660
Moisture (per cent)	8.90

ANNONACEAE

GONIOTHALAMUS AMUYON Blanco. Amuyong.

Local names: *Amúyong* (Tayabas); *lanútan* (Occidental Negros); *sagiát* (Ilocano, Abra).

A glabrous tree with oblong coriaceous leaves, rather large flowers, and cylindric, elongated aromatic fruits; of local occurrence, but widely distributed at low altitudes in the Philippines.

The most conspicuous characteristic of *Goniothalamus amuyon* bast is its attractive apricot-buff color. Like most of the basts tested, the fiber of this rope is in the form of strips, which average 3 millimeters wide, 0.33 millimeter thick, and 794 millimeters long.

When dry, rope made of this bast is very low in tensile strength and breaking length. Wetting reduces the mean tensile strength 15 per cent. The wet specimens gave very uniform breaks, the maximum variation from the mean being 9 per cent, while that shown by the five dry specimens was 21 per cent. Three of the dry, and two of the wet, specimens failed in eye-splices.

A summary of the tests of this species made in the Bureau of Science is given in Table XXXIX.

TABLE XXXIX.—*Physical tests of rope made from the bast of Goniothalamus amuyon.*

[Rope made at Dolores, Abra Province.]

Mean diameter:	
Millimeters	9.2
Inches	0.36
Mean perimeter, or girth:	
Millimeters	29
Inches	1.14
True mean sectional area:	
Square millimeters	40.9
Square inches	0.063
Ultimate tensile strength (dry):	
Mean in kilograms	141
Maximum in kilograms	157
Minimum in kilograms	112
Mean in pounds	311
Maximum in pounds	347
Minimum in pounds	247
Ultimate tensile strength (wet):	
Mean in kilograms	120
Maximum in kilograms	130
Minimum in kilograms	109
Mean in pounds	264
Maximum in pounds	287
Minimum in pounds	241
Mean ultimate tensile strength per unit area (dry):	
Kilograms per square centimeter	345
Pounds per square inch	4,940
Mean ultimate tensile strength per unit area (wet):	
Kilograms per square centimeter	293
Pounds per square inch	4,180
Mean elongation at instant of rupture:	
Dry (per cent)	9
Wet (per cent)	13
Mean weight per unit length:	
Grams per meter	38.4
Pounds per foot	0.0258
Average breaking length:	
Meters	3,680
Feet	12,050
Moisture (per cent)	8.65

VARIATIONS IN TESTS

The handmade bast-fiber rope, with one or two exceptions, gave very erratic results. Taken as a whole the wet specimens gave somewhat more erratic results than the dry ones. For the dry specimens the maximum average variation from the mean was 17 per cent, and for the wet, 20 per cent. Table XL records the maximum variations from the mean in tensile-strength tests of five samples, each, of dry and wet rope specimens.

TABLE XL.—*Maximum variation from the mean tensile strength of rope in the dry and the wet series of five tests each.*

HANDMADE BAST-FIBER ROPES.

Fiber.	Maximum variation from mean tensile strength.	
	Dry series.	Wet series.
	Per cent.	*Per cent.*
Abroma fastuosa; unretted bast	21	22
Abroma fastuosa; retted bast	[a] 6	(b)
Commersonia bartramia	20	26
Helicteres hirsuta	17	11
Kleinhovia hospita	17	30
Pterocymbium tinctorium	26	18
Pterospermum diversifolium	14	8
Sterculia crassiramea	7	16
Sterculia foetida	4	[c] 28
Sterculia oblongata	9	17
Sterculia stipularis	29	22
Bombycidendron vidalianum	18	30
Malachra fasciata	20	6
Sida acuta	12	[c] 7
Thespesia lampas	24	21
Urena lobata	34	11
Columbia blancoi	16	10
Corchorus olitorius	7	18
Grewia eriocarpa	19	34
Grewia bilamellata	11	29
Grewia multiflora	13	29
Allaeanthus glaber	15	19
Artocarpus communis; young bast	20	16
Ficus benjamina	19	22
Ficus forstenii	23	21
Ficus pachyphylla	16	25
Ficus palawanensis	12	30
Cordia cumingiana	20	13
Cordia myxa	15	34
Gnetum sp	29	11
Bombax ceiba	[c] 9	37
Trema orientalis	25	(d)
Goniothalamus amuyon	21	9
Average	17	20

TABLE XL.—*Maximum variation from the mean tensile strength of rope in the dry and the wet series of five tests each*—Continued.

MACHINE-LAID ROPES MADE OF COMMERCIAL CORDAGE FIBERS.

Fiber.	Maximum variation from mean tensile strength.	
	Dry series.	Wet series.
	Per cent.	*Per cent.*
Musa textilis; grade "F" abacá rope, 31 millimeters in circumference	5	8
Musa textilis; grade "F" abacá rope, 15 millimeters in circumference	10	13
Musa textilis; grade "G" abacá rope, 26 millimeters in circumference	7	6
Musa textilis; grade "G" abacá rope, 16 millimeters in circumference	3	15
Agave cantala; maguey, grade Cebu No. 2, rope, 26 millimeters in circumference	8	11
Average	7	11
HAND-LAID ROPES MADE OF MISCELLANEOUS FIBERS.		
Cocos nucifera; rope 50 millimeters in circumference	8	[d] 12
Cocos nucifera; rope 44 millimeters in circumference	8	[d] 2
Cocos nucifera; rope 24 millimeters in circumference	25	20
Corypha elata; buntal	11	10
Amomum sp	15	18
Anamirta cocculus	14	[c] 10
Dendrocalamus merrillianus	29	19
Average	16	13

[a] Three tests only.
[b] No test made.
[c] Four tests only.
[d] Only two tests made and these are practically identical.

In Table XLI are tabulated the number of rope test specimens ruptured, together with the manner of their failure. Two hundred forty-eight dry specimens were broken, of which 122, or 49 per cent, failed in eye-splices. Of the 217 wet test pieces 78, or 36 per cent, ruptured in eye-splices.

Fifty-seven per cent of the dry, and 69 per cent of the wet, specimens that gave maximum tensile-strength values failed in the unspliced portion of the test pieces. Breaks in eye-splices do not necessarily imply that the various test specimens are faulty, abnormal, or low in value; for frequently the minimum values in both wet and dry specimens were obtained from those that failed in the unspliced portion of the rope between the eye-splices, whereas the maximum values were often obtained for pieces that ruptured in the eye-splices.

In the dry specimens the number of breaks and of maximum values from test pieces breaking in the eye-splices is about equal to the number of those obtained from test pieces that failed in the unspliced sections of the test specimens. However, wetting reduced considerably the number of specimens breaking in eye-splices and seemed to cause failure in the un-

TABLE XLI.—*Number of rope test specimens ruptured and the manner of their failure.*

[U = in the unspliced section; E = in an eye-splice.]

HANDMADE BAST-FIBER ROPES.

Fiber.	Number of tests averaged.		Specimens broken in eye-splices.		Occurrence of failure in specimen giving—			
					Maximum value.		Minimum value.	
	Dry.	Wet.	Dry.	Wet.	Dry series.	Wet series.	Dry series.	Wet series.
Abroma fastuosa (unretted)	5	5	2	1	U	U	U	U
Commersonia bartramia	5	5	4	1	U	U	E	U
Helicteres hirsuta	5	5	0	2	U	U	U	E
Kleinhovia hospita	5	5	0	2	U	U	U	U
Pterocymbium tinctorium	5	5	3	0	E	U	E	U
Pterospermum diversifolium	5	5	5	1	E	U	E	U
Sterculia crassiramea	5	5	1	3	U	U	U	E
Sterculia foetida	5	4	0	1	U	E	U	U
Sterculia oblongata	5	5	2	3	U	U	U	U
Sterculia stipularis	5	5	2	5	U	E	U	E
Bombycidendron vidalianum	5	5	1	2	U	U	U	U
Malachra fasciata	5	5	2	1	U	U	E	E
Sida acuta	5	4	3	3	U	U	E	E
Thespesia lampas	5	5	3	1	E	U	U	U
Urena lobata	5	5	4	2	E	U	E	U
Columbia blancoi	5	5	2	2	U	U	E	U
Corchorus olitorius	5	5	3	2	E	E	U	E
Grewia eriocarpa	5	5	2	3	E	E	E	E
Grewia bilamellata	5	5	1	0	U	U	U	U
Grewia multiflora	5	5	3	3	E	U	U	E
Allaeanthus glaber	5	5	4	2	E	E	U	U
Artocarpus communis; (young bast)	5	5	2	2	E	U	U	U
Ficus benjamina	5	5	2	0	U	U	E	U
Ficus forstenii	5	5	2	0	U	U	E	U
Ficus pachyphylla	5	5	1	2	U	E	U	E
Ficus palawanensis	5	5	1	1	E	U	U	E
Cordia cumingiana	5	5	3	0	E	U	U	U
Cordia myxa	5	5	2	1	E	E	U	U
Gnetum sp	5	5	0	1	U	U	U	U
Bombax ceiba	4	5	3	1	E	E	E	U
Trema orientalis	5	2	2	1	U	E	U	U
Goniothalamus amuyon	5	5	3	2	U	U	E	U
Total	159	155	[i] 68	[j] 51	(a)	(b)	(c)	(d)

[a] 19U, 59 per cent; 13E, 41 per cent.
[b] 23U, 72 per cent; 9E, 28 per cent.
[c] 20U, 63 per cent; 12E, 37 per cent.
[d] 22U, 69 per cent; 10E, 31 per cent.
[i] 42.7 per cent.
[j] 32.9 per cent.

TABLE XLI.—*Number of rope test specimens ruptured and the manner of their failure*—Continued.

MACHINE-LAID ROPES MADE OF COMMERCIAL CORDAGE FIBERS.

Fiber.	Number of tests averaged.		Specimens broken in eye-splices.		Occurrence of failure in specimen giving—			
					Maximum value.		Minimum value.	
	Dry.	Wet.	Dry.	Wet.	Dry series.	Wet series.	Dry series.	Wet series.
Musa textilis; grade "F" abacá rope, 31 millimeters in circumference	14	10	14	6	E	E	E	E
Musa textilis; grade "G" abacá rope, 26 millimeters in circumference	15	10	12	6	U	U	E	E
Agave cantala; grade Cebu No. 2	15	10	11	2	E	E	E	U
Total	44	30	[k]37	[l]14	(e)	(e)	(f)	(e)
HAND-LAID ROPES MADE OF MISCELLANEOUS PHILIPPINE FIBERS.								
Cocos nucifera; coir rope, 50 millimeters in circumference	5	4	2	0	E	U	U	U
Cocos nucifera; coir rope, 44 millimeters in circumference	8	4	5	1	U	U	E	E
Cocos nucifera; coir rope, 24 millimeters in circumference	12	6	2	3	U	U	U	U
Corypha elata; buntal rope, 22 millimeters in circumference	5	5	3	2	U	U	E	E
Amomum sp	5	5	1	2	E	U	U	E
Anamirta cocculus	5	3	0		U	E	U	U
Dendrocalamus merrillianus	5	5	4	4	E	E	E	U
Total	45	32	[m]17	[n]13	(g)	(h)	(g)	(g)
Grand total	248	217	[o]122	[p]78	(q)	(r)	(s)	(t)

[e] 1U, 33 per cent; 2E, 67 per cent.
[f] 3E, 100 per cent.
[g] 4U, 57 per cent; 3E, 43 per cent.
[h] 5U, 71 per cent; 2E, 29 per cent.
[k] 84 per cent.
[l] 46.7 per cent.
[m] 37.8 per cent.
[n] 40.6 per cent.
[o] 49.3 per cent.
[p] 36 per cent.
[q] 24U, 57 per cent; 18E, 43 per cent.
[r] 29U, 69 per cent; 13E, 31 per cent.
[s] 24U, 57 per cent; 18E, 43 per cent.
[t] 27U, 64 per cent; 15E, 36 per cent.

spliced sections of a larger proportion of the specimens giving maximum values. On the other hand, the preponderance of minimum values is not found in those that broke in eye-splices. About half of the dry test pieces giving minimum values failed in the unspliced section of the test piece. As in the case of the maximum values, wetting had the effect of causing a still less number of breaks in eye-splices.

Machine-laid rope made of commercial cordage fibers gave very concordant results, the average maximum variations from the mean tensile strength in the dry and the wet specimens being 7 and 11 per cent, respectively. Handmade coir rope (coir is a filamentous fiber like abacá) also gives excellent agreement; this indicates that machine fabrication is not necessarily the main factor in determining whether the tensile-strength values will be concordant or not. Therefore, the failure of a test specimen in an eye-splice is normal and there can be no question as to the acceptability of such values. Apparently uniformity in tenacity values depends largely upon the nature of the fiber, and the irregular tensile-strength values must be attributed largely to the crude, nonuniform nature of the bast itself.

The summary of averages of the tensile-strength tests, breaking length, weight per unit length, elongation, girth, diameter, etc., of the test specimens is arranged by species in Table XLII.

SUMMARY

The averages of two series of tests on the tenacity of Philippine bast-fiber ropes are given; the one on air-dry specimens, and the other on specimens that had been immersed in fresh tap water for twenty-four hours. In order to show the relative strength of bast ropes, as compared with standard fiber cordage, a few tests of machine-laid abacá and maguey rope are given. A few results of tests of miscellaneous ropes made of material not coming under the classification of either bast or standard cordage fiber have been included also. A primitive wooden rope-laying apparatus is described and illustrated.

In Table III are recorded the mean tensile strengths of the dry bast ropes tested. Dry rope made of *Gnetum* sp. bast, having a mean circumference of 18 millimeters, heads the list with a maximum mean tensile strength of 773 kilograms per square centimeter (11,100 pounds per square inch). This value compares favorably with the values for "F" and "G" grades abacá rope. Rope made of coir fiber, which ranges in strength from 170 to 185 kilograms per square centimeter (2,420 to 2,640 pounds per square inch), ranks with the poorest basts.

In Table IV are recorded the mean tensile strengths of ropes that had been immersed for twenty-four hours in fresh tap water. Rope made of *Gnetum* sp. fiber still heads the series with even augmented tenacity. It will be noted that wetting

has a marked influence upon, and generally causes a slight decrease in, the tensile strength of most bast ropes.

In Table V are recorded, in the order of their magnitude, the breaking lengths of the ropes tested, and the general order follows that of the relative tenacity. Of the bast ropes, the rope made of *Gnetum* sp. is the highest, with a breaking length of 8,450 meters (27,700 feet), which closely approaches the values of the various abacá ropes tested. Despite its light weight, rope made of coconut fiber, which is sometimes considered a standard cordage material, has a breaking length inferior to most of the bast-fiber ropes tested. The elongation of bast-fiber ropes is generally less than that of most standard cordage fibers. Wetting has the effect of increasing the mean elongation of nearly all of them. The minimum and maximum averages for dry and wet specimens are 6 and 16 per cent, and 9 and 25 per cent, respectively.

TABLE XLII.—*Summary of tensile-strength and other tests of Philippine fiber ropes, arranged by species.*

BAST-FIBER ROPES.

Scientific name.	Name most commonly used in the Ilocano provinces.	Mean tensile strength.							
		Dry.				Wet.[c]			
		Kilos.	*Pounds.*	*Kilos per sq. cm.*	*Pounds per sq. inch.*	*Kilos.*	*Pounds.*	*Kilos per sq. cm.*	*Pounds per sq. inch.*
Abroma fastuosa; rope made of crude strips of bast	Anabó	482	1,063	545	7,760	282	621	319	4,530
Abroma fastuosa; rope made of retted bast	do	157	345	643	9,100	(1)	(1)	(1)	(1)
Commersonia bartramia	Kakaag	382	843	392	5,580	259	570	266	3,780
Helicteres hirsuta	Kol-lokol-lot ti bao	345	761	438	6,230	311	685	396	5,620
Kleinhovia hospita	Bitnong	360	793	309	4,370	334	737	286	4,070
Pterocymbium tinctorium	Marakapas	435	959	381	5,420	496	1,093	435	6,180
Pterospermum diversifolium	Baroy	75.7	167	263	3,740	75.3	166	261	3,690
Sterculia crassiramea	Bannakalau	483	1,064	398	5,660	373	823	308	4,380
Sterculia foetida	Bangar	56.7	125	200	2,840	56.7	125	200	2,840
Sterculia oblongata	Sinaligan	382	842	398	5,650	279	615	291	4,130
Sterculia stipularis forma	Labnay	79.4	175	268	3,800	108	239	366	5,200
Bombycidendron vidalianum	Lusuban	199	438	630	8,940	148	327	468	6,670
Malachra fasciata	Bakembakes	135	298	637	9,030	115	253	543	7,700
Sida acuta	Tackimbaca	193	426	475	6,760	205	453	502	7,190
Thespesia lampas	Dal-dal-lupang	155	341	268	3,800	168	370	291	4,130
Urena lobata var. *scabruscula*[d]	Puriket	146	322	482	6,850	111	244	366	5,200
Columbia blancoi	Keddeng	347	765	302	4,270	352	776	306	4,340
Corchorus olitorius	Saluyot	165	364	503	7,130	118	260	360	5,100
Grewia eriocarpa	Bariw-an	102	225	394	5,630	98.8	218	381	5,450
Grewia bilamellata	Benglaren	124	274	320	4,570	69.8	154	180	2,570
Grewia multiflora	Alinau	321	708	376	5,360	283	624	332	4,730
Allaeanthus glaber	Bungon	231	509	231	3,290	253	557	253	3,590

Artocarpus communis [k]	Bakak	101	223	356	5,070	96.5	218	340	4,830
Artocarpus communis [j]	do	222	490	367	5,220	(l)	(l)	(l)	(l)
Ficus benjamina	Balete	156	343	480	6,830	153	338	471	6,700
Ficus forstenii	Puos or puspus	59.8	132	154	2,200	86.2	190	222	3,160
Ficus pachyphylla	Pasakla	150	330	464	6,600	176	388	544	7,760
Ficus palawanensis	Agamid	154	339	752	10,700	157	346	766	10,900
Cordia cumingiana	Maratarong	337	743	388	5,500	316	696	364	5,160
Cordia myxa	Anonang	144	318	324	4,610	117	257	263	3,730
Gnetum sp	Kaliat	166	366	773	11,100	217	478	1,000	14,500
Bombax ceiba	Bobor or taroktok	174	383	405	5,720	151	332	351	4,960
Trema orientalis	Arandong	62.6	138	134	1,920	122	268	262	3,720
Goniothalamus amuyon	Saguiat	141	311	345	4,940	120	264	293	4,180

[d] This rope sample was made of a mixture of *Urena lobata* and *Corchorus olitorius* basts in about equal proportions.

[j] Bast from old tree.

[k] Bast from young tree.

[l] No test made.

[o] Rope submerged in fresh tap water twenty-four hours before testing.

TABLE XLII.—*Summary of tensile-strength and other tests of Philippine fiber ropes, arranged by species*—Continued.

ROPES MADE OF MISCELLANEOUS PHILIPPINE FIBERS.

Scientific name.	Name most commonly used in the Ilocano provinces.	Mean tensile strength.							
		Dry.				Wet.[o]			
		Kilos.	*Pounds.*	*Kilos. per sq. cm.*	*Pounds per sq. inch.*	*Kilos.*	*Pounds.*	*Kilos per sq. cm.*	*Pounds per sq. inch.*
Musa textilis; grade "F" abacá[b]	Abacá	724	1,596	943	13,400	727	1,604	946	13,500
Do	do	151	333	974	13,800	143	316	923	13,100
Musa textilis; grade "G" abacá[b]	do	398	878	744	10,600	406	896	759	10,800
Do	do	157	345	1,110	15,700	166	366	1,180	16,700
Agave cantala; Cebu No. 2[b]	Maguey	322	709	739	10,400	284	626	651	9,220
Agave cantala[h]	do	146	322	408	5,850	(l)	(l)	(l)	(l)
Agave cantala[i]	do	122	270	288	4,080	(l)	(l)	(l)	(l)
Corypha elata[e]	Silag	403	887	232	3,300	(l)	(l)	(l)	(l)
Corypha elata[f]	Buntal	77.1	170	222	3,150	89.3	197	257	3,650
Cocos nucifera; coir[n]	Bonot	295	651	185	2,640	217	479	136	1,940
Cocos nucifera; coir[c]	do	222	490	170	2,420	191	420	146	2,070
Do	do	68.8	152	176	2,490	[a] 57.6	[a] 127	[a] 148	[a] 2,100
Dendrocalamus merrillianus	Bayog	378	834	237	3,380	285	628	179	2,540
Anamirta cocculus[m]	Labtang	192	424	149	2,120	142	313	110	1,570
Amomum sp	Agset or sag-et	89.8	198	349	4,950	83.5	184	325	4,600

[a] Strength after having been immersed in stagnant tap water twenty-one days.
[b] Machine-made rope; all other ropes are handmade.
[c] Rope made from fiber machine cleaned at the Bureau of Science.
[e] Rope made from the leaf of the buri palm.
[f] Rope made of the vascular fibers found in the petioles of the buri-palm leaf.
[h] Rope made at Santo Domingo, Ilocos Sur.
[i] Rope made at Sulvec, Ilocos Sur.
[l] No test made.
[m] Entire vine twisted into a three-strand rope.
[n] Rope made at Caoayan, Ilocos Sur, from salt-water retted coir.
[o] Rope submerged in fresh tap water twenty-four hours before testing.

BAST-FIBER ROPES.

Scientific name.	Name most commonly used in the Ilocano provinces.	Mean breaking length.		Average weight per unit length.		Average elongation at the instant of rupture.		Average girth of cord.		Average diameter of rope based on a circle having a circumference equal to girth of rope.	
						Dry.	Wet.				
		Meters.	*Feet.*	*Pounds per foot.*	*Grams per meter.*	*Per cent.*	*Per cent.*	*mm.*	*in.*	*mm.*	*in.*
Abroma fastuosa; rope made of crude strips of bast	Anabó	5,770	18,900	0.0562	83.7	[g] 12	[g] 13	36	1.42	11.5	0.45
Abroma fastuosa; rope made of retted bast	do	7,740	25,400	0.0136	20.2	[1]	[1]	19	0.75	6.1	0.24
Commersonia bartramia	Kakaag	4,070	13,300	0.0632	93.9	[g] 14	[g] 13	38	1.50	12.1	0.48
Helicteres hirsuta	Kol-lokol-lot ti bao	3,950	12,950	0.0587	87.4	[g] 13	[g] 13	35	1.38	11.2	0.44
Kleinhovia hospita	Bitnong	3,870	12,700	0.0625	92.9	[g] 13	[g] 13	39	1.54	12.4	0.49
Pterocymbium tinctorium	Marakapas	4,560	14,900	0.0642	95.4	[g] 10	[g] 12	42	1.66	13.4	0.53
Pterospermum diversifolium	Baroy	2,620	8,620	0.0194	28.9	11	15	21	0.83	6.7	0.26
Sterculia crassiramea	Bannakalau	5,050	16,600	0.0642	95.5	[g] 13	[g] 14	40	1.58	12.7	0.50
Sterculia foetida	Bangar	1,964	6,450	0.0194	28.8	6	10	22	0.87	7.0	0.28
Sterculia oblongata	Sinaligan	4,490	14,700	0.0572	85.1	[g] 13	[g] 14	38	1.50	12.1	0.48
Sterculia stipularis forma	Labnay	2,980	9,780	0.0179	26.6	7	10	22	0.87	7.0	0.28
Bombycidendron vidalianum	Lusuban	6,950	22,800	0.0192	28.6	12	14	22	0.87	7.0	0.28
Malachra fasciata	Bakembakes	7,580	24,800	0.0120	17.9	8	10	17	0.67	5.4	0.21
Sida acuta	Tackimbaca	5,770	18,900	0.0225	33.5	14	18	24	0.95	7.6	0.30
Thespesia lampas	Dal-dal-lupang	3,180	10,400	0.0327	48.7	9	13	30	1.18	9.6	0.38
Urena lobata var. *scabruscula* [d]	Puriket	6,180	20,300	0.0159	23.7	8	11	21	0.83	6.7	0.26
Columbia blancoi	Keddeng	3,510	11,500	0.0663	98.7	[g] 13	[g] 15	43	1.69	13.7	0.54
Corchorus olitorius	Saluyot	5,420	17,800	0.0205	30.5	8	10	22	0.87	7.0	0.28
Grewia eriocarpa	Bariw-an	5,050	16,600	0.0136	20.2	6	9	20	0.79	6.4	0.25

[d] This rope sample was made of a mixture of *Urena lobata* and *Corchorus olitorius* basts in about equal proportions.

[g] Gauge length, 100 centimeters; all other test pieces had a gauge length of 50 centimeters.

[1] No test made.

TABLE XLII.—*Summary of tensile-strength and other tests of Philippine fiber ropes, arranged by species*—Continued.

BAST-FIBER ROPES—Continued.

Scientific name.	Name most commonly used in the Ilocano provinces.	Mean breaking length.		Average weight per unit length.		Average elongation at the instant of rupture.		Average girth of cord.		Average diameter of rope based on a circle having a circumference equal to girth of rope.	
						Dry.	Wet.				
		Meters.	*Feet.*	*Pounds per foot.*	*Grams per meter.*	*Per cent.*	*Per cent.*	*mm.*	*in.*	*mm.*	*in.*
Grewia bilamellata	Benglaren	3,810	12,500	0.0219	32.6	11	11	24	0.95	7.6	0.30
Grewia multiflora	Alinau	3,660	12,000	0.0591	87.9	[g] 10	[g] 11	36	1.42	11.5	0.45
Allaeanthus glaber	Bungon	2,440	8,030	0.0635	94.4	[g] 13	[g] 25	39	1.54	12.4	0.49
Artocarpus communis [k]	Pakak	4,450	14,600	0.0153	22.8	11	15	19	0.75	6.1	0.24
Artocarpus communis [j]	do	4,560	14,900	0.0328	48.8	(1)	(1)	30	1.18	9.6	0.38
Ficus benjamina	Balete	5,030	16,500	0.0208	31.0	9	15	23	0.91	7.3	0.29
Ficus forstenii	Puos or puspus	1,600	5,260	0.0251	37.3	11	18	22	0.87	7.0	0.28
Ficus pachyphylla	Pasakla	4,930	16,200	0.0204	30.3	12	17	22	0.87	7.0	0.28
Ficus palawanensis	Agamid	6,230	20,400	0.0166	24.7	12	19	19	0.75	6.1	0.24
Cordia cumingiana	Maratarong	4,450	14,600	0.0508	75.6	[g] 16	[g] 16	38	1.50	12.1	0.48
Cordia myxa	Anonang	4,125	13,500	0.0235	34.9	11	14	25	0.99	7.96	0.31
Gnetum sp	Kaliat	8,450	27,700	0.0132	19.7	10	12	18	0.71	5.7	0.23
Bombax ceiba	Bobor or taroktok	4,620	15,150	0.0253	37.7	8	10	26	1.02	8.3	0.33
Trema orientalis	Arandong	1,420	4,660	0.0296	44.1	7	21	26	1.02	8.3	0.33
Goniothalamus amuyon	Saguiat	3,680	12,050	0.0258	38.4	9	13	29	1.14	9.2	0.36

[g] Gauge length, 100 centimeters; all other test pieces had a gauge length of 50 centimeters.
[j] Bast from old tree.
[k] Bast from young tree.
[1] No test made.

ROPES MADE OF MISCELLANEOUS PHILIPPINE FIBERS.

Musa textilis; grade "F" abacá [b]	Abacá	12,300	40,400	0.0395	53.8	[g]13	[g]18	31	1.22	9.9	0.39
Do	do	11,900	39,000	0.0085	12.7	8	12	15	0.59	4.8	0.19
Musa textilis: grade "G" abacá [b]	do	8,390	27,500	0.0319	47.5	[g]16	[g]19	26	1.02	8.3	0.33
Do	do	10,200	33,300	0.0104	15.4	13	15	16	0.63	5.1	0.20
Agave cantala; Cebu No. 2 [b]	Maguey	9,350	30,700	0.0231	34.3	[g]12	[g]17	26	1.02	8.3	0.33
Agave cantala [b]	do	3,750	12,300	0.0262	38.9	(l)	(l)	23	0.91	7.3	0.29
Agave cantala [i]	do	3,810	12,500	0.0216	32.2	(l)	(l)	25	0.99	7.96	0.31
Corypha elata [c]	Silag	3,630	11,900	0.0746	111.2	[g]18	(l)	47	1.85	14.9	0.59
Corypha elata [f]	Buntal	3,700	12,100	0.0140	20.8	14	18	22	0.87	7.0	0.28
Cocos nucifera; coir [n]	Bonot	2,620	8,610	0.0756	112.5	[g]36	[g]38	50	1.97	15.9	0.63
Cocos nucifera; coir [c]	do	2,730	8,950	0.0543	81.5	39	42	44	1.73	14.0	0.55
Do	do	3,550	11,650	0.0130	19.4	30	32	24	0.95	7.6	0.30
Dendrocalamus merrillianus	Bayog	3,800	12,450	0.0669	99.6	[g]15	[g]16	46	1.81	14.6	0.58
Anamirta cocculus [m]	Labtang	3,200	10,500	0.0404	60.1	[g]19	[g]14	44	1.73	14.0	0.55
Amomum sp	Agset or sag-et	5,530	18,150	0.0109	16.2	9	10	20	0.79	6.4	0.25

[b] Machine-made rope; all other ropes are handmade.
[c] Rope made from fiber machine cleaned at the Bureau of Science.
[e] Rope made from the leaf of the buri palm.
[f] Rope made of the vascular fibers found in the petioles of the buri-palm leaf.
[g] Gauge length, 100 centimeters; all other test pieces had a gauge length of 50 centimeters.
[h] Rope made at Santo Domingo, Ilocos Sur.
[i] Rope made at Sulvec, Ilocos Sur.
[l] No test made.
[m] Entire vine twisted into a three-strand rope.
[n] Rope made at Caoayan, Ilocos Sur, from salt-water retted coir.

ILLUSTRATIONS

PLATE I

FIG. 1. Laying a three-strand rope having a mean girth of 30 millimeters, made of crude strips of *Artocarpus communis* bast at Sappaac, Abra, obtained from the trunk of an old tree.

2. Heavy hardwood rope-laying apparatus (*pagtalian*, Ilocano) used in Caoayan, Ilocos Sur, for making large-sized mooring ropes, together with two coils of rope made therewith. One coil of rope is made of maguey (*Agave cantala*) and the other of a species of bamboo (*Dendrocalamus merrillianus*).

PLATE II

FIG. 1. Laying a three-strand rope having a mean girth of 19 millimeters, made of retted *Abroma fastuosa* bast at Sappaac, Abra. The view shows the triple-crank end of the crude rope-laying apparatus with strands still separate. In the foreground are two men holding spun and unspun bast.

2. Form of specimen used for making tensile-strength tests of Philippine bast-fiber ropes.

PLATE III. PHILIPPINE BAST-FIBER ROPES

FIG. 1. Rope having a mean girth of 19 millimeters, made of retted *Abroma fastuosa* bast.

2. Rope having a mean girth of 36 millimeters, made of crude (unretted) strips of *Abroma fastuosa* bast.

3. Rope having a mean girth of 38 millimeters, made of crude strips of *Commersonia bartramia* bast.

4. Rope having a mean girth of 35 millimeters, made of crude strips of *Helicteres hirsuta* bast.

5. Rope having a mean girth of 39 millimeters, made of crude ribbons of *Kleinhovia hospita* bast.

6. Rope having a mean girth of 42 millimeters, made of crude strips of *Pterocymbium tinctorium* bast.

7. Rope having a mean girth of 21 millimeters, made of crude strips of *Pterospermum diversifolium* bast.

8. Rope having a mean girth of 40 millimeters, made of crude ribbons of *Sterculia crassiramea* bast.

9. Rope having a mean girth of 22 millimeters, made of *Sterculia foetida* bast.

10. Rope having a mean girth of 38 millimeters, made of crude ribbons of *Sterculia oblongata* bast.

11. Rope having a mean girth of 22 millimeters, made of crude strips of *Sterculia stipularis* bast.

12. Rope having a mean girth of 22 millimeters, made of crude strips of *Bombycidendron vidalianum* bast.

13. Rope having a mean girth of 17 millimeters, made of retted *Malachra lineariloba* bast.

14. Rope having a mean girth of 24 millimeters, made of retted *Sida acuta* bast.
15. Rope having a mean girth of 30 millimeters, made of crude *Thespesia lampas* bast.

PLATE IV. PHILIPPINE BAST-FIBER ROPES

FIG. 1. Rope having a mean girth of 21 millimeters, made of a mixture, in about equal proportions, of crude strips of *Urena lobata* and *Corchorus olitorius* bast.
2. Rope having a mean girth of 43 millimeters, made of crude strips of *Columbia blancoi* bast.
3. Rope having a mean girth of 22 millimeters, made of crude strips of *Corchorus olitorius* bast.
4. Rope having a mean girth of 24 millimeters, made of crude strips of *Grewia bilamellata* bast.
5. Rope having a mean girth of 20 millimeters, made of crude strips of *Grewia eriocarpa* bast.
6. Rope having a mean girth of 36 millimeters, made of crude strips of *Grewia multiflora* bast.
7. Rope having a mean girth of 39 millimeters, made of crude strips of *Allaeanthus glaber* bast.
8. Rope having a mean girth of 19 millimeters, made of crude strips of young *Artocarpus communis* bast.
9. Rope having a mean girth of 30 millimeters, made of crude strips of old *Artocarpus communis* bast.
10. Rope having a mean girth of 23 millimeters, made of crude strips of *Ficus benjamina* bast.
11. Rope having a mean girth of 22 millimeters, made of crude strips of *Ficus forstenii* bast.
12. Rope having a mean girth of 22 millimeters, made of crude strips of *Ficus pachyphylla* bast.
13. Rope having a mean girth of 19 millimeters, made of crude strips of *Ficus palawanensis* bast.

PLATE V. PHILIPPINE BAST- AND MISCELLANEOUS-FIBER ROPES

FIG. 1. Rope having a mean girth of 38 millimeters, made of crude strips of *Cordia cumingiana* bast.
2. Rope having a mean girth of 25 millimeters, made of crude strips of *Cordia myxa* bast.
3. Rope having a mean girth of 18 millimeters, made of crude strips of *Gnetum* sp. bast.
4. Rope having a mean girth of 26 millimeters, made of crude strips of *Bombax ceiba* bast.
5. Rope having a mean girth of 26 millimeters, made of crude strips of *Trema orientalis* bast.
6. Rope having a mean girth of 29 millimeters, made of crude strips of *Goniothalamus amuyon* bast.
7. Rope (two strands only) having a mean girth of 46 millimeters, made of a species of bamboo (*Dendrocalamus merrillianus*).
8. Rope having a mean girth of 44 millimeters, made of the entire stem of a vine (*Anamirta cocculus*).

9. Rope having a mean girth of 50 millimeters, made of coir (fiber extracted from the husk of the fruit of the coco palm, *Cocos nucifera*).
10. Rope having a mean girth of 47 millimeters, made of the leaf of the buri palm (*Corypha elata*).
11. Rope having a mean girth of 22 millimeters, made of the vascular fibers (buntal) found in the petioles of the buri palm (*Corypha elata*).
12. Rope having a mean girth of 20 millimeters, made of strips of *Amomum* sp. bast.

TEXT FIGURES

FIG. 1. Typical cross-sectional profiles of ropes tested. Actual size.
a, rope made of *Cordia cumingiana* bast.
b, rope made of *Kleinhovia hospita* bast.
c, rope made of split bamboo (*Dendrocalamus merrillianus*).
d, rope made of "F" grade abacá (machine laid).

2. Showing the twist of two-, three-, and four-strand ropes, respectively.

Fig. 1. Laying a three-strand rope.

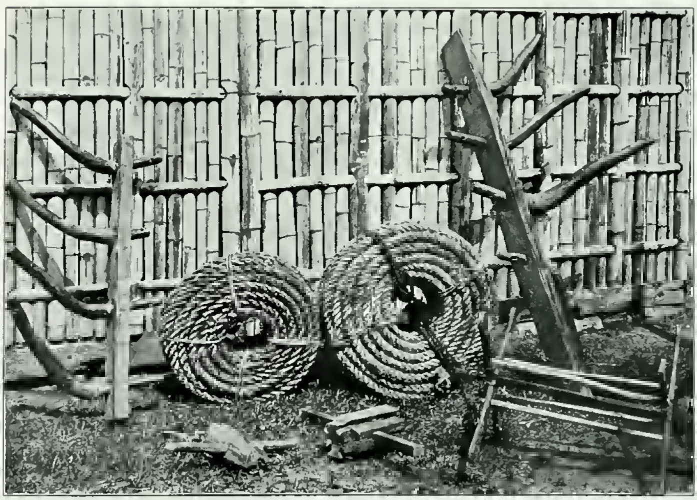

Fig. 2. Rope-laying apparatus.

PLATE I.

Fig. 1. The triple-crank end of the crude rope-laying apparatus.

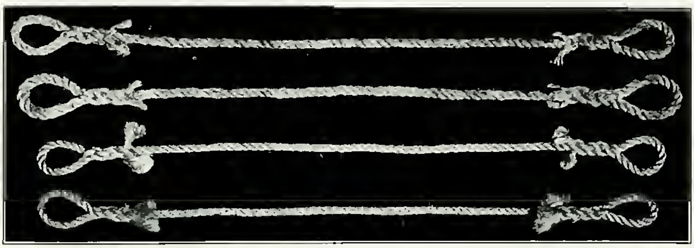

Fig. 2. Form of specimen used for making tensile-strength tests of Philippine bast-fiber ropes.

PLATE II.

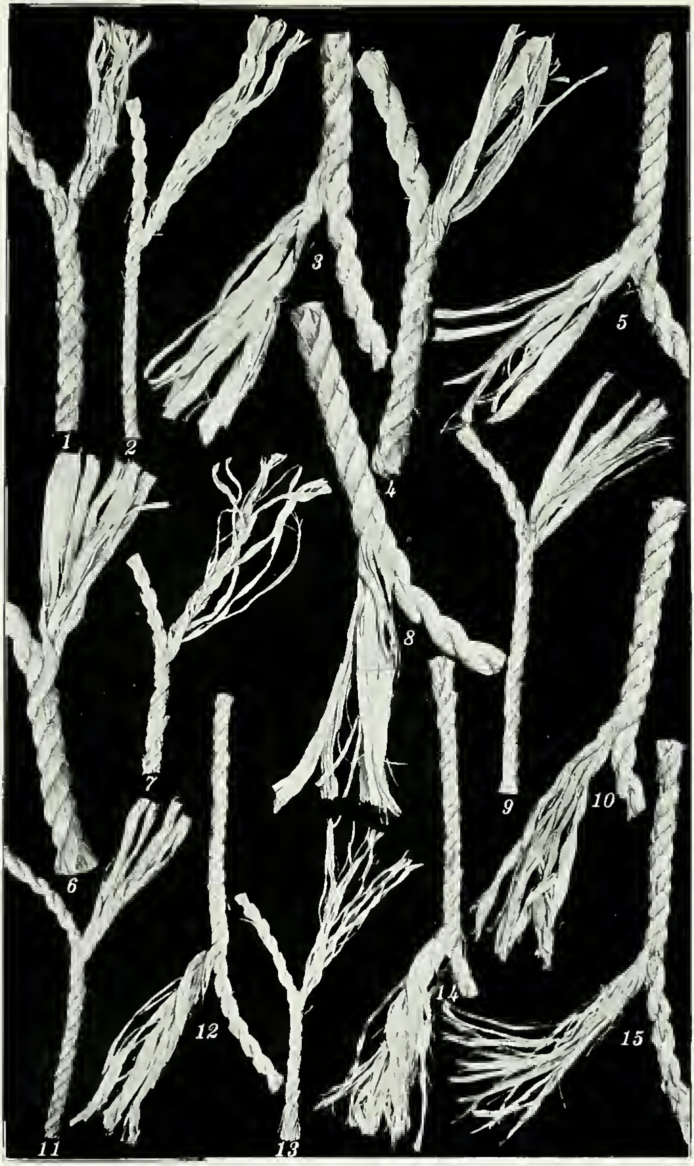

PLATE III. SAMPLES OF PHILIPPINE ROPES.

PLATE IV. SAMPLES OF PHILIPPINE ROPES.

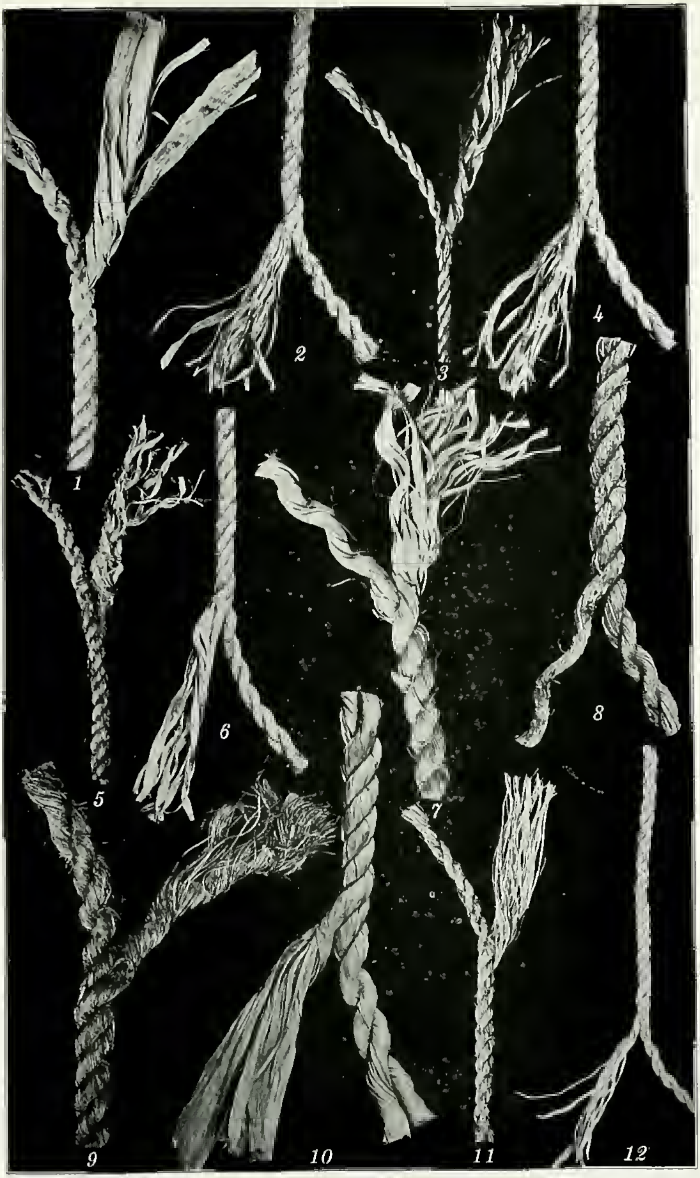

PLATE V. SAMPLES OF PHILIPPINE ROPES.

PINK DISEASE OF CITRUS

By H. Atherton Lee and Harry S. Yates [1]

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SEVEN PLATES AND TWO TEXT FIGURES

During field work in 1917 an apparently serious stem and branch disease of citrus trees was discovered. Subsequent and more extended observation has indicated that the disease may cause the death of the affected branches or even of the whole tree. The spread of the disease and subsequent destruction of the trees during the rainy season was found to be very rapid. Specimens of diseased material in various stages were collected, and examination showed the organism responsible to be the previously well-described *Corticium salmonicolor* B. & Br.[2] Though this species of *Corticium* is known to cause very serious diseases of *Hevea brasiliensis* (HBK) Muell., *Theobroma cacao* Linn., *Coffea* sp., *Thea* sp., and other plants in the Orient, and has previously been reported upon *Citrus*, it has apparently not been known to cause an important disease of the latter host. Since the disease at present appears to be localized in its occurrence and as its spread over the Islands may involve serious damage not only to *Citrus* but also to cacao, coffee, rubber, and possibly

[1] The writers wish to express their appreciation to Mr. E. Bateson, director of agriculture and mycologist for the Government of British North Borneo, for assistance and many courtesies extended to the junior writer, while on a recent visit to that country. The senior writer is indebted to Col. Adriano Hernandez, director, and Mr. S. Apostol, chief, division of plant industry, Philippine Bureau of Agriculture, for their kindness in making available to him opportunities for field work. He wishes to thank also Dr. Alvin J. Cox, former director, and Mr. E. D. Merrill, botanist, of the Philippine Bureau of Science, for many courtesies and the facilities of the botanical laboratories of that bureau.

[2] The identification of *Corticium salmonicolor* B. & Br. is based, not only upon a careful study of the organism and a comparison with the published descriptions and figures, but also upon comparison of material of *Corticium salmonicolor* B. & Br. collected upon *Hevea brasiliensis* (HBK) Muell. and on *Annona* sp. in British North Borneo where an opportunity was found to observe pink disease as it occurs in the field on *Hevea brasiliensis* (HBK) Muell., *Hibiscus* sp., and *Annona* sp.

other plants, it has seemed desirable to present certain data regarding the occurrence, appearance, and means of control of *Corticium*. Photographs of the various stages on *Citrus* are also presented, so that this disease may be recognized and the necessary measures applied for its control or eradication before it becomes widely distributed over the Philippine Islands. The name pink disease is commonly accepted by rubber planters throughout British Malaya and elsewhere as denoting the disease caused by *Corticium salmonicolor* B. & Br. This term is descriptive of the commonest form taken by the fungus and, as its use seems acceptable, it is continued here. Although *Corticium* has been thoroughly studied by us, no pretension is made that this paper contributes anything to the excellent studies on the morphology of the fungus already published by Rant, Brooks and Sharples, and others.

HISTORY

Corticium salmonicolor B. & Br. apparently first attracted attention about 1897 when it appeared as a disease of coffee in Malaya. Specimens sent to Kew were described by Massee [3] as a new species and genus of *Fungi imperfecti* which he named *Necator decretus* Massee. In 1901 Zimmermann,[4] working on the disease on coffee in Java, described the organism as *Corticium javanicum* Zimm. In 1904 Ridley [5] mentioned a specimen of a fungus occurring upon *Hevea* that had been sent from Sandakan, apparently to be referred to this species, and in 1905 [6] he reported the disease on two estates in the Malay Peninsula. Material sent to Kew was determined by Massee, this time as *Corticium calceum* Fr., a harmless and widely distributed species of Europe and America. In 1906 it was also found by Petch [7] to attack *Hevea* in Ceylon and southern India, and was recorded as *Corticium javanicum* Zimm. In 1909 Gallagher [8] reported *Corticium zimmermanni* Sacc. & Syd., which is a synonym of *Corticium salmonicolor* B. & Br., to be associated with a disease of rubber trees in Malaya. Petch [9] showed that material of this fungus was collected by Thwaites in Ceylon and was named

[3] Kew Bull. (1898) 119.

[4] Centralbl. f. Bakt. Abth. 2, 7 (1901) 146.

[5] Agr. Bull. Straits & Fed. Malay States 3 (1904) 174.

[6] Agr. Bull. Straits & Fed. Malay States 4 (1905) 423.

[7] Report of Gov. Mycologist Ceylon (1906).

[8] Bull. Dept. Agr. F. M. S. 6 (1909).

[9] Petch, T., Physiology and Diseases of Hevea brasiliensis. London (1911) 209.

Corticium salmonicolor by Berkeley and Broome [10] in 1873; as this name has undoubted priority over all other names proposed, it must be used for the species.

Rant [11] has described the disease known as "djamoer oepas" (poison fungus) in Java, caused by *Corticium javanicum* Zimm., and has listed one hundred forty-one wild and cultivated plant species attacked by the fungus; among these are *Citrus* sp. and *Murraya exotica* Linn. Inoculation experiments made by Rant proved for the first time the identity of *Necator decretus* Massee as a form of *Corticium javanicum* Zimm. He also published a number of very good figures. In 1914 Brooks and Sharples [12] gave the history of the disease in the Malay Peninsula together with a description of the life history of the fungus and suggestions for treatment. In 1908 von Faber [13] reported its occurrence on coffee in the Cameroons. It has also been reported to our knowledge from Burma, Sumatra, Borneo, southern India, the Caucasus, and Formosa.

From a study of the history of the disease we find it to be very widely distributed throughout the eastern Tropics, and to occur upon a very large number of economic and wild plants. In 1900 the disease was practically unknown. Sharples [14] stated that in 1912 the fungus causing pink disease was known in only three small centers in Malaya, but by 1914 it had spread over practically the whole peninsula. One of us on a recent visit to British North Borneo found the disease to be very common on rubber in that country, where it would undoubtedly cause serious financial losses if control measures were not applied.

CORTICIUM IN THE WEST INDIES

A disease of cacao, lime, and other economic plants has been reported from the West Indies. It appears to have been long known as pink disease and was supposed to be due to a *Corticium;* however, it was believed to be a different species from that known in the East and was identified as *Corticium lilacinofuscum* B. & C., a species described from temperate North America. Stockdale [15] calls attention to the existence of a similar disease in the East, but does not suggest the possibility

[10] Journ. Linn. Soc. Bot. 14 (1873) 71.
[11] Bull. Jardin Bot. Buitenzorg 4 (1912) 1–50, *f. 1–14.*
[12] Bull. Dept. Agr. F. M. S. 21 (1914).
[13] Centralbl. f. Bakt. Abth. 2, 21 (1908) 112.
[14] Kew Bull. (1917) 227.
[15] West Indian Bull. 9 (1908) 178.

that the organisms may be identical. Petch[16] appears to have been the first to suggest the identity of the organism causing pink disease in the two regions. Though not all of the literature relating to the disease occurring in the West Indies is available here, we note that recently Stevenson[17] has reported *Corticium salmonicolor* B. & Br. as the cause of a disease of *Citrus* in Porto Rico. The determination of the organism is credited to Doctor Burt, of the Missouri Botanic Garden.

OCCURRENCE OF CORTICIUM SALMONICOLOR B. AND BR. IN THE PHILIPPINES

Corticium salmonicolor B. & Br. has been found only recently in the Philippines, and the supposition seems justified that it is of recent introduction here. It was first collected in the fall of 1917 at Novaliches, near Manila, on *Annona* sp. Since that time it has been found at Los Baños, Laguna Province, and abundantly at Lamao, Bataan Province. The Lamao experiment station is the center of plant introduction and distribution in the Philippines, and plant materials are known to have been shipped from Lamao to both Novaliches and Los Baños. It seems very likely that *Corticium salmonicolor* B. & Br. was brought to Lamao on some plant introduced from another part of the Orient; for, while the fungus flora of the Philippines is far from being fully known, it seems very unlikely that botanical collectors and agricultural inspectors would have overlooked so conspicuous and destructive a fungus as *Corticium*—one likely to occur upon a very large number of hosts—had it existed in the Philippines for any considerable period.

As *Corticium* is very destructive to *Hevea brasiliensis* in other parts of the Orient, it is interesting to note that apparently it has not made its appearance on this host in the Philippines. The junior writer, while visiting the Basilan Rubber Plantation in November, 1917, made a careful survey of the estate for pink disease, but none was discovered. While Para rubber is cultivated in other parts of the Philippines, the Basilan plantation is the oldest and most accessible, and probably the one most likely to be infected through the introduction of young plants from Malaya. In the Philippines, *Corticium salmonicolor* B. & Br. has been collected only upon cultivated species, never upon naturally occurring plants.

[16] Circulars & Agr. Journ. Roy. Bot. Gard. Ceylon 4 (1909) 189.

[17] Stevenson, John A., Fifth Report of the Board of Commissioners of Agriculture of Porto Rico (1915–1916) 43, 44.

DESCRIPTION OF THE DISEASE ON CITRUS

The first stage of the disease appears to be a slight gumming (Plate II, fig. 1, Plate IV, fig. 2), similar in many ways to the gumming which is produced coincident with many other injuries to the bark of *Citrus*. At this stage the bark seems dry and very hard, and it adheres closely to the wood. Often longitudinal cracks form in the bark at the same time with the gumming.

Usually the first appearance of the fungus is in the form of pustules, which push through the hardened bark (Plate I, fig. 1, Plate II, fig. 1). These pustules are dirty white to pinkish in color, usually 1 millimeter or less in diameter, and rather irregular in shape when observed under the hand lens; so far as known, they are sterile. These pustules appear to be the "Höckerchen" form described by Rant. Following the pustule stage, or sometimes occurring without any appearance of it, there is a formation of the mycelium of the fungus over the surface of the branch. This mycelium spreads and extends over the entire lesion (Plate IV, fig. 1, Plate III), forming a pink incrustation, which varies somewhat in shade but perhaps typically approaches most closely the "orange-pink" of Ridgway's [18] nomenclature. This color is the most striking characteristic of the fungus (Plate I). The incrustation is at first almost entirely smooth and of a velvety appearance, but with age it becomes roughened and broken up into patches, passing through transitional stages of color until it finally fades out to a dirty white. The mycelium advances up and down the branch as a characteristically delicate, smooth, fan-shaped white mycelium (Plate II, fig. 2).

In some cases, upon cutting through the bark beneath the actively advancing mycelium, no visible effect of the fungus is found even though the mycelium on the surface has advanced considerably beyond the cut; in others the bark is shown to have a watery, darkened, greenish appearance; while in still other cases the affected area extends beyond the limits of the surface mycelium. This variation may perhaps be explained by different seasonal conditions. As the disease advances, the watery appearance of the bark passes off, and the tissue becomes still darker in color and presents a dried-out appearance. The bark at this stage is a dry mass of shredded fibers, running

[18] Ridgway, Robert, Color Standards and Color Nomenclature. Washington (1912) *pl. 2.*

longitudinally with the branch; the last condition seems typical of the effect of *Corticium.*

On *Citrus* the outermost layers of the wood become discolored to a light brown. The extent of this brown tissue, however, is small in comparison with the area covered by the surface mycelium of the fungus, and the discoloration of tissue has never been observed to extend deep into the wood. Brooks and Sharples, in their study of the disease on rubber, found that the fungus hyphae followed the medullary rays well into the tissue.

The ultimate effect of the growth of the fungus is the stoppage of the water conduction, followed by the wilting of the leaves and the ultimate death of the affected limb. This last stage takes place very rapidly; frequently the leaves wilt, yellow, and drop within a period of five days. Small twigs, main branches, or even trunks of trees are attacked (Plate VI, fig. 1, Plate VII, fig. 2). It has never been observed on roots. The susceptibility of young and old trees seems to be equally great. The accompanying photographs probably show these stages much more clearly than can a written description.

Pink disease has been found upon the following horticultural varieties of *Citrus* species:

Citrus nobilis Lour.: Tizon, Kishiu, Suntara Nagpur.
Citrus sinensis Osbeck: Native cajel, Pineapple orange, Washington navel, Mediterranean, Valencia, White Siletta, Jaffa, St. Michael, Sawyer's navel, Navelencia.
Citrus aurantifolia Swingle: Tahiti, West Indian, Dayap.
Citrus limonia Osbeck: Valencia, Clark, Villa Franca, Messina, Belair, Lisbon.
Citrus aurantium Linn.: Seville.
Citrus maxima Merr. (*C. decumana* Linn.): Marsh, Triumph.
Citrus medica Linn. var. *sarcodactylis.*
Citrus hystrix DC.
Citrus micrantha Wester.
Citrus webberi Wester var. *montana* Wester.
Citrus species: Natsumikan.
Citrus hybrid: Tangelo, Sampson.

Feronia elephantum Corr. and *Murraya exotica* Linn., the genera of which are closely related to *Citrus,* have also been observed as hosts of *Corticium salmonicolor* B. & Br. in the Philippines. The omnivorous character of the fungus and the diversity of *Citrus* varieties attacked by *Corticium* seem to indicate that the occurrence of species or varieties of *Citrus* resistant to the disease is highly improbable.

DISSEMINATION OF THE FUNGUS

Very little is known about the means of dissemination of the fungus. Our observations upon the pustule, or "Höckerchen," stage have always shown it to be sterile. We have always observed the pink incrustation, which is the most noticeable stage of the fungus, to be sterile upon *Citrus*. Brooks and Sharples report and figure basidiospores upon the pink incrustation formed on rubber, but we have not observed them on the incrustation as it occurs upon *Citrus*.

Plate II, figs. 3 and 4, show the gross appearance of the stage first described by Massee as *Necator decretus*. This stage is found very abundantly on *Citrus* during the early months of the rainy season, usually upon wood that has been previously killed by the fungus. It is conspicuous for its bright orange color (bitter-sweet orange of Ridgway), very distinct from the pink color of the sterile mycelium of the fungus. Irregularly shaped, thin-walled spores are formed abundantly in this stage; and these spores would appear to be the principle means of dissemination of the fungus, at least over any considerable distance. This fact assumes a bearing on the methods of control, since it indicates the value of the removal of all twigs and branches affected with the disease before the appearance of the *Necator* stage. The *Necator* stage as it occurs on rubber has been well figured and described by Brooks and Sharples; and, in general, our observations of this stage on *Citrus* confirm their conclusions.

CONTROL EXPERIMENTS

In the fall of 1917, in connection with experiments in the control of citrus canker conducted at Lamao experiment station by the senior author, control methods against *Corticium* were also taken up. The orchards selected at Lamao for the citrus-canker experiments were so badly affected with pink disease that control measures were desirable in order that they might be maintained in good condition.

In the past, control measures against pink disease have been for the most part based upon the removal of affected tree parts, followed by disinfection. A number of disinfection methods have been practiced, probably the most commonly employed being the application of tar. Van Hall [19] suggests carbolineum

[19] Van Hall, C. J. J., Cocoa. Macmillan & Co. Ltd., London (1914) 252.

as a disinfectant, and experiments in Malaya with other similar compounds are reported as being successful. Painting with a Bordeaux paste has also been recommended by a number of writers.

Butler [20] writes that, in India, the application of Bordeaux mixture, 6–4–45, to the parts of Para rubber trees most susceptible to attack by pink disease has resulted in a reduction of the disease of from 50 to 75 per cent. The mixture was applied with a brush around the forks, for a foot or two down the stem, and up the branches. Two or three applications during the year appear to have produced the most satisfactory results. Butler states that over 200,000 trees were treated at a cost varying from 1 to 2 rupees an acre (about 1.65 to 3.30 pesos per hectare).

With reference to the practice of spraying as a preventive and remedial measure for pink disease, Petch [21] states that applications of Bordeaux, 5–5–45, against pink disease on cacao resulted favorably. His statement is but a brief mention of fact in connection with another subject, and he does not give his spraying data. Bancroft [22] has also recommended the practice of spraying without, however, giving his experimental data. So far as we know, the results discussed in this paper constitute the first experimental evidence of the value of spraying practices against pink disease.

Orchard A at the Lamao station, which consists of various horticultural varieties and species of *Citrus*, was the most badly affected by pink disease and the control-experiment data and results for this orchard are presented in the following pages. The diagram (fig. 1) shows the position of the trees and the rows in the orchard, and also indicates the location of the cases of pink disease existing in October, 1917.

The orchard was divided into plats as follows: Rows 1, 2, 3, 4, 5, 6, in Plat I; rows 7, 8, 9, in Plat II; rows 10, 11, 12, in Plat III; rows 13, 14, 15, in Plat IV; rows 16, 17, 18, 19, 20, in Plat V. These plats were treated as follows:

[20] Butler, E. J., Fungi and Disease in Plants. Thacker, Spink & Co., Calcutta (1918) 505.

[21] Petch, T., Physiology and Diseases of Hevea brasiliensis. London (1911) 212.

[22] Bull. Dept. Agr. F. M. S. 1 (1912) 218.

TREATMENT OF ORCHARD A, LAMAO EXPERIMENT STATION

Plat I, rows 1, 2, 3, 4, 5, and 6.
- October, 1917: Limbs affected with pink disease pruned out.
- November 28: Lime sulphur.
- January 10: Neutral Bordeaux.
- May 31, 1918: Lime sulphur (change necessitated by increase of scale insects).
- June 25, 1918: Neutral Bordeaux.
- It was the original intention to continue the application of neutral Bordeaux through the entire period of the control experiments, but the increase of scale insects made changes to lime sulphur necessary.

Plat II, rows 7, 8, and 9.
- Neither pruning nor spraying was employed in this plat, the trees consisting of a check on the treated plats.

Plat III, rows 10, 11, and 12.
- October, 1917: Limbs affected with pink disease pruned out.
- November 28: Formalin 1–100.
- December 1: Formalin 1–75.
- December 6: Lime sulphur plus formalin 1–80.
- January 9, 1918: Neutral Bordeaux plus formalin 1–100.
- May 31: Lime sulphur.
- June 24: Lime sulphur.
- July 29: Lime sulphur.
- It was originally the intention to spray this plat entirely with lime sulphur; the applications of formalin, however, were employed because of the citrus canker experiments, while the application of neutral Bordeaux was made because no lime sulphur was available.

Plat IV, rows 13, 14, and 15.
- October, 1917: Pruned for *Corticium.*
- November 28: Formalin 1–100.
- December 6: Lime sulphur plus formalin 1–80.
- January 9, 1918: Neutral Bordeaux.
- May 31: Lime sulphur.
- June 26: Bordeaux 4–4–50.
- The changes from Bordeaux to lime sulphur and formalin were necessitated by the increase in scale insects and developments in the citrus canker work.

Plat V, rows 16, 17, 18, 19, and 20.
- The trees in this plat were neither sprayed nor pruned.

When pruning is mentioned it means that the trees of the plat indicated were gone over thoroughly to locate each case of the disease. Every affected limb was cut back far enough beyond the extent of the fungus to avoid all possibility of the fungus remaining in the unpruned portions. After each cutting the wound and the pruning implements were disinfected with a 2 per cent formalin solution. Subsequently each wound was painted with white lead.

In August, 1918, notes were made of the cases of pink disease in the orchard. The diagram, fig. 2, shows the number and location of diseased trees at that date.

DISCUSSION OF RESULTS

The text figures (figs. 1 and 2), showing the orchard with distribution of the spray plats, indicate perhaps most clearly the control obtained. To summarize, however:

In October, 1917, there were upon Plats I, III, and IV twenty-six trees affected with pink disease. At the same time in the unsprayed plats, II and V, there were fifteen cases of pink disease.

In August, 1918, the middle of the warm rainy season, no case was found in pruned and sprayed Plats I, III, and IV, the results amounting to effective and complete control. In untreated Plats II and V the fifteen cases of pink disease had increased to eighteen cases, in addition to which two trees, recorded in 1917 as having pink disease, had been killed as a result of the attacks by the disease.

The junior writer has observed control attempts on rubber in British North Borneo by pruning and disinfection methods alone. Such attempts appeared to give fairly satisfactory results without the accompanying spraying. However, the value of spraying is demonstrated by several cases observed at the Lamao orchard. In September tree 6, row 10, of this orchard was badly affected and nearly girdled with pink disease on the trunk. Because it was a large, valuable tree the station superintendent did not wish to have it entirely destroyed; and in deference to his wishes the tree was left, although its recovery appeared very improbable. Nevertheless, at every spraying period this lesion was given a strong application of the fungicide. In the last observation, August, 1918, the tree was in fine growing condition, and although in the middle of the rainy season the mycelium had not reappeared.

A similar experience was had with tree 8, row 11, exhibiting a very bad case of pink disease on the trunk and forks, where spraying resulted in the complete recovery of the tree. Trees in the unsprayed rows that showed similar attacks were killed within a short time.

Very similar results on rubber are reported by Richards [23] as having been obtained in the Federated Malay States by painting

[23] Richards, R. M., Diseases of the leaves and stem of Hevea brasiliensis in the Malay Peninsula, *Proc. First Agr. Conference Malaya*, Kuala Lumpur (April 25, 1917) 45–47.

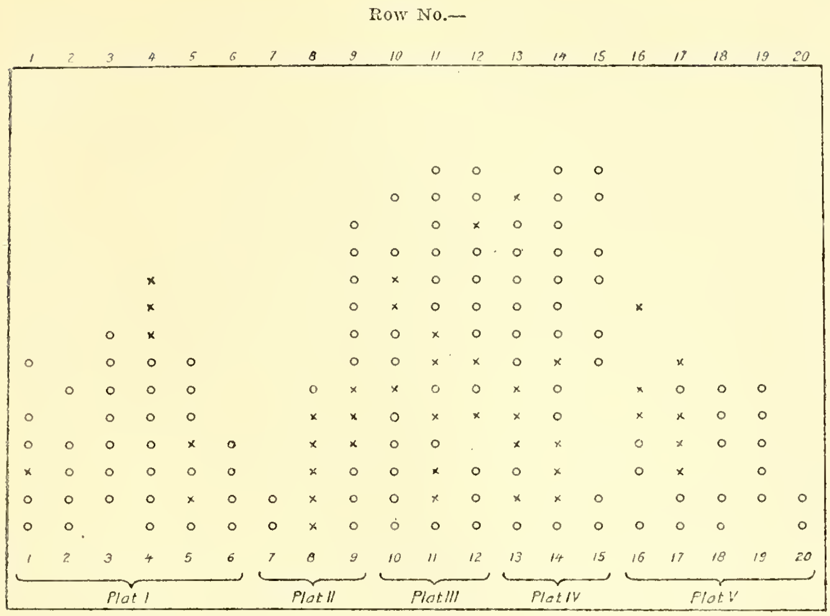

FIG. 1. Orchard A, at Lamao, Bataan Province, Luzon, showing location of *Corticium* cases in October, 1917. Circles show location of unaffected trees. Crosses show location of affected trees.

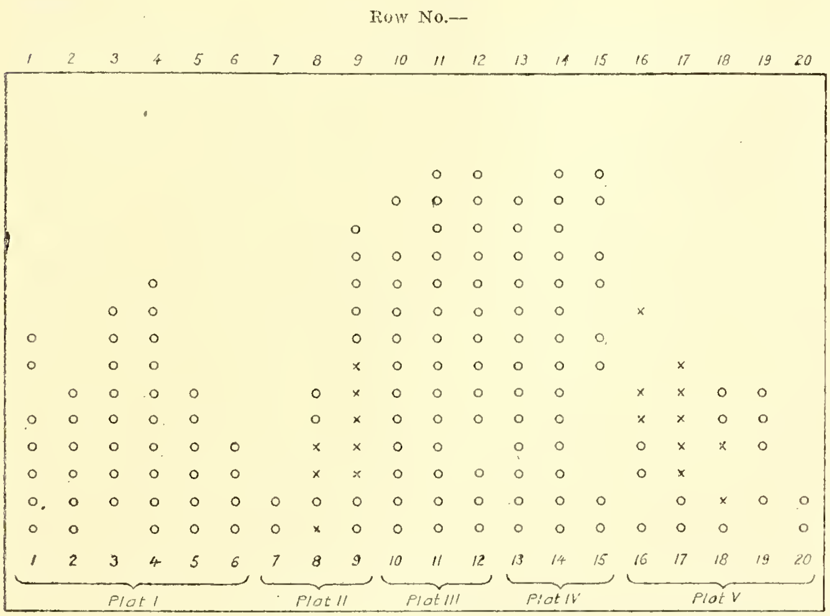

FIG. 1. Orchard A, at Lamao, Bataan Province, Luzon, showing location of *Corticium* cases in August, 1918. Circles show location of unaffected trees. Crosses show location of affected trees.

the affected places with tar. Although it does not seem reasonable to assume that such applications penetrate and kill the mycelium within the tissues, the report states that control is obtained in most cases. These results are in agreement with the observations made in the Philippines on the superficial application of fungicides; there, strangely enough, such applications have resulted in apparently complete control.

Although spraying is usually not practicable against pink disease on rubber, because of the size of the trees, it would seem to be the simplest method for the control of this disease on *Citrus*, since the application of fungicides may be combined with control methods against citrus canker, citrus scab, and, when lime sulphur is used, against scale insects. It seems probable that spray applications in connection with pruning would also prove an effective and simple control of the disease upon cacao, coffee, tea, and similar plants.

RECOMMENDATIONS

It is apparent that a control approaching almost complete eradication has been attained at Lamao. It seems probable that the fundamental procedure is the careful removal of affected limbs together with precautionary disinfection methods. However, it is also apparent that much can be accomplished by spraying as a preventive measure. Although copper sprays, such as Bordeaux and Burgundy mixtures, have proved successful against pink disease, they have the disadvantage of killing the fungus parasites of scale insects, thus bringing about a great increase in the latter. The use of copper sprays, therefore, is not recommended in the treatment of pink disease on *Citrus*, because of the great increase of scale insects following their repeated application. For this reason lime sulphur is suggested, not only because it is apparently as efficacious as are the copper sprays against pink disease, but also because it has been found of value against scale insects. Lime sulphur 1 to 40 is sufficiently strong, although it has been found that lime sulphur 1 to 35 will cause no injury to the foliage of citrus trees. A discussion of the preparation of lime sulphur is given by Waite.[24]

The time for spray applications varies with the season. For a normal season in central Luzon an application about May 15, another June 15, and another July 15, should be sufficient; that

[24] Waite, M. B., Fungicides, and their use in preventing disease of plants, *Bull. U. S. Dept. Agr.* 243 (1916).

is, at the beginning of the wet season, in the middle of the wet season, and toward its close. Should heavy rains and high humidity continue into August, another application in August would be advisable.

It should be emphasized that moisture conditions vary greatly in different parts of the Philippines and that the time for spraying in different islands would also vary with the periods and degree of rainfall in the various localities.

It seems probable that similar control methods would prove of value against pink disease of tea, coffee, cacao, and other crop plants, although we have no experimental data on which to make a definite statement.

DISCUSSION OF THE SERIOUSNESS OF PINK DISEASE AND ITS OCCURRENCE IN THE PHILIPPINES

Pink disease when uncontrolled causes serious injuries and often results in the death of entire trees and consequent economic losses. Plates V, VI, and VII show some of the effects of the disease. At present it is apparently not widely distributed in the Philippine Islands; but, should control measures not be adopted, conditions in regard to this disease may be expected to develop similar to those existing in the Federated Malay States, where the disease had gained a foothold before its seriousness was appreciated. Pest gangs are now maintained upon many rubber estates there for the purpose of disinfecting *Corticium* wounds and treating other diseases. It is to be hoped that Filipino planters will profit by experience in other countries, especially as the activities of the disease on *Citrus* trees at Lamao indicate what may take place if no control methods are attempted. In an area of not more than 12 hectares (30 acres) at least three hundred cases of *Corticium* have been observed. It should be remembered also that pink disease is a killing disease rather than one that merely takes its percentage from the financial returns by lowering the efficiency of the tree.

Although control by spraying and pruning is simple and comparatively inexpensive on *Citrus,* because of its localized occurrence at present, it seems possible to go further and entirely eradicate this disease from the Philippine Islands. Such eradication being effected, enforcement of adequate quarantine regulations should prevent the reintroduction of *Corticium salmonicolor* B. & Br., and the continual fight against the disease and the consequent expenditure of money would not need to be repeated from year to year. That eradication is possible is shown by the results being obtained in the United States against citrus canker, a disease which is much more infectious and difficult to control. It is particularly desirable to take steps to eradicate this disease before it has spread into privately owned Filipino holdings, where eradication would be extremely difficult.

Another question perhaps worthy of consideration is the possibility of the introduction of the disease into the southern United States. Von Speschnew [25] has reported *Corticium salmonicolor* B. & Br. on tea in the Caucasus. More recently Sawada has reported the fungus in Formosa at a latitude much the same as that of lower Florida, and the climate of southern Florida would seem quite as tropical as is that of Formosa. Rant, moreover, has reported *Corticium* on cinchona in Java, at an elevation of 2,000 meters, at which altitude in the Tropics the temperature is very considerably lowered.

Therefore, there seems to be the possibility that this fungus would develop readily in southern Florida or even in the other Gulf States, where the summer months are warm, wet, and humid. The necessity of preventing the introduction of this disease into the southern United States by quarantine measures is emphasized even more strongly by the report of *Corticium salmonicolor* B. & Br. in Porto Rico.

SUMMARY

1. Pink disease caused by *Corticium salmonicolor* B. & Br. has been observed in the Philippines upon various species and varieties of *Citrus*. It has been found in only three localities and is apparently a recent introduction.

2. Review of the literature shows it to be widely distributed throughout the oriental Tropics and that it causes serious economic losses in various countries on a number of hosts.

3. The appearance of the disease on *Citrus* is described. Control experiments are discussed which show that removal of affected limbs, accompanied by spraying, results in an effective control approaching entire eradication. The methods are simple and comparatively inexpensive. The results indicate that the commonly used fungicides are equally effective; however, lime sulphur is recommended since it is of value against scale

[25] Von Speschnew, N. N., Die Pilzparasiten des Theestrauches. Berlin (1907).

insects also. The control methods employed against pink disease combine well in a general spraying plan against other citrus disease.

4. It is probable that these control methods may be equally effective against pink disease on cacao, coffee, tea, and similar plants.

5. Since pink disease is as yet localized, we recommend that strong measures be taken for its complete eradication. Effective measures taken now would probably save the Philippine Islands from considerable financial loss in the future.

6. The possibility of this disease becoming established in the Gulf States of the United States is indicated.

ILLUSTRATIONS

[From photographs by Lee and by Cortes.]

PLATE I

FIG. 1. The sterile mycelium stage and pustule stage of *Corticium salmonicolor* B. & Br. The white advancing mycelium is also shown. Natural size.

2. *Corticium salmonicolor* in culture upon potato plug; in culture and occurring naturally the color is the most characteristic feature of this fungus in its sterile stages. Natural size.

PLATE II

FIG. 1. Early stage of pink disease on *Citrus*, showing gumming and first appearance of pustules. Natural size.

2. Showing the color of the sterile mycelium and advancing hyphae of *Corticium salmonicolor*. Natural size.

3. *Necator* stage of the fungus on *Citrus* twigs. Natural size.

4. Another specimen, showing *Necator* stage of the fungus on *Citrus* twigs. Natural size.

PLATE III

Showing early appearance of *Corticium salmonicolor* on *Citrus;* the pustule stage. Natural size.

PLATE IV

FIG. 1. Early stages of surface mycelium of *Corticium salmonicolor* on *Citrus* sp. Natural size.

2. A specimen similar to that of fig. 1; also showing gumming. Natural size.

PLATE V

Effect of pink disease on tree of *Citrus maxima* in nursery row.

PLATE VI

FIG. 1. Showing effect of pink disease on tree of Washington navel (*Citrus sinensis*).

2. The pink disease as it spreads up and down branches; in this case on Washington navel tree.

PLATE VII

FIG. 1. Tree of *Citrus sinensis* killed by pink disease. Lamao, Bataan, P. I. August 16, 1918.

2. Another view of orange tree killed by pink disease. Lamao, Bataan, P. I.

TEXT FIGURES

FIG. 1. Orchard A, Lamao, showing location of *Corticium* cases in October, 1917.

2. Orchard A, Lamao, showing location of *Corticium* cases in August, 1918.

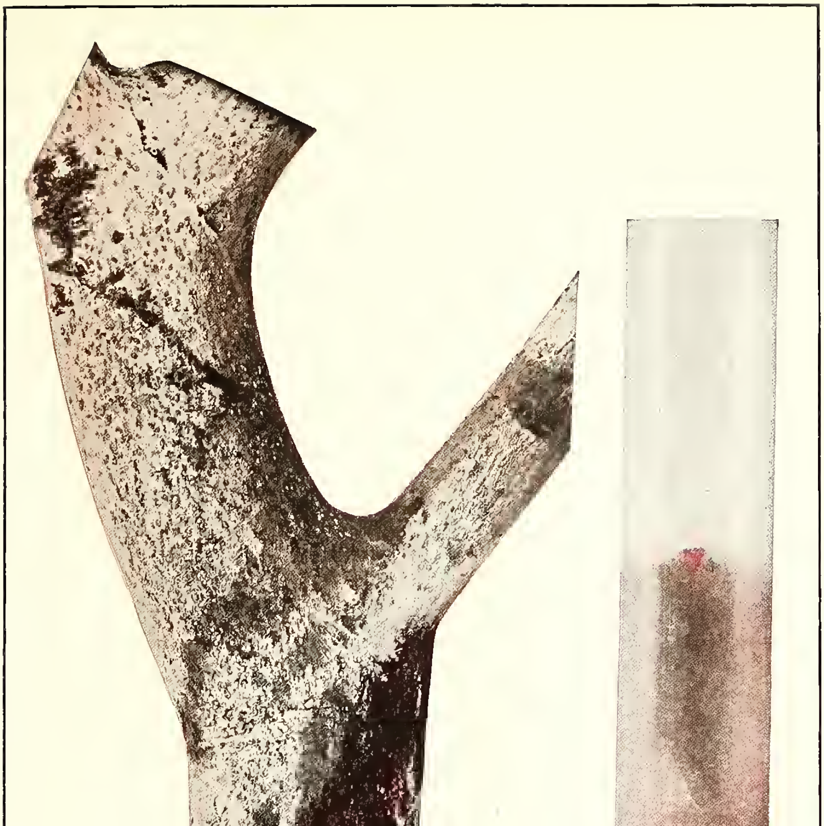

PLATE I. CORTICIUM SALMONICOLOR B. & BR.

PLATE II. PINK DISEASE ON CITRUS.

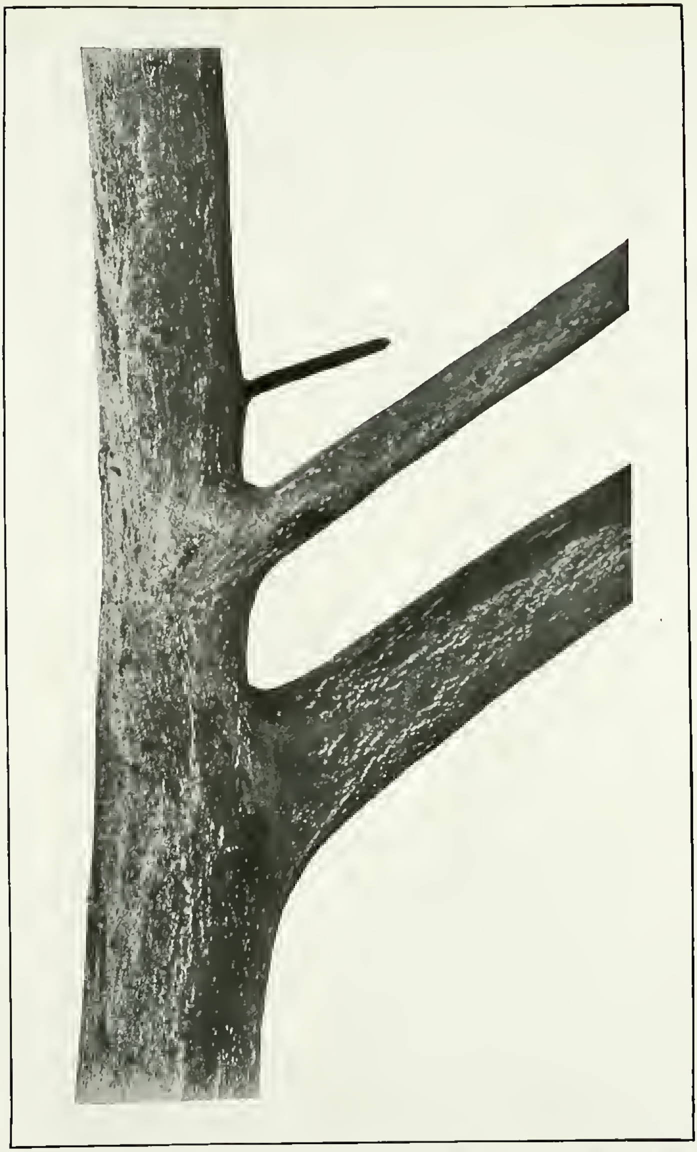

PLATE III. CORTICIUM SALMONICOLOR ON CITRUS; THE PUSTULE STAGE. NATURAL SIZE.

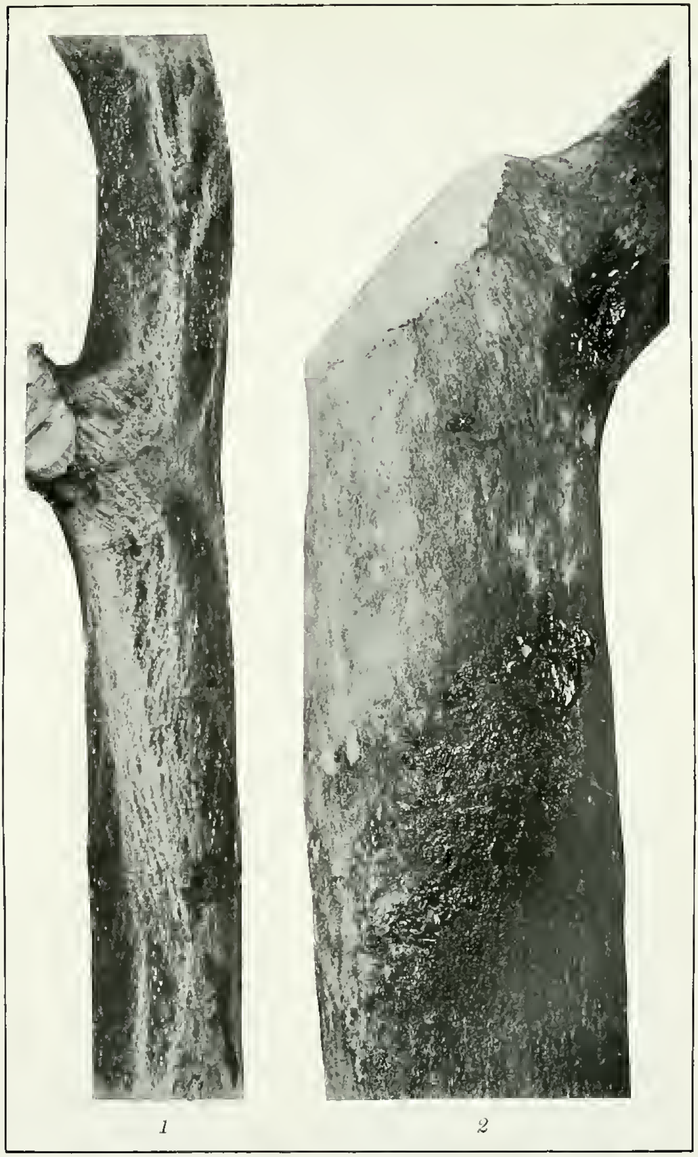

Fig. 1. Early stages of surface mycelium of Corticium salmonicolor on Citrus sp. 2. Similar to fig. 1; also showing gumming. Both figures natural size.

PLATE IV.

PLATE V. EFFECT OF PINK DISEASE ON TREE OF CITRUS MAXIMA IN NURSERY ROW.

Fig. 1. Pink disease.

Fig. 2. Pink disease.

PLATE VI.

Fig. 1. A citrus tree killed by pink disease.

Fig. 2. An orange tree killed by pink disease.

PLATE VII.

ERRATA

Page 1, line 21, for *Xanthorriza* read *Xanthorrhiza*.

Page 3, line 11 from the bottom, *for* SIMEA *read* SIAMEA.

Page 50, column 2, line 1, Table XXIII, *for* Intramuscular *read* Intravenous.

Page 299, column 2, line 15 from the bottom for *Meyerianus* read *meyenianus*.

Page 300, column 1, lines 25, 26, and 28, for *siphonosphathus* read *siphonospathus*.

Page 300, column 2, lines 1, 3, and 5, for *siphonosphathus* read *siphonospathus*.

Page 326, last line, for *cagayensis* read *cagayanensis*.

Page 328, lines 5 and 6 from bottom, for *cagayensis* read *cagayanensis*.

Page 338, line 7 from bottom, *for* **FRUCTICANS** *read* **FRUTICANS**.

Page 347, line 10 from the bottom, for *siphonosphathus* read *siphonospathus*.

Page 354, line 25, *for* **SIPHONOSPHATHUS** *read* **SIPHONOSPATHUS**.

Page 396, line 7 from the bottom, for *zamboanguensis* read *zamboangensis*.

Page 437, line 2 from the bottom, for *machranta* read *macrantha*.

INDEX

[New generic and specific names and new combinations are printed in **clarendon**; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

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