

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOLUME 20, 1930

290080

day and the same of the same o

EDGAR W. WOOLARD

BOARD OF EDITORS

EDGAR T. WHERRY UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS
CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY
EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY
BY THE

WASHINGTON ACADEMY OF SCIENCES

THE WAVERLY PRESS
BALTIMORE, MD.

ERRATA

Vol. 20, 1930

Page 48, line 21: for "chacteristic" read "characteristic." Page 48, line 32: for "tubersoa" read "tuberosa." Page 392, line 20: for "Illinois" read "Illinoian." Page 402, line 26: for "than" read "as." Page 406, line 20: for "Ospores" read "Oospores." Page 422, line 22: for "by" read "to." Page 422, line 22: for "terminants" read "Eureka." Page 424, line 27: for "reminants" read "Eureka." Page 425, line 22: for "consist" read "consists." Page 425, line 22: for "southern" read "northern." Page 425, line 33: for "same" read "name." Page 426, line 31: for "Dinorthes" read "Dinorthis." Page 426, line 35: for "laminatedy" read "laminated." Page 427, line 33: for "neither" read "none." Page 429, line 39: for "diminantly" read "dominantly." Page 430, line 7: for "many" read "may." Page 431, line 36: for "is" read "are." Page 432, line 10: for "Trissic" read "Triassic." Page 435, line 31: for "about 81,000" read "over 80,000."

JOURNAL

OF THE



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

JOHN B. REESIDE, JR. NATIONAL MUSEUM

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

ASSOCIATE EDITORS

- L. H. ADAMS
 PHILOSOPHICAL SOCIETY
- E. A. GOLDMAN BIOLOGICAL SOCIETY
- AGNES CHASE BOTANICAL SOCIETY

- S. A. ROHWER ENTOMOLOGICAL SOCIETY
- G. W. STOSE GEOLOGICAL SOCIETY
- J. R. SWANTON
 ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

Mt. ROYAL AND GUILFORD AVES.
BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, aims to present a brief record of current scientific work in Washington. To this end it publishes: (1) short original papers, written or communicated by members of the Academy; (2) short notes of current scientific literature published in or emanating from Washington; (3) proceedings and programs of meetings of the Academy and affiliated societies; (4) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Reprints will be furnished at the following schedule of prices.

Copies	4 pp.	'8 pp.	12 pp.	16 pp.	Covers
50	\$.85	\$1.65	\$2.55	\$3.25	\$2.00
100	1.90	3.80	4.75	6.00	2.50
150	2.25	4.30	5.25	6.50	3.00
200	2.50	4.80	5.75	7.00	3.50
250	3.00	5.30	6.25	7.50	4.00

An additional charge of 25 cents will be made for each split page.

Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, will be furnished when ordered.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	. 50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, R. L. Faris, Coast and Geodetic Survey, Washington, D. C. European Agent: Weldon & Wesley, 28 Essex St., Strand, London.

Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

January 4, 1930

No. 1

PALEONTOLOGY.—A new Callianassa from the Cretaceous of South Dakota.¹ Mary J. Rathbun, U. S. National Museum.

In 1927 a number of fossil crustaceans collected by William L. Russell of the South Dakota Geological Survey were received through Dr. Carl O. Dunbar of the Peabody Museum of Yale University. They came from the Cretaceous of South Dakota and represent an undescribed species of *Callianassa*.

Callianassa cheyennensis, sp. nov.

Type-locality.—Very top of Pierre shale and just below Fox Hills sandstone; collected along both banks of the Missouri River at several points between the mouth of the Cheyenne River and the Cheyenne Agency; 17 fragmentary specimens showing portions of the chelae. Type in the Geological Museum at the University of South Dakota at Vermillion.

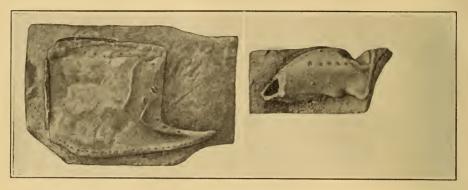
Measurements.—Propodus of left cheliped, holotype, length to end of finger 14.6, length to sinus between fingers 10, greatest height 10.6, distal

height of palmar portion 9.2 mm.

Description.—The type-specimen (Fig. 1) shows the inner face of a propodus of a left and probably major cheliped. Palm short and high, the greatest height equal to the length through the middle. Upper margin straight or a little convex, rounding down at each end. Proximal end not exactly at right angles to upper margin but forming a slightly acute angle. Considering the upper margin as horizontal, the lower margin after rounding down from the proximal end slopes gradually upward to the tip of the finger. Surface nearly flat. Finger (propodal) narrow, its base less than a third the height of the distal end of the palm; from the base it narrows rapidly to a slender extremity and curves gradually upward. On the inner surface of the hand there is, close to the lower margin, a row of hair sockets of which 27 can be made out; this does not include a few that may be at the proximal end. On the upper margin the sockets are fewer and more distant but the number cannot be determined. On the inner surface near the margin of the finger there is a curved row of three small distant sockets; the two distal of these are paired by a socket higher up, either on or just over the finger edge. At the distal end of the palm near the sinus between fingers there are two large sockets,

¹ Received November 18, 1929.

much larger than any others. A little below the upper margin in a straight line not quite parallel with the margin, but sloping a little downward distally to the condyle articulating with the dactylus, there is a row of linear spaced sockets of which about 9 can be made out. A few more sockets are scattered over the inner surface.



Callianassa cheyennensis.

Fig. 1. Inner view of propodus of left cheliped, × 3. Holotype.

Fig. 2. Inner view of dactylus of right cheliped, × 4. Paratype.

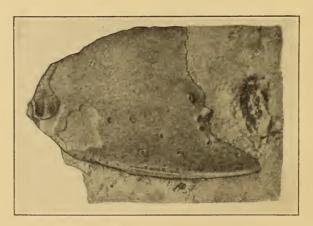


Fig. 3. Callianassa cheyennensis. Paratype. Outer view of propodus of right cheliped, × 4.

The paratype (Fig. 3) is a right palm with the outer surface exposed. If, as I assume, it is the same species as the holotype, it is a minor chela of a larger specimen. The upper portion is broken off, the outer surface is convex from top to bottom and the inner is flat. Parallel to the lower margin outside there is a row of rather large well separated sockets 12 of which are visible, running on to the finger. A large socket near the sinus between the fingers is by far the largest of a series of 5 which follow the line of the propodal finger; and on the edge there is a row of small, evenly spaced sockets at least 7 in number. Below the middle of the palm there are 5 or 6 distant fair-sized sockets making 2 subparallel oblique lines. On the distal edge of the palm between the fingers there is a strong tuberculiform tooth pointing distad.

The movable finger (Fig. 2) belongs to a right chela, perhaps to the propodus just described, near which it lies; it is very thick, upper surface broad, upper margin convex except for a deep transverse sinus which embraces the articulating condyle. Two sockets transversely placed on upper surface not far from sinus. On inner surface just below upper margin there is a row of 5 prominent oblique sockets. Further down at the middle two small sockets are disposed longitudinally; 2 sockets on lower surface and a broad triangular subbasal tooth. The thin prehensile edge is nearer the outer

surface; it, as well as the tip, are incomplete.

Affinity.—The specimens have been compared with 3 specimens of C. whiteavesii Woodward² from Sounding Creek, N.W. Territory. In this species the palm is definitely longer than wide, its proximal end is at right angles to both upper and lower margins, although the latter begins to slope upward at about the middle of its length, making the proximal half of the palm higher than the distal half. None of the specimens show the inner surface. outer surface is less convex than in cheyennensis, its upper edge thin and not bent over so far on to the inner side. A smooth, blunt ridge runs inward from the upper edge of the propodal finger and fades out about half way along the palm. The surface below this is flattened or a little concave. In the new species this surface is evenly convex. Close to the upper edge in whiteavesii there is a row of lengthwise punctae 12 of which can be made out. Near and parallel to the proximal end, a row of 6 punctae, visible on the counterpart of Woodward's fig. 2b; and a row of 3 punctae arranged lengthwise and slightly obliquely at the middle of the palm and pointing toward the upper edge of the propodal finger (on the counterpart only of fig. 2b). The fingers are of about equal size. On the original of Woodward's fig. 2a there is a large, depressed, transverse socket on the palm near and parallel to the dactylus.

BOTANY.—Botanical notes on, and descriptions of, new and old species of Venezuelan plants.—III. Old and new species of Euphorbiaceae (Conclusion).¹ H. PITTIER, Caracas, Venezuela.

Croton redolens Pittier, sp. nov. (Sect. Eluteria)

Arbuscula redolens, aromatica, coma depressa, ramis contortis, nodosis, glaberrimis, cortice griseo tectis, ramulis novellisque dense fulvo-tomentosis; foliis alternis, petiolatis, membranaceis, petiolis laminis 2–3-plo brevioribus, teretibus, tomentellis, apice 2–7-glandulosis, glandulis brevissime stipitatis, laminis late ovatis, subcordiformibus, basi leviter emarginatis rotundatisve, 5–7-nerviis, apice acutatis obtusiusculis, supra velutinis vel praeter nervis parce stellulatis, subtus dense cano-tomentellis, marginibus plus minusve sinuato-dentatis, dentibus villosulis; stipulis inconspicuis; racemis terminalibus axillaribusve, pedunculatis, rhachi anguloso, longitudinaliter sulcato, fulvescente-tomentello; bracteis inconspicuis; floribus flavescentibus virescentibusve, pedicellatis, haud congestis, foemineis remotis 1–3 basalibus, masculinis 1–4-fasciculatis, cito deciduis; flor. foem.: pedicello crasso calyce subaequante, calyce haud accrescente extus tomentoso intus

¹ Geol. Mag. n. s. 7: 435. pl. 17, fig. 2. 1900.

¹ The two first contributions on new and old species of Venezuelan plants appeared in This Journal 19: 175-186 and 351-357. 1929. Received November 15, 1929.

parce stellulato, pilis bombycinis, segmentis ovato-lanceolatis obtusis; petalis lineari-lanceolatis, villosis, calyce brevioribus; ovario dense tomentello, stylis semel dichotomi, cruribus denticulatis, basi parce stellulatis; flor. masc.: pedicello gracili calyce subbreviori, calycis segmentis ovato-oblongis, obtusis, tomentosis; petalis ovato-oblongis, obtusis, utrinque villosulis; receptaculo bombycino-villoso; staminibus 15-17, glabris; capsula pedicellata, subglobosa, trisulcata, extus dense stellulato-tomentosa; seminibus carunculatis, laevibus, oblique transverse-sulcatis.

Arbuscula 2-3 m. alta, basi ad 12 cm. crassa. Petioli 0.8-3.5 cm. longi; laminae 2.5-8 cm. longae, 1.5-6 cm. latae. Racemi 4-10 cm. longi, pedunculis 2-2.5 cm. Flos masc.: pedicelli sub-2 mm. longi; calvcis segmenta ex centrum 2-2.5 mm. longa, 0.8-1.2 mm. lata; petala circa 1.5 mm. longa, 0.5-0.8 mm. lata. Flos foem.: pedicelli plus minusve 5 mm. longi; calvcis segmenta ex centrum 4-4.7 mm. longa, basi 1.5-1.8 mm. lata; petala 1.8-2.5 mm. longa, 0.1-0.4 mm. lata. Capsula 4-7 mm. longa; semina 2-5 mm.

FEDERAL DISTRICT: On arid hills near Las Trincheras, 900 m.; Tacagua valley, on the old cart-road from Caracas to La Guaira, forming small groves; flowers and fruits September 6, 1925 (Pittier 11886, type); other collections, same locality Pittier 10250 (var. parvifolia), 10254 (var. velutina).

The female flowers are always distinctly 5-petalous, so that this interesting species has to be placed in Section Eluteria, where it has so far no nearly related Venezuelan ally. It presents itself in at least three distinct varieties: the typical one (var. genuina Pittier, var. nov.); another with larger leaves velvety on the upper face (var. velutina Pittier, var. nov.); and a third, the tree more twisted and gnarled, the leaves also tomentellose on both faces, but much smaller, biglandular or the glands obsolete (var. parvifolia Pittier, var. nov.).

All parts of the tree, the leaves especially, have a very aromatic, pungent smell, and are used as a home medicine. Vernacularly, the plant is known as Sangredrago, a name which applies to the arborescent species of Croton generally.

Croton anomalus Pittier, sp. nov. (Sect. Decarinium)

Arbuscula ramis glabris glabrescentibusve, ramulis parce adpresseque stellulato-pubescentibus: foliis alternatis, membranaceis, breviter petiolatis, basi eglandulosis, petiolis teretibus, adpresse pubescentibus indumento stellulato pilis paucis erectis longioribus intermixto, laminis ovalibus ovatolanceolatisve basi rotundatis, leviter emarginatis, quintuplinerviis apicem versus sensim angustatis et abrupte cuspidatis, marginibus irregulariter sinuatis, dentatis serrulato-dentatisve, supra pilis simplicibus parcissime hirtis vel glabrescentibus asperulisque, subtus dense cano-tomentellis; stipulis elongatis, lanceolato-linearibus, pubescentibus; racemis terminalibus, rhachi pubescente; bracteis linearibus, stellulato-villosis, persistentibus; floribus foemineis 1–3 sessilibus subsessilibusve, calycis segmentis 6 (interdum 7) ovalibus, obtusiusculis, valde inaequalibus, 4 anteriores reliquis majoribus, supra obscure viridis stellulato-puberulis, subtus cano-tomentellis; ovario dense fulvo-hispido, stylis ter-dichotomis, cruribus gracilibus, villosis, supremis brevibus; floribus masculis numerosis caducissimis pedicellatis, foemineis minoribus; pedicellis gracilibus, calycis segmentis late ovalibus, obtusis, tenuiter membranaceis, venulosis, atque receptaculo utrinque villosis; petalis calycis segmentis paullo longioribus, obvato-spathulatis, longe angusteque unguiculatis, utrinque villosulis; staminibus 16, filamentis villosis; capsula

ignota.

Arbuscula ad 2 m. alta. Petioli 0.6–1.2 cm. longi; laminae 3–6.5 cm. longae, 1–2.7 cm. latae. Stipulae 0.8–1 cm. longae. Racemi 5–7 cm. longi; bracteae circa 3 mm. longae. Flos masc.: pedicelli 1.5–2.5 mm. longi; calycis segmenta ex centrum 4 mm. longa, 1.8–2.4 mm. lata; petala 4 mm. longa, 1.2–1.6 mm. lata. Flos foem.: calycis segmenta majores ex centrum 6.5–7.2 mm. longa, 2.8–3.8 mm. lata.

Lara: Los Rastrojos, between Sarare and Barquisimeto, in bushes; flowers

April 9, 1925 (Pittier 11757, type).

This species departs from all the other species of *Croton* found heretofore in Venezuela in the 6–7 calycinal segments, 4 of which are manifestly larger than the 2 remaining ones. Though I am aware that its relationship to *C. glandulosus* and *C. chamaedryfolius* is very remote, I have placed it provisionally in Section *Decarinium*.

Croton timotensis Pittier, sp. nov. (Sect. Decapetalon)

Arbuscula tronco ramisque in aetate glabrescentibus, ramulis teretibus villoso-tomentosis pilis simplicibus fulvescentibus; foliis modice petiolatis, membranaceis, petiolis canaliculatis dense stellulato-tomentosis apice pauci-(2-6-) glandulosis, laminis ovato-cordiformibus basi late emarginatis subtruncatisve (3-)5-(7)-nerviis, apice longe cuspidatis, margine dentatis, supra praeter nervis stellulato-puberulis glabrescentibus minute tuberculatis, subtus dense estellulato-tomentosis, pilis fulvescentibus; stipulis setaceis, stellulato-villosis; racemis elongatis, remotifioribus, rhachi pedicellisque dense tomentellis, bracteis lineari-subulatis; floribus 4-6-fasciculatis; foemineis subsessilibus interdum solitariis, calycis segmentis anguste oblongis, obtusis, extus tomentellis, glandulis atris substipitates alternantibus; ovario fulvotomentoso, stylis semel dichotomis, cruribus basi parce stellulatis; calycis segmentis florum masculorum late ovatis, obtusis, extus fulvo-tomentosis; petalis 10, calycis segmentis brevioribus, lanceolatis, basi longe attenuatis glabris, apice ciliatis; receptaculo villoso; staminibus 39-51, filamentis villosotomentosis; capsula ovoidea, extus parce stellulata; seminibus laevibus, carunculatis.

Arbuscula usque ad 2.5 m. alta. Petioli 1.5–5 cm. longi; laminae 4–11 cm. longae, 2–5 cm. latae. Stipulae 3–4 mm. longae. Racemi 15–22 cm. longi; pedicelli florum masculorum circa 4 mm. longi; bracteae 4–5 mm. longae. Flos masc.: calycis segmenta ex centrum 4–4.5 mm. longa, 2–2.5 mm. lata; petala 3–4.2 mm. longa, 0.9–1.6 mm. lata. Flos foem.: calycis segmenta ex centrum 5–6.5 mm. longa, 1.1–1.6 mm. lata. Capsula circa 6 mm. longa; semina 4.5–5.5 m. longa.

Mérida: Vicinity of Timotes, 2000 m., in bushes along river; flowers and

fruits January 20, 1928 (Pittier 12646, type).

This species is a most interesting addition to the flora of Venezuela, being the first and only representative of Section *Decapetalon*, which according to Muell.-Arg. comprised heretofore only 3 species, 2 in the Tropics of Asia and Africa and another in Southern Brazil.

Croton confusus Pittier, sp. nov. (Sect. Eucroton-Eutropia)

Arbor elegans, trunco erecto, cortice griseo tecto, coma elongata, ramis vestutis glabrescentibus, juveniis dense rufo-tomentellis, pilis stellulatis; foliis submembranaceis, imprimis utrinque stellulato-tomentosis, indumento subtus petiolorumque densius et canescente, in aetate utrinque glabrescentibus nervibus supra subtusque prominentibus, venulis reticulatis subtus prominulis; petiolis elongatis, gracilibus vix sulcatis, laminis amplis, integris trilobatisve, basi leviter emarginatis biglandulosis, glandulis magnis sessilibus, lobis acuminatis, saepe sublobulatis, margine sinuato-dentatis, dentibus glandulosis; stipulis setaceis, caducissimis; racemis foliis brevioribus rhachi dense stellulato-tomentoso; bracteis inconspicuis, ovatis, villosis; floribus luteis 6-9-fasciculatis, masculis foemineisque inmixtis, pedicellatis; pedicellis masculis calvee subduplo longioribus, foemineis brevioribus; calveis masculi segmentis ovatis, obtusis, extus dense stellulato-tomentosis intus receptaculoque tomentosis pilis simplicibus; petalis lanceolatis obovato-spathulatisve, tomentosis, calycis segmentis longioribus; staminibus 24, glabris; calycis foeminei segmentis oblongis, apice acutatis, obtusis; disci glandulis majusculis; ovario dense fulvo-hirsuto, pilis simplicibus; stylis e basi divisis, fere glabris, cruribus apice breviter bilobulatis, lobulis latis obtusis. Capsula non vidi.

Arbor ad 20 m. alta, basi 40 cm. crassa. Petioli 4–14 cm. longi, laminae 7–22 cm. longae, 3.5–16.5 cm. latae. Racemi 12–16 cm. longi; pedicelli florum masc. 4–6 mm., foemin. circa 2 mm. longi. Flos masc.: calycis segmenta ex centrum circa 4 mm. longa, 2.2 mm. lata; petala 4.5-5 mm. longa, 1-1.5 mm. lata. Flos foem.: calycis segmenta ex centrum circa 5 mm. longa, 1-2 mm. lata.

YARACUY: Forested hills around Iboa near San Pablo, at an altitude of

450 m.; flowers January 2, 1929 (Pittier 13077, type).

Confused at first with Croton gossypiifolius Vahl, it differs in the number of stamens, which was found to be 24 in all the flowers examined; in the contexture of the leaves almost invariably with two large glands at the base and with small yellow glands on the margin; in the yellow flowers; and in several other good characters. The vernacular name is Sangrito.

Croton caracasanus Pittier, sp. nov. (Sect. Eucroton-Cleodora)

Arbor parva vel mediocris, ramis glabrescentibus, ramulis plus minusve lepidotis; foliis alternis, membranaceis, opacis, modice petiolatis, petiolis gracilibus, anguste canaliculatis, parce lepidotis, apice hirtellis superne biglandulosis, inferne hirtellis, glandulis sessilibus crateriformibus; laminis ovalibus, basi rotundatis 5-nerviis, apicem versus acutatis, margine irregulariter grosse serrato-dentatis, utraque pagina stellulato-lepidotis, lepidibus haud contiguis, supra obscure viridis, subtus pallidioribus nervis vix prominulis basi hirtellis; stipulis inconspicuis; racemis elongatis, rigidis, remotifloris, saepe unisexualibus; basi saepe bracteis 2, foliaceis alternis suffultis; rhachi gracili, anguloso, densius lepidoto; bracteis inconspicuis; floribus parvis, numerosis, foemineis sessilibus, vulgo solitariis interdum binis; calyce breviter tubuloso, lepidoto, segmentis ovatis, obtusiusculis; ovario cano-tomentoso, stylis bifidis, cruribus crassis, subciliatis; floribus masculis breviter pedicellatis, calycis segmentis late ovatis, extus tomentellis; petalis calyce subaequantibus, extus glabris, intus receptaculoque bombycinis, margine dense cano-tomentellis; staminibus 14-16; capsula depressa, trisulcata, parce stellulato-lepidota.

Arbor usque ad 12 m. alta, basi 35–40 cm. diam., vel saepe arbuscula depressa 2–3 m. alta. Petioli 1.5–4 cm. longi; laminae 5.5–12 cm. longae, 3–7.5 cm. latae. Racemi 10–22 cm. longi. Flos masc.: pedicelli 1–1.5 nm. longi; calycis segmenta ex centrum 2.3–3 mm. longa, 1.7–1.9 mm. lata. Petala 2.4–3 mm. longa, 0.9–1.2 mm. lata. Calyx foemineus circa 2.5 mm. longus, segmentis 1.4–2 mm. longis, 0.9–1.3 mm. latis. Capsula 8 mm. longa, circa 10 mm. lata.

LARA: Vicinity of Duaca; flowers July 1925 (Saer d'Héguert 276, type). FEDERAL DISTRICT: Catia de los Frailes near Caracas, on rocky slopes; flowers and fruits December 21, 1923 (Pittier 11289); Chacaíto Gorge, in

forest; flowers August 24, 1923 (Pittier 11131).

This species, which seems to be very variable in size, is not uncommon on the wooded hills with southern exposure and in the cool gorges around Caracas. I do not think to be mistaken in placing it in Series Argyrocroton, Subsect. Cleodora of Sect. Eucroton, although the two other Venezuelan species of that Series, C. orinocensis and C. multicostatus differ in the habit, in the glandless leaves and in the twice divided styles. C. caracasanus would come near to C. stenotrichus Muell.-Arg. In Lara, it is known vernacularly as Sangre de drago and Cáscara amarga.

Croton multicostatus Pittier, sp. nov. (Sect. Eucroton-Cleodora)

Arbor parva vel mediocris, ramulis crassis creberrime subferrugineolepidotis, in aetate glaberrimis; foliis magnis, coriaceis, integerrimis, modice
petiolatis, petiolis teretibus, anguste canaliculatis, lepidotis, lepidis haud
contiguis, laminis late ovatis, basi emarginatis, eglandulosis, apice vulgo late
rotundatis, supra primum praeter costam nervosque dense stellulato-hirsutis
parce stellulatis, demum glaberrimis, subtus primum utrinque densissime
lepidotis, mox glabrescentibus glabrisve, costa venisque 12–15 parcissime
stellulato-lepidotis; stipulis lineari-lanceolatis, lepidotis, cito deciduis; racemis
terminalibus densifloris haud bene evolutis, rhachi alabastrisque lepidotis;
bracteis masculis 3-floris, lepidoto pubescentibus late triangularibus, concavis, unilateraliter lobulatis, lobulo triangulari; petalis oblongis, obtusiusculis, extus minutissime puberulis, intus glabris, margine dense ciliatis; receptaculo villoso; staminibus 11–12, filamentis basi barbatis; bracteis foemineis
masculis majoribus, unifloris, intus glabris; calyce foem. subtubuloso, segmentis ovatis, acutis, extus lepidotis, intus plus minusve villoso-tomentosis;
ovario dense rufo-villoso, stylis bis vel ultra dichotomis; et caetera ignota.

Arbor 8–12 m. alta. Petioli 4–5 cm. longi; laminae 9–19 cm. longae, 6–14 cm. latae. Stipulae 1.2–2 cm. longae, 2–3 mm. latae. Bracteae foem. ad 1 cm. longae, masc. 0.5 cm. longae. Čalyx foem. circa 1.2 cm. longus,

lobulis 0.5 cm. longis, 2.5-3 cm. latis.

Carabobo: Hacienda de Cura, 900 m., in forests; in bud August 15, 1918 (*Pittier* 8013, type).

This fine species, of which we unfortunately have only imperfect specimens, belongs undoubtedly to Series Argyrocroton, Subsect. Cleodora of Section Eucroton (Medea). The scales are of the same type as those of the Brazilian Croton migrans Casaretto. The most striking character, which this species has in common with C. umbratilis H.B.K., consists in the unusually large

number of primary veins; the size and glabrescence of the mature leaves are also unusual in the Venezuelan species. The tree is known locally as Torco.

Until more complete information is obtained, we assign to this species our No. 11948, also imperfect, with unripe capsules. It differs from the typical C. multicostatus mainly in the oval-lanceate leaves. The scales of the petioles also seem to be smaller, with indistinct rays. The young capsules are obovoid, 13-15 mm. long and scaly furfuraceous, the seeds 11 mm. long, smooth and with a sessile caruncula. The calyx is persistent, but apparently not accrescent. The tree is a large one with a trunk not less than 4 m. up to the main limbs and about 50 cm, in diameter. In the valley of Caruao (Federal District) whence our specimens come, it is known as Sarasaro.

Croton grossedentatus Pittier, sp. nov. (Sect. Eucroton-Cleodora)

Frutex humilis, trunco ramis vestutis glabris glabrescentibusve, ramulis squamuloso-stellulatis, novellis petiolis racemorum rhachidibusque dense hirto-tomentosis; foliis membranaceis, modice petiolatis, basi eglandulosis 7-nerviis, petiolis leviter canaliculatis, laminis oblongo-ovatis basi cordiforme emarginatis, apice sensim acuminatis acutissimis mucronulatis, marginibus fere e basi grosse serrato-dentatis, dentibus serrulatis apicibus glandulosomucronulatis, supra obscure viridis parce stellulatis, subtus cano-tomentosis costis nervibus venulisque transversalibus prominentibus; stipulis linearisetaceis, stellulato-pilosis; racemis brevibus axillaribus terminalibusque, basi floribus foemineis 2-4 breve pedicellatis, apice floribus masculis cito caducis gerentibus; bracteis parvis, hirsutis, caducissimis; floribus parvis; foemineis: calvee persistente, segmentis oblongo-acuminatis, extus dense fulvo-tomentosis, intus glabris; ovario fulvo-hirsuto, stylis sub-4-partitis, cruribus gracilibus. saepe bifidis, fere ad apicem villosis; floribus masculis foemineis minoribus, calvois segmentis oblongis, apicem obtusem versus angustatis; receptaculo villoso; staminibus 12, exsertis, filamentis glabris; capsulis obovoideis, extus cano-villosis, indumento stellulato in aetate depauperato; seminibus ovalibus, carunculatis, laevibus, brunneis.

Frutex usque ad 1.50 m. alta. Petioli 1-5.5 cm. longi; laminae 6.5-12 cm. longae, 3.5-6 cm. latae. Stipulae 8-10 mm. longae. Racemi 2.5-4.5 cm. longi. Flos masc.: pedicelli 3 mm. longi, calycis segmenta ex centrum 2.7-3.2 mm. longa, 1.2–1.4 mm. lata. Petala 2.8–3.3 mm. longa, 0.5–1 mm. lata. Flos foem.: pedicelli 2–3.5 mm. longi, calycis segmenta e basi 5.5 mm. longa (longitudino calycis 7 mm.), plus minusve 2.5 mm. lata. Capsula 6-7 mm.

longa; semina circa 3.5 mm. longa

LARA: On arid hills along the road between El Tocuyo and Humocaro Bajo; flowers and fruits, January 6, 1929 (Pittier 13105, type).

Related to C. populifolius Mill. through the mode of division of the styles and the number of stamens but differs in the eglandular calyx, in the serrature of the leaves, and the simply subulate stipules. From C. urticaefolius Lam. it is distinguished by the number of stamens (12 instead of 9-11), the glabrous filaments, and also the shape of the leaves and the eglandular stipules.

Croton truxillanus Pittier, sp. nov. (Sect. Eucroton-Cleodora)

Frutex vel arbuscula ramulis novellisque sordide pubescentibus, foliis alternis, breviter petiolatis, membranaceis, sub-3-plinerviis, petiolo sordide pubescente laminis 5-7-plo breviori, apice biglanduloso, laminis ovatis, basi cuneatis apice breviter acuminatis, supra pubescentibus cinereo-viridisque, in aetate glabrescentibus, subtus dense cano-tomentosis, pilis omnium stellatis, marginibus obscure denticulatis; racemis terminalibus, elongatis, basi floribus foemineis 2-7 subsessilibus, apice floribus masculis dense congregatis gerentibus, rhachi gracili tomentoso; bracteis triangulari-lanceolatis, tomentosis, foemineis 1-, masculis 1-3-floris; floribus foemineis: calyce persistente, segmentis ovato-triangularibus, obtusiusculis, extus dense tomentosis, intus glabris: petalorum rudimentis conspicuis, glanduliformibus: ovario dense flavescente-tomentoso, stylis bifidis, basi glabris, cruribus gracilibus, stellatopilosulis; floribus masculis: calycis segmentis late ovatis obtusis, extus tomentosis, intus glabris; petalis oblongo-linearibus, obtusis, basi villosis, calyce longioribus; receptaculo villoso-tomentoso; staminibus 15-17, filamentis basi villosis; capsulis subovoideis, extus dense stellulato-tomentellis; seminibus oblongo-ovoideis, minute carunculatis, lucidis, biseriatim oblique undulatocostatis.

Frutex vel arbuscula 0.50–3-metralis. Stipulae triangulares, inconspicuae, 1–3 mm. longae. Petioli 0.6–2 cm. longi; laminae 5–12 cm. longae, 2–5 cm. latae. Racemi 6–12 cm. longi. Bracteae 3–4 mm. longae. Flos masc.: calycis segmenta ex centrum 3 mm. longa, circa 1.5 mm. lata; petala 2.5 mm. longa, 0.5–0.7 mm. lata. Flos foem.: calycis segmenta ex centrum 3.5–4 mm. longa, basi 1–1.2 mm. lata. Capsula circa 4 mm. longa; semina 3.5 mm. longa, 2 mm. lata.

TRUJILLO: El Dividive, in scattered savanna groves; flowers and fruits November 27, 1922 (*Pittier* 10820, type); Loma del Morón, near Valera, in bushes; flowers November 18, 1922 (*Pittier* 12723, 12725); Mendoza, on steep, arid hills; flowers January 19, 1928 (*Pittier* 12627).

So far this species has been collected only in State Trujillo, where it seems to be rather common and is known as salvia muñeca and punta de lanza. It looks very much like Croton rhamnifolius H.B.K., but differs in the obliquely grooved seeds, in the shape and dimensions of the calyx and in the rudimentary petals in the female flowers.

Croton dolichostachyus Pittier, sp. nov. (Sect. Eucroton-Cleodora)

Arbuscula vel arbor parva, ramulis sordide pubescentibus, apice ramorum congregatis subverticillatisve; foliis magnis mediocrisve, longe petiolatis, membranaceis, discoloribus; petiolis crassis, canaliculatis, fulvo-pubescentibus, laminis 3–4-plo brevioribus; laminis ovato-lanceolatis, basi breviter 3-nerviis, obsolete 3–4-glandulosis, cuneatis subrotundatisve, apice breviter acuminatis, supra punctulatis parce pilosulis, subtus densius stellato-pubescentibus tomentosisve sordide canescentibus, marginibus minute serrulatis; stipulis obsoletis; racemis longissimis, remotifloris, rhachi pubescente, anguloso, sulcato; bracteis triangularibus apiculatis; flos foem.: bracteis 1-floris, floribus sessilibus, numerosis, calyce extus tomentello, intus glabro, segmentis lineari-triangularibus, angustis, apice obtusiusculis; ovario dense rufotomentoso; stylis profunde bifidis, cruribus longissimis, apice saepe clavatis, parcissime stellulato-pilosulis; flos masc.: bracteis 2–5-floris, floribus breviter

pedicellatis; calyce dense stellulato, segmentis ovato-acuminatis; petalis linearibus, calyce subaequantibus, basi bombycino-barbatis; receptaculo villoso; staminibus circa 20; filamentis glabris; capsula ovoidea, extus dense

rufo-stellulata.

Arbuscula usque 3-metralis. Petioli 2-7 cm. longi; laminae 12-16 cm. longae, 3.5-7.5 cm. latae. Racemi 18-30 cm. longi. Bracteae 2.5-4.5 mm. longae. Flos masc.: pedicelli circa 2⁷m. longi; calycis segmenta ex centrum 2.5–3 mm. longa, 1.3–1.6 mm. lata; petala 2.2–2.6 mm. longa, 0.5–0.9 mm. lata; flos foem.: calycis segmenta ex centrum 3-3.5 mm. longa, basi 0.5-1 mm. lata; stylorum crures ad 4 mm. longa. Capsula circa 4 mm. longa.

LARA: Between Corora and Trentino, common on valley flats; flowers January 16, 1928 (Pittier 12616, type). Zulia: Near Mene Grande, in

bushes; flowers and fruits November 2, 1922 (Pittier 10651).

Belongs to the group of Croton rhamnifolius, from which it differs mainly in the much longer petioles, in the very long racemes, in the shape of the petals and in the number of stamens.

Croton Ferrugineus H.B.K. Nov. Gen. & Sp. 2: 77. 1817 (Sect. Eucroton-Cleodora.)

Arbuscula ramis elongatis cortice griseo tectis, ramulis, novellis rhachibusque densius stellato-ferrugineis; foliis parvis, breviter petiolatis, membranaceis, penninerviis, petiolis ferrugineo-hirsutis, laminis circa 5-plo brevioribus; laminis ovalibus, basi rotundatis biglandulosis, apice late obtusis mucronulatis, margine minute denticulatis, supra parce subtus densius sordideque stellatis, costa venisque subferrugineis subtus prominulis; stipulis nullis vel inconspicuis; racemis brevibus subdensifioris, rhachi anguloso; bracteis parvis triangularibus, acutis, hirsutis, persistentibus, marginibus glandulosis; flos foem.: bracteis unifloris, floribus sessilibus, calycis segmentis ovato-lanceolatis, subacutis, utrinque flavescenti-hirsutulis; petalorum rudimentis conspicuis, brevibus, glanduliformibus; ovario densius fulvescente stellato-hirsuto; stylis fere usque ad basin bifidis, cruribus parce stellatopilosiusculis; flos masc.: bracteis 1-3-floris, floribus breviter pedicellatis; calycis segmentis ovato-lanceolatis, obtusiusculis, extus dense villosis; petalis obovatis, spathulatisve, sepalis longioribus, unguiculo elongato, angusto, margine longe barbato; receptaculo villoso; staminibus 14-19, filamentis basi villosis; capsula parva, ovoidea, dense stellato-pubescente; seminibus carunculatis, lucidis, minutisime rugulosis.

Petioli 5–10 mm. longi; laminae 2.5–4 mm. longae, 0.9–2 cm. latae. Racemi 5-8 cm. longi. Bracteae circa 1 mm. longae. Flos masc.: pedicelli 2-5.5 mm. longi; calycis segmenta ex centrum 2.7-3 mm. longa, circa 1.3 mm. lata; petala 2.7–3 mm. longa, circa 1 mm. lata. Flos foem.: calycis segmenta ex centrum 3-3.4 mm. longa, 0.7-1.1 mm. lata. Capsula 6 mm. longa; semina

5 mm. longa.

Mérida: Páramo del Morro, 2500 m.; flowers and fruits April 1st, 1922 (Jahn 1063; redescription based on this).

It is difficult to distinguish Croton ferrugineus from the several varieties of C. flavens L. Jahn's specimen, however, seems to correspond closely to the description of the first species, differing only in the smaller leaves, the larger calyx and also in the presence of glandular rudiments of petals in the pistillate flower, a detail which may have escaped to the original observer. From *C. flavens* it differs in that the primary veins emerge from the costa at an acute, not nearly right angle; also in the shape of the basal glands, in the caducous female calyx, in the styles divided nearly from the base, and in the shape and indumentation of the male petals.

Julocroton acuminatissimus Pittier, sp. nov. (Sect. Oligonychia)

Frutex elatus, ramis ramulis angulosis petiolisque dense sordideque stellulato-pubescentibus; foliis membranaceis, petiolis teretibus, laminis 6–7-plo brevioribus; laminis ovato-lanceolatis, basi latioribus, 3–7-nerviis, rotundatis, obsolete biglandulosis, apice longissime gradatim acuminatis, marginibus irregulariter denticulatis, supra viridis crebre minuteque stellulatis, subtus dense stellulato-pubescentibus; stipulis lineari-setaceis, integris, stellulato-pilosulis; inflorescentiis subcapituliformibus, apice ramulorum congestis; spicis breve pedunculatis basi bibracteatis, rachidibus pubescentibus; bracteis foliaceis, bracteolis unifloris, lineari-setaceis, pilosulis; flos masc. non evolutus; flos foem.: pedicellis brevibus, sepala utrinque stellulato tomentosis, 3 anterioribus magnis, ovato-lanceolatis, pinnatisectis, 2 posterioribus minoribus, integris, setaceo-linearibus; disci glandulis 3 anterioribus cohaerentibus, subacutis, glabris, posterioribus obsoletis; ovario globoso, stellato-tomentoso, stylis bis dichotomis, cruribus longissimis, tenuibus, pilosis. Et caetera ignota.

Frutex usque ad 2 m. altus. Petioli 0.7–1.5 cm. longi; laminae 4.5–10 cm. longae, 2–7 cm. latae. Stipulae 1–1.5 cm. longae. Pedunculi primarii 7–8 cm., secundarii (spicarum) 0.5–2 cm.; pedicelli florum foeminorum usque ad 0.5 mm. longi. Bracteae 2–2.5 cm., bracteolae 0.8–1.2 cm. longae. Sepala majora circa 9.5 mm. longa, 4.5–5 mm. lata. Styli plus minusve 7

mm. longi.

YARACUY: Between La Piedra and Yaritagua, in bushes; flowers September 18th, 1923 (*Pittier* 11175, type).

Belongs to Sect. Oligonychia, and is perhaps closely allied with Julocroton montevidensis Muell.-Arg., differing mainly in the very long acuminate leaves with shorter petioles, and in the less divided styles.

Manihot filamentosa Pittier, sp. nov.

Arbuscula glaberrima, trunco brevi, ramoso, brunneo, ramis cinereis, efoliatis, ramulis glaucescentibus, stipulis parvis, lanceolatis subulatisve, apice plus minusve denticulatis, deciduis; foliis apice ramulorum congestis, longe petiolatis, membranaceis, petiolis gracilibus, laminis vulgo longioribus, purpurascentibus, laminis plus minusve ovato-reniformibus, fere ad basin 5-lobulatis, basi late emarginatis minute bistipellatis, supra obscure viridis, subtus glaucescentibus, reticulatis, costis prominentibus venis venulisque vix prominulis, lobis penninerviis, sinuato-lyratis, lobulis apice plus minusve rotundatis, longe acuminatis acutissimis, exterioribus interdum auriculatis, saepe integris; stipellis subulatis; inflorescentiis terminalibus, ramulosis, ramulis longe pedunculatis; floribus pedicellatis, virescentibus, pendulis; pedicellis basi 2-bracteolatis, bracteolis subulatis; floribus masculis: pedicellis longiusculis; alabastris ovoideis, angulosis; calyce campanulato, lobulis late ovatis, brevissime acutatis, marginibus introflexis; disci glandulis plus minusve

coalitis: staminibus 10, liberis, filamentis longissimis convoluto-flexuosis, 5 exterioribus longioribus, omnium glabris, antheris lineari-oblongis; floribus foemineis masculis majoribus: lobulis fere usque ad basin liberis, anguste lanceolatis, acuminatis, marginibus introflexis; discus annularis; ovario ovoideo, 6-carinato, glabro, stigmatibus brevibus biseriatim flabellatis;

capsula globosa, pedicello apicem versus gradatim incrassato.

Arbuscula (fide Saer) 2-3 m. alta. Stipulae 4-6 mm. longae. Petioli 6-23 cm. longi; laminae 6-14 cm. longae, 9-15 cm. latae; lobulo mediano 6-13 cm. longo, 3.5-6 cm. lato, infimi 4-7.5 cm. longi, 2-3.5 cm. lati. Inflorescentiae partiales 10–12 cm. longae, pedunculi circa 7 cm., pedicelli 8–10 mm. longi; bracteolae 4 mm. longae. Flos masc.: calyx 10 mm. longus, lobulis circa 4.5 mm. longis, 4-4.5 mm. latis; filamenta longiora circa 15 mm., breviora 5 mm. longa; antherae bene evolutae 4-5.2 mm. longae. Flos foem.: calyx 9-11 mm. longus, lobulis 6.5-7.5 mm. longis, 2-3 mm. latis. Capsula (non bene evoluta?) 17 mm. longa, 18 mm. diam., pedicello 15 mm. longo.

LARA: Scattered in sandy thorn-bushes along the La Ruesga (mostly dry) River in the vicinity of Barquisimeto; flowers and fruits August 20, 1929 (J. Saer d'Héquert 366, type); same locality, flowers April 1925 (same collector;

191).

Closely allied to M. carthagenensis (Jacq.) Muell.-Arg., but differs in the description of the leaves, in the longer, denticulate stipules, and more especially in the stamens with very long filaments and elongate, almost linear anthers. I am indebted to Mr. Saer d'Héguert for several interesting details taken from the live plant and for the communication of the common name, Yuca sibidiqua.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

The 993d meeting was held in the Cosmos Club Auditorium, May 25, 1929. Program: L. W. Tilton, Variations in the optical density of glass.—Most optical glasses are not sufficiently homogeneous to obviate compensatory figuring of the surfaces of certain highly corrected optical systems. These variations in the optical properties of good glass are matters of the fifth and sixth decimal places of index of refraction. They have been generally considered as due to unavoidable differences in chemical composition. It has, however, been shown by Tool and others that the properties of glass, as measured at ordinary temperatures, are dependent on the character of the heat treatments to which the glass has been subjected. Some quantitative relationships between refractive index and effective annealing temperature have been recently determined. Furthermore, in the case of a barium flint glass, 90% of the existing optical heterogeneity was removed by special reannealings under iso-thermic conditions.

It is now of interest to inquire as to whether the uniformity of optical glass in general may be improved by more careful annealings. Local variations in the index of refraction of samples from six types of optical glass were measured by a prism method and the corresponding index gradients were computed. The values so obtained for these specimens of ordinary crown, medium flint, and dense flint were, respectively, 0.6, 2.4, and 2.3×10^{-6} per cm. They were all lower than the gradients found in borosilicate crown, light barium crown, and dense barium crown, viz., 4.9, 3.1, and 3.7×10^{-6} per cm., respectively. Considering only two categories in classing these six types of glass, it is found that the group which has the low index gradients is identical with the group which has low index sensitivity to differences in effective annealing temperature. Apparently there is a significant correlation existing here. The index deviations can not be due entirely to differences in chemical composition, and it may be inferred that more careful annealings will greatly decrease the existing heterogeneities in all of these glasses.

By way of confirmation, Gifford's data on the existing limits of uniformity in optical glass were analyzed in a similar way, and with the same result. When considering this encouraging prospect for increased uniformity in optical glass, it is well to remember, however, that the index variations now existing over distances of several centimeters in the best glass correspond to differences of only 1°C. or less in effective annealing temperature. Consequently, there are difficult problems in connection with the practical

execution of sufficiently iso-thermic annealings. (Author's abstract.) Discussed by Heyl, Gish, L. H. Adams, and Priest.

E. G. Anderson, Colored light measurements on various photometers.— Four different photometers were used to measure the light transmission of red, orange-amber, green and blue filters. Each of ten observers made two sets of measurements on each filter, the measurements being made on different Each observer made from five to ten individual observations in each set of measurements. The average deviations of the individual observations from the observer's mean, for each set of measurements were 3.0, 4.2, 4.5, and 4.5 per cent, respectively, for the Ives-Kingsbury, Flicker, Weber, Martens, and the Standard Lummer-Brodhun photometers. The average deviations of the means of each set of measurements from the mean of the two were 3.1, 5.0, 4.1 and 5.0 per cent respectively, for the photometers named in the same order as above. The results indicate that the measurements on the Weber and Martens might well be adjusted for a normal or average observer by the method of Ives and Crittenden for flicker measurements. The adjustment of the Lummer-Brodhun measurements appear to be less definite. (Author's abstract.) Discussed by Priest and L. H. Adams.

Harlan W. Fisk, Secular variation of magnetic intensity and its accelerations in Pacific countries.—Charts showing the lines of equal annual change in the horizontal component of the Earth's magnetic field have been prepared in detail for various parts of the world by investigators in the countries chiefly concerned, but it is difficult to combine these small charts into a chart of the whole Earth, chiefly since they refer to different epochs. World-charts have been prepared, such as that given as an inset on the British Admiralty chart of "Curves of Equal Horizontal Force," but these show the general trend of the changes over large areas, and omit details which the latest observations have disclosed. In a previous discussion the author pointed out that in the Western Hemisphere there are two distinct centers, or "foci," around which the rate of annual decrease of horizontal intensity is large, one of these foci being in southern Argentina, and of greater intensity in the West Indies. Separating these along the Amazon Valley there is a belt within which up to about the year 1917, the horizontal intensity was increasing, but since that date has been decreasing at a low rate in the west, and increasing slightly along the Atlantic coast. Hence the lines of equal annual change of this element on a chart of the Western Hemisphere take the form of two series of concentric ovals which seem to undergo alternate dilation and contraction,

in part but not wholly, in phase with the sunspot cycle.

An analogous condition was found to exist in the Eastern Hemisphere. A negative center (around which the horizontal component is decreasing) exists in western Siberia, but in the southern part of the hemisphere there are two such centers, one of extremely rapid change south of Cape Town, and a second of less intensity west of Australia. In southern India there is a center around which the horizontal intensity is increasing, and which offers especially favorable conditions for investigation because of the number of active observatories in the vicinity. When the mean annual values of horizontal intensity from the reports of an observatory near one of these foci of rapid change have been suitably smoothed and plotted, it is found that the resulting rate-curves are very dissimilar, even for observatories comparatively near together. The contrast is even more striking when the acceleration-curves are compared. The acceleration-curves for Sitka, Honolulu and Christchurch (New Zealand), all of which are remote from foci of rapid change, are very similar and all bear a close resemblance to the smoothed sunspot curve for the same years. When a composite of these three acceleration-curves from such widely separated observatories is plotted, and upon it is superposed a curve made by plotting the departure of the annual sunspot numbers from the mean number for the years under discussion, it is found in general that the accelerations are positive as long as the number of sunspots is greater than the mean number, and becomes negative when the number falls below the mean. This is not in agreement with the widely accepted principle, that the apparent secular rate increases as the number of spots decreases, and vice versa.

Acceleration-curves for stations within the area of rapid annual change show other characteristics which seem to be superimposed upon the typical changes which are concurrent with the sunspot cycle and exemplified by the three observatories named. By use of the observatory reports and available field-observations, it was possible to construct the lines of equal annual change around the positive center in the vicinity of Ceylon as they were in 1918. With much less data it was possible to draw the same lines in the positions occupied in 1906. Consideration of the positions occupied by these lines as the center passed from southern China to Ceylon furnishes an explanation of the apparent inconsistencies in the acceleration-curves for neighboring observatories. For illustration, as the center passed very near Toungoo, the annual rate increased very rapidly on its approach and diminished correspondingly as it receded; Barrackpore on the other hand was so situated with respect to the path of the center that it remained between the same two contours, and therefore experienced a very small change in rate. In a similar way the differences in the acceleration and rate-curves for the Soviet observatories

near the negative center in western Siberia can be accounted for.

It is probable therefore that these areas within which the annual change of horizontal intensity is large, are undergoing changes of various kinds. There is an alternate expansion and contraction, in phase with the sunspot cycle, and a continual shift of position accompanied by alterations in form. Whether such areas disappear altogether to reappear elsewhere, it is not possible at present to say. That high rates of change should continue in a given locality for long periods is improbable because of the unreasonable distortions in the distribution of the element which would result. For example, the horizontal intensity at Cape Town has diminished by more than 16 per cent in the past 30 years. Should the same rate of decrease be maintained for 150 years more,

that component would vanish, creating the conditions of a magnetic south pole at that place. Whether the movement of these areas on opposite sides of the Earth are in any way connected has not thus far been disclosed, and unfortunately the present means for collecting the data necessary for a satisfactory solution of the problem are far from sufficient. (Author's abstract). Discussed by GISH.

OSCAR S. Adams, Recording Secretary.

ENTOMOLOGICAL SOCIETY

The 412th meeting was held at 8 p.m., Thursday, June 6, 1929, in the National Museum. In the absence of the president and first vice-president. Mr. F. C. Bishopp, the second vice-president, presided. There were present 29 members and 22 visitors. Mr. Frank D. DeGant, Cleveland, Ohio, was

elected to membership.

The first feature on the regular program was an informal address by Dr. L. O. Howard, entitled "Observations on some entomologists and their work, during a recent western trip." He outlined briefly the work being done by a considerable number of entomological workers met by him during his recently completed tour of certain portions of the West. Among these were the entomologists at New Orleans, La.,—Holloway in his work with sugar cane insects, and Bliss in his investigations of the camphor scale. During the time spent in California inspections were made of the activities of CAMPBELL, STONE, SMITH, TIMBERLAKE, QUAYLE, BOYDEN, and others at Alhambra, Riverside, and various other places in southern California. An auto trip was then taken to San Francisco and Berkeley, where contacts were made with Van Duzee, Van Dyke, Blaisdell, Evermann, Herms, Severin, STANDLEY, FREEBORN, and others, and inspections were made of the sugar leafhopper work and the recent accessions to the Museum there. While at Berkeley, Dr. Howard received from the University of California the honorary degree of "LL.D" and was guest of honor at a banquet at which over 70 entomologists were present. While in Oregon, inspection was made of the work of Mote, Atwell, and others on European earwig, and of Rockwood, REEHER, and others on cereal and forage pests, and while in Washington State with that of Kincade, Hatch, Doucett, Spright, and others. While en route homeward, stops were made with such State workers as Chapman, RILEY, WILSON, METCALF, FLINT, HAYES, BALDUFF, FRISON, and others at the Universities of Wisconsin, Minnesota, and Illinois. Dr. Howard compared the scope and character of the present day entomological work with that of the limited field and restricted activities of early workers, and had only words of earnest praise for, and appreciation of, the work now being done, and dwelt with hearty enthusiasm upon the prospects for the future in entomological work. A number of slides of the entomologists under consideration were shown. Discussed by Bishopp, McIndoo, Gahan, Morrison,

The next feature on the program was an informal address by R. E. Snod-GRASS, entitled "Reviews of some European literature on insect morphology." This was a brief resume of some of the more important recent items which had come to his attention of entomological literature dealing with morphology. These included certain papers by Weber, Denis, Morison, Jackson, and Uvarov. Separates of the papers were exhibited. Discussed

by Howard, Campbell, Rohwer, and Bishopp.

Dr. William Schaus reported briefly on the recent accession by the National Museum of the collection of Lepidoptera recently presented by the Brooklyn Museum of Arts and Sciences. He was in Brooklyn from April 8 to 15 packing the collection and making arrangements for its shipment by truck. It contains a considerable number of very valuable types of species described by Smith, Grote, Hultze, Harry Edwards and others. The entire collection comprises over 900 drawers and is valued at over \$60,000. It contains, among others, the Nomogan collection valued at \$10,000.

The bequest to the National Museum by the late Col. WIRT ROBINSON, of the U.S. Military Academy at West Point, was reported by H.S. BARBER, whose duty it had been to prepare the insect collection for transportation to Washington. Col. Robinson's interest in Natural History had built up a large collection of insects, besides birds and mammals, and he had erected a private museum near his residence overlooking the James River at Wingina, Va., where he had intended to devote his leisure to their study. By his untimely death only three months after retirement and just at the beginning of this long contemplated leisure we have lost the chance of such discoveries as his ardent, experienced industry would surely have made in this neglected section of Virginia. The collection of beetles was arranged in about 150 large drawers and is rich in unstudied material. His great liberality to students resulted in his having no types but original series (probably paratypes) of such of his discoveries as Arthromacra robinsoni Leng, Anthonomus robinsoni Blatchley, Piezocorynus virginiae Leng, Gyrohypnus davisi Notman, etc., besides certain very rare forms such as the third known U. S. example of Enoclerus viduus (Klug) (synonym, Clerus jouteli Leng), are added to the National collection. The occurrence of Lucanus elaphus in central Virginia is demonstrated by four males and a female from near Wingina. The bulk of the material was collected by him either near West Point, N. Y., or Wingina, Va., but he also collected in Panama, Jamaica, Cuba, and elsewhere.

Mr. BISHOPP reported that an investigation recently had been started of parasites of reindeer in Alaska, and that Dr. W. E. Dove had been assigned to the problem, and would sail from Seattle on June 8 for Alaska, where a laboratory would be established at Nome in coöperation with the territorial government and the U. S. Biological Survey, with Palmer at Fairbanks and

MILLER at Nome.

J. S. Wade, Recording Secretary

Obituary

Rev. Francis Anthony Tondorf, S. J., Professor of Physics and Director of the Seismological Observatory at Georgetown University, and a member of the Academy, died on November 29, 1929, at the age of 59 years. He was born in Boston, Mass., and received the degree of A.B. from Woodstock, Md., College in 1895, and Ph. D. from Georgetown in 1914. He was an eminent authority on seismology and related subjects.

ANNOUNCEMENTS OF THE MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Thursday, January 2.
Friday, January 3.
Saturday, January 4.
Tuesday, January 7.
Wednesday, January 8.
The Entomological Society
The Geographic Society
The Botanical Society
The Geological Society
The Medical Society

Thursday, January 9. The Chemical Society
Friday, January 10. The Geographic Society
Saturday, January 11. The Biological Society

Tuesday, January 14. The Academy

The Institute of Electrical Engineers
The Society of Military Engineers

Wednesday, January 15. The Society of Engineers

The Medical Society

Friday, January 17. The Geographic Society Saturday, January 18. The Philosophical Society

The Helminthological Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

CONTENTS ORIGINAL PAPERS

Paleontology. - A new Callian

rassa	from	the	Cretaceous	of	South	Dakot

MARY

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries

OFFICERS OF THE ACADEMY

President: Aleš Hrdlička, U. S. National Museum.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: W. D. LAMBERT, Coast and Geodetic Survey.

Treasurer: R. L. FARIS, Coast and Geodetic Survey.

D2W 23



OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

JOHN B. REESIDE, JR. NATIONAL MUSEUM

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY BUREAU OF CHEMISTRY AND SOILS

ASSOCIATE EDITORS

- L. H. ADAMS
 PHILOSOPHICAL SOCIETY
- E. A. GOLDMAN BIOLOGICAL SOCIETY
- AGNES CHASE BOTANICAL SOCIETY

- S. A. ROHWER ENTOMOLOGICAL SOCIETY
- G. W. STOSE GEOLOGICAL SOCIETY
- J. R. SWANTON
 ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, aims to present a brief record of current scientific work in Washington. To this end it publishes: (1) short original papers, written or communicated by members of the Academy; (2) short notes of current scientific literature published in or emanating from Washington; (3) proceedings and programs of meetings of the Academy and affiliated societies; (4) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Reprints will be furnished at the following schedule of prices.

Copies	4 pp.	[8 pp.	12 pp.	16 pp.	Covers
50	\$.85	\$1.65	\$2.55	\$3.25	\$2.00
100	1.90	3.80	4.75	6.00	2.50
150	2.25	4.30	5.25	6.50	3.00
200	2.50	4.80	5.75	7.00	3.50
250	3.00	5.30	6.25	7.50	4.00

An additional charge of 25 cents will be made for each split page.

Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, will be furnished when ordered.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (13, 14, 15, July, August, September)	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, R. L. Faris, Coast and Geodetic Survey, Washington, D. C. European Agent: Weldon & Wesley, 28 Essex St., Strand, London.

Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

JANUARY 18, 1930

No. 2

GEOPHYSICS.—Hypotheses on the development of the earth. B. Gutenberg, Frankfort a/M. (Communicated by W. D. Lambert.)

The hypotheses that have been made as to the evolution of the earth involve a great many assumptions. In general there are four groups of these: the condition of the earth at the moment when the assumed forces began to act, the forces themselves, the mode of action of the forces and the condition of the interior of the earth today.

The usual method has been to search for a single force that might have effected all the changes in the earth's crust, and then to try to explain all of them by this one force. But that method, of which the best example is the hypothesis of contraction, is not sound. We must try to find out all the forces that can produce changes in the structure of the earth and the effects themselves. Only by applying this method can we solve our problem.

The researches on the forces that act have given the following results. We have:

Chemical forces and gravity: They formed the different shells of the earth and the changes due to chemical causes continue to occur in the crust of the earth.

We have *cosmical forces*: They are difficult to state. The most important are the tidal forces, which seem to have caused the separation of the moon from the earth.

Forces, the importance of which seems to have been overlooked are those caused by the deviation of the earth's crust from hydrostatic pressure. The higher continents try to move toward the oceans. These forces are of the order of 10° dynes per square centimeter (dynes/cm²).

¹ Received November 26, 1929. These hypotheses are to be more fully explained and developed in the *Handbuch der Geophysik*, Band 3.

Other important forces are those caused by the *cooling of the earth* and the *crystallizing of the matter* in the earth's interior. Both together effect a contraction of the circumference of the earth of the order of 2 cm. in a century.

Movements of masses, which disturb the equilibrium of the earth's crust, are caused by *erosion* and *sedimentation*.

The difference of height between the center of gravity of the continents and the matter that forms the bottom of the oceans causes the "Polflucht" forces, which strive to move the continents against the equator with a force of the order of 10⁷ dynes/cm.².

To the greater forces belong, finally, the stresses caused by movements of the earth's crust relative to the axes of the earth.

All other forces seem to have no influence on the great changes in the figure and the state of the earth. This seems to hold in the case of the forces causing a westerly drift which are due to tidal friction, and, according to Schweydar,² to the precession of continents. In the latter case the complete analysis seems not to have been made, and it appears to me to be not impossible that such a force is very small or does not exist at all. Local chemical and physical occurrences are the causes of local volcanic events. Finally small stresses are caused by the movements of the poles with a period of one year and the Newcomb period, by the changes of air pressure, by tides and changes of the water level, by formation and melting of ice, by denudation and other similar forces. They have only a little effect. In some cases they are the "trigger" forces that cause breaking of the earth's crust and earthquakes, and in others they cause changes of level, for instance the uplift of Scandinavia.

The original state of the earth is unknown, but we can suppose that at an early time it was a hot amorphous body the crystallizing point of which was nowhere attained and which possessed relatively little strength. Nevertheless even at that time the incompressibility and rigidity might have been of the same order as today.

Now gravity acted on the matter and caused the heavier material to be pushed down near the center. In addition there was a chemical separation which, according to Goldschmidt,³ acted in a similar manner as the processes taking place in a blast furnace. Both events together caused the division of the matter into the core, the intermediate layer and the mantle. In subsequent time the difference of density between core and intermediate layer prevented the mixture

² W. Schweydar. Zeitschr. Ges. Erdkunde (Berlin) 1921: 123.

³ V. M. Goldschmidt. Naturwissenschaften 10: 918. 1922.

of these two parts and the existence of currents between them, and we may suppose that the core of the earth is today in the same state as after its formation. In the outer shell, however, currents might have been caused by thermal and chemical events, which continue today.

At an early time when this occurred, the tides of the earth caused by the sun seem to have come into resonance with the period of free vibration of the earth, and, according to the researches of Jeffreys,⁴ it seems possible that in this way one tide rose so high that a portion of the earth was torn away and formed the moon. In the region where it was formed, the outer shell of the earth was removed, hot magma rose from the deeper parts to the earth's crust which had cooled to such a degree that its strength was great enough to prevent currents. Before the formation of the moon, the earth's crust probably had been nearly in a hydrostatic equilibrium. Now this was disturbed, and from that moment we have one part of the earth's crust with a sialic shell and another part without it, where the moon was removed from the outer shell. The bottom of the Pacific seems to be the remaining part of this region which was denuded of sial, while other parts are still covered by sial.

The sialic part of the earth's crust must have a higher surface than the region from which the moon has been removed, because the matter of the deeper layers which entered the gap was heavier. These depressed parts of the earth's crust were filled by water which had condensed and caused a sinking down of the bottom of the ocean and uplift of the continental parts, so that the difference of height between ocean and continent grew larger. Now the forces that tend to bring about equilibrium of the earth's crust increased. They are given by the following formula:

$$P_{\text{max.}} = (\rho - 1) \cdot g \cdot \dot{h} = 2 \cdot 10^3 \cdot \text{h dynes/cm.}^2$$

where P = hydrostatic pressure; $\rho = average$ density of the rocks; g = gravity; and h = average height of rocks above the average height of the bottom of the sea, the water of the latter being assumed to have the depth h and $\rho = 1$; the configuration of the coast is without influence.

At the time before these forces caused an increase of the continental part of the earth's crust, the height of the continents above the bottom of the ocean was probably greater than today, but even if we accept

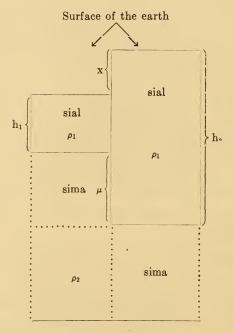
⁴ H. Jeffreys. The Earth. Ed. 2, Cambridge, 1929.

⁵ Cf. T. Geszti. Gerland's Beitr. Geophys. 22: 353. 1929.

5 km., we get $P_{\rm max}=10^{9}$ dynes per square centimeter. The average strength of the earth's crust (cf. Jeffreys, note 4) today is of the order of 5.10^{9} dynes/cm². It is therefore to be expected that in the course of time the continental matter in the regions with less strength would flow and spread. This event must have occurred in such a manner that the isostatic equilibrium was maintained, that is to say, for any two arbitrarily chosen columns with a height Z of the order of 100 kilometers,

$$\int_{\circ}^{h} \rho \ d \ Z$$

must have the same value. In the case of a homogeneous layer of sial overlying a homogeneous mass of sima with densities ρ_1 and ρ_2 respectively, as shown in the accompanying diagram, the following relations must exist:



$$\mu \rho_{2} + h_{1} \rho_{1} = h_{2} \rho_{1} \quad \mu \rho_{2} = \rho_{1} (h_{2} - h_{1}) \quad \mu \rho_{2} = \rho_{1} (h_{2} - h_{2} + x + \mu)$$

$$\mu : (x + \mu) = \rho_{1} : \rho_{2} \quad \mu : x = \rho_{1} : (\rho_{2} - \rho_{1})$$

Then, since ρ_1 is much greater than $\rho_2-\rho_1$, μ is much greater than \mathbf{x} ; in other words, in places where the layer of sial has grown thinner, this must generally happen in the lower parts where sima must enter.

Now the researches of Taylor, Wegener, Köppen⁶ and others show that observations of many different sorts are readily explained only with the assumption that all continents were one entire complex in earlier geological times and have moved apart one from the other and do so even today. But contrary to Wegener,⁷ I think that this happened by flowing as an effect of hydrostatic pressure and not by fissuring.⁸

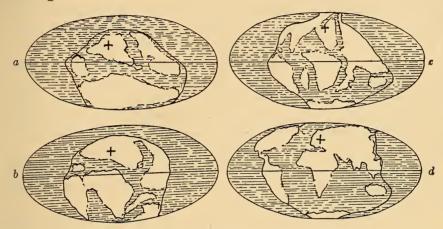


Figure 1. Development of the continents (+ = Europe) a. Carboniferous; b. Cretaceous; c. Eocene; d. Quaternary

We do not know what was the position of the continental block immediately after the formation of the moon. The equilibrium of the earth's crust was completely disturbed and stresses were caused which tended to come into equilibrium. This must have been a period of great movements. There is not enough climatic evidence that can be used to determine the position of the different parts of the earth's surface. The first geological epoch in which some quiet seems to have been restored was the Carboniferous. All climatic evidence seems to show, as Köppen, Wegener and others have found, that at this time nearly the whole complex of continents was situated in the southern hemisphere of the earth. (Fig. 1.) Under the action of the hydrostatic forces of the earth this block began to drift apart. At the same time the *Polflucht* forces tended to move the entire block over its base in such a manner that the integral of all these forces became zero, so that the masses of the continental block situated north of the equator

⁶ KÖPPEN UND WEGENER. Die Klimate der geologischen Vorzeit. Berlin, 1924.

⁷ A. Wegener. Die Entstehung der Kontinente und Ozeane. Aufl. 4, 1929.

⁸ B. Gutenberg. Gerland's Beitr. Geophys. 16: 239. 1927; 18: 225. 1927.

were of the same order as the masses south of it. This state now has been reached with some approximation. The movements must cause high mountains at the borders of the block, as actually observed.

In this case we must take into consideration that today the limits of the continental block are given by the western coast of North and South America, Antarctica, New Zealand, the Tonga Islands, New Guinea, the Philippines and Japan. All parts of the earth's crust between these limits, according to seismological researches, seem to have the same structure, and only the thickness of the layer of sial varies. It is less in the bottom of the Atlantic and the Indian Oceans. On the other hand, the limits of the Pacific are sharply marked by very great absorption of the surface waves. The varying friction on the base of the block, which surely is of lesser order than the strength of the different parts, caused variations in the flow. Also a great deal of the earth's crust was too strong to permit flowing at all. In such a manner the difference of the thickness of the uppermost layer was caused.

Besides these motive powers there are apparently some kinds of forces which strive to move the earth's crust westward, but as has been said, these seem to have been small.

During the action of these forces, the cooling of the earth's crust was proceeding, crystallization was going on, and the deeper layers of the earth's crust (say between 50 and 200 kilometers, as a first approximation) contracted, so that the outer shell had to fit the diminishing The stresses arising in this manner accumulated. Only in the outermost parts of the shell can they be equalized by breaking and movements of the broken parts. In the deeper regions, in general, there are movements by flow which begin as soon as the forces exceed the strength, which differs in different parts of the earth's crust. The smallest strength is in the weak parts of the earth, which are the boundaries of the different layers, notably the borders of the Pacific. It is there that the movements compensating the stresses caused by contraction must be most noticeable. These movements of shrinking are accompanied by outflow of magma. Indeed the whole borders of the Pacific are covered by volcanoes and signs of magmatic action have occurred at different geological epochs.

But other factors have also influenced the events. There exist a great many other forces¹⁰ which cause stresses superimposed upon those caused by cooling. Where all these stresses act in the same direction, movements must reach their maximum. On the other hand

⁹ B. GUTENBERG. Handb. Geophys. 4: Lief. 1. 1929.

¹⁰ B. GUTENBERG. Handb. Geophys. 3: Abschn. 1. 1930.

the strength of the earth's crust was influenced by different events. Movements of the poles, or movements of the earth's crust relative to its base, caused regressions and transgressions, as the water at once assumes any new position of equilibrium. Furthermore, sedimentation was greatest in the regions of transgression, and caused new sinking of the bottom of these regions. In all places where sedimentation occurred, there must have taken place compensating movements of flow in deeper regions. The masses pressed down reached hotter parts, melting began below such parts of the earth's crust, and a geosyncline, an extremely weak zone, was formed. One recognizes that in such a manner the weakness and the strength were modified in the different parts of the continental block. Especially is it evident that in certain regions sedimentation was relatively very great, and that even there weak zones were formed. If now the forces assumed greater proportions and the strength was exceeded, these zones were pressed out and mountains were formed. During all these events isostasy was maintained as nearly as possible by movements in the deeper layers. On the other hand there originated thick layers of sediments, vast regions of which, with thicknesses of many kilometers, being laterally pressed together to depths of ten or even more kilometers.

I think that in this way all attributes of geosynclines are explained in the most simple manner and in connection with the great events of the history of the earth's surface. The material of these geosynclines being pressed out forms, as we have seen, a smaller but thicker region of rocks. Therefore it is not permissible from the thickness of these layers to draw conclusions about the original thickness, and it is not necessary to base calculations upon sedimentation of so great a thickness as has usually been done.

After this event the geosyncline has lost its mobility and the weak zone has disappeared. The mountains thus formed are very steep, denudation has abnormally great values, and sedimentation increases near the new coast, the conditions there being then favorable to the formation of a new geosyncline, running nearly parallel to the preceding one.

Now we will turn back to the forces that press out the weak zones and form the geosynclines. First we have the stresses caused by shrinking of the earth's crust. They are superimposed on forces caused by the *Polflucht*, which press together the northern and southern parts of the continental block in the neighborhood of the equator, where they tend to produce an elevation with a height of twenty meters. The stresses caused in this way are entirely insufficient to produce any

motions as they are only of the order of one hundredth of the strength, but they enhance the effect of the stresses caused by the contraction, with the result that these stresses reach their maximum to the north and to the south of the equator and are directed against it.

Generally the first motions caused by these stresses must arise in a geosyncline in the neighborhood of the equator, and must produce mountains nearly parallel to it which extend over large regions. In these regions the geosynclines were pressed out, as has been pointed out. This happens not only at the outside of the earth's crust, but also on the inside, approximately according to the laws of isotasy. Unterströmungen,—currents in the deeper layers,—were produced to maintain the equilibrium, as nearly as possible. The motion extended over larger regions, but by degrees the stresses caused by contraction became exhausted. The Polflucht forces remained unaltered. They could affect some motions in the disturbed regions, but finally all was solidified, strength reached its normal value, the motions ceased, the initial conditions recurred, an epoch of the revolution of the history of the earth had passed and, during subsequent time, only epirogenic movements took place.

In the following epochs the stresses caused by the cooling of the earth accumulate anew and finally a new orogenic period begins, but now according to the changes of the position of the equator and other regions in the neighborhood of the new equator. These parallel changes of the position of the equator and the zones of mountain building can be easily traced in the case of Europe, where both travelled southward during the later geological epochs.

My sketch of the evolution of the earth has come to its end. I think I have shown how it can be explained on the basis of forces that must be expected according to theory, and is in good agreement with a great deal of observation. Let me now put a last question: What will be the further evolution of the earth? The continental block is at present lying nearly symmetrical to the equator. Therefore it is not probable that great movements of this block as a whole will arise. In other words, it is improbable that the poles will make greater movements relative to the earth's crust. Indeed observations of Lambert¹¹ and others have shown that these movements today are very small and that their direction is opposite to that we have found for the preceding geological epochs. The changes of climate during the last epoch, the glacial period, have nothing to do with our problem. They are

¹¹ W. D. LAMBERT. Astron. Journ. 34: 107. 1922.

caused by changes of the astronomical elements of the earth (cf. Köppen and Wegener, footnote 6).

The motions caused by hydrostatic pressure continue, though diminishing a little according to the degree of spreading out of the continental layer. The distances between the different points of the continents must increase and the surface of the stretched regions must continue to sink. Probably the sinking of the western coast of Europe is an accompanying effect of these events. Finally stresses caused by the shrinking of the earth and the *Polflucht* forces accumulate until a new orogenic period begins and new mountain building sets in, in the neighborhood of the equator. It may be stated that there is a great difference between the events in the interior of the continental block,—for example, in Europe, where *Polflucht* forces and shrinking work together—and in the borders of the block,—the coast of the Pacific, where as in the case of America the shrinking stresses are compensated together with the hydrostatic movements which continue to act nearly unaltered.

BOTANY.—A long lost Phlox.¹ Edgar T. Wherry, Washington, D. C.

The herbarium of Samuel B. Buckley, now at the Missouri Botanical Garden in St. Louis, includes a specimen of Phlox labelled "Phlox No. 2, Mts. White Sulphur Springs, Va. June, 1838." This bears a superficial resemblance to P. pilosa, but closer examination shows that Buckley was right in declining to ascribe it to that or any other recognized species. How this striking plant escaped the attention of the many botanists who visited the region around White Sulphur Springs (now in West Virginia) during the subsequent three quarters of a century is a mystery, but the fact remains that it is not included in any collection made during that period to which the writer has had access, nor is it mentioned in Millspaugh's flora of the state. This Phlox was first rediscovered by Miss Marian S. Franklin of Lewisburg about 1919, and specimens collected by her near White Sulphur Springs are preserved in the Gray Herbarium (September 4, 1920, in fruit) and the herbarium of the University of Pennsylvania (May 22, 1922). It had been labeled P. pilosa, and when I first saw it in the field, during a vacation trip in 1923, the same misidentification was made. Early in June, 1929, on another visit to the region, in the company of Mr.

¹ Received December 15, 1929.

J. E. Benedict, Jr., its relationships were worked out, and several stations for it were discovered. The data obtained justify announcing it as an independent species, which seems appropriately named:

Phlox buckleyi Wherry, sp. nov.

Plant perennial, with one or more decumbent stems 3 to 20 cm. long, each bearing at the tip a closely set group of long narrow evergreen leaves, from the midst of which arises the erect flowering shoot, 15 to 40 cm. tall, with 3 to 7 nodes below the inflorescence; stem glabrous below and increasingly glandular-pubescent upward; leaves glabrate, or the upper more or less pubescent, opposite, the blades thickish, sessile, acuminate; lower leaves linear to somewhat lanceolate or oblanceolate, often ensiform, mostly 50 to 125 mm. long and 2 to 5 mm. wide, the upper ones ranging from short lanceolate at the base of the flowering shoot, to linear-lanceolate, up to 80 mm. long and 8 mm, wide, near the middle, and to broadly lanceolate, 40 mm, long and 12 mm. wide, toward the top; inflorescence a small to moderately large corymbose or somewhat paniculate group of cymes, densely glandular-pubescent; bracts similar to the uppermost leaves, rapidly decreasing in size upwards; pedicels short; calyx 7 to 13 mm. long, the sepals united to about 2/3 their length, tipped with short awns; corolla-limb bright purple, usually near phlox or mallow purple (Ridgway's 65 or 67 b), the eye somewhat paler and often bearing a purple 5-rayed star formed by deltoid patches of slightly deepened color toward the lobe-bases, the tube purplish violet to gray, glandular-pubescent; petals 25 to 35 mm. long, united to 2/3 their length, the tube thus 17 to 23 mm. long, the obovate to nearly orbicular lobes 8 to 12 mm. long and 7 to 10 mm. wide, terminally truncate and entire, slightly erose, or barely emarginate; stamens nearly as long as the corolla-tube, or one sometimes longer, the average distances from tube-orifice to anther tips being respectively 0, 0.5, 2.0, 3.5, and 5.0 mm.; anthers cadmium yellow or essentially so: styles 14 to 20 mm. long, united to within 1 mm. of the tip, the 3 stigmas lying in the midst of the anthers, or slightly exserted; ovules usually 2, but sometimes 1 or 3 per cell; capsule about 5 mm. long.

Type locality, White Sulphur Springs, Greenbrier County, West Virginia; type specimen collected by S. B. Buckley in June, 1838, in herbarium of Missouri Botanical Garden.

Thus far, six localities for *Phlox buckleyi* have been found, which, from west to east, are as follows: Greenbrier County, West Virginia,— \(\frac{3}{4} \) mile southeast of Caldwell, \(\frac{1}{4} \) mile south of White Sulphur Springs station (probably the site of Buckley's original collection), and \(1\frac{1}{2} \) miles southeast of White Sulphur Springs village; Alleghany County, Virginia,—1 mile north of Alleghany station, \(1\frac{1}{2} \) miles southeast of this station, and 1 mile southwest of Longdale Furnace. The maximum diameter of its recognized range is thus barely 40 miles (65 kilometers). The normal habitat at all these places is a thinly wooded slope toward the base of a hill of Devonian shale, the soil being usually a humusrich gravel of subacid reaction.



Figure 1. Phlox buckleyi Wherry.

This very distinct species belongs in a different section of the genus from P. pilosa, which it resembles at first sight, as shown by the decumbent stems with evergreen terminal leaves, the well-united sepals. and the long stamens and styles. It is actually most closely related to P. ovata, which grows in the same region, but differs in the much narrower leaves, the abundant glandular pubescence, and the double ovules; moreover, even where intimately associated, the two show no tendency to intergrade or to hybridize. Its aspect is brought out by the two photographs reproduced on page 27, the upper representing a habitat view taken at the locality southeast of Caldwell, West Virginia, June 1, 1929, and the lower a group of pressed specimens from the same place, $\times \frac{3}{10}$. The highly distinctive tufts of ensiform leaves suggest, as a common name for the species, Swordleaf Phlox.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

The 995th meeting was a joint meeting with the Geological Society of Washington, and was held in the auditorium of the Interior Department building, Wednesday, October 23, 1929, with Vice-President LAMBERT of the Philosophical Society in the chair.

The program of the evening consisted of an illustrated address by Dr. Beno Gutenberg, Professor of Geophysics at the University of Frankfurtam-Main, on "Some hypotheses on the development of the Earth's crust" (published in this number). It was discussed by Messrs. Bowie and Heck.

The 996th meeting was held in the Cosmos Club Auditorium, November 9,

The program of the evening consisted of two illustrated communications: P. R. HEYL, V. L. CHRISLER, and W. F. SNYDER. Absorption of sound at oblique angles of incidence.—The effect of oblique angles of incidence upon the sound absorption of a substance is a point concerning which there has been up to the present time no experimental evidence. Paris has published a theoretical discussion leading to a formula which indicates that as we pass from normal incidence to grazing incidence the absorption should increase considerably, being about 50 per cent greater at 60°.

Experiments recently performed at the Bureau of Standards appear to show that the absorption of sound is independent of the angle of incidence.

It seems probable that the error in Paris' discussion is due to the fact that sound absorption is produced by friction, converting sound energy into heat. Friction is likely to produce rotational motion in fluids, and where rotational motion exists there can be no velocity potential. In consequence, the customary differential equation for sound motion, in which the dependent variable is the velocity potential, fails to hold in a region of sound absorption. (Authors' abstract.) Discussed by Humphreys, Hulburt, Littlehales, GISH, PAWLING, and others.

E. O. Hulburt: Ions and electrical currents in the upper atmosphere.— It is assumed that the ionization in the upper atmosphere is caused by the ultraviolet light of the sun and that the ion and electron densities at noon at the equator are those required by the theory of wireless wave propagation. From the laws of recombination of the ions and the diffusion and drift of the ions in the earth's magnetic and gravitational fields the distribution of the ions over the earth is worked out. This distribution turns out to be that required by the diamagnetic theory of the solar diurnal variation of the earth's magnetism. The gravitational drift currents are found to flow mainly along the parallels of latitude in the following way: On the daylight hemisphere (1) a current sheet flowing eastward in the levels above 150 km. which at the sunrise and sunset longitudes divides into two sheets; (2) one of these flows westward on the day side of the earth underneath (1) in the levels below 150 km., and (3) the other sheet continues eastward in the upper levels around on the night side of the earth. The current is mainly between the fortieth parallels of latitude, north and south, and falls to lower values at the higher The total currents in the three sheets are about 10^7 , 8×10^6 and 2×10^6 amperes, respectively. The east and west daytime current sheets subtract from each other leaving in effect an eastward current of about 2×10^6 amperes flowing around the earth all the time. This causes a magnetic field agreeing in magnitude and type with that obtained by Bauer in his 1922 analysis of the magnetic field of the earth of external origin.

As a result of the drift currents, the sunset longitude of the earth is at a potential of several hundred volts above that of the sunrise longitude. This electric field combined with the earth's magnetic field causes the ions and electrons on the night side of the earth to drift upward with velocities of order 10² cm. sec.⁻¹. The ions and electrons move into regions of lower pressure and therefore do not recombine as fast as they otherwise would. This removes a difficulty from an earlier calculation which yielded too great a night-time rate of disappearance of the free charges. The upward drift of the ionization causes a rise of the Kennelly-Heaviside layer which is, partially at least, compensated by the fall due to the cooling and contraction of the atmosphere at night, and is complicated by the diffusion of the ions. It is difficult to say how much of the night-time rise of the layer observed in experiments with wireless rays may be genuine rise and how much may be an apparent rise due to delayed group velocities, or to other causes. (Author's

abstract.) Discussed by GISH, L. H. Adams, and others.

Edgar W. Woolard, Recording Secretary pro tem.

GEOLOGICAL SOCIETY

455TH MEETING

The 455th meeting was held at the Cosmos Club November 13, 1929, President Capps presiding.

Program: E. W. Berry: Arctic climates as indicated by fossil plants, and a possible explanation. Discussed by David White.

Remington Kellogg: Migration of marine mammals in relation to climate. W. J. Humphreys: Factors of climatic control.

456TH MEETING

The 456th meeting was held at the Cosmos Club November 27, 1929, President Capps presiding.

Informal communications: David White called attention to the excellent exposure of Cretaceous and Tertiary sediments along 16th Street above

Florida Avenue.

Program: H. H. Bennett: Contributions by the Bureau of Soils to the problem of erosion. The farm and grazing lands of the country are not inexhaustible, as vast areas are subject to severe impoverishment and destruction by unrestrained soil erosion. The normal process of soil erosion of undisturbed land is insignificant compared to the accelerated washing of the land due to the removal of forest and brush growths, the breaking of ground and the matted sod of the prairies, and the destruction of herbage by overgrazing. Erosion, due to the latter causes, operates chiefly on the top soil, the most productive part of the land, and the amount of wastage depends on the soil, the slope, the amount and rapidity of rainfall, the crops grown and the methods of cultivation. On some highly erosive lands as much as one inch of soil may be removed in one year and it is believed that not less than one billion five hundred million tons of rich soil matter are swept out of the fields each year. The amount of plant food washed out of the fields each year is more than twenty times the annual loss by the crops taken from those fields. That lost through crops can be replaced by fertilizers and soil improving crops but that removed by erosion is irreplaceable. Experimental erosion and moisture conservation stations are being established in a number of major regions of varying soils and climate and various structures such as terraces and dams, as well as various types of vegetation, will be tested under field conditions in attempts to slow down the losses.

Discussed by Goldman, White, Pepperberg, and Rubey.

C. N. Munns: Contributions by the Forest Service to the problems of erosion.

Discussed by Rubey and Thompson.

C. S. Howard: Suspended matter in the Colorado River. Water-Supply Paper 636-B of the United States Geological Survey describes the methods of sampling and the results obtained in a study of suspended matter in the Colorado River from 1925 to 1928. These results, with additional data for 1928–1929, show that the most rapid fluctuations and the largest loads occurred during the periods of the summer floods when a large proportion of the flow of the river was caused by rains in the semi-arid portion of the drainage area. The daily load of suspended matter at the Bright Angel station in the Grand Canyon ranged from 3,700 to 20,700,000 tons. The annual load at the same station ranged from 189,000,000 tons in the lowest year to 443,000,000 tons in the highest year. (Author's abstract.) Discussed by Baker, Bennett, Munns, Goldman, Rubey, Thompson, Collins, and Alden.

457TH MEETING

The 457th meeting was held at the Cosmos Club December 11, 1929, President Capps presiding. Vice-President G. R. Mansfield took the chair during the presentation of the presidential address: Glaciation in Alaska.

37TH ANNUAL MEETING

The 37th annual meeting was held at the Cosmos Club after the adjourn-

ment of the 457th regular meeting, President Capps presiding.

The annual report of the Secretaries was read. The Treasurer presented his annual report showing an excess of assets over liabilities of \$1,205.54 on December 10, 1929. The auditing committee reported that the books of the Treasurer were correct.

The results of balloting for officers for the ensuing year were as follows: President: G. R. Mansfield; Vice-Presidents: O. E. Meinzer and F. L. Hess; Treasurer: H. G. Ferguson; Secretaries: James Gilluly and C. H. Dane; Members-at-Large of the Council: W. D. Collins, Herbert Insley, H. D. Miser, G. B. Richardson, and W. C. Mansfield; Nominee as Vice-President of Washington Academy of Sciences representing the Geological Society: S. R. Capps.

A. A. Baker, James Gilluly, Secretaries.

SCIENTIFIC NOTES AND NEWS

Mr. and Mrs. W. H. Hoover and Mr. F. A. Greeley have returned in November from their three years' occupation of the Smithsonian solar observing station on Mount Brukkaros, South West Africa.

Professor A. S. Hitchcock has returned from Africa, where he obtained large collections of grasses.

The collections of the Division of Fishes, U.S. National Museum have been greatly enriched by the receipt of a large number of Chinese fishes from Mr. A. DEC. SOWERBY and Dr. D. C. GRAHAM.

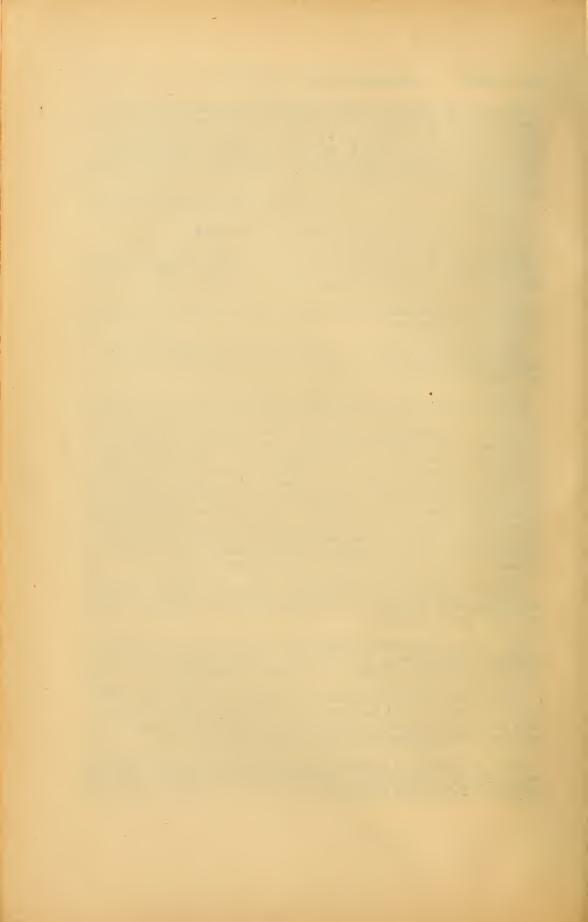
Dr. E. P. Clark, research chemist of the Interstate Cottonseed Crushers' Association, and Dr. Herbert L. J.*Haller, associate in the department of chemistry of the Rockefeller Institute for Medical Research, have accepted appointment in the insecticide division of the chemical and technological research unit of the Bureau of Chemistry and Soils. As organic chemists in the field of insecticides, they will investigate the structure of substances occurring naturally in certain tropical plants which are characterized by high toxicity to fish and which are believed to have promising possibilities as insecticides. When the structure of such compounds has been sufficiently investigated, attempts will be made to synthesize them or certain of their derivatives. The effect of all compounds isolated or synthesized will be physiologically tested upon fish, tadpoles, insects, and animals, as it is important to know their toxicity to man as well as their effect upon insects.

Professor C. C. Ghosh, Entomologist in the Agricultural College at Mandalay, Burma, paid a brief visit to Washington in December during the course of a trip around the world.

W. V. King, of the Bureau of Entomology, who has been for seven months investigating mosquitoes in the Philippines for the Rockefeller Foundation, has been studying the mosquito collections in the National Museum.

Professor Josiah Bridge, of the School of Mines of the University of Missouri, is studying Ozarkian gastropods at the National Museum in connection with the work of the Missouri State Bureau of Geology and Mines and in cooperation with members of the U. S. Geological Survey.

Dr. C. E. Resser has been appointed Curator of Stratigraphic Paleontology in the National Museum. Dr. Resser has been connected with the Division of Paleontology since 1915.



ANNOUNCEMENTS OF THE MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Tuesday, January 21, The Anthropological Society

The Historical Society

Wednesday, January 22, The Geological Society

The Medical Society

Friday, January 24, The Geographic Society Saturday, January 25, The Biological Society

Wednesday, January 29, The Medical Society

Friday, January 31, The Geographic Society Saturday, February 1, The Philosophical Society

Tuesday, February 4, The Botanical Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

CONTENTS

	Pag
Geophysics.—Hypotheses on the development of the earth. B. GUTENBERG	
Botany.—A long lost Phlox. EDGAR T. WHERRY	. 2
Proceedings	
The Philosophical Society	. 28
The Geological Society	. 29
Screymyng Nomes and News	21

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries

OFFICERS OF THE ACADEMY

President: Aleš Hrdlička, U. S. National Museum.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: W. D. LAMBERT, Coast and Geodetic Survey.

Treasurer: R. L. Faris, Coast and Geodetic Survey.



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE

ASSOCIATE EDITORS

- L. H. ADAMS
 PHILOSOPHICAL SOCIETY
- E. A. GOLDMAN BIOLOGICAL SOCIETY
- AGNES CHASE BOTANICAL SOCIETY

- S. A. ROHWER ENTOMOLOGICAL SOCIETY
- G. W. STOSE GEOLOGICAL SOCIETY
- J. R. SWANTON
 ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, sims to present a brief record of current scientific work in Washington. To this end it publishes: (1) short original papers, written or communicated by members of the Academy; (2) short notes of current scientific literature published in or emanating from Washington; (3) proceedings and programs of meetings of the Academy and affiliated societies; (4) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Reprints will be furnished at the following schedule of prices.

Copies	4 pp.	[8 pp.	12 pp.	16 pp.	Covers
50	\$.85	\$1.65	\$2.55	\$3.25	\$2.00
100	1.90	3.80	4.75	6.00	2.50
150	2.25	4.30	5.25	6.50	3.00
200	2.50	4.80	5.75	7.00	3.50
250	3.00	5.30	6.25	7.50	4.00

An additional charge of 25 cents will be made for each split page.

Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, will be furnished when ordered.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (13, 14, 15, July, August, September)	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, R. L. Faris, Coast and Geodetic Survey, Washington, D. C. European Agent: Weldon & Wesley, 28 Essex St., Strand, London.

Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made

within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3 00. Specia rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

February 4, 1930

No. 3

METEOROLOGY.—On the effect of vertical convection on lapse rates.¹ C.-G. Rossby, Massachusetts Institute of Technology. (Communicated by Edgar W. Woolard.)

Because of the dynamic (adiabatic) heating or cooling which accompanies vertical motion of air in the earth's atmosphere, the occurrence of convectional movements will in general result in a modification of the lapse rates that exist prior to such convection. The following treatment of this effect, which is believed to be new, is shorter and simpler, and in several respects more satisfactory, than that customarily given.²

Let T be the absolute temperature, θ the potential temperature, ρ the density, and dT/dz the lapse rate within an infinitesimal stratum of dry air of thickness dz and cross section q. Suppose the stratum to undergo a vertical displacement, due to convectional movements; and let T_0 , θ , q_0 , ρ_0 , $(dT/dz)_0$, dz_0 , denote the values of the preceding quantities before the displacement, and T_1 , θ , q_1 , ρ_1 , $(dT/dz)_1$, dz_1 , those after the displacement; the potential temperature θ remains constant, the process being assumed adiabatic. Denote the lapse rate before displacement by $-\alpha_0$, that after displacement by $-\alpha_1$; and put $\gamma = Ag/c_p$, where A is the reciprocal of the mechanical equivalent of heat, c_p is the specific heat at constant pressure and g is gravity. The potential temperature is given by

$$\theta = T \left(\frac{p}{P}\right)^{-\frac{AR}{c_p}},$$

¹ Received November 19, 1929.

² F. M. Exner. Dynamische Meteorologie. 2te aufl., pp. 57-59, 85-86. 1925.

W. J. Humphreys. *Physics of the Air*. 2 ed., pp. 36-37. 1929.

in which p is the barometric pressure, P is the standard pressure, and R is the characteristic gas constant. Differentiating this equation, we have

$$\frac{d\,\theta}{dz} = \frac{\theta}{T} \left\{ \frac{dT}{dz} \, - \, \frac{ART}{pc_p} \, \frac{dp}{dz} \right\}. \label{eq:delta_potential}$$

Substituting $dp = -\rho g dz$ gives

$$\frac{d\theta}{dz} = \frac{\theta}{T} \left\{ \frac{dT}{dz} + \frac{Ag}{c_p} \right\},\,$$

whence

$$\left(\frac{d\theta}{dz}\right)_0 = \frac{\theta}{T_0} \left(\gamma - \alpha_0\right),\tag{1}$$

$$\left(\frac{d\theta}{dz}\right)_1 = \frac{\theta}{T_1} \left(\gamma - \alpha_1\right),\tag{2}$$

The constancy of mass requires that $\rho_0 q_0 dz_0 = \rho_1 q_1 dz_1$, or

$$\frac{dz_0}{dz_1} = \frac{\rho_1 \ q_1}{\rho_0 \ q_0} = \frac{p_1 \ q_1 \ T_0}{p_0 \ q_0 \ T_1}.$$

Now

$$\frac{d\theta}{dz_1} = \frac{d\theta}{dz_0} \frac{dz_0}{dz_1} = \frac{d\theta}{dz_0} \frac{p_1 \ q_1 \ T_0}{p_0 \ q_0 \ T_1}.$$
 (3)

Multiplying (1) by $\frac{p_1q_1T_0}{p_0q_0T_1}$ gives, by (3),

$$\frac{d\theta}{dz_1} = \frac{\theta}{T_0} (\gamma - \alpha_0) \frac{p_1 q_1 T_0}{p_0 q_0 T_1}.$$
 (4)

Eliminating $d\theta/dz_1$ between (4) and (2), we have

$$\frac{\theta}{T_0} (\gamma - \alpha_0) \frac{p_1 q_1 T_0}{p_0 q_0 T_1} = \frac{\theta}{T_1} (\gamma - \alpha_1),$$

or

$$\gamma - \alpha_1 = \frac{p_1 \ q_1}{p_0 \ q_0} \left(\gamma - \alpha_0 \right). \tag{5}$$

In particular, if $q_1 = q_0$, we get from (5)

$$\left(\frac{dT}{dz}\right)_1 = \frac{p_1}{p_0} \left\{ \left(\frac{dT}{dz}\right)_0 + \frac{Ag}{c_p} \right\} - \frac{Ag}{c_p}.$$

The explanation of subsidence inversions is apparent from these equations.

The equation of continuity furnishes an adequate expression for the variation in dz.

GEOLOGY.—The Cretaceous faunas in the section on Vermilion Creek, Moffat County, Colorado.¹ John B. Reeside, Jr., U. S. Geological Survey.

Some years ago the writer assisted Messrs. J. D. Sears and W. H. Bradley in studying the unusually complete stratigraphic section along Vermilion Creek, in T. 10 N., R. 101 W., Moffat County, Colorado. Mr. Sears later published² a description of the lithologic units together with correlations based on areal studies, on stratigraphic and lithologic considerations, and on the fossils found. The regional sequence of rocks from pre-Cambrian to Eocene is present. No detailed statement of the species of fossils observed in the section has been published, however, and it is the chief purpose of this paper to record in some detail the collections from the Cretaceous beds.

The nomenclature applied to the Cretaceous beds of Vermilion Creek is that derived from southwestern Colorado: Dakota (?) sandstone, Mancos shale, and Mesaverde group, though only part of the last is exposed, a fault having carried the higher Cretaceous rocks far below the present surface. The locality is close enough to southern Wyoming, however, to show some of the stratigraphic subdivisions generally accepted in that region. As Mr. Sears has noted in the report cited above and in a later one,³ the Mancos shale contains at the base a thin member similar to the Aspen and Mowry shales in its peculiar lithology and its fossil content; resting upon the basal member a thin sandstone similar in lithology and fossil content to beds at some places included in the Frontier formation; and upon it a thick shale member corresponding to the Hilliard shale in position, though including in the upper part shaly marine equivalents of part of the coal-bearing rocks that farther northwest would not be included in the Hilliard shale.

¹ Received January 4, 1930. Published with the permission of the Director of the U. S. Geological Survey.

² J. D. SEARS. Geology and oil and gas prospects of part of Moffat County, Colorado, and southern Sweetwater County, Wyoming. U. S. Geol. Surv. Bull. 751: 278-281. 1924.

³ J. D. Sears. Geology of the Baxter Basin gas field, Sweetwater County, Wyoming. U. S. Geol. Surv. Bull. 781: 15-22. 1926.

In terms of the section east of the Rocky Mountains the Mancos of Vermilion Creek includes equivalents of the Graneros, Greenhorn, Carlile, Niobrara, and lower Pierre formations, the last containing representatives of the Eagle and Telegraph Creek beds. In terms of the European classification it is the Turonian, Coniacian, Santonian, and lower Campanian, possibly extending also into the upper Campanian. The part of the overlying Mesaverde group present is probably equivalent to the middle part of the Pierre or upper Campanian, though very few fossils are available as a basis for an opinion. In summary form the section of the Mancos may be interpreted as follows, the unit numbers referring to the detailed section given below:

			Equivale	nt in
European equivalent		Feet.	Plains Region	
Campanian:				
Upper(?):	No. 1, fossiliferous	100		
	No. 2 (part), fossiliferous			
	No. 2 (part), barren	735 1324		
		\		Lower
Lower:	No. 3, fossiliferous		Eagle	part of
	No. 4 (part), fossiliferous	}	sandstone	Pierre
	No. 4 (part), barren	816 1156)		shale
Santonian:				
Upper:	No. 4 (part), fossiliferous	886	Tel. Creek	
Opper.	ivo. + (part), rossimerous		formation	
		,	101111ac1011)	
Lower:	No. 4 (part), fossiliferous	í		
	No. 5, fossiliferous	75		
	No. 6, fossiliferous	75 533	Niobrara	
a	NT W 0 110	200	formation	
Coniacian:	No. 7, fossiliferous	1		
	No. 8, fossiliferous			
	No. 9, fossiliferous	106 856)		
Turonian:				
Upper:	No. 10, fossiliferous	1		
	No. 11, barren	315		
	No. 12, barren	2	Carlile shal	e
	No. 13, barren	4	(Frontier	of
	No. 14, fossiliferous	55	authors)	
	No. 15, barren	25		
	No. 16, fossiliferous	54		
	No. 17, barren	1 457		

It is notable that the Turonian Prionotropis woolgari fauna, which should appear between that containing Metoicoceras whitei and that containing Prionocyclus wyomingensis, was not found in this section and that there is little room for it. It is possible that the sediments which represent the time of the woolgari fauna are very thin or lacking, though there is no particular physical evidence of a hiatus. The fauna in the lower part of the Niobrara equivalent (Coniacian), containing Inoceramus deformis, Baculites codyensis, Phlycticrioceras oregonense, etc., is much like that described by the writer from the lower part of the Cody shale of northern Wyoming.⁴ The very large shells of Inoceramus (Haploscapha?), mostly represented by fragments coated with Ostrea congesta, are abundant in the Niobrara equivalent and extend above it into the Telegraph Creek equivalent (upper Santonian) only in a scarcer and depauperate development. In some parts of the section specimens more than four feet in maximum dimension were seen in cross section. In the upper part of the Mancos shale fossils are extremely rare and extended search yielded only a few scattered species, except in the sandstone lenses at the top of the equivalent of the Eagle sandstone (lower Campanian), where a more extensive and significant fauna occurs.

The detailed section is as follows:

CRETACEOUS BEDS ON VERMILION CREEK, MOFFAT COUNTY, COLORADO

Feet.

Mesaverde group (part):

Williams Fork (?) formation:

Iles (?) formation:

Massive white sandstone predominant; a little gray shale and carbonaceous shale. At 75 feet above base occur Halymenites major Lesquereux, Inoceramus sp., Cardium sp., Mactra formosa Meek and Hayden. About...... 1700

⁴ J. B. Reeside, Jr. Cephalopods from the lower part of the Cody shale of Oregon Basin, Wyoming. U.S. Geol. Surv. Prof. Paper 150: 1-19. 1927.

3. Rusty-brown medium-grained sandstone in short lenses at four horizons, separated by gray shale; most prominent lens, 6 feet thick, at base; next, 2 feet thick, 25 feet higher; third, 1 foot thick, 88 feet above base; fourth, 8 feet thick, at top. In the highest lens occur Inoceramus sagensis Owen, Ostrea sp., Lucina n. sp., Corbula n. sp., Teredo sp., Volutoderma n. sp., Anisomyon aff. A. subovatus Meek and Hayden, Hamites novimexicanus Reeside, Baculites ovatus Say, B. asper Morton, Scaphites hippocrepis DeKay, S. aquilaensis Reeside, S. stantoni Reeside; in the next to lowest, Inoceramus sagensis Owen and Haresiceras natronense Reeside; in the lowest, Solemya bilix White, Inoceramus sp., Ostrea ef. O. congesta Conrad, Lucina n. sp., Corbula n. sp., Ichthyodectes? sp.

140

4. Gray to slate-colored shale, irregular bedding; a line of gray calcareous septarian concretions at base; thin beds of soft, fine-grained gray sandstone at 647, 657, 1213, 1233, and 1269 feet above base of unit. At 2085 feet above base occur Lucina n. sp., Corbula n. sp., Baculites sp., Hypsodon? radiatulus Cockerell; at 1269 feet, Inoceramus sp., Hypsodon? radiatulus Cockerell; at 657 feet, Desmoscaphites bassleri Reeside and Ichthyodectes? sp.; at 150 feet, Pteria gastrodes Meek, Inoceramus sp., Ostrea congesta Conrad, Baculites sp., Scaphites vermiformis Meek and Hayden; at 45 feet, Baculites codyensis Reeside; at 35 feet, Inoceramus aff. I. stantoni Sokolow; at 25 feet, Lingula aff. L. nitida Meek and Hayden, Veniella mortoni Meek and Hayden, Lucina subundata Hall and Meek, Fusus? sp., Baculites codyensis Reeside, Scaphites ventricosus Meek and Hayden. In the lowest 400 feet fragments of a large, thick-shelled species of Inoceramus (Haploscapha?), coated with Ostrea congesta Conrad, are abundant; in the next overlying 800 feet they still occur but are rather rare and of smaller size.....

2285

5. Dark slate-colored shale, including five or six bands of fine-grained gray sandstone that weather to low ridges. At 25 feet above base occur Lucina sp., Baculites sp.; at 15 feet, Ostrea congesta Conrad and Lucina subundata Hall and Meek. Inoceramus (Haploscapha?) sp. and Ostrea congesta are abundant throughout.

6. Light bluish-gray shale, laminated, breaking into flat pieces when fresh; a line of gray calcareous septarian concretions as much as 1 foot in diameter at base. At 20 feet above base occur Lingula aff. L. nitida Meek and Hayden, Nucula sp., Yoldia aff. Y. scitula Meek and Hayden, Arca n. sp., Inoceramus sp., Ostrea congesta Conrad, Lucina subundata Hall and Meek, Anchura? sp., Anisomyon n. sp., Fusus n. sp., Baculites asper Morton; at base, Inoceramus umbonatus Meek and Hayden, Ostrea congesta Conrad, Baculites asper Morton, Ichthyodectes? sp. Inoceramus (Haploscapha?) and Ostrea congesta are abundant throughout...

- 7. Dark slate-colored shale with irregular bedding; zones of lightgray laminated shale; many thin layers of shaly sandstone that weather into papery flakes; lines of gray calcareous septarian concretions as much as 1 foot in diameter at 75 and 90 feet above base of unit; reddish sandy streaks with some reddish concretions at 125 and 190 feet above base. At 215 feet occur Inoceramus sp., Ostrea congesta Conrad, Anisomyon n. sp., Baculites codyensis Reeside; at 190 feet, Inoceramus aff. I. stantoni Sokolow; at 180 feet, Inoceramus aff. I. stantoni Sokolow, Ostrea congesta Conrad, Lucina sp., Baculites codyensis Reeside, Helicoceras aff. H. corrugatum Stanton, Echidnocephalus? sp., Leucichthyops vagans Cockerell (?); at 130 feet, Inoceramus aff. I. stantoni Sokolow, I. undulatoplicatus Roemer, Ostrea congesta Conrad, Baculites codyensis Reeside; at 125 feet, Inoceramus sp., Ostrea congesta Conrad, Sauvagesia cf. S. austinensis (Roemer), Isurus? sp.; at 75 feet, Inoceramus aff. I. stantoni Sokolow, Baculites sp., Scaphites vermiformis Meek and Havden; at 55 feet, Inoceramus aff. I. stantoni Sokolow, Ostrea congesta Conrad, Vanikoro? sp., Baculites asper Morton, Hypsodon? sp.: at base, Inoceramus aff. I. stantoni Sokolow, Baculites sp. Inoceramus (Haploscapha?) sp. and Ostrea congesta are abundant throughout....
- 8. Light bluish-gray shale, laminated, breaking into flat pieces when fresh; a line of gray calcareous septarian concretions at 335 feet above base of unit. In the concretions occur *Inocera*-

75

75

320

e- t, a se t,	mus aff. I. stantoni Sokolow, Ostrea congesta Conrad, Lucina subundata Hall and Meek, Phlycticrioceras oregonense Reeside, Scaphites sp.; at 325 feet, Inoceramus deformis Meek, Ostrea congesta Conrad, Baculites asper Morton; at 295 feet, Inoceramus deformis Meek, I. aff. I. stantoni Sokolow, Pteria gastrodes Meek, Baculites sp., Phlycticrioceras oregonense Reeside, Helicoceras cf. H. corrugatum Stanton; at 285 feet, Cyphosoma n. sp., Solemya n. sp., Inoceramus deformis Meek,
	Inoceramus aff. I. stantoni Sokolow with original color pattern preserved, Ostrea congesta Conrad, Anisomyon?
ie –	n. sp., Baculites asper Morton, Phlycticrioceras oregonense
,	Reeside, Scaphites ventricosus Meek and Hayden; at 240 feet, Inoceramus deformis Meek, Ostrea congesta Conrad, Baculites
	sp., Scaphites sp.; at 220 feet, Inoceramus deformis Meek,
ĺ,	Inoceramus aff. I. stantoni Sokolow, Ostrea congesta Conrad,
	Baculites asper Morton. Inoceramus (Haploscapha?) sp. and Ostrea congesta are abundant throughout
	9. Dark slate-colored shale with irregular bedding. Near top of
	unit occur Nodosaria n. sp., Inoceramus aff. I. stantoni Soko-
	low, Lucina sp., Mactra emmonsi Meek, Lunatia? sp., Anchura
	n. sp., Cerithium? n. sp., Baculites cf. B. gracilis Shumard,
	Helicoceras aff. H. corrugatum Stanton, Placenticeras cf. P.
	pseudoplacenta Hyatt. Inoceramus (Haploscapha?) sp. and
	Ostrea congesta Conrad are fairly abundant throughout
	10. Large, dark reddish-brown sandstone concretions containing Inoceramus fragilis Hall and Meek, Ostrea sp., Scaphites
	warreni Meek and Hayden, Prionocyclus sp., Corax sp
	11. Dark slate-colored shale with irregular bedding
	12. White sandstone, stained somewhat brown on surface; makes
. 2	a dip slope
	13. Gray and brown carbonaceous shale; lens of coal as much as
	18 inches thick
,	14. Massive fine to medium grained sandstone; upper part white,
	lower part buff; slightly cross-bedded; a little gray shale present. Near top of unit occur <i>Lingula</i> cf. <i>L. nitida</i> Meek
	and Hayden, Solemya? obscura Stanton(?), Inoceramus sp.,
	Mactra sp., Corbula kanabensis Stanton, Lunatia aff. L.
	concinna Hall and Meek, Prionocyclus sp., Petalolepis? fibril-
. 55	latus Cockerell(?)
25	5. Grav sandy shale

16. Gray fine-grained sandstone in layers 1 to 6 inches thick, and gray sandy shale, interbedded. At middle of unit occur	
Inoceramus fragilis Hall and Meek, Ostrea sp., Scaphites sp.,	
Prionocyclus wyomingensis Meek; at base, Ptychodus sp	54
17. Limy shale with cone-in-cone structure	1
18. Hard platy shale; bluish-white to cream-colored on weathered	
surface, dark brown on fresh surface. Fish scales abundant	34
19. Bentonite	3
20. Hard platy shale; bluish-white to cream-colored on weathered	
surface, dark brown on fresh surface. Fish scales abundant	
and at 75 feet above base of unit occur <i>Inoceramus labiatus</i>	
Schlotheim, Metoicoceras whitei Hyatt, Leucichthyops vagans	
Cockerell	118
Total thickness	5367
Dakota(?) sandstone:	
Gray coarse-grained sandstone; gritty and conglomeratic bands	50
Gray shale and thin sandstones	15
White medium-grained sugary sandstone, friable	22
Dark-gray shale	24
Light-gray shale, greenish tint	16
White coarse-grained sugary sandstone, friable; contains many	
white coarse-granted sugary sandstone, illuste, contains many	
black grainsblack grains	3
black grains	3
black grains	3

Morrison formation.

PALEONTOLOGY.—A new hypural fan from the Miocene of Maryland.¹ Willard Berry, Ohio State University (Communicated by John B. Reeside, Jr.)

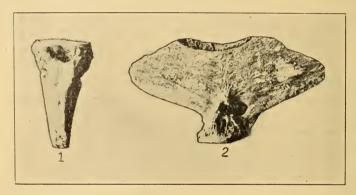
While collecting along the Calvert Cliffs of Maryland this past summer the writer found many fragments of fossil bone. Those worth preserving were turned over to the National Museum at Washington. However, in a chunk of material collected to show the lithology of the formation, a rather well preserved hypural fan was later found that seems worthy of record. The material was from the talus at the base of the cliffs south of Camp Roosevelt, and is probably from the Calvert formation of the Miocene.

The specimen may be described as follows:

¹ Received December 6, 1929.

Xiphias? drydeni W. Berry, n.sp.

Terminal vertebral centrum moderately concave in front and circular in cross section, its neural and haemal spines fused into a solid fan-shaped body; the anterior haemal spine less completely fused with the next following than are the rest, and separated from it near the point of attachment to the centrum by a perforation 4 mm. in diameter passing completely through the fan and connecting with a perforation of equal diameter on the dorsal side of the anterior haemal spine at the point of attachment to the centrum. There is also a smaller perforation extending posteriorly through the fan. There were apparently lateral processes which have been broken off but the bases are still present on either side of the centrum.



Figures 1-2.—Dorsal and side views, natural size, of the hypural fan of Xiphias? drydeni W. Berry, n. sp.

This species cannot be referred to Xiphias? radiata, described from the Aquia Formation (Eocene) by Clark,² because of the difference in concavity of the front of the centrum and because of the perforation opening above the anterior haemal spine. The extreme height of the fan is 5.6 cm. and the diameter of the centrum is 1.5 cm., the ratio of the two differing greatly from those fans described from the Eocene. This species differs also from those found in the Tertiary of South Carolina in having a circular cross section of the centrum. It is named after Mr. A. L. Dryden, who was with me during the collecting season when it was found.

Occurrence.—Calvert formation (?), Miocene, Calvert Cliffs, Maryland. The type is in the Geological Museum of The Ohio State University, Accession number 17109.

² W. B. Clark. *Eocene deposits of Maryland*. Md. Geol. Survey Rept., p. 112. 1901.

BOTANY.—Plants of the Appalachian shale-barrens.¹ Edgar T. Wherry, Washington, D.C.

The term shale-barren was appropriately applied by Steele² to a unique type of plant habitat occurring locally in the central Appalachians, within the area delimited by two heavy lines on the accompanying map, figure 1. These barrens are developed on shale-slopes,—places where hard shaly rocks of the Romney (middle Devonian) and Jennings (early upper Devonian) formations outcrop on steep hillsides, the surface being strewn with frost-broken fragments. They are typically occupied by a sparse, scrubby growth of pine, oak, mountain-laurel, and other woody plants, with herbaceous ones scattered between, grading into normal woodland wherever conditions permit the accumulation of sufficient soil. A number of endemic species and

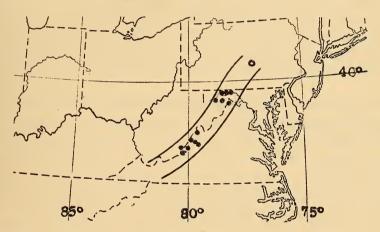


Fig. 1. Location of the Shale-barren Region

varieties have been observed to characterize this shale-barren plant-association, and others no doubt remain to be discovered. As no annotated list of these has ever been published, one is here presented in the hope of encouraging further investigation of the region.

The shale-barrens thus far discovered are located as follows:

Maryland, at intervals along the National Highway, U. S. route No. 40, between Cumberland and Indian Springs (20 miles west of Hagerstown).

Northern West Virginia; similarly along route No. 50 from south of Keyser to Gore, west of Winchester, Virginia.

¹ Received January 4, 1930.

² Contr. U. S. Nat. Herb. 13: 359, 1911.

Southeastern West Virginia, on various hills in the vicinity of White Sulphur Springs, especially the western slope of Kates Mountain, which is reached by a trail from the railroad station; Slaty Mountain, north of Sweet Springs.

West-central Virginia, along state route No. 39 east of Monterey; on various hills in the neighborhood of Hot Springs; along the Chesapeake and Ohio railroad near Millboro, Goshen, and Augusta Springs, and its branch line north of Covington; and near U. S. route 60 west of Covington.

In figure 1 the above listed places are indicated by dots, which apparently fall into two separate groups, although the gap between these merely reflects the relative inaccessibility and consequent lack of exploration of the intervening territory. Further northeast as well as further southwest the shale-slopes rapidly diminish in size and barrenness, owing to changes in physical and chemical character exhibited by these Devonian strata along their strike. Certain formations of other geologic ages, such as the Martinsburg (upper Ordovician) occasionally yield superficially similar shale-slopes, but no typical barrens.

The peculiarities of the shale-slopes which lead to their being occupied by endemic plants appear to be the sparsity of soil, the way in which the loose rock-flakes creep down the slopes under the influence of the weather, and the limited amount of available moisture and nutrient elements. The rock is made up largely of quartz and clay minerals, and exhibits a neutral reaction. The accumulation of humus in the heaps of loose fragments results in the development of considerable acidity, little mineral matter capable of neutralizing the organic acids formed being present. The litter is evidently too porous to permit the accumulation of much available nitrogen, and tests have failed to show the presence of nitrates or ammonia in appreciable amount.

The more notable plants of these habitats are here listed in the standard order followed in manuals of botany, notes being given as to the distribution, relationships, history, etc., of the endemic ones.

NOTABLE PLANTS OF THE SHALE-BARRENS.

Cheilanthes.—The Hairy Lipfern, C. lanosa (Michx.) Watt, grows on various kinds of rock throughout the southeastern uplands, and invades the barrens wherever cliffs are well-developed. The only peculiarity it shows here is a stunted aspect, owing to the general sterility.

Woodsia.—Abundant evidence has been assembled by Fernald³ indicating that during pre-Glacial times Rocky Mountain plants migrated eastward across northern North America, and some of these plants found their way down the Allegheny mountain system. One of the latter was the Rocky Mountain Cliff-fern, W. scopulina D.C. Eaton, which as recently recorded,⁴ is now known from six southeastern stations. Two of these, near Covington and Sweet Springs, are on the cliffs of typical Devonian shale-slopes, the remainder being on more or less similar rocks of other geologic ages. The fronds exhibit features differing to some extent from those of the Rocky Mountain occurrences, and Fernald has suggested that the differences may be of specific rank, although in view of the variability of the species, it seems more probable that this Allegheny Cliff-fern should be classed only as a variety.

Selaginella.—The widespread Rock Spikemoss, S. rupestris (L.) Spring, varies in aspect somewhat with the nature of the substratum. On the shale-barrens, which it occasionally enters, it is often relatively slender and grayish in color, but the differences are not believed to be of taxonomic importance.

Allium.—Nodding Onions, grouped under the general head of A. cernuum Roth, occur nearly throughout the United States, falling into several geographic races, not as yet fully worked out. One of these, A. oxyphilum Wherry, is endemic in the shale-barren region, usually occurring on the more heavily wooded portions of the shale-slopes, though sometimes remote from them. Perhaps it should be classed as only a variety, but this can not be decided until someone makes a field study of the group as a whole.

Eriogonum.—This typical Rocky Mountain genus has very few representatives in the east, but one of the latter, E. alleni Wats., is a highly characteristic member of the shale-barren flora. The Yellow-buck-wheat, as it is locally called, prefers the barest and most sterile situations, its long tough roots penetrating crevices in the shale rocks and holding the clumps in place in spite of the downward creep of the surface fragments. Its ancestors presumably crossed the continent and came down the Alleghenies during pre-Glacial times, but subsequent climatic changes destroyed all traces of them, leaving behind this single endemic species.

³ Mem. Amer. Acad. Arts Sci. 15: 239. 1925.

⁴ Amer. Fern. Journ. 19: 101. 1929.

Polygonum.—One of the dry-soil Knotweeds, apparently P. tenue Michx., is abundant in the more open parts of the barrens.

Anychia.—Several members of this genus occur on sterile gravelly soils in many parts of the eastern United States, and naturally invade the shale-barrens. The one which becomes most conspicuous in these habitats, though without exhibiting any consequent morphologic changes, is A. divaricata Raf. This has often been regarded as identical with A. polygonoides Raf., but, as pointed out by Steele,⁵ is undoubtedly distinct.

Paronychia.—Only one Nailwort has been observed on shale-slopes, the Texan species, P. dichotoma (L.) Nutt., which is known in the eastern states in few localities.

Silene.—The Pink Catchfly, S. pennsylvanica Michx. or S. caroliniana Walt., growing as it does in gravelly soil in so many places, could not fail to invade the shale-barrens. So far as known no significant change results, although the plants are often rather stunted in aspect. One of the many forms of Fire Catchfly, S. virginica L. is also occasional in these habitats; it does not seem to be an endemic type, although the variations of this species remain to be interpreted.

Anemone.—On the more heavily wooded shale-slopes one or more members of the section Anemonanthea of this genus occur, but their identity has not been worked out. Perhaps only forms of A. lancifolia Pursh (A. trifolia of current manuals) are represented, although it seems quite probable that the imperfectly known A. minima DC. is a member of the same flora, and has been largely overlooked owing to the fact that little collecting has been done in these regions in early Spring.

Clematis.—Members of the section Viorna of this genus are present on several shale-barrens, but their relationships are obscure. In 1814 Pursh had described C. ovata from the mountains of South Carolina, and Britton⁶ concluded this to be identical with the plant of the Kates Mountain shales, although the published description of the type specimen indicates that it is too incomplete to justify considering this as established. The Clematis of the Millboro barren was described by Steele in 1911 as C. viticaulis, and matters are still further complicated by the occurrence on others of C. sericea Michx., which is usually supposed but not known to be the same as C. ochroleuca Ait. of Atlantic lowland regions. Before this tangle can be unravelled it will be neces-

⁵ Contr. U. S. Nat. Herb. 13: 363, 1911.

⁶ Mem. Torr. Bot. Club 2: 28, 1890.

sary to study all of these plants in fresh condition, make sure as to the identity of Michaux's and Pursh's species by exploration of the type localities, and find out the extent of variability within the individual colonies. This would make an interesting study for someone who has the opportunity to carry on the necessary field work.

Arabis.—An endemic derivative of the widespread Smooth Rockcress, A. laevigata (Muhl.) Poir., grows on the shale-barrens, being remarkable in blooming in Summer instead of Spring. It has been named A. serotina by Steele, but its relationships to other variants of the species remain to be worked out.

Draba.—The little Rock-twist, D. ramosissima Desv., grows on cliffs of many kinds of rock in the southeastern uplands, and enters the shale-barrens on the more sheltered ledges, without exhibiting any resulting morphologic effects.

Sedum.—Three of the Stonecrops of the Allegheny region occur to some extent on shale slopes: American Live-for-ever, S. telephioides Michx.; Triplet Stonecrop, S. ternatum Michx.; and Mountain Stonecrop, S. nevii Gray, the last being most characteristic of these habitats. None of them show, however, any recognizable changes on passing from one type of rock to another, which they do freely.

Trifolium.—The most chacteristic endemic of the shale-barrens is the Longleaf Clover, T. virginicum Small. This is a derivative of the Buffalo Clover, T. reflexum L., which grows on the western slopes of the Alleghenies and further west, and was reduced to a variety, T. reflexum virginicum, by McDermott. The latter author stated it to be "abundant throughout the Appalachian mountains", although for many years but one locality was represented in herbaria. Up to early in 1929, eight stations for it had been definitely made known, another since reported in Mineral County, West Virginia, bringing the total to nine. It favors the barest and most sterile situations, withstanding the instability of the surface fragments by sending long tough roots into crevices in the more solid rock below.

Astragalus.—A small member of this genus is well developed on a few of the shale-barrens; it has also been found on limestone in Frederick County, Virginia, by Hunnewell.⁹ This agrees fairly well with A. distortus T. & G., but may be varietally distinct from the species as developed in the central United States—Texas to Iowa and eastward, but not coming within 400 miles of the shale-slope region.

⁷ North American Species Trifolium, p. 273. 1908.

<sup>Torreya 29: 105, 1929.
Rhodora 31: 256, 1929.</sup>

Viola.—The Birdsfoot Violet, V. pedata L., is a typical occupant of sterile gravelly soils in many parts of the eastern states, and would naturally be expected to invade the shale-barrens. When it does, its leaves exhibit a distinctive type of cutting, but whether it also differs in other characters has not been ascertained.

Oenothera.—Both an unusually small and an unusually large flowered representative of the section *Onagra* of this genus grow on shale-slopes. The former was suggested by Steele¹⁰ to be O. parviflora L., but has not been sufficiently studied. The latter is, however, an endemic species. O. argillicola Mackenzie. When this remarkable Evening-primrose is in bloom in late Summer, its habitats seem rather inappropriately classified as barrens, for it makes a magnificent floral display. It is, however, rather closely restricted to sterile situations, having, for a biennial, an unusually extensive root system. An interesting outlying occurrence of it has been noted, along the Juniata River opposite Losh Run station, in Perry County, Pennsylvania (marked by a circle on the map, Fig. 1); this has unfortunately been destroyed by the construction of U. S. Highway No. 22. The rock there is a shale of the same geological age as that underlying the more southern shale-barrens, but apparently too rich in lime and other plant-food elements, or too readily weathered into soil, to favor the growth of other endemics.

Pseudotaenidia.—P. montana Mackenzie, or, as it may be called, the Mountain-pimpernel, represents not only an endemic species but also an endemic genus, no near relatives being known anywhere. Few localities of it appear to be on record, but it is not uncommon in woods on shale-slopes. The occurrence reported near Luray, Virginia, was no doubt on the shale there, which though resembling the Devonian rock in appearance, is actually of another geologic age, and differs so much in composition as to yield no typical barrens.

Asclepias.—Several common milkweeds of sterile gravelly soils enter the shale-barrens, including A. quadrifolia Jacq., A. verticillata L., and A. tubersoa L. The last named often has abnormally pale corollacolor in such habitats, but no other differences have been recognized.

Convolvulus.—The widespread Dwarf Convolvulus, C. spithamaeus L., exhibits considerable geographic variation, the details of which remain to be worked out. One of its derivatives, which may be termed the Velvet Convolvulus because of the strikingly velvety leaves, appears to be particularly well adapted to shale-barren habitats, where it locally forms vast patches of more or less regularly spaced stalks,

¹⁰ Contr. U. S. Nat. Herb. 13: 366, 1911.

to the exclusion of most other vegetation. As recently pointed out, this is apparently C. stans Michx., the type locality of which was in Canada, near Lake Champlain. It is noteworthy that shale rocks, similar in aspect to those of the region under discussion, occur in this vicinity, although for that matter the plant is not entirely restricted to such rocks, for specimens have been seen in herbaria from Ducktown, Tennessee, and Atlanta, Georgia, where very different formations are represented. Further field study of this group is much to be desired.

Phlox.—Festoons of Moss-Phlox drape the ledges on many of the shale-slopes, the white or pale lavender flowers with which they are covered in Spring giving them a different aspect from the related material of other habitats, and the name P. brittonii Small has been applied. A detailed study¹² has shown, however, that in view of the marked variability of this group of Phloxes, the differences can not be regarded as having more than varietal significance, leading to the combination P. subulata brittonii. Besides growing on shale, this plant extends down the Potomac valley nearly to Washington, D. C., on other types of rock.

A highly distinctive species, termed the Sword-leaf Phlox from the shape of its evergreen basal leaves, and recently named P. buckleyi Wherry, is included in this enumeration because, although not growing on barrens, it seems to thrive best in woods near the bases of shale-slopes. It is an endemic relative of the more widespread Mountain Phlox, P. ovata L., which enters the same habitats to some extent without, however, exhibiting any recognizable morphologic changes.

Penstemon.—The Mountain Penstemon, P. canescens Britton, thrives on sterile gravelly slopes throughout the southeastern uplands, and naturally invades the shale-barrens. When it does so, the corolla color seems to be paler than usual, although no other distinctive features are known to have developed.

Houstonia.—Several species of Summer-bluets grow in the shale-slope region, and H. tenuifolia Nutt. becomes particularly abundant in these habitats, showing no differences from occurrences on other formations.

Campanula.—The lovely little Allegheny Bluebell, C. divaricata or C. flexuosa Michx., thrives on various types of rocks in the Appalachians, including the shales here under discussion. Its characters remain, however, essentially uniform throughout.

¹¹ Torreya **29**: 106. 1929.

¹² Bartonia 11: 27. 1929.

Liatris.—Gayfeathers are a striking feature of several of the shale-barrens, but their nomenclature needs further consideration. Perhaps the commonest is a derivative of L. spicata (L.) Willd., which corresponds more or less to L. spicata montana Gray.

Solidago.—One of the several goldenrods of these habitats, an apparent relative of S. arguta Ait., has been described as a distinct species, S. harrisii Steele. Others also deserve critical study.

Aster.—The widespread A. lowrieanus is represented on the barrens by a plant with creeping rootstocks which adapt it to growth in the heaps of loose shale, and it has received the appropriate name of A. schistosus Steele. Other species of this genus also occur in these habitats, but show no recognizable changes there. The latter statement apparently applies as well to the Antennarias, although they have not been investigated closely.

Silphium.—Rosinweeds are mostly native to the prairies of the central United States, but a few of them push eastward into the Alleghenies. One of these, S. reniforme Raf., is a striking member of the shale-barren flora, although it grows to some extent on other formations as well.

Helianthus.—Several Sunflowers occur on or near shale-barrens, but the only one recognized as showing distinctive characters is a rough-leaved representative of a widespread species, which has been named *H. laevigatus reindutus* Steele.

Senecio.—Three or four Groundsels are known in the shale-slope region, one of them being especially noteworthy. The Everlasting-Groundsel, S. antennariifolius Britton, is a highly characteristic occupant of the barer situations, often spreading into large patches, and having been but rarely observed in any other habitats. This endemic, like several others, is most nearly related to a Rocky Mountain species, and in the key in Gray's Manual, ed. 7, the range is actually the only feature used to distinguish it from S. canus Hook. (S. purshianus Nutt.) of that region.

In conclusion, two tabular arrangements of the species above discussed may be given to bring out certain interesting points about them: (1) a geographic list, showing the inferred sources of the plants and the type of endemism they represent; and (2) a chronologic list of the articles in which the more pronounced endemics have been described, showing how this interesting flora has been critically studied only at more or less long intervals.

TABLE 1. GEOGRAPHIC LIST OF PLANTS OF THE SHALE-BARRENS13

Without near relatives: Pseudotaenidia montana

Derived from Rocky Mountain species: Woodsia scopulina var.?

 $Eriogonum\ alleni$

Senecio antennariifolius

Derived from prairie species: Trifolium reflexum virginicum
Astragalus distortus var.?

Silphium reniforme

Derived from surrounding species: Allium oxyphilum (from A. cernuum)

Arabis serotina (from A. laevigata)

Anemone spp.
Clematis spp.
Viola pedata var.?

Oenothera argillicola (from O. biennis) Convolvulus stans (from C. spithamaeus)

Phlox subulata brittonii Phlox buckleyi (from P. ovata) Liatris spicata montana?

Solidago harrisii (from S. arguta) Aster schistosus (from A. lowrieanus) Helianthus laevigatus reindutus

Entering without essential change: Ch

Cheilanthes lanosa Selaginella rupestris Polygonum tenue

Anychia divaricata et al. Paronychia dichotoma Silene pennsylvanica et al.

Draba ramosissima Sedum nevii et al. Oenothera parviflora? Asclepias tuberosa et al.

Phlox ovata

Penstemon canescens Houstonia tenuifolia et al.

Campanula flexuosa

Aster spp.
Antennaria spp.
Helianthus spp.
Senecio spp.

¹³ This is by no means a complete list of the plants which grow on the barrens, but does include most of the more striking or noteworthy ones thus far observed. Further study will no doubt result in adding to the list, as well as in shifting of some species from the category "entering without essential change" to other classes.

TABLE 2. CHRONOLOGICAL LIST OF SHALE-BARREN ENDEMICS OR NEAR-ENDEMICS

1803. Michaux, Flora Boreali-Americana 1: 136. Convolvulus stans.
319. Clematis sericea.

1814. Pursh. Flora America Septentrionalis 2: 736. Clematis ovata.

1841. RAFINESQUE, Trans. Amer. Phil. Soc. n. s. 7: 342. Silphium reniforme.

1889. Watson, in Gray's Manual, ed. 6, p. 734. Eriogonum alleni. 1894. Small, Mem. Torr. Bot. Club 4: 112. Trifolium virginicum.

1898. Britton, in Britton & Brown Illustr. Flora 3: 478. Senecio antennariifolius.

1900. SMALL, Bull. Torr. Bot. Club 27: 279. Phlox brittonii.

1903. Mackenzie, Torreya 3: 159. Pseudotaenidia montana.

1904. Mackenzie, Torreya 4: 56. Oenothera argillicola.

1911. Steele, Contr. U. S. Nat. Herb. 13: 364. Clematis viticaulis.

365. Arabis serotina.

369. Solidago harrisii.

373. Aster schistosus.

374. Helianthus laevigatus reindutus.

1925. Wherry, This Journal 15: 370. Allium oxyphilum.

1929. WHERRY, THIS JOURNAL 20: 25. Phlox buckleyi.

SCIENTIFIC NOTES AND NEWS

The largest single monetary award in America for scientific accomplishment has been created by Popular Science Monthly, which, beginning this autumn, will confer an annual prize of \$10,000, accompanied by a gold medal, upon the American citizen who has been responsible, during the preceding year, for the achievement in science of greatest potential value to the world.

The award will be bestowed under the auspices of the Popular Science Institute, a research organization maintained by the magazine, of which Prof. Collins P. Bliss, associate dean, New York University, is director. The Institute has enlisted the services of twenty-four leaders in American science to serve as a Committee of Award, whose task it will be to select the prize-winning effort. The prize will be conferred for the first time in September, 1930, and the initial period of scientific accomplishment to be considered by the Committee of Award will be the twelve months ending June 30,1930. All scientific workers, professional and amateur, academic and commercial, are eligible.

The Committee of Award consists of: Dr. Charles G. Abbot, Prof. Collins P. Bliss, Dr. Samuel A. Brown, Dr. George K. Burgess, Dr. William W. Campbell, Dr. Harvey N. Davis, Dr. Arthur L. Day, Dr. E. E. Free, Travis Hoke, Dr. Frank B. Jewett, Dr. Vernon Kellogg, Charles F. Kettering, Dr. Arthur D. Little, Dr. John C. Merriam, Dr. Robert A. Millikan, Dr. Henry Fairfield Osborn, Dr. Elmer A. Sperry, Dr. Samuel W. Stratton, Dr. Elihu Thomson, Dr. Edward R. Weidlein, Henry Herman Westinghouse, Dr. Albert E. White, Dr. Willis R. Whitney, and Orville Wright.

The creation of this award, it is expected, will serve to further stimulate scientific and inventive activity in this country, especially along practical lines.

ANNOUNCEMENTS OF THE MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Wednesday, February 5, The Society of Engineers

The Medical Society

Thursday, February 6, The Entomological Society
Friday, February 7, The Geographic Society
Saturday, February 8, The Biological Society

Tuesday, February 11, The Institute of Electrical Engineers

Wednesday, February 12, The Geological Society

The Medical Society
Thursday, February 13,
The Chemical Society

Friday, February 14,
Saturday, February 15,
The Geographic Society
The Philosophical Society
The Halminthelogical Society

The Helminthological Society
The Anthropological Society

Tuesday, February 18, The Anthropological Society

The Historical Society

Wednesday, February 19, The Society of Engineers

The Medical Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

CONTENTS

ORIGINAL PAPERS

L OS	ø
Meteorology.—On the effect of vertical convection on lapse rates. C. G. Rossbr 3	3
Geology.—The Cretaceous faunas in the section on Vermilion Creek, Moffat	
County, Colorado. John B. Reeside, Jr	5
Paleontology.—A new hypural fan from the Miocene of Maryland. WILLARD BERRY 4	1
Botany.—Plants of the Appalachian shale-barrens. Edgar T. Wherry 4	3
Scientific Notes and News	2

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries

OFFICERS OF THE ACADEMY

President: William Bowie, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY BUREAU OF CHEMISTRY AND SOILS U. S. GEOLOGICAL SURVEY

C. WYTHE COOKE

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

MT. ROYAL AND GUILFORD AVES. BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, aims to present a brief record of current scientific work in Washington. To this end it publishes: (1) short original papers, written or communicated by members of the Academy; (2) short notes of current scientific literature published in or emanating from Washington;
(3) proceedings and programs of meetings of the Academy and affiliated societies; (4) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Reprints will be furnished at the following schedule of prices.

Copies	4 pp.	[8 pp.	12 pp.	16 pp.	Covers
50	3.85	\$1.65	\$2.55	\$3.25	\$2.00
100	1.90	3.80	4.75	6.00	2.50
150	2.25	4.30	5.25	6.50	3.00
200	2.50	4.80	5.75	7.00	3.50
250	3.00	5.30	6.25	7.50	4.00

An additional charge of 25 cents will be made for each split page.

Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, will be furnished when ordered.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (13, 14, 15, July, August, September)	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, R. L. Faris, Coast and Geodetic Survey, Washington, D. C. European Agent: Weldon & Wesley, 28 Essex St., Strand, London. Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

FEBRUARY 19, 1930

No. 4

GEODESY.—The scientific and practical value of triangulation. WILLIAM BOWIE, U. S. Coast and Geodetic Survey.

Triangulation, as is well known, is a method of surveying by means of which the distances and directions between widely separated points on the earth's surface can be determined with almost any degree of accuracy desired. When the triangulation is connected with astronomical determinations of latitude, longitude and azimuth, geographic positions of points on the earth's surface can be derived.

Triangulation is based on the elementary mathematical principle that when the length of one side of a triangle and the angles of that triangle are known the lengths of the other two sides can be computed. In actual practice base lines, varying in length from 4 to 15 miles, are measured on suitable terrain and from such bases chains of triangles are extended across the country to cover areas that are to be investigated scientifically or which are to be surveyed and mapped. Necessarily, the two ends of a triangle side must be intervisible from the ground, or structures in the form of stands or towers must be erected in order that the observer at one end of the line may see a pole, target, heliotrope or lamp placed directly over the station at the other end.

Every nation of the world that is well-developed industrially has at least made a start in extending a triangulation net over its area. In the United States we have about 27,000 miles of arc of first-order triangulation and traverse, by which geographic positions are determined, in addition to what is called third-order triangulation which has been executed along our coasts. Then, in the interior of the country, there is a large amount of triangulation of various orders below first-order which has been used in the topographic mapping.

¹ Received January 11, 1930.

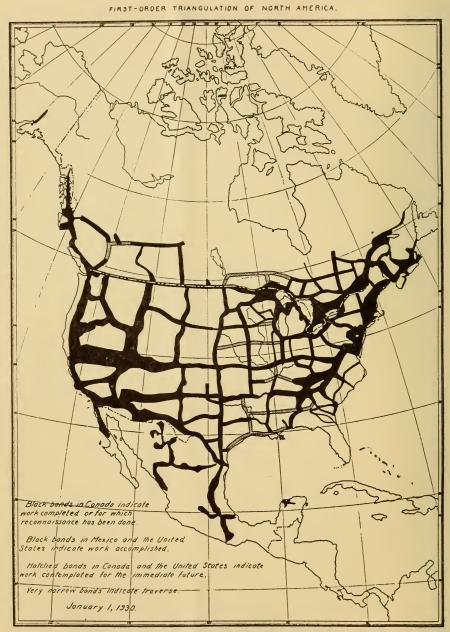


Fig. 1.—Triangulation of North America, showing recent work in Canada, the United States, and Mexico.

First-order triangulation which is the framework on which all lower orders are based is now being executed only by the Coast and Geodetic Survey. This bureau will supplement the first-order work with arcs of second-order triangulation. The arcs of these two classes of triangulation will be so spaced that when the network is completed there will be few places in the United States more than about 25 miles from a first or second-order triangulation station.

In this high grade triangulation the best available theodolites are used. The tendency has been during the past few decades to reduce the theodolites in size but to increase the accuracy with which the parts are fitted together, to improve the optics and to increase the refinement with which the horizontal circle is graduated or divided. atmosphere is seldom very clear, only in exceptional cases is it possible to make observations on poles or targets, for the lines are in general more than 8 miles long and sometimes reach a length of 100 miles or more. Heliotropes have been used as targets on which to make observations but they can only be employed when the sun is shining and even then only during the latter part of the afternoon when the atmosphere becomes steady. For several decades the Coast and Geodetic Survey has been making practically all the angle measurements for the main scheme of triangles at night. For this purpose, automobile headlights, each provided with a contracted filament lamp, are used. The beam going out from such a lamp can be easily observed with the unaided eye at distances varying up to 40 miles if the atmosphere is at all favorable. In some parts of the country, notably the southwest where the atmosphere is generally quite clear, the light from the signal lamp has been seen with the unaided eye over distances of more than 100 miles.

Thirty-two pointings are made over each line of the triangulation during the angle measurements and the average of the results is used as the direction to be employed in computing the angles of the triangles. Necessarily in the computations the spheroidal shape of the earth's surface must be taken into consideration. If the lines are only a fraction of a mile long the curvature of the earth really does not affect the measured angles, but the spherical excess, the amount that the sum of three angles of a spherical triangle exceeds 180 degrees, is in some cases more than one minute.

The closing error of the triangles as observed for first-order triangulation averages slightly under 1". This accuracy is all that is required for any except the most special scientific work.

The base lines of the triangulation are measured now with 50-meter invar tapes and the probable error of the derived length is seldom greater than one part in a million. The actual error is believed to be seldom or never greater than 1/300,000.

The principal purposes of the triangulation are eminently practical. In the subdivision of our country into states, counties and even smaller political units, it is essential that the boundary lines be known in their proper geographical positions. The triangulation of the country furnishes just the information that is needed in the accurate location of such political boundary lines. It is also essential that the boundaries of private property be easily recoverable. This can be assured whenever geographic positions or plane coordinates are determined for the angle points of the boundary of a farm or of a city lot. When such coordinates have been given and they are referred to the general triangulation system of the country, it is possible to relocate the boundary corners even though all of the monuments set on them may have been destroyed.

Triangulation furnishes information of value in connection with the alignment surveys of highways and railroads and in bridge and tunnel location and construction. Also it furnishes the basis for the surveys made along rivers for flood control or river improvement. Its most important practical value is in connection with the charting of the coasts and the topographic mapping of the country. Commercial and naval vessels must have accurate charts. There are few important human activities that do not depend for their successful execution on exact knowledge of geographic positions, distances, directions, elevations and the configuration of the ground. All of this information is furnished by the modern topographic map. That map in turn depends on the triangulation system of the country in order that the various adjoining sections of it may be accurately fitted together. When the triangulation system of the whole country is used in mapping there will not be those gaps, overlaps and offsets where two maps meet which often bother the cartographer who constructs them and others who use them. Triangulation is used extensively in military surveying and mapping.

Triangulation also has very important scientific values. It is only by means of connected arcs of triangulation with the astronomic latitudes and longitudes determined at some of the stations that one can determine the dimensions of the earth. From gravity data alone the shape of the earth can be obtained, but triangulation by which dis-

tances across wide areas are measured is necessary for the determination of the size. The shape and size of the earth have already been determined a number of times but in each case the data used covered only a comparatively small part of the earth's surface. With more extensive data over greater areas closer approximations to the true figure of the earth can be made.

The shape and size of the earth are needed in all surveying and mapping operations which are executed on a large scale, in navigation, and in explorations. The figure of the earth is needed as well as the distances between widely separated points in connection with certain astronomical observations, especially in the determination of the parallax of the moon.

It has been found that the combination of astronomical and triangulation data enable one to learn much in regard to deviations from normal density in the outer portion of the earth. In fact it is by means of astronomical and triangulation data that the first comprehensive quantitative test of isostasy was made. It was found that the material under continental areas is lighter than normal while the material under ocean areas is heavier than normal. The deviations from normal density were found to be sufficient to balance the topographic features. This condition of balance or equilibrium of prisms of the earth's crust is called isostasy.

While the application of the principle of isostasy to triangulation and astronomical data brought these data into very close agreement it was found that there were some outstanding differences. Further investigation in the field of isostasy involving values of gravity led to the rather definite conclusion that the abnormalities or residuals in the geodetic data resulted from the presence of extra heavy or extra light material near the geodetic stations, both horizontally and vertically. It seems to be reasonably certain that the deflections of the vertical, as differences between triangulation and astronomical data are called, can be used for the purpose of disclosing buried structure. There is now available in the United States a large amount of geodetic data in the form of deflections of the vertical which can be used in connection with geological studies.

Now that isostasy has been substantiated as a scientific principle we are able to use triangulation and astronomical data to show the deviations of the geoid or water surface of the earth from the spheroid or mathematical surface which most nearly fits the geoid. A surface can be passed through the astronomical stations at right angles to the direc-

tion of gravity and also through the derived directions of gravity at places where triangulation has not been executed or astronomical observations made, but where the deflection of the vertical on the isostatic principle has been computed. What might be called a geoid contour map could be constructed which would show the deviations of the geoid from the spheroid.

One of the most notable cases of the use of triangulation in a scientific problem was the measurement, by means of a base and triangulation, of the distance between San Antonio Peak and Mt. Wilson in southern California for the use of Prof. A. A. Michelson in the determination of the velocity of light. The length of the base was about 22 miles while the distance between the two peaks was about 23 miles. Every possible correction was applied to the triangulation in order to eliminate the effect of systematic errors. The base line was measured with a probable error of about one part in 10 million, while the probable error of the distance between the two peaks was about one part in 6 million. It seems reasonably certain that the distance furnished Prof. Michelson was not in error by as much as one millionth of the distance.

Triangulation has been used in this and other countries in the determination of the distortion of the earth's surface during earthquakes. Already rather extensive investigations have been made in California by means of triangulation, and plans are now being formulated for an extension of the tests. Arcs of triangulation are being extended across areas where there are fault zones which have been active in historical or at least in late geological time. It is planned to have this triangulation repeated at intervals of ten or some other number of years to see if any strains have taken place in the earth's material. Should an earthquake occur along any of the faults or in fact anywhere in the vicinity of this triangulation the work will be repeated in order to learn how much movement of the ground had occurred at different distances from the fault, and how far from the fault one must go in order to find undisturbed points. These tests by triangulation in regions of seismic activity are of particular importance to the geologist for by them he can obtain an idea as to whether an earthquake is a local or a general phenomenon.

The Coast and Geodetic Survey has in the last few years made a readjustment of the triangulation net of the western half of the United States involving about 13,000 miles of arc. The bureau is now engaged in the computation and adjustment of the net of the eastern half of the country. The latter work will be completed in the next two or three

years after which standard or final geographic positions can be furnished for the triangulation stations to engineers, scientific workers, or others who may need the data. Of course there is no such thing as a final position for there is abundant evidence that the earth's surface during geological time has undergone changes both vertical and horizontal, but it seems reasonably certain that very few of the triangulation stations of this country will be affected by geological processes to an extent that will vitiate the data in a few hundred years at least. Regions of considerable seismic activity will of course have triangulation stations whose positions are likely to change during earthquakes and even between such earthquakes but such areas form only a small portion of the total area of the country.

The accuracy of the triangulation, as shown by the adjustment of the western net, is quite remarkable. There were 16 circuits with perimeters averaging about 1200 miles. The average closing error of these circuits was about one part in 430,000. There were only two of the circuits for which the closing error was greater than about 1/200,000. While it is doubtful if the length of a line of triangulation is known with an accuracy greater than 1/100,000, yet where there is a series of such lines combined to measure a distance across country, the errors of the individual lines tend to balance out according to the law of accumulation of accidental errors.

The scientific and practical needs for triangulation data are increasing from year to year. The demands for such data have led the President of the United States to include in his budget for the fiscal year 1931 a substantial increase in the money to be devoted to geodetic surveys, including triangulation. It is hoped that the triangulation net composed of first and second order work will be finished within the next ten or twelve years.

PALEONTOLOGY.—A Cretaceous pelecypod with color markings.
John B. Reeside, Jr., U. S. Geological Survey.

Color markings are so rarely preserved on fossil shells that the exceptional case of their preservation seems always worthy of record, particularly where the genus concerned is extinct. The writer here presents a note and figures descriptive of a species of *Inoceramus* related to *Inoceramus stantoni* Sokolow from the lower part of the Mancos

¹ Received January 4, 1930. Published with the permission of the Director of the U.S. Geological Survey.

shale of Vermilion Creek, Moffat County, Colorado.² The specimens are completely flattened in a calcareous shale and the original sculpture and outline may be only guessed at. The fossils in adjacent layers, however, show that the age of the beds is that of the lower part of the Niobrara limestone (Coniacian).

The markings on these shells show as light-brown, nearly straight bands radiating from the beaks and gradually increasing in width toward the basal margins. The width of the individual bands differs much, though there seems to be a wider band near the middle of each shell and narrower bands on each side of it. What the original color of the bands may have been seems scarcely worth conjecture, but it is beyond doubt that the pattern preserved is that of the coloring of the shell in life.

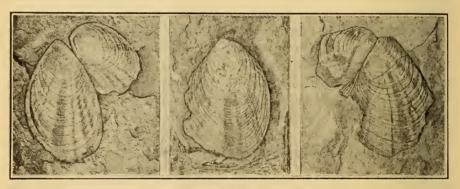


Figure 1.—Inoceranus aff. I. stantoni Sokolow, from the Mancos shale of Vermilion Creek, Colorado. Three individuals showing color markings. U.S. National Museum cat. No. 73736.

PETROGRAPHY.—Pacificite, an anemousite basalt.¹ Tom. F. W. Barth, Geophysical Laboratory, Carnegie Institution of Washington. (Communicated by L. H. Adams.)

Introduction. In many lavas the amount of silica is insufficient for the formation of feldspar, and consequently minerals undersaturated in silica are formed, among them the feldspathoids. Microscopic investigations of the undersaturated lavas of the Pacific island volcanoes have shown that nephelite occurs throughout the area, forming

² See This Journal, 20: 40. 1930.

¹ Received January 18, 1930.

nephelite basanite, as well as phonolitic trachyte and, rarely, phonolite, these lavas being in much smaller amount than the basalts. The minerals of the sodalite group and analcite, as well as melilite, occasionally occur, but the feldspathoid leucite is never met with at the Intra-Pacific volcanoes.

It has been noted, however, that there occur certain purely feld-spathic basalts, without nephelite and usually with olivine, the analyses of which show the presence of very considerable amounts of nephelite in the norm, although none of this appears in the rock. A number of these rocks have been studied by me and the conclusion has been arrived at that much of what is apparently a normal plagioclase is in reality anemousite.

Anemousite is a plagioclase with carnegieite in solid solution, carnegieite being the triclinic form of the molecule Na₂Al₂Si₂O₈, which ordinarily occurs as the hexagonal nephelite. Anemousite was first described by Washington and Wright² on specimens from the island of Linosa, in the Mediterranean, this being, so far, the only known occurrence. Carnegieite has been made artificially,³ and it appears to be the abnormal nephelite described by Esch from the Kamerun.⁴ Bowen⁵ has studied the system, nephelite (carnegieite)-anorthite. The possibility of the presence of anemousite or carnegieite instead of nephelite in lavas, dependent on the conditions of solidification, was pointed out in the paper on the feldspar from Linosa, in which it is said (p. 64): "With identical chemical composition of the rock, we would have in the one case a nephelite tephrite, and in the other a feldspar basalt, but the norms of both would be the same and would show normative nephelite." The pacificites are an example of this.

We have in these lavas a rock that, under other conditions, would have contained very considerable nephelite, whereas this molecule actually enters a triclinic plagioclase. Under the former conditions the rock would be a nephelite basanite or tephrite, while it has the mineral composition of a feldspar basalt. Recognition of this difference seems to be called for, so that I propose the name pacificite for this group of anemousite basalts. If olivine is present in abundance the rock would be called olivine pacificite. This name is appropriate inasmuch

² Washington and Wright, Am. Journ. Sci. 29: 52-70. 1910.

³ Thugutt, Neues. Jahrb., Beil. Band 9: 561. 1894; Washington and Wright, op. cit., p. 64; Bowen, Am. Journ. Sci. 33: 564. 1912; Bowen and Greig, Ibid., 10: 204. 1925.

⁴ E. Esch, Sitzb. Berl. Akad. 18: 400. 1901.

⁵ Bowen, op. cit., pp. 551-573.

as such anemousite-bearing lavas would seem to be widely scattered throughout the Intra-Pacific basin, as is shown by the descriptions and analyses published by Lacroix, Washington, and others. For example, in discussing the lavas of Maui, it is remarked⁶ that the alkalic tendency of these rocks is indicated "by the constant presence, *modal or normative or both*, of nephelite in the andesites and basalts of Haleakala."

Although the feldspar of the pacificite is undersaturated it can not be called feldspathoid, and consequently the rock can not be reckoned with the tephrites or basanites, because according to the definition of these the presence of a feldspathoid is essential. Therefore pacificite is to be classed with the basalts.

Mineral composition. A quantitative description of two pacificites follows.

1. Pacificite. Three miles from Rest House, Haleakala, Maui, Hawaiian Islands. Analyzed by M. G. Keyes, under name of nephelite andesine basalt.⁷

This rock is somewhat trachytoidal in texture. Abundant thin laths of plagioclase grade on the one hand into larger phenocrysts (labradorite), and on the other hand into an interstitial groundmass (anemousite). Very few phenocrysts of euhedral olivine, and many of grayish brown pyroxene are present. In the groundmass very minute augite grains and much ore are met with.

Olivine (2 per cent⁸). The axial angle is very close to 90°, some grains probably show a negative character. The composition is consequently about 15 fayalite.⁹

Pyroxene. The phenocrysts and microphenocrysts of pyroxene make up 15 per cent of the rock; the amount in the groundmass is probably somewhat lower. The axial angle is $2V\gamma = 56^{\circ} \pm 3^{\circ}$, dispersion $\rho > v$, the extinction angle is $c : \gamma = 48^{\circ}$. The refringence shows some variation, indicating a different composition of the various grains; an average value is $\beta = 1.705$.

The value of 2V indicates that no appreciable amount of either clinoenstatite or acmite can be present, and the value of β indicates an amount of about 50 per cent of the diopside molecule, the rest being chiefly hedenbergite.

⁶ Washington and Keyes, Am. Journ. Sci. 15: 216. 1928.

⁷ Washington and Keyes, op. cit., p. 210.

³ This is the volumetric percentage found by the Rosiwal method.

⁹ This is approximately the composition of the olivine of Kilauea, as shown by Aurousseau and Merwin (Am. Mineral. 13: 560, 1928).

Ore (8 per cent). The percentage of ore shown in the thin sections is less than that shown in the norm. This is because much of the normative magnetite and ilmenite is modally present in the augite. It was not possible to determine the relative amounts of magnetite and ilmenite in the thin sections, but the norm indicates that the amount of ilmenite is equal to that of the magnetite or that the latter is very titaniferous.

Feldspars. The phenocrysts show the following properties:

The lowest index of refraction, $\alpha = 1.557$: 55 An Maximum extinction in zone \bot (010), α' : (010) = 33°: 58 An Positive axial angle, $2\mathring{V} = 75^{\circ}$: 55 An Extinction angle in section $\bot \gamma$, $a: \alpha = 28^{\circ}$: 53 An.

This feldspar may be an anemousite, for the data correspond fairly well with those given by Wright² for the anemousite from Linosa. However, the above data also fit in very well with a normal labradorite, and since no further proofs of the presence of carnegieite are obtainable, the feldspar of the phenocrysts may be regarded as a normal plagioclase of about 50 An.

TABLE 1,—Calculation of the Mineral Composition of Pacificite from Haleakala

	Ore	- Ane	emousite	Labrado	orite	Oliv.	Pyrox.	Apat.	Total
		Or	Ĉg	Āb	An	(15 Fa)	1 ylox.	Apat.	10041
SiO ₂		6.9	6.7	14.5	4.6	0.8	12.1		45.6
TiO ₂	4.3						0.8		5.1
Al_2O_3		1.9	5.7	4.1	3:9		0.6		16.2
Fe ₂ O ₃	3.5						0.9		4.4
FeO	5.5					0.3	1.9		7.7
MgO				4		1.0	3.1		4.1
CaO					2.1		5.7	0.7	8.5
Na ₂ O			3.5	2.5			0.1		6.1
K ₂ O		1.8							1.8
P ₂ O ₅								0.5	0.5
Total	13.3	10.6	15.9	21.1	10.6	2.1	25.2	1.2	100.0

The more sodic feldspars of the groundmass, however, certainly exhibit optical properties that do not correspond with those of any normal feldspar series.¹⁰ The shading of the feldspar laths into an interstitial groundmass is accompanied by a lowering of the refringence. A common value of the mean index is $\beta = 1.550 \pm$, while α still is higher

 $^{^{10}}$ This was referred to andesine or oligoclase-andesine by Washington and Keyes, who determined the optical characters only approximately.

than 1.545; the axial angle of such grains is (+) 2V = $60^{\circ} \pm 3^{\circ}$. It is hardly possible to detect any grains with β lower than 1.550, obviously indicating that neither nephelite nor ordinary alkali feld-spars are present.

There does not exist any known mineral with the above stated optical properties. But since the aspect is very much like that of a feldspar, and since the chemical analysis of the rock shows that some undersaturated mineral has to occur, a plausible explanation is that this mineral belongs to the anemousite series.

The calculation of the rock analysis is shown in Table 1. Table 2 shows the mode compared with the norm.

TABLE 2.-Mode and Norm of Pacificite from Haleakala

Mode		Norm	
Anemousite	48	Or	
Plagioclase (50 An)	10	Ab	
		An	
Pyroxene	25	Ne	
Olivine (15 Fa)	2	Di	
		Ol	
Ore	13	Mt	6.5
		I1	
Apatite			

A pyroxene from Haleakala has already been studied by Washington and Merwin.¹¹ A comparison of the composition of this pyroxene¹² with the calculated composition of the pyroxene in the pacificite gives a further proof of the correctness of the interpretation of the rock analysis. The molecular compositions (by weight, with titanium dioxide reckoned with silica) are as follows.

Diopside		Augite from pacificite 66
Hedenbergite	. 15	25
Acmite		3
Enstatite	. 2	-
Sesquioxides	. 9	5

For the analyzed augite: $\beta = 1.706$, c: $\gamma = 48^{\circ}$, 2V = 60°; for the pacificite augite: $\beta = 1.705$, c: $\gamma = 48^{\circ}$, 2V = 56°.

¹¹ Washington and Merwin, Am. Journ. Sci. 3: 117. 1922.

¹² This pyroxene was found along the trail from the Rest House to Red Hill.

The slightly higher content of hedenbergite in the augite of the pacificite is probably due to the admixture of the groundmass pyroxenes which presumably are richer than the phenocrysts in iron.

The anemousite is not homogeneous but consists of a series of solid solutions. The average composition by weight calculated from the chemical analysis comes out as follows:

Orthoclase		 	22
Albite		 	33
Anorthite	 	 	12
Carnegieite		 	33

This composition must correspond with fair accuracy to that of the average feldspar of the groundmass of the rock. No serious alteration of the figures is possible, and since the optical properties of the groundmass exclude with certainty any ordinary undersaturated mineral, the fact that this rock represents a new lava type has been established, and in all probability the undersaturated mineral must be looked upon as an anemousite feldspar.

2. Olivine pacificite. Kaula Gulch, above Ookala, Mauna Kea, Hawaii, Hawaiian Islands. Analyzed by H. S. Washington and by him called chrysophyric basalt.¹³

This lava contains abundant phenocrysts of olivine in a very fine grained, grayish groundmass consisting of small crystals of pyroxene, a little ore and some feldspar laths that partly grade into an interstitial feldspar-like mineral.

Olivine (17 per cent). The negative axial angle is 85°, the mean index of refraction, $\beta = 1.703$, corresponding to 26 Fa.

Pyroxene (34 per cent) shows somewhat variable optical properties. The positive axial angle is around 58°, and the mean index is about $\beta = 1.700$.

The index indicates an amount of not less than 40 per cent diopside, and the axial angle shows that no clinoenstatite or acmite molecules are present in appreciable amount. The residual 60 per cent must consequently be chiefly hedenbergite. The amount of sesquioxide is presumably small, but can not be accurately stated.

Ore (6 per cent) is a mixture of ilmenite and magnetite.

Feldspars. Very few phenocrysts (much less than 1 per cent) of labradorite-bytownite (about 72 An) are present.

¹³ Washington, Am. Journ. Sci. 5: 499. 1923.

Some of the well developed thin feldspar laths in the groundmass have a mean index of refraction, $\beta = 1.555-1.550$; they are optically positive with 2V about 85°, and may consequently be regarded as normal plagioclase with the composition of a calcic andesine. The more sodic feldspars, however, are anomalous, a great many of them show the following properties: $\beta = 1.545 \pm 0.002$, (+) 2V = 84° \pm 4°.

Some feldspar powder of the rock was obtained by magnetic separation and was embedded in different index liquids. On grains lying normal to an optic axis the following measurements were made:

$\beta = \dots$	1.552	1.550	1.545	1.540	1.535
Approx. axial angle	(+)85	(+)85	(+)84	(+)75	(+)50

Variations of the axial angle from $+10^{\circ}$ to $+65^{\circ}$ were observed on grains of low refringence ($\beta < 1.540$).

That the relation between the refringence and the axial angle in these feldspars is very different from that in the plagioclase series is shown graphically in Fig. 1. Since all the potash feldspars and also the nephelite are optically negative, they can with certainty be excluded, and thus the only possible explanation again seems to be that these feldspar-like minerals belong to the anemousite series.

TABLE 3.—Mode and Norm of Olivine Pacificite from Kaula Gulch, Mauna Kea

Mode		Norm	
Anemousite	34	Or	5.6
Plagioclase (43 An)	7	Ab	19.9
		An	6.1
Pyroxene		Ne	10.8
Olivine (26 Fa)	18	Di	30.9
		O1	
Ore	7	Mt	4.9
		II	4.3
Apatite	1		

The mode and norm of this rock are entered in Table 3. The method of calculation is the same as that which was used for the rock previously described. The figures are in perfect agreement with the microscopic observations.

¹⁴ The colorless substance of the ground mass was doubtfully referred to nephelite by Washington, who remarks that its amount is much less than that of the nephelite in the norm.

The calculated average composition of the pyroxenes is as follows:

Diopside	61
Hedenbergite	35
Acmite	

The calculated average composition of the anemousite is:

Orthoclase	9
Albite	54
Anorthite	12
Carnegieite	24

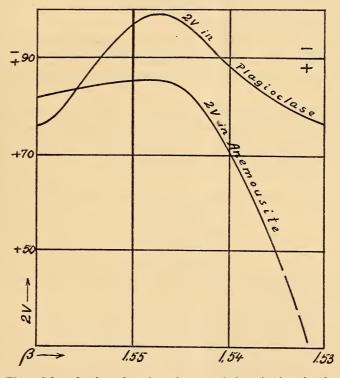


Fig. 1.—The axial angle plotted against the mean index of refraction for the plagioclase series and for the series of feldspar-like minerals occurring in the pacificite. The value at $\beta=1.559$ is taken from Wright's (Washington and Wright, Am. Journ. Sci. 29: 52-70. 1910) measurements on anemousite from Linosa.

The preceding pages contain all the information on this anemousite feldspar available by analytical and optical methods. Several vain attempts have been made to obtain pure anemousite from the rock for a chemical analysis. But these lavas are too fine grained; very fine dust and minute grains and skeletons of ore and pyroxene are mixed with the colorless minerals in such an intricate way that even if the rock is ground down so extensively that the powder sticks together like clay, and all methods of mechanical separation are carried out very slowly, it has been impossible to get even approximately pure material. Of course it is possible to concentrate the colorless minerals, but so much of the dark minerals is always admixed that the calculation of the composition of the colorless phases can never be very accurate, because an estimation of the proportion and nature of the colored contaminations in such a finely ground powder would always be a mere guess. If the calculation is based directly on the chemical analysis of the rock, however, both the amount and composition of the colored minerals can be obtained by optical analysis.

It is hoped that a study of the system nephelite-albite will throw more light on the nature and properties of anemousite. In connection with such a synthetical study the genesis of the pacificites will also be discussed.

I wish to express my sincere thanks to Dr. H. S. Washington of this Laboratory for the free use I have had of his large rock collection, for his furnishing me with data of the petrology of the Pacific Islands, and for his very welcome criticism of this paper.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

225TH MEETING

The 225th meeting was held in the Assembly Hall of the Cosmos Club on

Thursday, April 4, 1929.

Program: Austin H. Clark of the U. S. National Museum delivered an illustrated address on Evolution. Any tenable theory accounting for the development of animal forms must take into consideration three distinct, but interrelated, sets of facts. These are: First, indubitable evolutionary lines, such as those found in the horses; second, breaks or gaps in the continuity of these lines, and especially between the lines themselves, as between the cat and the dog lines; third, the fact that all fossils, including the very earliest, fall at once into their respective phyla as the phyla are defined on the basis of the data derived from recent animals alone—in other words that in all geological history there has been no change in the interrelationships between the phyla. Perhaps the term evolution might be so restricted as to cover only development of animal types within the phyla, the word mutations being used to indicate the gaps, and primagenesis might be used to cover the original formation of the phyla by different paths of development from the single cell; the entire concept of the development of animal forms might be called zoögenesis.

The evolutionary history and present interrelationships of animal types are a reflection of the possibilities for variation afforded in the early stages. These are least in the birds, which form the most unified of any of the vertebrate groups. Indeed, all of the vertebrates together show scarcely more structural diversity than is seen in certain individual species of insects or

crustaceans in the course of their life history.

The relationship between man and any one of the apes may be compared to that between the greyhounds and the bull-dogs, which differ physically and mentally both from each other and from the wolf from which they are derived and do not intergrade either with each other or with the wolf. These dogs thus illustrate perfect continuity of descent coupled with abrupt discontinuity of form and mental attributes. The ancestor of man is not known, but probably was not an ape as we understand that term. (Author's abstract.)

226TH MEETING

The 226th meeting was held in the Assembly Hall of the Cosmos Club on

Friday, May 10, 1929.

Program: Edward W. Berry of Johns Hopkins University delivered an illustrated address on The history of the Andes. Among the major tectonic features of the earth the Andes are unique in their continuous great elevation over 65 degrees of latitude; in that they overhang a coast with several great deeps near shore; and in that they cross much of the equatorial and south temperate zones and hence lie across the paths of the two most continuous and most important wind systems of our planet—the southern trades and the south temperate westerlies. Nearly all of the apparent anomalies of South American climate are explained by this fact, which is also the clue to the most important method for arriving at the amount and date of uplift of

the present mountains.

In the central and northern Andes the present coastal region lies in the rain shadow of the moisture-carrying trade winds, gets little moisture from the Pacific because of the cool Humboldt or Peruvian current, and is consequently a desert or semi-desert. In the southern Andes, Patagonia lies in a rain shadow of the moisture-carrying "roaring forties" and is consequently arid. The evidence furnished by late Tertiary fossil plants, which have been collected from a great many localities on both sides of the mountains as well as from great elevations within the montane belt, shows that the major elevation did not take place until near the close of the Tertiary period, or slightly later. Traces of wet lowland tropical forests, whose existing relatives are confined to the basin of the Amazon, are found at elevations of from 11000 to 13500 feet along with petrified woods showing no seasonal rings, and similar floras are found fossil in the Peruvian desert. Similarly, fossil floras indicative of a heavy rainfall, and with coal measures, are found not only along the West Coast in southern Chile, but also east of the present mountains in the, at present, arid belt of Argentina.

These prove that the amount of vertical elevation since Pliocene time amounted to over 5000 feet as a minimum figure. This is corroborated by the present physiography with its discordant stream profiles, by the great topographic maturity of the more elevated as compared with the less elevated parts of the terrain, by the finding of marine Pliocene fossils in the southern Andes at elevations of over a mile, by observed changes in the drainage pattern, and by the distribution of the present life—especially the plants, birds, and

freshwater fishes.

The general geologic history of South America was shown to have consisted of sedimentation in a series of geosynclines extending approximately north and south, the western margins of these geosynclines lying progressively farther west during the Paleozoic. The major periods of folding, according to our present information, were in supposed pre-Cambrian rocks, in pre-Carboniferous rocks, in the pre-Mesozoic rocks, and in the pre-Cenozoic rocks. Igneous activity appears to have reached a maximum during the Cenozoic, and the major uplift was many millions of years subsequent to the folding of the rocks. The antecedent times when the Andean segment was above sea level were early Cambrian, and earlier, part of the Ordovician, late Devonian and early Carboniferous, during the Permian (maximum earlier emergence) and most of the Triassic.

The address was illustrated by diagrams and maps showing the main tectonic lines, the climatic elements, etc., and views illustrating the types of country developed in the various climatic zones and in the rocks of various

geological ages. (Author's abstract.)

227TH MEETING

The 227th meeting was held in the Assembly Hall of the Cosmos Club on

the evening of Tuesday, November 26, 1929.

Program: The meeting was devoted to a symposium on The 1929 Scientific Explorations in Alaska. Brief addresses on the various phases of the work were given by Aleš Hrdlička for Anthropology, H. B. Collins for Archeology, R. Y. Stuart and E. E. Carter for Forestry, Philip Smith for Geology, and W. R. Gregg for meteorology. Abstracts of most of these addresses follow:

The 1929 anthropological researches of the speaker in Alaska were devoted to the Yukon River, throughout its extent (2300 miles). Their main objects were to secure anthropometric data on the remaining full-blood Indians and Eskimo along the river; to collect whatever older skeletal remains might still be found along the river; and to advance as far as possible our knowledge of the earlier settlements or migrations along the Yukon River. Substantial and interesting progress was made in all these directions, notwithstanding the inclement season. The expedition resulted in the securing of valuable data as well as much of the older skeletal material, and due to good fortune brought also a large series of specimens belonging to the fossil ivory culture of the northwestern Bering Sea and northeastern Asia. (Author's abstract.)

Archeological investigations of the past four years around Bering Strait have revealed the existence of an ancient phase of Eskimo culture more highly developed, especially in regard to art, than any since known to the Arctic regions. This old Bering Sea culture is apparently ancestral to the extinct Thule culture, the most ancient Eskimo culture of the eastern regions. However, there may possibly have been a late return migration which superimposed certain Thule traits on the older Bering Sea culture. A vague similarity in art and other general resemblances in material culture may indicate an ancient connection with the Indians of the Northwest Coast, although this cannot be determined until some knowledge is had of the archeology of the latter region. The rich curvilinear art of the old Bering Sea culture has been traced through a transitional stage, much less elaborate, into the still simpler patterns of the modern Eskimo. The early stages have not been found. Evidence of a direct and indirect nature points to Northeastern Siberia, between the Anadyr and Kolyma Rivers, as the probable place of origin of the old Bering Sea culture. (Author's abstract.)

There is great need for continued employment within the Territory. The activities there are largely seasonal. The fishing season is quite short and the timber and mining work must be curtailed in the open during the more rigorous months. The largest opportunity for building up a twelve months pay roll seems to lie in the establishment of forest industries in the Territory, such as the pulp and paper industry, which could operate their plants throughout the entire year. There is also a large opportunity open for the development of trade in fur-bearing animals, if the proper protection is given to the range available to them. The need for protection in this respect is much greater in interior Alaska than in southeastern Alaska because

the fire hazard is more acute in the interior. (Author's abstract.)

Five projects were undertaken by the Geological Survey, namely, (1) in coöperation with the Forest Service inducing the Navy Department to send a detachment of airplanes to southeastern Alaska to photograph 12,000 square miles for mapping and study and participating in the conduct of the work in the field; (2) a reconnaissance of the Alaska Range at the head of the Copper River valley and extending northward into the Tanana Valley; (3) an exploration of the western slopes of the Alaska Range west of Cook Inlet and north of Lake Clark; (4) a scouting trip into parts of the Yukon-Tanana region of central Alaska, with a view to visiting tracts that had not heretofore been studied and making a comprehensive correlation of the geology of that general region; (5) the installation of a new seismograph at Dutch Harbor, Unalaska Island, and the rehabilitation of the seismograph at Kodiak Island and the placing of observers at each of these stations. In addition, the Geological Survey carried on its usual investigations of the general development of the mineral resources of the Territory and its technical administrative duties relating to the operations under leases and permits granted for mining certain mineral deposits on Government-owned lands. (Author's abstract.)

In 1927 the Alaskan Legislature requested coöperation and assistance from the Federal Government in the development of facilities for safe and efficient flying in the Territory. One of the aids specially requested was the organization of an airways weather service. A definite start to this end was made early in 1929. Fairbanks was chosen as the organization center largely because it is the point from and to which there is the greatest amount of flying. Five substations have been established, at Anchorage, Crooked Creek, Dillingham, Golovin and Ketchikan. These regularly report by Signal Corps radio twice daily, or oftener if necessary, to Fairbanks. In addition, reports are received from twelve other stations which had previously been established. The observations are used not only for the information they give as to current conditions but also as the basis for flying-weather forecasts. In addition, permanent records are kept and these will be used in statistical and other studies of conditions in this region,—one of the most interesting, meteorologically speaking, in the world. (Author's abstract.)

Walter D. Lambert, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

The Geological Society of America, together with its affiliated organizations, the Mineralogical and Paleontological Societies, held their annual meetings from December 26th to 28th in Washington, celebrating the fiftieth anni-

versary of the creation of the U. S. Geological Survey. Most of the sessions were held at the Wardman Park Hotel, but some at the National Museum. Thursday evening the retiring President of the Geological Society, Professor Heinrich Ries, gave an address entitled Some Problems in the Non-metallics, pointing out how much remains to be learned as to the origin, significance, etc., of many deposits of non-metallic minerals. In all about 125 papers on a wide variety of subjects were presented.

A series of five illustrated lectures relating to The evolution and cultural history of mankind is in progress under the auspices of the Anthropological Society of Washington. They are being given in the auditorium of the U.S. National Museum and are open to the public. Dr. Fay Cooper-Cole spoke on January 7 on The coming of man, and Dr. Aleš Hrdlicka on January 21 on The differentiation of man into races and his spread over the earth. The remaining lectures are as follows: February 4, Dr. Clark Wissler, The culture area; February 18, Dr. Herbert J. Spinden, The Civilizations of Middle America; March 4, Mr. Neil M. Judd, Prehistoric pueblos and cliff-dwellings of the Southwest.

Mr. Herbert J. Krieger, of the National Museum, is continuing field work in Santo Domingo, where he has been carrying on anthropological researches during the past two years. Mr. Henry B. Collins is inspecting excavations at village sites at Vaughan, Miss., where work is being carried on by the University of Mississippi.

Mr. George G. Ainslie, of the Bureau of Entomology, is spending several months at the National Museum in a study of certain groups of moths.

Mr. Kurt Teichert, who has a Rockefeller Foundation fellowship in paleontology for 1930, is studying American Ordovician and Silurian fossils in the National Museum for comparison with those of Europe.

Dr. F. Drevermann, Director of the Senckenbergische Institution at Frankfort, Germany, recently visited the department of geology of the National Museum to examine methods of preservation and exhibition of collections.

The second half-year of the Bureau of Standards Educational Courses has recently begun. In addition to the continuation of most of those announced in This Journal 19: 442, there are to be courses in advanced radio theory and the theory of elasticity given during this period.

The second semester of the Department of Agriculture Graduate School has also opened. New courses comprise: Physiology of plant growth and development, Russian for beginners, and business cycles in relation to agriculture.

ANNOUNCEMENTS OF THE MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Wednesday, February 19. The Academy

The Society of Engineers

The Medical Society

Thursday, February 20. The Academy

Friday, February 21. The Geographic Society Saturday, February 22. The Biological Society

Wednesday, February 26. The Geological Society

The Medical Society

Friday, February 28. The Geographic Society
Saturday, March 1. The Philosophical Society

Tuesday, March 4. The Botanical Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

CONTENTS

ORIGINAL	PAPERS
----------	--------

Pi Pi	age
Geodesy.—The scientific and practical value of triangulation. WILLIAM BOWIE	53
Paleontology.—A Cretaceous pelecypod with color markings. John B. Reeside, Jr.	5 9
Petrography.—Pacificite, an anemousite basalt. Tom. F. W. Barth	60
Proceedings	
The Academy	68
Scientific Notes and News	71

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD

EDGAR T. WHEREY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN
BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. ROYAL AND GUILFORD AVES.
BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: Inis Journal, the coincial organ of the Washington Academy of Sciences, publishes:
(1) original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers

bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100,

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

*Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

March 4, 1930

No. 5

GEOPHYSICS.—Note on a comparison of sunspot numbers, terrestrial magnetic activity, and long wave radio signal strength. L. W. Austin, Bureau of Standards.

The figure shows a comparison of the monthly averages of sunspot numbers, terrestrial magnetic activity (horizontal range) measured at Cheltenham, Md., and the daytime ratio field strength of signals received in Washington from the trasmitting stations at Bordeaux, France (FYL) (f = 15.9 kc, λ = 18900 m,) and at Nauen, Germany (DFW) (f = 23.4 kc, λ = 12800 m).

The resemblance of the sunspot curve to the other three is not close, but the similarity in the changes in magnetic activity to those in day-light signal strength seems to be unmistakable. The resemblance of the Bordeaux signal curve to that of the magnetic activity seems closer even than the resemblance between the two signal curves. The deep drop of both the magnetic and signal values in November (more rarely in December) is especially striking. This early winter drop in signals has often been noticed, and in the case of transmission between Europe and America, has been sometimes ascribed to the proximity of the signal path to the area of Arctic darkness. It now appears that this and other seasonal variations both in magnetic activity and East-West long-wave signal strength may be due to common causes.

¹ Received January 22, 1930. Publication approved by the Director of the Bureau of Standards.

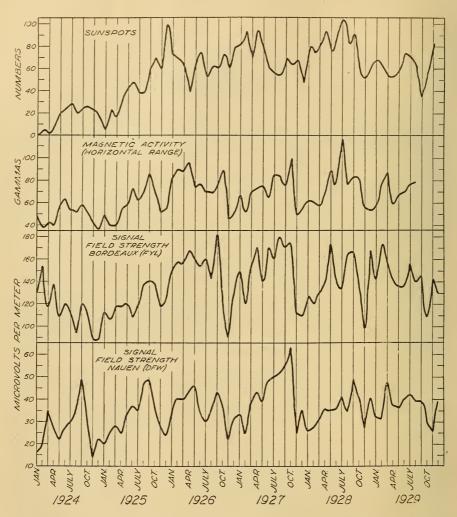


Fig. 1.—Curves of sunspot numbers, magnetic activity, and radio signal strength.

BOTANY.—The identity of the South American fish poisons, "cube" and "timbó." E. P. Killip, U. S. National Museum, and A. C. Smith, New York Botanical Garden.

Recent investigations by chemists and entomologists, members of the Department of Agriculture staff, and others have shown that the roots of a plant called "cube" contain a substance of value as an in-

¹ Published by permission of the Secretary of the Smithsonian Institution.

secticide.² The plant was brought to the attention of the Department of Agriculture through the suggestion of William J. Dennis, an American resident in Peru, who obtained a patent (U. S. No. 1,621,240) on its use. The roots first tested came from Huancayo, a city of the high cordillera of Peru; a second lot of roots was obtained later from Iquitos, in the low-lying Amazon region of northeastern Peru. The plant was said to be a shrub about five feet high. Little additional information was available.

On a trip of botanical exploration which we have just made into the interior of Peru and across Amazonian Brazil in the interest of the Smithsonian Intitution and the New York Botanical Garden we saw thousands of plants of "cube" in cultivation on plantations, and in a wild state in the dense forest occasional plants that appear to be nearly or quite identical. The name cube³ was applied to it in the region about Huancayo and southward. Farther to the north in Peru the plant was referred to locally as "coñapi" or "pacai," the most commonly used names, however, being "barbasco legítimo" or simply "barbasco," which is the general name given to fish poisons in Spanish America. In Brazil the word "timbó" is used for fish poisons in general, the "barbasco legítimo" of Peru becoming "timbó legítimo." In British Guiana cube and other fish poisons are known as "haiari;" in French Guiana the word "nicou" is similarly employed.

We found that although several kinds of plants were used as fish poisons, such as Cracca toxicaria, Cracca nitens, and one or more species of Clibadium, and in Brazil, certain species of Lonchocarpus, one plant alone (cube) was most commonly cultivated and almost everywhere was said to be the most powerful. Curiously we never discovered this plant in flower or fruit, a circumstance giving rise to interesting speculation. Inasmuch as the roots are dug up at the end of the third or fourth year and we rarely saw individuals that were more than six or seven years old, it is possible that the plant flowers only with age. Or, cultivated for centuries as a fish poison, the present plants may represent a selected strain in which the content of the roots is at a maximum and the production of inflorescence at a minimum state.

From the vegetative characters it seems clear that the plant in question is *Lonchocarpus nicou* (Aubl.) DC., described by Aublet in 1775 as *Robinia nicou* from a plant cultivated in French Guiana.

² See Dept. Agr. Bull. **1201**: 6-7, 10-20, 34, 53, 54. 1924; Science **70**: 478-479. Nov. 15, 1929.

³ Pronounced coo'bay. Sometimes called cubi (coo'bee).

⁴ Aubl. Pl. Guian. Franc. p. 771. pl. 308. 1775.

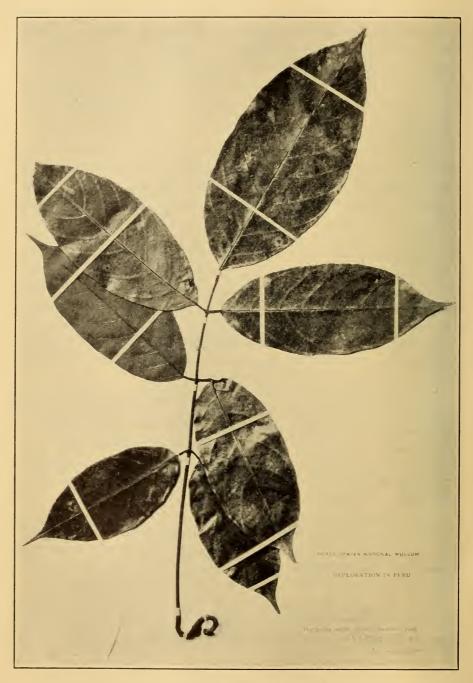


Fig. 1. Lonchocarpus nicou (1 natural size).

In shape and size the leaflets correspond almost exactly with those figured by Aublet; in both cases the tips are caudate-acuminate and the bases show variation from subacute to subrotund. Portions of our material were submitted to the British Museum (Natural History) for comparison with the type specimen of *Lonchocarpus nicou*, and the comparison has confirmed our identification. The striking appressed pubescence noted on the under surface of the leaflets in recent material is matched in the original. Aublet states, moreover, that his plant was used as a fish poison under the name "nicou."

From our field observations and from study of the herbarium material collected the species may be described thus:

Lonchocarpus Nicou (Aubl.) DC. Prodr. 2: 261. 1825.

Robinia nicou Aubl. Pl. Guian. Franc. 771, pl. 308. 1775.

Shrub or small tree, up to 3 meters high, with a main stem 4 to 8 cm. in diameter, with branches borne near summit, the trunk and the branches becoming scandent with age, the trunk sometimes climbing upon nearby shrubs or trees often to a height of 10 meters; leaves alternate, odd-pinnate, the base of rachis and petiolules thickened, the leaflets opposite (2 to 4, usually 3, pairs), oblong, occasionally lance-oblong or oblanceolate-oblong, 12 to 25 cm. long, 4 to 10 cm. wide (average size about 17 x 8 cm., extremes up to 35 cm. long, 17 cm. wide), caudate-acuminate at apex (tip averaging 2 cm. long), subacute to subrotund at base, entire, coriaceous or subcoriaceous, above dark green, sublustrous, and essentially glabrous, beneath paler, sometimes glaucescent, usually densely covered with straight appressed reddish- or golden-brown hairs, pinnate-nerved, the midnerve sometimes impressed above, prominent beneath, the lateral nerves 7 to 10 to a side, ascending, arcuate toward margin, the venation closely reticulate.

Aublet describes the inflorescence as:

"Calix; perianthium monophyllum, turbinatum, quinquedentatum. Corolla papilionacea, purpurea, vexillo amplo, erecto. Pericarpium; legumen longum, acutum, gibbosum, glabrum, rufescens, uniloculare, bivalve. Semina tria aut quatuor, subrotunda, compressa, marginibus valvarum affixa."

The type specimen was collected in a clearing above the home of M. Budet,

at Orapu, French Guiana.

Specimens examined:7

⁵ Our notes show the following variation of the height with age:

Plants 1 year old, 0.75-1.3 meters; plants 2 years old, 1-1.3 meters; plants 4 years old but recently cut back, 1-1.7 meters; plants 2 years old, 1-1.7 meters; plants 2 to 3 years old, 2.5-3 meters; plants 3 years old, 3.7 meters; plant 2 years old, 2.2 meters high, the main stem bending toward a tree and climbing up its trunk to a height of about 8 meters.

⁶ In the case of forest plants and those in overgrown abandoned plantations, the indument was invariably paler and less dense, owing presumably to the greater amount of shade.

 7 Unless otherwise stated the collections here cited are of cultivated plants collected by the writers.

Peru: Dept. Ayacucho: Kimpitiriki, Río Apurimac, 400 meters, nos. 22913, 23053. Dept. Junín: Near La Merced, 1300 meters, no. 23878; Santa Rosa, on Pichis Trail, 650 meters, no. 26200; Puerto Yessup, 400 meters, no. 26369; Puerto Bermudez, 375 meters, nos. 26490, 26597, 26612; El Trionfo, on Río Pichis, 350 meters, no. 26692; Cahuapanas, on Río Pichis, 340 meters, no. 26712. Dept. Loreto: Puerto Leguia, 290 meters, no. 27504; Masisea, 275 meters, no. 26837; Iquitos, 100 meters, nos. 26886, 26893, 26895, 26945, 27096, 27135, 27159, 27278, 27362, 27369, 27380, 27487; Mishuyacu, near Iquitos, nos. 29917, 29957; Peña Blanca, on Río Itaya, near Iquitos, 110 meters, no. 29668; Yurimaguas, lower Río Huallaga, 135 meters, nos. 27565, 27566, 27994, 27997, 28211, 28812, 29061, 29066; Balsapuerto, 135–350 meters, nos. 28158, 28255, 28300, 28325 (wild), 28458, 28586 (wild), 28621 (wild); Lower Río Marañon, 150 meters nos. 29279, 29280; mouth of Río Santiago, Tessmann 4447 (in Berlin herbarium; fragment U. S. N. M.).



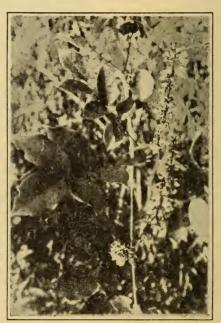


Fig. 2. Plants of Lonchocarpus nicou.

Fig. 3. Lonchocarpus floribundus.

Brazil: State of Amazonas: Manáos, 25 meters, no. 30026, 30038, 30137, 30177 (apparently wild). State of Pará: Gurupá, lower Rio Amazon, no. 30608 (apparently wild); Breves, Amazon Estuary, no. 30576; Pará, no. 30241. State of Matto Grosso: Santa Izabel, F. Lima (Herb. Mus. Goeldi 10863).

British Guiana: Demerara, Parker (in Kew herbarium).

⁸ At this locality alone the name "cube de almidón" was sometimes used, "almidón" meaning starch.

From this list it may be seen that we found the plant most extensively cultivated in the region about Iquitos (100 meters altitude). Many of the plantations contained several thousand trees. Yurimaguas, on the Huallaga River, a few miles above its mouth, is also a center of cultivation. Doubtless this is also the plant used by the natives of eastern Ecuador. Our stops in Brazil were few, but we found Lonchocarpus nicou, both in the forest and in cultivation, at Manáos and Gurupá, and in cultivation at Pará. In material recently lent us through the courtesy of the Director of the Royal Botanic Gardens, Kew, England, there is a specimen of a cultivated fish poison from Demerara, British Guiana, that clearly is Lonchocarpus nicou.

A more detailed account of South American fish poisons, including descriptions of the native method of use, is in preparation for future publication. At present it seems advisable to mention two other plants, the roots of which serve for poisoning fish.

Along the south bank of the Rio Negro above Manáos we found a large plantation of a second species of *Lonchocarpus*, *L. floribundus* (Killip & Smith 30041). This was a low shrub, 1 to 1.5 meters high, in fine flower and fruit. The roots were of a softer, more porous texture than those of *Lonchocarpus nicou*, but were said to be quite as effective as a fish poison. Samples of these are being analyzed.

At Gurupá, a settlement on the lower Amazon River at the mouth of the Rio Xingú, several plants of a third species of Lonchocarpus were obtained, the roots of which were reported as a fish poison even more effective than Lonchocarpus nicou, which also is grown in that vicinity. This exceptionally powerful plant had been identified9 by Dr. Adolfo Ducke, the Director of the Museu Nacional of Rio de Janeiro as Lonchocarpus nicou. Although at the time of our visit, November, the plant was neither in flower nor in fruit, excellent flowering and fruiting material has generously been deposited in the U.S. National Herbarium by Dr. Ducke. Comparison of this with Aublet's description and illustration of Lonchocarpus nicou leads us to the conclusion that it represents a distinct species. In this Gurupá plant the leaflets have short tips, not over 1 cm. long, and the fruit is broadly ovate to oblong-ovate; whereas, as already noted, the leaflets of Lonchocarpus nicou are long-acuminate (tip 2 to 4 cm. long) and the fruit, as shown in Aublet's illustration, is linear-oblong.

The Gurupá plant may be known as:

⁹ Archiv. Jard. Bot. Rio de Janeiro 4: 88, 89, 139. 1925.

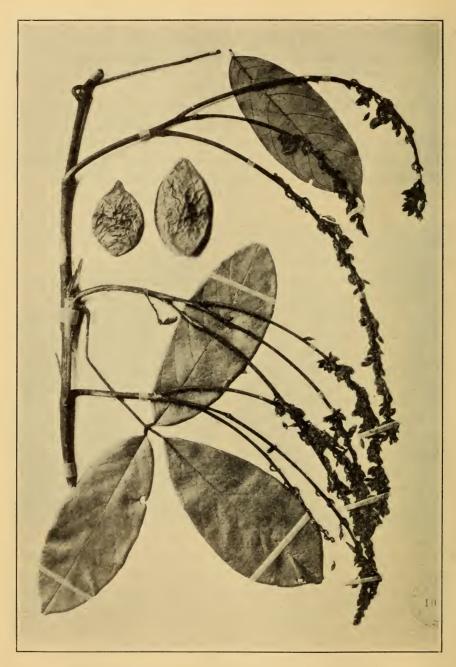


Fig. 4. Lonchocarpus urucu (type specimen, ½ natural size).

Lonchocarpus urucu Killip & Smith, sp. nov.

Robust, much-branched shrub, the upper branches slightly scandent, the bark of the larger branches grayish, that of the smaller branches brown, lenticellate, and usually puberulous; leaves 5- to 9-foliolate, the rachis subterete, longitudinally striate, 12 to 25 cm. long (leaves of scandent portions much smaller), puberulous with dark brown or grayish, often gland-tipped hairs, the base (about 1 cm.) very fleshy; petiolules fleshy, sparingly puberulous; leaflets broadly ovate, obovate, or oblong, 10 to 17 cm. long, 5 to 8 cm. wide, abruptly short-acuminate at apex (tip 5 to 10 mm. long), rounded at base, pinnate-nerved (nerves prominent beneath and covered beneath with a dark brown or blackish indument, the midnerve impresed above, the secondary nerves 9 or 10 to a side, ascending, arcuate toward margin), thickcoriaceous, essentially glabrous and lustrous above, appressed-hirtellous with reddish-brown hairs beneath; racemes axillary, 3 or 4 borne near the ends of stout branchlets 8 to 18 cm. long, the rachis 10 to 20 cm. long, rufo-sericeotomentose; flowers in short-peduncled, closely approximate fascicles, the pedicels about 3 mm. long, densely rufo-sericeo-tomentose; bractlets orbicular-ovate, 0.7 to 1 mm. long, acute; calyx cylindric-campanulate, 4 to 5 mm. long, 2 to 2.5 mm. in diameter, densely rufo-sericeous, 5-toothed, the teeth triangular, 2 mm. long, 3 mm. wide at base, the two vexillar teeth connate into a broad lobe 5 mm. wide at base; petals reddish violet, pubescent without (especially distally), with short, appressed, pale hairs, the wings and carinal petals conspicuously ciliate at apex; standard suborbicular, bilobulate at apex, rounded at base to a narrow claw 3 mm. long, the blade about 10 mm. long, 12 mm. wide; wings obovate-oblique, rounded at apex, tapering at base to a narrow claw about 4 mm. long, the blade 9 mm. long, 5 mm. wide; carinal petals falcate, auriculate, obtuse, the claw 4 mm. long, the blade 9 mm. long, 5 mm. wide; staminal tube glabrous, slightly dilated at base, the filaments about 13 mm. long, free for the ultimate 3 mm.; ovary sessile, linear, minutely pale-puberulous, 4-ovuled; style about 7 mm. long, glabrous or slightly pubescent, arcuate; stigma capitellate, slightly broader than the slender tip of the style; legume broadly ovate to oblong-ovate, 4 to 9 cm. long, 2.5 to 3 cm. wide, rounded or subacute at apex, subacute or bluntly acuminate at base, strongly flattened, minutely hirtellous with subappressed hairs, 1- (rarely 2 or 3) seeded, the vexillar margin faintly ridged, the carinal margin rounded; seeds cochleate-reniform, about 2 cm. long, 2 cm. wide, dark brown.

Type in the U. S. National Herbarium, no. 1,040,936, from a plant cultivated at Gurupá, State of Pará, Brazil, September 29, 1916, A. Ducke (Museu Goeldi no. 16561, flowering specimen). Description of the fruit is based on a specimen collected by Dr. Ducke at the same locality in November, 1923 (Jardin Botanico Rio de Janeiro no. 11708; U. S. National Herbarium no. 1,442,506).

Represented also by *Killip & Smith* 30585, from the same locality. The name "timbó urucú" is given this plant by the natives because of the reddish indument of the inflorescence.

ZOOLOGY.—A new raccoon from Lower California. E. W. Nelson and E. A. GOLDMAN, Biological Survey.

Study of the raccoons of Lower California has indicated differential characters for a hitherto unrecognized subspecies inhabiting the southern half of the peninsula. The new form may be described as follows:

Procyon lotor grinnelli,2 subsp. nov.

Lower California Raccoon

Type.—From La Paz, Lower California, Mexico. No. 147181, ♂ adult, U. S. National Museum (Biological Survey collection), collected by Nelson

and Goldman, February 15, 1906. Original number 19139.

General characters.—A large, pale subspecies with a rather broad, high, evenly arched skull. Similar to Procyon lotor pallidus but slightly darker and cranial characters, especially the more evenly arched profile of skull, distinctive. Compared with Procyon lotor psora, general color paler, more grayish, less deeply suffused with buff, the long black guard hairs over dorsum less in evidence; top of head grayer, less heavily mixed with black; black areas at posterior base of ears smaller; skull with frontal region more highly arched.

Color.—Type: Upper parts in general coarsely grizzled iron grayish, the median dorsal area faintly suffused with pale buff, becoming pronounced on back of neck, rather thinly overlaid with black; top of head gray, mixed with black, producing a grizzled effect; face with solid black mask and white markings usual in the group; under parts in general overlaid with very pale buffy grayish, the brown undertone showing through; throat patch blackish; ears grayish, with rather small black patches at posterior base; limbs about like under parts, but becoming whitish on feet; hind limbs with a small, pure brownish area on outer side near heel; tail with the usual annulations and black tip, the light rings pale cream buff and the narrower dark rings (six in this specimen, varying to seven in others) consisting of black-tipped hairs with an underlying buffy suffusion; dark rings less evident on under side of tail and scarcely complete, tending to fade out on median line, except two near tip.

Skull.—Similar to that of P. l. pallidus, but braincase and interorbital region broader; frontals rising higher anteriorly, the upper outline a more evenly convex curve (anterior frontal outline descending in a more nearly straight line from apex immediately behind postorbital processes in pallidus); dentition about the same. Compared with that of P. l. psora the skull is less flattened, the frontal region more highly arched; braincase rather broad

and other cranial details much as in psora.

Measurements.—Type: Total length, 913 mm; tail vertebrae, 335; hind foot, 132. Skull (type): Greatest length, 122.1; condylobasal length, 115.5; zygomatic breadth, 77.9; interorbital breadth, 24.3; least width of palatal shelf (between last molars and interpterygoid fossa), 16.7; upper caninemolariform toothrow (alveolar length), 44.1.

¹ Received January 27, 1930.

² Named for Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California, in recognition of his extensive contributions to the knowledge of the fauna of Lower California.

Remarks.—Two subspecies of raccoons enter northern Lower California. These are Procyon lotor pallidus Merriam, of the Colorado desert in the northeastern part of the peninsula, and the animal described by Mearns as Procyon lotor californicus from the ocean beach near the last Mexican boundary monument, San Diego County, in the southwestern corner of California. The latter inhabits the comparatively humid northwest coast region of Lower California south to San Quentin. Some specimens from near the type locality of californicus suggest gradation toward pallidus, but general comparisons indicate that californicus can not satisfactorily be separated from P. l. psora Gray, from Sacramento, California.

Raccoons are dependent upon water for existence, and owing to exceedingly arid conditions in the central section of Lower California their general range is interrupted for considerable distances. The form here described, occupying the southern half of the peninsula differs rather markedly in combination of characters from both of the more northern subspecies. It requires no very close comparison with $P.\ l.\ mexicanus$ of the adjacent mainland of Mexico, which in general, is paler, with the black postauricular spots obsolescent, and skull notably depressed in frontal region.

Specimens examined.—Eight, all from Lower California, as follows: La Paz (type locality), 2; Mount Miraflores, 1; San Ignacio, 5.

ZOOLOGY.—A new murine opossum from Argentina.¹ H. Harold Shamel, U. S. National Museum. (Communicated by John B. Reeside, Jr.)

In 1920, Dr. A. Wetmore visited southern South America in the interests of the United States Biological Survey to make a study of the present status of northern migratory birds, particularly shore birds, which winter in the southern portion of the southern hemisphere. While engaged in this work he incidentally made a collection of 120 mammals, which is now in the U. S. National Museum. In this collection I have found a small opposum new to science.

Marmosa muscula sp. nov.

Type.—Adult male skin and skull, No. 236330 U. S. National Museum, collected by Dr. A. Wetmore in Formosa, Kilometro 182 (Central Formosa), Argentina, August 9, 1920.

Diagnosis.—A very small member of the genus, the smallest so far known, distinguished by its mouse-like coloration and its comparatively short tail.

Color.—This little animal is brownish in general tone of color. The hairs everywhere dark slate for the greater part of their length, this area followed by a subapical ring of colonial buff (Ridgway 1912). On the back the ends of the hairs are tipped with mars brown (Ridgway 1912), which gives to the

¹ Received January 28, 1930.

back a mixed buff and brown appearance, neither element strongly predominating. On the sides the buff is nearly clear and the dark tips are few and inconspicuous. Underparts clear colonial buff, the dark bases of the hairs showing through inconspicuously. There is a dark-brown eye ring, also a dark streak from the corner of the eye to the nose. Cheeks, sides of head, and shoulders are reddish brown, which changes into buff on the sides of the body. The tail is dark brown above, much paler below.

Skull.—In the skull the sides of the frontals are expanded, but unridged; in the interorbital region this swelling extends well down into the orbit; nasals pointed at juncture with the frontals, a portion of frontal coming down wedge fashion between them; the premolars are spaced closely together, all touching,

the second (pm²) being longer than the first or third.

Measurements.—Type: Total length, 123; tail, 55; foot, 11; ear (moistened) from crown, 9; total length of skull, 21.5; condylobasal length, 19.6; zygomatic width, 11.5; interorbital width, 3.5; length of nasals, 8.5; width of braincase, 8.5; maxillary tooth row (including incisor), 8.2; mandibular tooth row, 8.5; height of mandible, 6.5.

Remarks.—Marmosa muscula is next smaller than M. bruchi in general size, but the pale color and much longer tail (89.0 mm) of the latter will readily separate them. It is very mouse-like in appearance and even smaller than some specimens of Mus muscula in this collection from Buenos Aires, thus representing one of the smallest marsupials known. This specimen was examined by Oldfield Thomas of the British Museum of Natural History who said, "The Marmosa is a very distinct little species, quite unlike anything I have seen * * * M. bruchi has a white belly and the body marking of the M. marmota group."

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE BIOLOGICAL SOCIETY

737TH MEETING

The 737th meeting was held at the Cosmos Club October 19, 1929, with

President Wetmore in the chair and 55 persons present.

The President announced the membership of the standing committees of the Society as follows: Committee on Communications: W. B. Bell, Chairman, V. Bailey, W. H. White, Lewis Radcliffe, W. R. Maxon, W. L. Schmitt; Committee on Zoological Nomenclature: G. S. Miller, Jr., Chairman, A. C. Baker, Paul Bartsch, E. A. Chapin, H. C. Oberholser; Committee on Publications: Chas. W. Richmond, Chairman, J. H. Riley, F. C. Lincoln, W. H. White.

A. Wetmore announced that the Pinchot expedition to the South Seas, although its collections have been received only in part as yet, has already

sent a dozen forms of birds new to the National Museum.

Program: J. M. Aldrich: Notes on the life zones of northern Europe (illustrated).—The speaker collected flies at Aare, Sweden, last July, and while there ascended the mountain called Aareskutan, just back of the hamlet. The railroad station beside the river has an altitude of about 1500 feet, while the summit of the mountain reaches about 5000 feet. The first 500

feet of ascent is in spruce forests, corresponding to the Canadian Zone in North America. The spruces end abruptly and are succeeded by a narrower zone of birches, perhaps 300 feet in vertical width; these begin with a few large, scattered, old trees, changing into smaller and more crowded growth, then into dwarfed forms. All tree growth ends within 1000 feet elevation above the river. The birch zone is thought to represent the Hudsonian of North America; the rest of the mountain above is Arctic. (Author's abstract.) HERBERT FRIEDMANN: Parasitism in birds (illustrated).—Parasitic breed-

HERBERT FRIEDMANN: Parasitism in birds (illustrated).—Parasitic breeding habits are found in five groups of birds—the cowbirds, cuckoos, honeyguides, weaver-birds, and ducks. The habit must have arisen independently in each, and the causative factors were probably different in the different groups. The cowbirds are the only group in which all the species have been

studied and the evidence put together into a coherent story.

The most primitive cowbird, the bay-winged cowbird of Argentina, is not parasitic but uses other birds' nests in preference to building for itself. The others are all parasitic. The results of a careful survey of the habits of all of them show that the immediate case of the parasitic habit was the loss of the territorial protecting instincts of the male, leaving the female in a condition where it lays eggs in nests which it has not built, and with no great desire to protect them once they are laid. (Author's abstract.)

738TH MEETING

The 738th meeting was held at the Cosmos Club November 2, 1929, with President Wetmore in the chair and 100 persons present.

S. F. Blake reported that a freshly dead specimen of Solitary Vireo was found in Clarendon, Virginia, by H. A. Allard on November 1, 1929.

I. Hoffman stated that C. F. Denly, who has a pheasantry near Washington, had succeeded during the past summer in raising three Elliott Pheasants, the first to be grown in this country. He also raised about 16 other species of

pheasant.

Program: A. H. Howell: Recent notes on birds and mammals of the Everglades (illustrated).—The speaker described the bird and mammal fauna of the southern tip of the Florida peninsula, illustrating his talk with specimens and slides. He prefaced his remarks by a description of the topography and plant life of the region, showing that the flora of the hammocks along the southeast and southwest coasts and in the Cape Sable region is composed mainly of tropical trees and shrubs of West Indian origin. The insect and land snail faunas are likewise considered by those who have studied them to have been derived in large part from the West Indies. Only about 6 species of birds of this region, however, are of tropical origin, these being confined mainly to the Florida Keys and to the mangrove forests on the coast of the There are no terrestrial mammals of tropical affinities found in Florida, the only tropical species being the manatee. A number of specimens of the rarer birds of the region were exhibited and suggestions made regarding the need for more rigid protection of certain disappearing species. (Author's abstract.)

E. F. Coe, Chairman Tropic Everglades Park Association: America's own tropics (illustrated).—The speaker, after referring to the rapid destruction of wild habitats by man, made an eloquent plea for the preservation of about 2500 square miles of the Cape Sable region of southern Florida, which is still in a practically unspoiled condition and which represents practically the only tropical habitat in the United States. The talk was illustrated by numerous

colored slides showing scenery and plant and animal life.

739TH MEETING

The 739th meeting was held November 19, 1929, with Vice-President Jackson in the chair and 35 persons present. New members elected: CLARENCE COTTAM, BENJAMIN MILLER.

S. F. Blake reported the observation on October 20, of what seemed to be a contest between two female English sparrows for possession of a birdbox. The birds fought vigorously inside the box, while a male sparrow perched

nearby without taking part in the quarrel.

Program: L. V. Coleman, American Association of Museums: Museums in South America.—The speaker described his recent trip to South America for the purpose of visiting the principal museums there. Besides mentioning the museums visited, he gave many interesting side lights on the countries

and people visited.

C. W. Stiles: Proposals Submitted as Amendments to International Rules of Zoological Nomenclature.—The speaker presented a paper summarizing the propositions which have been submitted to the International Commission on Zoological Nomenclature as amendments to the International Rules. With each proposition, he discussed the theoretical background. A brief summary of the proposed amendments will appear in Entomological News, December, 1929.

S. F. Blake, Recording Secretary.

740TH MEETING

The 740th meeting was held at the Cosmos Club November 30, 1929, with President Wetmore in the chair and 44 persons present. New member elected: J. W. Bulger.

Frank Thone called attention to several recent biological publications. A. Wetmore commented on birds new to the National Museum collections

received from the Pinchot South Sea Expedition.

Paul B. Johnson gave a brief review of the life and work of the Rev. Francis Tondorf of Georgetown University, a distinguished seismologist.

and biologist.

Vernon Bailey called attention to the fact that the natural food supply of squirrels is scanty this year and urged that steps be taken to provide food for them. E. P. Walker suggested a series of letters to newspapers to keep this need before the public.

P. B. Johnson reported seeing a black squirrel captured by a red-tailed

hawk in the Zoological Park.

A. Wetmore reported the capture of sharp-tailed sparrows at Ocean City, Maryland, last year, as well as the recent capture of two more specimens,

one at Ocean City, the other at Cornfield Harbor, Maryland.

Program: E. R. Kalmbach: Notes on waterfowl sickness in 1929 (illustrated).—In 1914, 1915, and 1916, Dr. Alexander Wetmore made a study of the malady that had killed many thousands of ducks at Great Salt Lake, Utah. Certain soluble salts in the "alkali," prevalent in the shallow waters and on the mud flats of that area, were found to be the causative agents.

Since that time "duck sickness" has been noted in many other areas, some

of which are quite different in character from the Great Salt Lake region. Although alkali in some form is almost always present at the scene of such outbreaks, its chemical composition varies greatly, and in some instances, "duck sickness" has occurred in areas in which the salts found to be the cause at Great Salt Lake are comparatively rare.

A study of this "disease" was resumed during the past season in the general vicinity of Klamath Falls, Oregon, where a number of bodies of water furnished varied environments in which the sickness occurred. In discussing this work the speaker pointed out some of the unsolved aspects of the trouble, the progress that had been made, and explained that the study would be continued next season. (Author's abstract.)

Reminston Kellogs: The migration of whales (illustrated).—See

Smithsonian Annual Report 1928: 467. 1929.

W. B. Bell, Recording Secretary pro tem.

741st meeting

741st meeting was held at the Cosmos Club December 14, 1929, with President Wetmore in the chair and 120 persons present. New members elected: Herbert Friedmann, F. A. Warren.

President Wetmore was nominated to represent the Biological Society on

the council of the Washington Academy of Sciences.

C. W. Stiles discussed the nomenclature of the South American fox-tailed

wolves.

Program: O. J. Murie: Elk studies in the Jackson Hole region (illustrated). The elk is largely a grazing animal but also utilizes browse to a considerable extent. In some of the so-called waste-land on the winter range are found certain shrubby plants which are very palatable for elk and help to augment the winter food supply. One of the most important phases of the study is the question of disease. Squirreltail grass in the hay and perhaps other rough feed produce abrasions in the mouth of the elk, resulting in an infection with necrotic stomatitis. This causes an annual loss of elk which can perhaps be remedied by suppression of squirreltail hay and scattering the herds. Conditions on the summer range are very favorable for the elk. (Author's abstract.)

The speaker also showed motion pictures of elk, moose, and other wild

animals of Jackson Hole region.

Discussed by V. Bailey, who stated that he considered the "fluting" of the elk to be a sort of song; by M. C. Hall who considered that ticks and scabies are probably of real importance under wild conditions, but that internal parasites are scarcely so; also by L. O. Howard, C. W. Stiles, W. B. Bell,

and E. A. GOLDMAN.

Maurice C. Hall: Parasites of elk and other wild ruminants.—The parasites of wild ruminants are of interest in connection with their actual or potential transfer from these ruminants to domesticated livestock, especially sheep, goats and cattle, and as forms which have transferred from domesticated livestock to wild ruminants. The evidence available points definitely to certain parasitic species as having made these transfers. Thus the common sheep stomach worm, Haemonchus contortus, has been found in at least 10 species of wild ruminants in North America, whereas such species as Ostertagia bullosa, first found in sheep and later in the pronghorn antelope, and Cooperia bisonis, first found in the bison and later in domesticated cattle, are evidently normal parasites of wild ruminants transferring to domesticated ruminants. The common sheep liver fluke, Fasciola hepatica, has been found occasionally in wild ruminants, while the large liver fluke, Fasciola magna, normally a parasite of American deer, has become a rather common parasite of cattle in some areas. The fringed tapeworm, Thysanosoma actinioides, is evidently a normal parasite of American wild ruminants which has become accustomed to sheep as hosts.

Another feature of interest is the fact that parasites in unusual hosts may behave differently from the way they behave in their usual hosts. Thus Fasciola magna forms large cysts in the liver of cattle, apparently with no communication to the exterior whereby the eggs could leave the host and continue the life cycle; little is known about this parasite in its deer hosts, but the present assumption is that it occurs in the bile ducts and thus is able to complete its life cycle in the usual way. The fringed tapeworm has been reported regularly from the small intestine of deer hosts, except in one instance where the writer found it in the fourth stomach of an elk, the worm being coiled in a ball with the head at the center, but in sheep the worm is frequently present in the bile ducts.

The question as to what can be done to control parasites in wild ruminants presents several rather interesting and difficult problems. It is probable that these problems will increase in importance as wild animals are confined in smaller areas with a resultant concentration of parasitic infection. (Author's

abstract.)

S. F. Blake, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

Dr. Louis A. Bauer, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington since the establishment of the Department on April 1, 1904, retired from this position on January 1, 1930, with the title of Director Emeritus. Provision is also made whereby if his health permit he may carry on studies during the coming year as a Research Associate of the Institution. Mr. John A. Fleming, associated with Dr. Bauer as chief assistant in the Department of Terrestrial Magnetism since 1904, as Assistant Director for observational and administrative work during 1922 and 1923, and as Assistant Director in charge of operations since 1924, continues in charge of the work of the Department with the title of Acting Director.

Obituary

DR. WILLIAM ALLEN ORTON, Director and General Manager of the Tropical Plant Research Foundation, and a member of the Academy, died on January 7, 1930. He was born at North Fairfax, Vermont, February 28th, 1877, and studied at the University of that state, receiving the degrees of B.S. in 1897 and M.S., in 1898; and in 1915, the honorary degree of Sc.D. spending two years as Assistant Botanist at the Vermont Agricultural Experiment Station, he was appointed as Plant Pathologist in the Bureau of Plant Industry, U. S. Department of Agriculture, where he remained until 1924, holding important positions including that of vice-chairman of the Federal Horticultural Board for 12 years. In 1924 he resigned from the government service to take up the position he held until the time of his death. For some years he was also Chairman of the Committee on Tropical Research of the National Research Council. He was a member or fellow of numerous scientific societies, serving as President of the Phytopathological Society in 1927. Besides being an eminent authority on plant diseases and quarantines, he made a study of diets adapted to use in diabetes, a disease from which he suffered for many years, and which finally led to his death in his 53rd year.

OFFICIAL COMMUNICATIONS THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

ANNOUNCEMENTS OF MEETINGS

Tuesday, March 4
Wednesday, March 5
The Engineering Society
The Medical Society
The Medical Society
The Entomological Society
The Geographic Society
Saturday, March 8
The Biological Society

Tuesday, March 11 The Electrical Engineering Society

Wednesday, March 12 The Geological Society
The Medical Society

Thursday, March 13 The Chemical Society
Friday, March 14 The Geographic Society
Saturday, March 15 The Helminthological Society

The Philosophical Society

The Anthropological Society

The Historical Society

Wednesday, March 19 The Engineering Society
The Medical Society

Tuesday, March 18

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

	. 250
Geophysics.—Note on a comparison of sunspot numbers, terrestrial magnetic activity, and long wave radio signal strength. L. W. Austin	
E. P. Killip and A. C. Smith	74
Zoology.—A new raccoon from Lower California. E. W. NELSON and E. A. GOLDMAN	82
Zoology.—A new murine opossum from Argentina. H. HAROLD SHAMEL	83
Proceedings	
The Biological Society	84
Scientific Notes and News	88
OBITUARY: WILLIAM ALLEN ORTON	88

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints will be furnished at cost when ordered.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

March 19, 1930

No. 6

PHYSICAL GEOGRAPHY.—Peat profiles of the Everglades in Florida: the stratigraphic features of the "Upper" Everglades and correlation with environmental changes. Alfred P. Dachnowski-Stokes, U. S. Bureau of Chemistry and Soils.

INTRODUCTION

In the following an account is given of the structural features of the Upper Everglades secured through a method of field work described elsewhere (5). The profile studies were made in the hope of determining the origin and past history of this vast area of sedge peatland, probably one of the largest sub-tropical low moors in the world.

The material was for the greater part collected in the winter months of 1920, 1928, and 1929. The field work in 1920 was made possible by the coöperation and aid of G. V. Scott, engineer in charge of the Everglades State Drainage District, in whose company the more inaccessible parts of the Everglades were sounded. In 1928 and 1929 the studies in the field have been supported by coöperation from the Agricultural Experiment Station of the University of Florida. Their prosecution was greatly facilitated by R. V. Allison of the Everglades Experiment Station at Belle Glade. The horizontal and vertical control data and lines of elevation above sea level are due to assistance in 1929 from engineers of the State Drainage District. The writer wishes to convey his sense of deep obligation to Dr. Wilmon Newell, Dean and Director of the State Agricultural Experiment Stations, to Dr. R. V. Allison, and to Mr. G. V. Scott for the special facilities provided for studying in detail many parts of the Everglades.

¹ Received February 3, 1930.

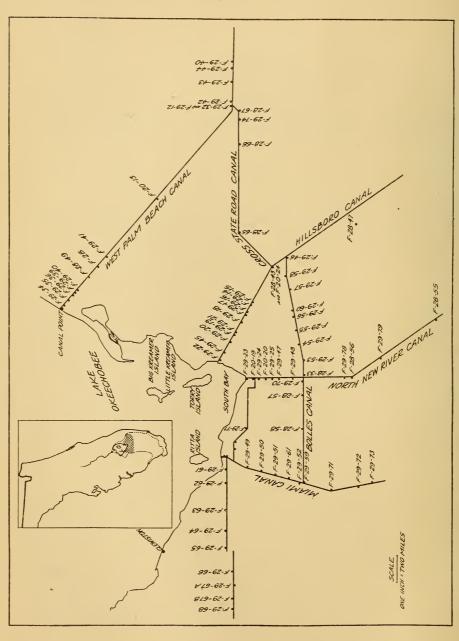


Fig. 1.—Map showing location and numbers of peat profile soundings in the Everglades of Florida covered by the reconnaissance survey of 1929. Prepared by the engineering division of the Everglades State Drainage District, West Palm Beach, Florida.

GENERAL CONSIDERATIONS AFFECTING THE STUDY OF EVERGLADES PEAT PROFILES

The present paper does not pretend to reconstruct conditions in all parts of this region but aims to present briefly the profile record of the Everglades south of Lake Okeechobee and a consideration of the consequences of changes in water level and shore lines.

The profiles used are representative of a much larger number obtained by the writer. The locations of the profiles along the several lines of traverse are indicated on the map Fig. 1 and the general relations of the peat layers to each other and to the configuration of the bedrock are shown in Figs. 2 to 7. The large number of soundings plotted to scale has made it possible to check the several layers of the

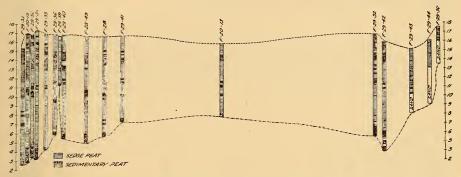


Fig. 2.—Peat profiles from Lake Okeechobee at Canal Point, Florida, northwest to southeast along the West Palm Beach canal, showing rock-bottom topography and diagrammatic details of the structural features of the Everglades. Surface variations are due to shrinkage, compression, and fires following drainage. Numbers at top of sections and distance apart between cross-sections correspond to locations shown on map of Fig. 1. Elevations are based on one common geodetic datum of sea level.

stratigraphic sections. The data from excavations made along the face of canals and from pits dug in differently situated parts of the same region show excellent correspondences wherever the exact location above sea level of the respective layers was determined.

In Fig. 2 are reproduced in graphic form the results of soundings made with an American peat-sampling instrument. The cross sections illustrate a transect profile running from Lake Okeechobee at Canal Point southeastward along the West Palm Beach Canal to the eastern border of the Everglades. The contour of the bedrock of limestone is well shown and it is evident, despite the decrease in number of soundings going eastward, that the structural features of the profiles show marked uniformity. The same conclusion applies to the profiles

in Figs. 3 to 5 which were taken parallel to the Hillsboro, North New River, and Miami canals. In the profile transect of Fig. 7 which combines the results of soundings along canals of two subdivisions of

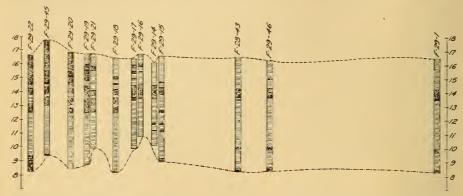


Fig. 3.—Peat profiles extending from Lake Okeechobee northwest to southeast across the Everglades along the Hillsboro canal, showing form of the bedrock contour and the sequence of the major layers of peat, the character of which was influenced by changes of water level and shore lines. Locations of cross-sections are given on the accompanying map in fig. 1.

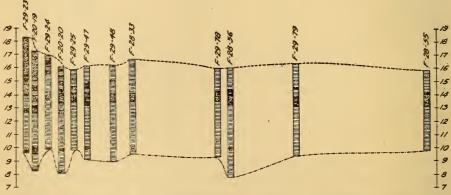


Fig. 4.—Cross-sections along the North New River canal showing rock-bottom configuration, contrasts in the sequence of peat layers, and transition of stratigraphic features from Lake Okeechobee to Okeelanta and southward. Changes in water level and shore line are recorded by the character and succession of the major layers of peat. Number and location of each profile are shown on the map of fig. 1.

the Drainage District, the sudden apparent greater simplicity of profiles near the western as well as the eastern border (Fig. 2), where they merge into higher land commonly called the rim of the Everglades, is particularly noticeable.

Before drainage began the Everglades presented the appearance of a broad, level, grass-covered prairie, sloping gently toward the south at the rate of about three inches per mile. Extensive drainage operations have caused, however, compression of the canalward edge of the Everglades, often changing the characteristic position above sea level of the main layers of peat. The profile sections along the south shore of Lake Okeechobee and the canals of the Everglades, it will be noted, show the discrepancy due to settling from drainage and the differences in the surface contour which now conform partly with the bedrock topography, but are chiefly the result of fires and oxidation.

A striking and important feature of the Everglades is the raised form of the southern shore of Lake Okeechobee. In cross section the surface forms a curve, abrupt at the margin of the lake, sloping gently southward from twenty-one feet just south of Lake Okeechobee to about six feet above sea level west of Miami. This slope is shown in the profile diagrams (Figs. 2 to 7) and on the charts of the main canals which accompany the reports to Congress of the Office of Experiment Stations, United States Department of Agriculture (7) and of the Florida Everglades Engineering Commission (8).

The cause of the raised and convex form of many peat deposits and the presence of lakes and ponds on them has received frequent consideration. It is well known, for example, that Sphagnum mosses and marsh vegetation by their growth and the clogging up of drainage channels, raise the water level to considerable heights. moors in Maine and in Europe, with ponds of standing water on the elevated surface, the presence of Lake Drummond within the Dismal Swamp near Norfolk, Va., and the ponded water of the present Lake Okeechobee are examples of such results. The interlacing net-work of roots and rhizomes from sedges and herbaceous perennials, constantly compacting under the increasing weight of accumulating plant remains. greatly hinders water from flowing out of the matted and felty-fibrous mass of peat to a lower level. Periodically changing in height under wet years and shrinking in drier times, the formation of areas of raised peat is generally attained best in humid climatic belts where the supply of water is abundant for the growth of native vegetation and where layers of peat, more or less impervious, impound drainage water at varying elevations. Lake Okeechobee represents the height at which a layer of dense, finely divided sedimentary peat, superimposed upon a basal layer of fibrous sedge peat can pond a large body of water at the margin in a hydrostatic condition. Prior to drainage operations

the lake did not rise to a higher stage than $22\frac{1}{2}$ feet because the lake overflowed its banks along the entire south shore. During prolonged periods of rainfall a sheet of water covered large portions of the Everglades, retarded in its movement by the dense growth of the saw-grass and the buoyancy of the water-soaked fibrous peat.

For the attempt to reconstruct from the profile soundings some of the important physical conditions which prevailed in the past of the Everglades, the clue is taken in the succession of peat layers from the base of the bedrock upward. Peat-profile studies carried out with uniform methods, as described by Lundquist (12), correlate and har-

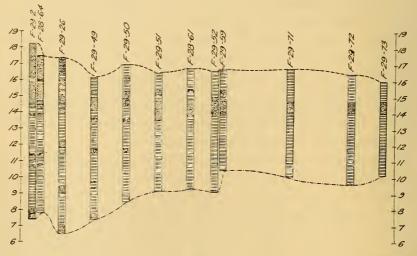


Fig. 5.—Peat-profile traverse along the Miami canal, showing bedrock topography and cross-sections through the Everglades from north to south. The locations of the peat profiles are given on the map in fig. 1.

monize results and increase greatly the knowledge of past vegetations and the growth of plants. Series of peat profiles furnish not only the best material for historical studies regarding the character of the ancient vegetation, but they serve also as a record for the study of changes in environment. The general profile studies of the Florida Everglades furnish independent evidence and confirm the same conclusion. The position of peat layers above sea level at one locality with the position of similar layers at other localities identifies them as the record of the same period and conditions. The profiles record without doubt geologically recent changes in the water level and shore line of Lake Okeechobee.

LOCATION AND DESCRIPTION OF TYPE PEAT PROFILES

It may at first thought appear undesirable to use the detailed field records available for representative type profiles. But in order that the reader may judge conclusions with a fuller knowledge of the nature of the evidence available, it is believed that the original data for at least three peat-profile soundings may be pertinent in connection with later discussions of the origin and history of the Florida Everglades.

A description is given, in the following, of the profile sections which were measured on the banks of the West Palm Beach Canal. The sequence of peat layers obtained along this canal affords as good a basis as any from the other main diagonal canals, of inferring the environmental conditions which prevailed during the deposition of the chief layers of peat.

1. Lake Okeechobee Area

F-29-33. At the lake shore, 300 feet north of the U.S. Sugar Cane Breeding Station at Canal Point, northeast of the entrance to West Palm Beach Canal. Elevation of ground surface and water in the lake 15.5 feet and of bedrock 2.9 feet above sea level.

1. Black, compact, sticky, wet sedimentary peat, sandy at the surface with thin band of shells (species of Planorbis and Physa) at 16 to 17 inches below the surface. Based upon sea level measurements the marly material appears to be identical with that in a profile sounding 2,000 feet from Lake Okeechobee, on the south side of the ridge of dune-like sand which borders the shore of the lake. The sedimentary material is finely divided, dense, and more or less colloidal between the 2 and 3-foot level below the surface; at the 4-foot level are 6 to 8 inches of brown, fibrous, laminated, compressed sedge peat mottled with yellowish, flattened rootstocks from Pontederia and other herbaceous plants. Below this continues to the $5\frac{1}{2}$ -foot level a very dark brown to black sticky sedimentary peat.

2. Dark brown partly sedimentary and fibrous sedge peat, stringy from coarse rhizomes of *Cladium* and *Scirpus*; the material is reddish-brown, moist, fibrous-matted, and poorly decomposed sedge peat at the 7-foot level below the surface; it gives off a fairly strong odor of hydrogen sulphide.

Marsh gas is escaping in slight amounts.

Between the levels of 7 and 9 feet from the surface the layer shows two to three alternating bands of dark brown sedimentary-fibrous sedge peat followed by reddish-brown poorly decomposed saw-grass peat. The limits of the bands are indistinct. Below the 9-foot level the sedge peat is predominantly reddish to yellow-brown, coarse, partly decomposed, matted to felty fibered and chiefly the network of roots of *Cladium* with culms of grass-like plants. The material is porous, spongy, and wet, and has a distinct odor of hydrogen sulphide.

At the 12-foot level appears a grayish oozy shell and *Chara* marl with the remains of roots and rhizomes from sedges. The marl varies in purity and thickness; it becomes cream-colored toward the bottom and rests on bedrock of white limestone.

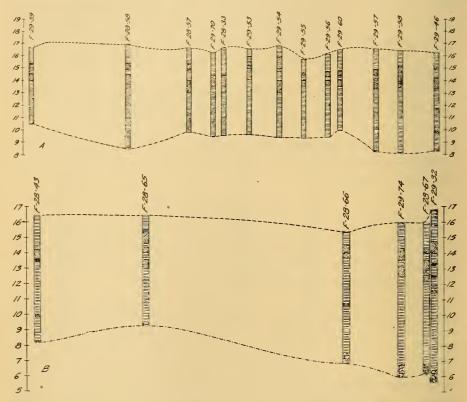


Fig. 6.—Peat profiles in a traverse from west to east across the Everglades along the Bolles canal, showing the development of peat layers by marsh and aquatic groups of vegetation in response to changes of water level and shore lines.

- A. Miami canal to Hillsboro canal.
- B. Cross-State Road canal from Hillsboro canal to West Palm Beach canal. Location of sections shown on map of fig. 1.

Essentially the same structural features were observed more typically in the peat sections on Torry Island in Lake Okeechobee, and in belts of different width bordering the lake shore at the Hillsboro, North New River, and Miami canals. The Okeechobee peat profiles are a typically two-layered series.

2. Upper Everglades Area

F-20-13. Opposite Lateral A, about 10 miles southeast of Lake Okeechobee and 50 feet west of West Palm Beach Canal on Conners highway. The section was first measured in 1920 when saw-grass vegetation and a high water table extended on all sides to the horizon line, relieved in a few places by clumps of low shrubs. The surface elevation at present is 15.10 feet, lower by 11 to 13 inches than formerly, due partly to fires and drainage. The bedrock stands at 7.3 feet and the water level in the canal is at 12.85 feet above sea level. The record below refers to the field notes of 1920.

1. Dark brown, wet, fibrous matted sedge peat, darkened by fires in the upper two inches, contains charred debris; scattered over the surface are thin lenses of small pond snails, plants of *Chara* sp., and small calcareous pellets of blue-green algae. This is followed by brown fibrous crumbly saw-grass peat, mottled with dark-brown, finely-divided debris; between the 12 and 18-inch level below the surface the sedge peat is coarser, reddish to yellow-brown and more firmly matted.

2. Blackish-brown sedimentary-fibrous peat approximately 8 to 10 inches in thickness; dense, sticky, plastic and rather impermeable at the lower level,

the fibrous components are more abundant at the limits of the layer.

3. Reddish-brown, felty-fibrous, matted sedge peat from about 38 to 50 inches below the surface; the material is firm, tough-fibered and has a moderately strong odor of hydrogen sulphide; at depths of 50 to 74 inches occur alternating bands of dark-colored sedimentary and fibrous mixtures followed by reddish to yellowish-brown, poorly decomposed, felty-fibrous sedge peat; the limits of the bands are indistinct and the upper one appears to separate into two thinner bands. This is followed by reddish to yellowish-brown fibrous moist saw-grass peat, spongy, poorly decomposed, odorous, in a compressed condition at the lower level; contains spicules of fresh-water sponges at the bottom and rootstocks of water-arum with needle-like raphides. Odor of hydrogen sulphide fairly strong below. At depth of 96 to 102 inches is found a grayish-white soft marl with rootlets of sedges, oozelike on bedrock.

The individual measurements, which were made in dugout pits and excavations along the main canals in addition to the soundings with the peat sampling device, show excellent agreement with each other. The Everglades series of profiles is distributed over a very large portion of the interior. The peat profiles are uniformly three-layered.

3. Marginal Area of the Upper Everglades

F-29-43. Approximately 22 miles southeast of Lake Okeechobee, along West Palm Beach canal, and 150 feet from north side of highway. Large areas in this neighborhood have been burned over severely. It was formerly a border zone of shrubs such as wax myrtle, swamp bay, magnolia, willow and a *Baccharis*. Wooded islands or hammocks

of cypress (*Taxodium distichum*) occur from 2 to 4 miles farther east, invading the saw-grass. Surface elevation 15.1 feet, bedrock elevation 8.1 feet above sea level. Water level in canal at 11.49 feet.

1. Thin horizon of charred granular debris, chiefly from saw-grass peat, with yellow ash. Below it the plant remains consist of poorly decomposed brown, coarse-fibered roots and rhizomes from saw-grass and unidentifiable grasses and sedges. The material is very compact and firm near the surface but porous, moist, and felty at the lower level. Toward the bottom, about 36 to 60 inches below the surface, the layer shows a scattered admixture of herbaceous plant remains and includes lenses of sand probably of windblown origin. Elongated veins contain black finely divided material, and rest on

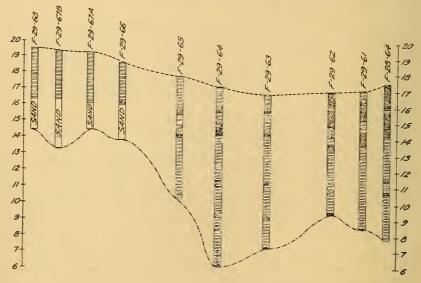


Fig. 7.—Peat profiles of belts extending from sand bars, bordering the margins of the Everglades, toward the Miami canal, and showing variations in the sequence of peat layers near the eastern and western end of the drainage canals. Locations of profile sections are indicated on the map of fig. 1.

gray sand with rootlets of sedges at the contact; the underlying sand rests on bedrock of porous limestone.

The peat profiles of the Ridge series are typically one-layered units, relatively young, and not of very extensive occurrence. They are abundantly distributed over the eastern and western border of the Everglades and occur also in some of the sedge marshes of the east and west coast.

PHYSICAL CONDITIONS DURING THE FORMATION OF THE EVERGLADES

From the sequence of the peat layers in the profile sections described above it is not difficult to reconstruct the history of the "Upper" Everglades.

It may be inferred from the conditions summarized by Sanford (13) that the lowest coastal plain, the Pensacola terrace within which the Everglades are included, was formed during comparatively recent Pleistocene time. Following an uplift of the mainland, the Kissimmee River and its tributaries flowed southeastward through a broad flat valley cut mainly in the bedrock of limestone. It was during this period of erosion that the major features of the present rock-floor configuration with its irregular and jagged ridges, deep fissures, hollows, and scattered Kevs were produced. Hills of sand were deposited, probably by a southward drift along the outcrop of bedrock around the border of the Everglades, and widespread beach sands, driven inland through the central part of the plain, assumed their present form. Concerning the geographic extent of the emergence, which may have been intermittent, there is still some doubt. The details that connect the geographic character of the country with its Pleistocene geology and with other natural features, are emphasized in the publications of the Federal Government (2, 7, 8), and the reports of the Florida State Geological Survey (10), the State Drainage District (6) and the State Agricultural Experiment Station (1).

The events which are primarily responsible for the history of the "Upper" Everglades may be set forth as follows:

Subsequent to the period of erosion a change came in the relative level of land and water. The change brought the surface of the bedrock of the Everglades to or near its present level, and, where formerly there was an effective drainage, now shallow waters occupied small blocked depressions, hollows, and potholes in the rock.

Aquatic vegetation began to invade the ponds and deeper axes of the drainage-valley bottoms where the bedrock sloped off more steeply. Reference to Forsaith's (9) microscopic and comparative studies of the plant remains in the lakes and ponds of Florida shows the character of most of this type of vegetation. Submerged aquatics were represented by cosmopolitan but essentially northern species comprising Vallisneria, Naias, Potamogeton, Utricularia and others; the floating aquatics included Nymphaea, and possibly Pistia and Piaropus, with detached masses of Scirpus scattered along the shores. - Large mats of Chara and blue-green algae together with numerous water snails and bivalves which fed on submerged roots and stems, yielded gray limey oozes and shell marl.

Bordering them, a fairly uniform saw-grass marsh, very much as today, with grasses, sedges, ferns, and herbaceous semi-aquatics having fleshy rootstocks, slowly encroached upon the exposed rocky floor. Many northern species, both of plants and animals, had extended their range southward to this region or were represented in the sedge marsh by varieties which take the place of northern types. They spread over sands and muddy oozes, and covered wide expanses of bedrock including large areas now occupied by the present Lake Okeechobee.



Fig. 8.—Upper portion of a profile section in a lateral canal showing on the face of the bank a surface horizon of saw-grass muck (the residue derived from decomposition of saw-grass peat) and a dark band of sedimentary-fibrous sedge peat between layers of brown fibrous saw-grass peat. Photographed by R. V. Allison, March 29, 1929.

Brown fibrous sedge peat, spongy and watersoaked, formed a continuous layer over the limestone. The fact that no true sedimentary layer of peat is discovered at the bottom of most of the soundings is sufficient proof that at no time during this early period of peat formation did the general water level occupy a high elevation or was it rising rapidly enough to destroy the growth of the saw-grass and initiate the accumulation of a different type of peat on the rock floor of the Everglades.

The effect of sand blown from dunes upon the marsh is shown in the extremely sandy peat material encountered in those soundings which are nearest the peat-covered dunes and bars.

That the rock floor of this region was not occupied at first by an inland sea or body of open water as Matson (13) and Harshberger (11) contend, is evidenced by F-29-33 which recapitulates the general history of Ritta and Torry islands in that lake (3). The profiles in Figs. 2 to 7 also present features incompatible with the interpretation of them as products of a basin-like depression or of the filling up of an inland lake; they are too strongly suggestive of their autochthonous origin. The east-west profiles along the Bolles Canal and its extension eastward to the West Palm Beach Canal (Fig. 6A and 6B) serve as a useful check since in places they cross certain of the significant profiles of the main diagonal canals and confirm the developmental features shown on the northwest-southeast series of transects. The origin of Lake Okeechobee did not take place until a later period. It came into existence probably through springs or the effects of subterranean drainage and solution. The dense growth of sedges and their matted network of roots and rhizomes held back the water of heavy rainfalls and at first a chain of narrow lakes was probably ponded off between Kreamer and Ritta islands (Fig. 1). The exact position of the original series of lakes between the islands is not yet known. On the north side of Lake Okeechobee floodwaters from the mouth of the Kissimmee River carried in suspension mineral material and deposited silt and sand over the bedrock bottom. This deposition may have proceeded for a considerable length of time, but the mineral sediments do not appear to be very thick. In contrast to this the evidence collected from profile soundings on the south side of the lake and in the Everglades proper indicates the presence of a basal layer of fibrous sedge peat. Minor overflows occurred from time to time, causing the water to encroach over the saw-grass marsh of that period and to persist for moderately long intervals. The admixtures of sedimentary peat, aquatic in origin, found embedded in the brown fibrous sedge peat at various levels, obviously are equivalent to the amount and length of overflow submergence. Especially at depths represented by tide elevations of 7 and 11 feet above sea level (Fig. 2), quantities of sedimentary material embedded in poorly decomposed sedge peat, differing in morphological characteristics from plant remains above and below these levels, must be credited to the agency of fluctuating water levels. The formation and deposition of both organic and silty material at the higher levels are proof of the existence of initial shore lines of a temporary lake, and an indication that a change to higher water levels had affected the region.

Subsequent to the minor overflows, and as the water level fell, saw-grass vegetation again advanced northward beyond the present shore line of Lake Okeechobee. The plants continued to build up an accumulation of sedge peat, holding water to surface level by capillarity. In addition to the saw grass, Cladium effusum (Mariscus jamaicensis), the most common component of the fibrous peat layer, the plant remains denote the presence of species of Rhynchospora, Panicum, Andropogon, ferns such as Osmunda regalis, Acrosticum sp., and herbaceous plants as elements of the ancient marsh community. The only species found as seemingly pure bands of peat are Peltandra with Sagittaria and Pontederia which occupied ancient lagoons and sloughs. The water appears to have oozed slowly southward, on the east side toward the southwest.

The most extensive submergence by overflow, greatest in amount of sedimentary peat deposition and bringing the layer farthest out over the interior of the Everglades region, occurred later. All the measurements strongly affirm the interpretation that a rapid change due to the release of large masses of water marks the period when the accumulation of fibrous sedge peat had reached elevations between 12 and 13 feet above sea level. In its inundated condition the region was covered with water, probably to a foot or more in depth, fluctuating in level from time to time but enduring for a relatively long period. Both the upper and lower edges of the sedimentary peat of that time are rather sharply demarked, and the continuity of the layer is traceable the entire distance from Kreamer Island in Lake Okeechobee to a line north of the Tamiami Trail, between Miami and the west coast, where the layer has the form of thin projecting lobes. A preliminary study of the plant remains seems to indicate a general and great change in surface vegetation.

The whole aspect of the peat profiles is such as to justify the assumption of fluctuating and long-standing high water conditions. But the factors are yet to be determined that caused the water level to rise and stand. The problem is exceedingly complex since some of the factors such as bedrock topography, rainfall, evaporation, run-off, and percolation in the Everglades are not well understood. The underground water supply through porous or probably cavernous limestone is also an unknown and vitally important factor which will require study and observation.

When the waters again fell and withdrew to a lower level, the present Lake Okeechobee came into existence. Lowering of the water table exposed a narrow zone of sedimentary mud flats on the south shore of the lake, and was accompanied by the rapid invasion of deciduous broad-leaved trees and shrubs. A dense growth of custard apple trees (Anona glabra) became dominant and formed a forest in which other tree-like vegetation was scant. Many of the older trees had enlarged bases induced by the influence of submergence in water. The location and width of the "custard-apple belt," previous to its destruction coincident with drainage and cultural operations, are shown on the phytogeographic map published by Harshberger (11).

A comparison of the peat profiles in the "custard-apple belt" between the shore of the Lake and the interior of the Everglades suggests more differences than correspondences in the upper and recent layer of peat. The disagreement, however, is essentially due to fluctuation in water level. Woody peat is lacking entirely. Readvances of the shore line are marked by readvances in aquatic vegetation and corresponding deposition of sedimentary peat; periods, short in duration, of lower water supply are correlated by the development of saw-grass vegetation and herbaceous plants which were favored and pushed forward over the exposed mudflats. Some of the bands of shell marl below laminated, platy, yellowish-brown, fibrous peat derived from Pontederia and semiaguatic members of the Naiadales and Arales surely record a wide re-entrance of saw-grass vegetation over sedimentary peat, and a corresponding drainage of the lake and of the Everglades. The extent and the number of oscillations in water level seem to have been small, for the bands are disturbed and alternate irregularly at several localities. Although thin layers of fibrous and herbaceous sedge peat extend beyond the present lake margin, they have only moderate thickness and indicate effects of an unstable shore line. supposition is strongly supported also by the fact that in the interior of the Everglades and in the bays of Lake Okeechobee the corresponding layers of sedge peat record more uniform conditions. As already noted in another connection (4) they suggest that during the last few thousand years there has been no major differential submergence and no appreciable change in the relative positions of water level. evidence indicates that custard-apple hammocks established themselves only recently upon the mud flats along Lake Okeechobee, and the record of the peat profiles leads toward the conclusion of an essentially stable coastal plain in historic time.

A ridge of fine silicious sand occupies the northeast and east shores of Lake Okeechobee. The sand ridge at Canal Point is about six feet high, varies in width from about 25 to 200 feet and rests on sedimentary peat along the entire southeastern shore of the lake. Prior to drainage operations it was clothed with bald cypress (Taxodium distichum), maple (Acer carolinianum), ash (Fraxinus caroliniana), holly (*Ilex cassine*), strangling fig (*Ficus aurea*), palmetto (*Sabal palmetto*), many shrubs, and herbaceous undergrowth; the stand was almost impenetrable in many places. These low dune-like ridges and mounds of sand are not directly related to the present shore line, although they occur near the shore of Lake Okeechobee and are not found inland on the saw-grass peat of the Everglades. From their position they may be in part the work of winds and in part due to wave action, particularly southward-setting currents; they were probably formed more or less recently, but at a time when water level conditions favored sand drift.

The present vegetation of the Everglades has been described in great detail by Harshberger (11). Consultation of the phytogeographic map which accompanies his monograph will show the limits of the saw-grass vegetation and diverse plant communities, but not of the actual accumulation of saw-grass peat. Harper (10) has listed the constituent plants of the principal types of vegetation and has given many sources of information in his bibliography. To complete the picture it is necessary to keep in mind that broad-leaved shrubs and trees belonging to types essentially southern in range and characteristic of the belt of cypress-tupelo-red gum swamps have been invading the Everglades only recently. As yet layers of woody peat derived from them are lacking. In the interior of the Everglades are scattered hammocks or islands of hardwood trees and shrubs with vines, ferns, and epiphytes. Where fires do not suppress it, this group of vegetation is displacing the saw-grass more or less rapidly. In a not-distant future hammock vegetation will be typical where the saw-grass is still in evidence.

CONCLUSIONS AND NEW PROBLEMS

In the present paper the primary object has been to treat in a preliminary fashion the general origin and nature of the upper portion of that large stretch of sedge moor, the Everglades of Florida, one of the largest subtropical peat areas in the world, extending from Lake Okeechobee to the Gulf of Mexico.

Three distinct but genetically related series of peat profiles are pointed out. (1) the area of profiles in and bordering Lake Okeechobee; (2) the area of profiles in the main interior portion of the Everglades; (3) the area of peat profiles bordering the highland. The general relations of these three series of profiles to each other are shown diagrammatically in Figs. 2 to 7. The morphological features and botanical composition which characterize representative soundings of each of these series of profiles have been described and the effects of oscillations of water level upon the stratigraphic origin and form of the profiles were considered. It is concluded that the salient features of the Everglades do not find an explanation in the geologic structure, or in the configuration of the bedrock as an inland lake; the peat profiles show a remarkable dependence upon inundations and oscillations of water level and corresponding changes in shore line during a time relatively recent. The Upper Everglades of Florida present the aspects of a eutrophic sedge moor characterized by series of one-, two-, and three-layered telmatogenic profiles.

A number of special problems possess more than ordinary interest. It is in the wide bearing not only on practical agriculture but also on fields of science, particularly Pleistocene geology, geography, botany, climatology and even archaeology that their scientific value and importance are to be found.

If a sufficient number of profile measurements can be secured together with their elevations above sea level, the successive positions of ancient Lake Okeechobee, the several stages and forms of the receding and advancing shore line can be mapped. It is hoped that such a valuable list of accurate measurements as that obtained through the coöperation with the Everglades State Drainage office will be made for a large number of points along lines of traverse in an east-west and north-south direction. They have a high scientific and practical value. There is a scarcity of trustworthy data for solving certain difficult problems in regional peat investigations, or on which to base reliable estimates of the rate and amount of shrinkage and decomposition of peat deposits under different climatic conditions and agricultural practices.

A closer treatment requires also biochemical analyses of the profile series, including the mechanical and chemical character of both the shore peat (littoral gyttja) and lake peat (limnic gyttja) as geographical types of sedimentary peat. Of considerable interest should be detailed quantitative and stratigraphic studies of pollen and other plant remains in the succession of peat layers.

It would be pertinent also to inquire into the causes of the inundations to which the region has been subject and which determined the primary characteristics of the Everglades peat soils. Determination of the extent, number, and duration of the overflows and changes in water level, the amount of fall and rise recorded by the peat profiles, should be of great interest in problems connected with the control of intermittent, impounded surface waters. The factors that caused longstanding high-water-level conditions and changes in the shore of Lake Okeechobee are yet to be determined. The theory of relatively recent oscillations of the coast, involving both emergence and subsidence of the Floridian mainland, is apparently disproved by the character of the Everglades peat layers and the absence of tidal-marsh peat.

An estimate of the length of time required for the formation of this interesting peat region with its flooded and ponded lake and shifting, complicated shore lines should be another aim in studies like this, especially if correlated with contemporaneous periods in the ice retreat in North America. Correlation tables already published (3) are only a beginning of the task of constructing a continuous record. The complexity and difficulty of the whole problem of possible changes of level requires contributions from different aspects, and the light of fuller knowledge than now at our command. Particular attention should be given to comparisons with northern coastal regions serving to clarify the relationship between stratigraphic features and environmental changes.

Studies to correlate the effects of drainage and of special chemical salts, applied to promote the growth of crops, are under way on fields representing each profile series.

REFERENCES

- (1) Allison, R. V., Bryan, O. C., and Hunter, J. H. The stimulation of plant response on the raw peat soils of the Florida Everglades through the use of copper sulphate and other chemicals. Univ. Florida Agric. Exp. Sta. Bull. 190. 1927.
- (2) Baldwin, M. and Hawker, H. W. Soil Survey of the Fort Lauderdale area, Florida. Field Operations, U. S. Bureau of Soils, 1919.
- (3) Dachnowski, A. P. The correlation of time units and climatic changes in peat deposits of the United States and Europe. Proc. Nat. Acad. Sci. 8: 225-231. 1922.
- (4) Dachnowski-Stokes, A. P., and Allison, R. V. A preliminary note on blue-green algal marl in southern Florida in relation to the problem of coastal subsidence. This Journal 18: 476-480. 1928.
- This Journal 18: 476-480. 1928.

 (5) Dachnowski-Stokes, A. P. The botanical composition and morphological features of "highmoor" peat profiles in Maine. Soil Sci. 27: 379-388. 1929.
- (6) Elliot, F. C. Bienn. Rept. Everglades Drainage District, Tallahassee, Florida. 1925–1926.

- (7) Everglades of Florida. U. S. Senate Doc. 89, 62nd Congress, 1st Session, Washington, D. C. 1911.
- (8) Florida Everglades. U. S. Senate Doc. 379, 63d Congress, 2nd Session, Washington, D. C. 1914.
- (9) Forsaith, C. C. Report on some allocthonous peat deposite of Florida. Bot. Gaz. **62**: 32-52, 1916, **63**: 190-208. 1917.
- (10) Harper, R. M. Natural resources of Southern Florida. Eighteenth Ann. Rep. Fla. State Geol. Survey, 27-206. 1927.
- (11) Harshberger, J. W. The vegetation of South Florida, south of 27°30′ north, exclusive of the Florida Keys. Trans. Wagner Free Inst. Sci. 7: 49-189. 1914.
- (12) Lundquist, G. Methoden zur Untersuchung der Entwicklungsgeschichte der Seen. Abderhalden's Handbuch der biologischen Arbeitsmethoden. Abt. 9, T. 2, (fig. 173), 427-462. 1925.
- (13) Matson, G. C., and Sanford, S., Geology and ground waters of Florida. U. S. Geol. Survey, Water Supply Paper 319. 1913.
- ZOOLOGY.—Descriptions of two new amphipod crustaceans (Talitridae) from the United States. Clarence R. Shoemaker, United States National Museum. (Communicated by Mary J. Rathbun.)

While sorting a small collection of crustacea which was sent to the U. S. National Museum for identification by the U. S. Biological Survey in May, 1929, I noticed a species of Orchestia which was new to science. The specimens, one male and two females, were collected by Mr. F. M. Uhler, and in answer to my inquiry as to the exact locality, he says in his letter, "The specimens were taken on the north side of a small lake or pond located on the northwest side of Lake Monroe, and were found under a board on a rather sandy gently sloping margin, 2-4 yards from the water's edge. This spot apparently is in Volusia County, Florida, very close to the Seminole County line, and Sanford is the nearest town of any importance. This pond is located about 1-1½ miles from the bridge across the outlet of Lake Monroe, and is separated from the lake only by a strip of semi-dry marsh covered with vegetation. The water of the pond is supplied by a large sulphur spring, a sulphurous artesian well, and by high water from the main body of Lake Monroe. Lake Monroe is merely a broadened portion of the St. Johns River, and although the water apparently is fresh, it contains such marine vertebrates as the sting ray (Dasyatis sabina) which frequently enters fresh water."

I have designated this new species Orchestia uhleri in honor of its discoverer.

¹ Received February 7, 1930.

In 1905, Dr. James E. Benedict took some specimens of an Orchestoidea at Pacific Grove, California, which upon examination proved to be a new species. Mr. E. M. Chase collected further examples of this species on April 27, 1918 at Anaheim Bay, Seal Beach, California. Dr. Waldo L. Schmitt, during his investigations of spiny lobsters, procured additional material from kelp hold-fasts on the beach at La Jolla, California. Mr. Frank F. Gander has presented the National Museum with specimens which he took in 1927 at San Diego, California. Mr. Gander states that he took this species both in the littoral marine and at Balboa Park, which affords another example of a member of the family Talitridae extending from the coast to a considerable distance inland.

This species I have named *Orchestoidea benedicti* in honor of its discoverer.

Orchestia uhleri, n. sp.

Figures 1 and 2

Type-locality.—Near Lake Monroe, Volusia County, Florida, collected by F. M. Uhler, March 22, 1928; 1 male holotype (Cat. No. 62956, U. S. N. M.). Male.—Eyes black, round, and of moderate size. Antenna 1 extending slightly beyond the fourth joint of antenna 2, flagellum composed of four joints and slightly longer than peduncle. Antenna 2 very nearly as long as the head and first four body segments, fourth joint of peduncle about threefourths the length of fifth, flagellum composed of thirteen joints and as long as the fourth and fifth joints of peduncle combined. Mandible, cutting edge rather narrow and oblique and armed with two large and three smaller teeth, secondary plate well developed, two stout plumose spines and one or two smaller ones in spine-row, molar large and strong, bearing many transverse ridges on its slightly concave surface, and having at its base near the spine-row a dense brush of plumose setae. Maxilla 1, inner plate long and narrow and bearing on its distal end three plumose spines, outer plate bearing 9 serrate spine-teeth, palp very small with second joint about one-third the length of first. Maxilla 2, inner plate very nearly as long as outer and bearing on its obliquely truncated extremity many plumose spines and setae, outer plate evenly rounded distally and bearing many curved spines. Maxillipeds, inner plates reaching very nearly to the end of the first joint of palp, broadened distally, and bearing four short spine-teeth on their truncated ends, outer plates short and broad, reaching about one-third the distance along the second joint of palp, palp very short and broad, all the joints being wider than long. Lower-lip about normal. Gnathopod 1, side-plate very slightly concave in front and evenly rounded below, fourth joint with shallow lobe on lower margin, fifth with prominent lobe on lower margin, sixth joint about two-thirds the length of fifth, lower margin produced distally into a soft tumid lobe, palm short, transverse and armed with a row of long slender spines, seventh joint as long as palm, bearing about one-third the distance from the apex several slender setae, and armed on inner edge with three short blunt spines. Gnathopod 2 large and powerful, second joint four-fifths as

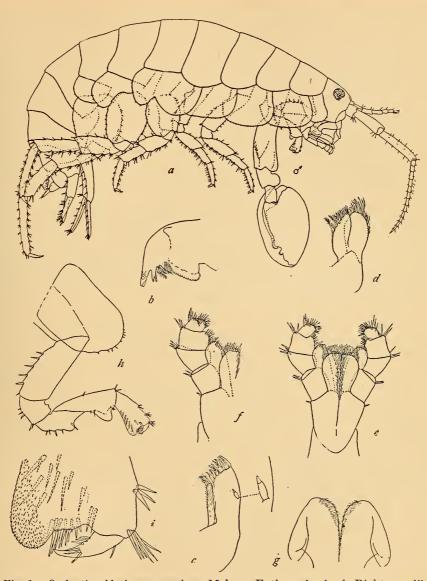


Fig. 1.—Orchestia uhleri, new species. Male, a, Entire animal. b, Right mandible. c, Maxilla 1. d, Maxilla 2. e, Maxillipeds. f, Maxilliped with palp flattened out to show entire width of joints. g, Lower lip. h, Gnathopod 1. i, End of sixth joint and seventh joint of gnathopod 2, enlarged.

long as sixth, produced at the lower anterior corner into a rounding lobe, third joint produced anteriorly into a prominent rounding lobe, sixth joint over half as wide as long, narrowing distally, with upper margin convex, and the entire lower margin which is about straight forming the palm, two rounding protuberances on palm adjacent to the hinge of seventh joint, palm armed on distal two-thirds with short spines which are more thickly clustered on the protuberances, seventh joint very long and curving inward toward the end, greatly overlapping palm and when closed against palm the apex extending nearly to the upper margin of fourth joint, a large tooth or protuberance on inner surface fitting between those of the palm. Peraeopods 1 and 2 about normal except that the seventh joints are rather small. Peraeopods 3 to 5 increasing consecutively in length and having all joints normally expanded. Uropod 1 projecting farther backward than uropod 2 which projects considerably farther than uropod 3. Uropod 1 with peduncle slightly longer than the rami which are very nearly equal in length. Uropod 2 with peduncle equal in length to outer ramus which is a little shorter than the inner. Uropod 3 with peduncle and ramus nearly equal in length, ramus about three times longer than wide, bearing four long spines on outer margin and a cluster of three spines on apex. Telson a little longer than wide, with the slightly concave sides converging toward the apex which is divided into two shallow lobes by a slight central notch, two long spines on each lateral margin, two extending backward from each lobe, and two shorter spines on upper surface near apex.

Length.—Male, 14.5 mm.; female, smaller.

Gnathopod 1 of the female is very distinctly subchelate, the palm being slightly oblique and armed near the defining angle with a row of five or six long slender spines, and the seventh joint bearing near its apex several setae and on inside margin two short blunt spines. Gnathopod 2 of female with second joint moderately expanded, sixth joint produced considerably beyond the very short seventh joint into an evenly rounded soft tumid lobe.

Although the genus *Orchestia* is mostly confined to marine beaches, a number of its members, in widely separated parts of the earth, are known to occur in moist earth and amongst decaying vegetation, at considerable distances from the coast and at times at elevations of 2000 to 3000 feet. Fritz Müller described a species (*O. darwinii*) from Brazil, of which he says, "The animal lives in marshy places in the vicinity of the sea, under decaying leaves, in the loose earth which the marsh crabs throw up around the entrance to their burrows, and even under dry cow dung and horse dung. If this species removes to a greater distance from the shore than the majority of its congeners, its male differs still more from all known species by the powerful chelae of the second pair of feet." The present record, I believe, is the first of the occurrence of this genus in North America at any locality removed from the coast, Lake Monroe being twenty miles from the nearest point on the east coast of Florida and about 120 miles from the sea by way of the St. Johns River.

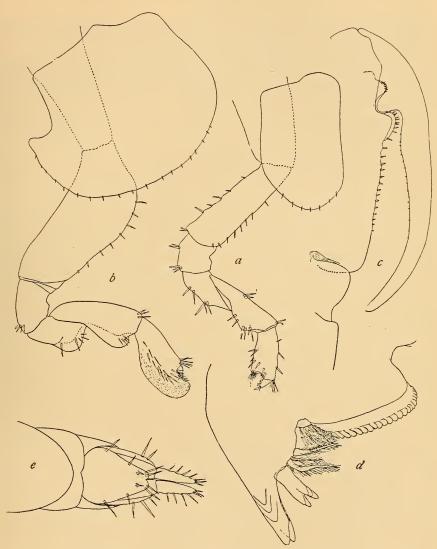


Fig. 2.—Orchestia uhleri, new species. a, Gnathopod 1, female. b, Gnathopod 2, female. c, Palm of sixth joint and seventh joint of gnathopod 2 of male, enlarged. d, Right mandible, enlarged. e, Telson and third uropods, male.

Orchestoidea benedicti, n. sp.

Figure 3

Type-locality.—San Diego, California (littoral marine), collected by Frank F. Gander, April, 1927; 1 male holotype (Cat. No. 62962, U.S.N.M.).

Male.—Head about as long as first thoracic segment, eye of medium size, very nearly circular, black and composed of many small elements. Antenna 1 scarcely reaching to the middle of fourth joint of antenna 2, flagellum half the length of peduncle and composed of four joints the last of which is very small. Antenna 2 very short and stout, fourth joint about twice as long as wide, fifth joint twice as long as fourth and only four times as long as wide, flagellum a little over half as long as fifth peduncular joint, first four joints of flagellum coalesced forming one long joint about equal in length to the remaining seven. Mandible, cutting edge with three large stout teeth and three or four smaller ones, secondary plate well-developed, four plumose spines, two of which are larger than the others, in spine-row, molar welldeveloped, and bearing a brush of plumose setae at base. Maxilla 1, inner plate long and slender and bearing two plumose spines on apex, outer plate longer than inner and bearing nine serrate spine-teeth on the obliquely truncated end, palp very small consisting of a slender basal joint and a very minute terminal joint. Maxilla 2, inner plate narrower and slightly shorter than outer, distal end very obliquely truncated and bearing a long plumose seta at lower obtuse angle, outer plate evenly rounded distally and armed with many long curved spines. Maxillipeds, inner plates long and slender, reaching to or a little beyond the middle of the outer plate, and armed on the transversely truncated end with three short spine-teeth and row of plumose setae, outer plate small and short, reaching to about the middle of the second joint of palp, the rounding apex bearing several plumose setae, and the inner edge bearing a row of closely set short spines, palm short and broad, the inner distal angle of second joint produced into a broad lobe, lower lip with lateral lobes short and broad. Gnathopod 1 about normal, fifth joint bearing on lower margin a short rounding lobe, sixth joint bearing at the lower posterior angle a low soft lobe which gives the joint the appearance of having a very short palm. Gnathopod 2, sixth joint very large and powerful and roughly oval in outline, the oblique palm consisting of a large spinose tooth and a deep depression adjacent to the hinge of the seventh joint, the palm is defined by a low rounding angle and a short stout spine, the oblique surface of the large tooth bears several additional stout spines some of which project forward on either side of the seventh joint when it is closed against the palm, seventh joint very stout and strongly curved and slightly overlapping palm, inner edge bearing a row of very short spinules. Peraeopod 1 much longer than 2. Peraeopod 3 about equal in length to 2, second joint broadly expanded. Peraeopods 4 and 5 subequal in length, second joint of 5 more widely expanded than that of 4. Abdominal segments 1-3 with lower posterior corners slightly produced into short acute points. Uropod 1 extending farther back than 2 which is farther produced than 3. Uropod 1, peduncle longer than the rami, the outer of which is the longer, peduncle and rami bearing spines on all their edges. Uropod 2, peduncle equal in length to outer ramus which is slightly shorter than inner, the edges of both peduncle and rami bearing spines, those of the peduncle being longer than the rest. Uropod 3, peduncle shorter than ramus. Telson about as wide as long, the sides converging to a narrowly rounded apex, several spines on the upper surface and a cluster on the rounding apex.

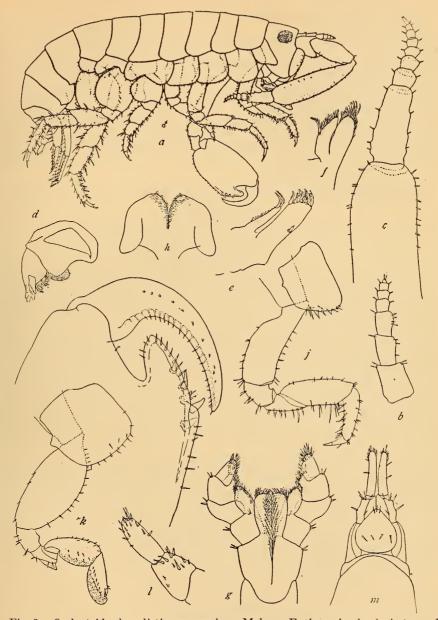


Fig. 3.—Orchestoidea benedicti, new species. Male, a, Entire animal. b, Antenna 1. c, End of fifth joint and flagellum of antenna 2. d, Right mandible. e, Maxilla 1. f, Maxilla 2. g, Maxillipeds. h, Lower lip. i, End of sixth joint and seventh joint of gnathopod 2, enlarged. j, Gnathopod 1, female. k, Gnathopod 2, female. l, Uropod 3. n, Telson and third uropods from above.

Length.—Male, 13 mm.; female, somewhat smaller.

Material examined.—

53 specimens; Pacific Grove, California, James E. Benedict, coll., June, 1905.

1 specimen; Entrance to Anaheim Bay, Seal Beach, California, E. M. Chase, coll., April 27, 1918.

27 specimens; La Jolla, California, from kelp hold-fasts on beach, W. L. Schmitt, coll., August 17, 1918.

9 specimens; San Diego, California (littoral marine), Frank F. Gander, coll.,

5 specimens; San Diego, California (Balboa Park), Frank F. Gander, coll., May, 1927.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ENTOMOLOGICAL SOCIETY

413TH MEETING

The 413th regular meeting was held October 3d, 1929, in Room 43 of the National Museum. The president, Mr. J. E. Graf, presided. Mr. Roy E. Campbell, Alhambra, California, and Mr. A. M. Vance, Hyères, France, were elected to membership.

The Secretary-Treasurer, Mr. Rohwer, read a communication from Prof. E. N. Cory, of College Park, Md., chairman of the Eastern branch of the American Association of Economic Entomologists, announcing a meeting of that organization in New York City beginning on November 21st at 9:30 A.M.

The chair reported the death of Dr. Frank Hurlbut Chittenden of the Bureau of Entomology on September 15th, 1929, in his 71st year, at his home in Washington, D. C. After a few remarks, by Dr. Howard, dealing in a reminiscent way with his associations with the deceased, a committee, consisting of White, Qauintance, and Howard, was appointed to recommend. action at the next meeting.

Program: J. M. Aldrich: Recent entomological experiences in Europe. The speaker spent some three months in Europe the past summer. He studied the types of American muscoid flies in the British Museum, and the museums in Stockholm, Copenhagen and Paris. He also collected Diptera in Northern Sweden (Aare and Oestersund) for the purpose of getting material to compare with the northern flies of America, in order to get further information about the species common to the holarctic region. Lantern slides were shown to illustrate the life zones of northern Sweden. (Author's abstract.)

Discussed by Howard.

F. L. Campbell: How do insects grow?

414TH MEETING

The 414th meeting was held November 7, 1929, in Room 43 of the National Museum. The President, Mr. J. E. Graf, presided. Mr. James I. Hambleton and Dr. J. W. Bulger, both of the U. S. Bureau of Entomology, were elected to membership.

The following communication was read:

"Your committee recommends that the following paragraph be inserted in the minutes of this meeting:

"'The Entomological Society of Washington feels that the death of Dr. Frank Hurlbut Chittenden has taken from us a devoted and accomplished entomologist whose long term of working years in Washington has enriched entomology in its biologic, taxonomic and economic aspects; that we feel his loss deeply and that we sympathize sincerely with his surviving sister.'

"Your committee further recommends that it be empowered to prepare and publish in the Proceedings of the Society a short account of Doctor Chittenden's life and activities."

Signed: W. H. WHITE A. L. QUAINTANCE L. O. HOWARD

Program: R. E. Snodgrass: How Insects Fly.

Insect wings probably were developed from paranotal lobes. The oldest known insects were fully winged—some with flexor apparatus and some with-Wing muscles comprise the dorsal longitudinal muscles, vertical tergosternal muscles, pleural muscles, and the flexor muscles. Wing movements of flight consist of up-and-down movements, forward and rearward movements, and partial rotary movements. Up-and-down movements are produced by the dorsal longitudinal and the tergo-sternal muscles, with strong depressor adjuncts in the posterior pleural muscles. Forward, rearward, and rotary movements are produced by the anterior and posterior pleural muscles. Movements by the flexion are produced by the flexor muscles; extension is produced by the anterior and posterior pleural muscles. Flight involves a driving and lifting force; both are produced by the wing movements which create an area of decreased air pressure before and above the insect (Demoll). Steering, sidewise and rearward flight, and hovering are functions controlled by the pleural muscles. Organs of equilibrium are not known in insects generally; a few species have organs that are possibly of a static (Author's abstract.)

Discussed by McIndoo, Currie, Mann, Howard, and Thone.

At request of Dr. S. F. Blake, Recording Secretary of the Biological Society of Washington, a notice was read by the Recording Secretary of an address to be delivered by Dr. Charles Wardell Stiles on Some Recent Developments in Zoological Nomenclature at the next regular meeting of that Society to be held at the Cosmos Club on November 16.

Remarks were made on invitation by a visitor, Father O. Piel, a missionary to China, who was introduced by Doctor Howard, and who greeted our Society, expressed his pleasure at being with us, and spoke briefly of his recent

travel contacts in this country and abroad.

Mr. Rohwer recorded the recent discovery of the pink bollworm of cotton in the Salt River Valley of Arizona, and the amendment to the quarantine effective on October 31, including within the regulated area Pinal and Maricopa Counties, Arizona. Specimens of this insect were collected in gin trash at two gins on October 24 and forwarded to Washington for final identification. Immediately on this discovery additional scouts were sent to the area and at this time specimens of the pest had been collected in ten different fields and in trash from four different gins. All points where infestations have been discovered are within a comparatively limited area of approximately five miles

southwest of the towns of Mesa and Gilbert. In some fields approximately 85% of the bolls were infested and within the general area in which the larvae

had been found the infestation ranged from 5 to 85%.

Mr. Rohwer also referred very briefly to the work done on the Mediterranean fruit fly and stated that no specimens of infested fruit had been discovered at any point within the State of Florida since August 27 nor had any adults been taken in traps since August 14. The apparent absence of fruit fly is very encouraging. During the summer intensive scouting has been done throughout the State of Florida. In addition to the scouting done within this State the States within the cotton belt have been intensively scouted and intensive scouting has also been done in California and the southwestern States. No infestations of the fruit fly have been discovered as the result of this work.

Discussed by Webb, McIndoo, and Thone.

415TH MEETING

The 415th meeting of the Entomological Society of Washington was held December 5th, 1929, in Room 43 of the National Museum. The President,

Mr. J. E. Graf presided.

The first item of business was the annual election of officers of the Society for 1930. All of the following were then reelected: President, J. E. Graf; First Vice President, A. C. Baker; Second Vice President, F. C. Bishopp; Recording Secretary, J. S. Wade; Corresponding Secretary-Treasurer, S. A. Rohwer; Editor, W. R. Walton; Executive Committee, the officers and C. T. Greene, A. N. Caudell, and T. E. Snyder; Representing the Society as vice

president of the Washington Academy of Sciences, A. G. Böving.

Remarks were made on invitation by the following visitors and non-resident members: Dr. C. C. Ghosh, entomologist of the Agricultural College of Mandalay, Burma, India, greeted the Society and spoke appreciatively of his early personal contacts years ago with the officials of our Department of Agriculture and of the aid received from studies of its entomological publications, of his previous associations with Dr. Howard, and of his pleasure at opportunity of visiting Washington. He also spoke briefly of the official organization of Agriculture in India and of the character and scope of some of the activities now under way in that country.

Dr. W. V. King, of the Malaria Mosquito Laboratory at Mound, Louisiana, also addressed the meeting, expressed his pleasure at being with us, and referred briefly to some of his recent work in the Philippines on mosquitoes and flies, specifically, an outbreak of considerable magnitude at Manila last year brought about through an accumulation of decaying algae along a lake shore near the City. He also described in a general way some work of the

Philippine Health Service.

Mr. A. F. Burgess, of the Gypsy and Brown Tail Moth Laboratory at Melrose Highlands, Mass., greeted the Society and referred humorously to some phases of the just completed election of our Society's officers, gave some reminiscences of other meetings attended years ago, and dwelt appreciatively on the work accomplished and the publications issued by our Society.

Program: F. W. Poos: Leafhopper injury to legumes. (Illustrated). The study of leafhopper injury to legumes was started in 1928 by the Division of Cereal and Forage Insect Investigations, Bureau of Entomology, in cooperation with the Division of Forage Crops, Bureau of Plant Industry, at Arlington Farm, Virginia, where plantings of the various varieties of forage

crop legumes are maintained by the latter Division and where laboratory and greenhouse facilities are also furnished for these studies. The work has been largely confined to the disease-like injury which is due to some intimate specific relationship other than that of purely mechanical punctures and depletion of plant food and water. About 30 species of leafhoppers, Cicadellidae, occur on forage crops in this section. Twenty of these species have been tested for the disease-like injury to date. Empoasca fabae and some of the new species of this genus are the only species in which no individuals have been found that are free from the infectious principle. Occasionally individuals from two other genera of Cicadellidae have been found which apparently caused the disease-like injury similar to that caused by E. fabae. The interrelationship of these species, the various responses to their host plants, and the study of their comparative biology makes up a very complicated but interesting field of work.

Observations on the injury and relative susceptibility of various varieties of alfalfa, red clover, sweet clover, white clover, cowpeas, soybeans, peanuts, and potatoes, have been made as well as on many other beans and clovers not mentioned above and on numerous other cultivated and wild hosts. The degree of susceptibility in relation to the amount and type of pubescence is

being studied and gives promise of some very interesting results.

The disease-like injury has not been found to be systemic. The infectious principle or toxicity has been found to be inherited through six generations with no apparent loss of virulence. The degree of injury to an individual plant is more or less directly proportional to the number of leafhoppers which are placed upon the plant. If the leafhoppers are removed before the plant

is too seriously injured, recovery follows.

Studies on the loss in quality and yield of hay caused by *E. fabae* to alfalfa planted during the spring of 1929 were made in cages one sq. rod in area and covered by tobacco cloth. The hay was carefully harvested, dried, and weighed and then submitted to the Bureau of Agricultural Economics for grading. All the hay taken from infested cages was graded No. 2 whereas all the hay taken from the uninfested cage, both cuttings, was graded No. 1. Based on the weights obtained and the average price for this hay in Kansas City during 1928 and 1929, the loss was 33%.

Preliminary work indicates that control will be largely ecological in that a rearrangement of certain crops may be advisable. A better use of existing varieties and the further development of varieties which best lend themselves

to the situation should have due consideration. (Author's abstract.)

Discussed by Bridwell, Graf, King, Rohwer, Howard, Balduf, and Ewing.

Notes and exhibition of specimens: Dr. Aldrich exhibited copies and discussed briefly a number of recently issued scientific and other books, notably: The Witchery of Wasps, by Rhinehart; Instinct and Intelligence, by Kingston; Handbook of the Dragonflies of North America, by Needham and Haywood; A Manual of External Parasites, by Ewing; Principles of Systematic Entomology, by Ferris; and An Orphan of Eternity, by Heinrich. These remarks were discussed by Howard.

J. S. Wade, Recording Secretary

PHILOSOPHICAL SOCIETY

997TH MEETING

The 997th meeting was held in the Cosmos Club Auditorium on November 23, 1929.

Program: H. B. Brooks, The sensitivity of a galvanometer as a function of its resistance. Maxwell stated that for the maximum deflection of a galvanometer connected to an external circuit containing a given electromotive force, the galvanometer resistance should bear to the external resistance the ratio, diameter of bare wire (in the galvanometer coil) to its diameter over the insulation. Ayrton and Perry stated that the ratio of these resistances should be unity. Heaviside found that both statements were correct for the respective assumptions. Maxwell having assumed a constant absolute thickness of insulation, Ayrton and Perry a thickness having a constant ratio to the diameter of the bare wire. The Ayrton and Perry theorem has become an established tradition. It appears, for example, in a 1928 textbook on electrical measurements, and in the current catalogue of a prominent instrument An extension of the analysis of the previous writers shows that for each case the curve of relative sensitivity as a function of galvanometer-coil resistance has such an extremely flat maximum that one may largely depart from the traditional optimum condition with only small loss in sensitivity, and with a considerable gain in most cases because considerations of proper damping forbid the use of modern moving-coil galvanometers on an external circuit of resistance equal to that of the coil. Because of the extreme flatness of the maxima, galvanometer makers need to construct, and users need to purchase, galvanometers of relatively few values of coil resistance, in order acceptably to cover all but very unusual requirements. (Author's Abstract.)

Howard S. Rappleye, Observers' patterns. This paper constitutes a brief review of the material presented about a year and a half ago on Observers' Patterns, or the personal equations of observers engaged in the firstorder leveling of the U.S. Coast and Geodetic Survey. In addition to the review of the first paper additional data were presented on the progress of the investigation since the first presentation. A piece of test apparatus was shown which was designed with the idea of compressing a "pattern test" into a sample of 100 separate estimations by having them distributed uniformly throughout the range of observations but presented to the observer in a random order. In its present form this apparatus, while it provided some useful sidelights on the whole matter, failed to provide a proper test. Additional work with it may possibly reveal the cause of the failure and make it, when properly modified, a useful adjunct to the test apparatus and program. A "1.000 test" in which the readings are taken at random on four separate positions of rod and instrument but the readings in each group being scattered up and down the rod in an accidental manner, was reported upon and a sample tally sheet shown. It was noted that the groups of 250 observations in each position exhibited the same general characteristics, which seems to further substantiate the belief that a sample of 1,000 to 1,500 observations taken at random is a large enough sample to bring out a characteristic pattern for an observer. A series of patterns were shown illustrating the behavior of an observer throughout a series of tests when the results of each preceding test were known to him. Also patterns were shown illustrating the behavior of the same observer after he had taken the field on actual leveling.

Another series of patterns illustrated the "shaking down" process of a new observer by exhibiting a gradual change in his pattern throughout the first half of a field season and a practically constant pattern or personal equation during the last half of the season. (Author's Abstract.)

OSCAR S. Adams, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

According to the *Journal of Agricultural Research* the tobacco plant shows specific symptoms of a deficiency of magnesium and of calcium in some light-sandy and sandy-loam soils. Fertilizers for such soils should contain small quantities of calcium and magnesium; 180 pounds of magnesium sulphate per acre in the drill or 500 to 1000 pounds of dolomitic limestone broadcast will effectively prevent symptoms of magnesium deficiency.

John C. Reed, recently appointed Senior Scientific Aid on the Geological Survey, is at present assisting the Chemical Laboratory in the determination of mineral specimens. In addition to such determinations made in the course of its regular work, the Survey identifies over 2000 specimens a year for the public.

L. W. Stephenson has resumed his duties as Chief of the Section of Coastal Plain Investigations in the Geological Survey after a four-months furlough for field work in Venezuela.

Miss Julia Gardner, who has spent the winter in examining collections of Tertiary and Cretaceous fossils in foreign museums and in visiting outcrops of fossiliferous strata in England and Denmark, returned to Washington early in March.

Dr. N. Ernest Dorsey, having completed his work as associate editor of the International Critical Tables, has returned to the Bureau of Standards.

Mrs. Agnes Chase, Associate Botanist in the Grass Herbarium, writes from Brazil that she had a severe trip ascending the mountain peak Caparaó in company with a botanical companion, Mrs. Mexia. She was assured "it would be impossible for the senhora to climb Caparaó," but after much insistence arrangements were made. Rain fell most of the time and everything was soaked. The first night out was to be spent at a cave which was reached about 4:30 p.m. It looked very inviting at first as it was dry, but the guide commented on the pulgas (fleas). She and her companion finally made camp in the rain rather than endure the fleas. They had dry clothes for the night but got back into wet clothes at day break. The trail became very steep through the bamboo zone. At last about 3:30 they struggled out of the bamboo into the campo. Antonio (the guide) said something about 'muita corajosa' [very courageous] for senhoras to make that ascent. He said no woman had ever done it before and very few men. Mrs. Chase at Viçosa visited Professor Rolfs, who is an American in charge of a large and important agricultural school. Traveling alone, she collected at Hargreaves and Bello Horizonte.

Mr. Matthew W. Stirling, Chief of the Bureau of Ethnology left Washington January 13 for a cruise among the Ten Thousand Islands between Charlotte Harbor and Cape Sable, Florida, where he hopes to discover evidences of

the former occupancy of this area by the Caloosa Indians. He will be aided by Mr. Lee Parish, of Tulsa, Okla., whose 85-foot yacht, *Esperanza*, will furnish transportation. After his explorations in the Ten Thousand Islands region Mr. Stirling will excavate a large sand mound on the west Coast of Florida, located south of Tampa Bay.

Obituary

Capt. James Percy Ault, who was killed on November 29, 1929, when an explosion destroyed the non-magnetic ship Carnegie in the harbor of Apia, Western Samoa, was born on October 29, 1881, at Olathe, Kansas, and educated at Baker University where he received an A.B. degree in 1904. Even while studying in the University he took an active interest in the work of the then newly established magnetic observatory of the United States Coast and Geodetic Survey at Baldwin, Kansas, where he served as observatory assistant from January 1901 to June 1904. In the latter month he was appointed as magnetic observer in the Department of Terrestrial Magnetism of the Carnegie Institution, and the next year, after receiving the necessary preliminary training on the U. S. Coast Survey vessel Bache on a cruise from Baltimore to Panama, he was assigned to scientific work on the magnetic-survey vessel Galilee where he remained until November 1906. During the next two years he was engaged at the office of the Department in Washington and on magnetic field work in Mexico and Canada, carrying out in the latter country a difficult exploratory trip in the course of which he secured magnetic results in territory where none had previously been obtained. In order to fit himself more thoroughly for a scientific career he next pursued postgraduate studies at Columbia University from which institution he received an A.M. degree in 1909. In view of his skill and experience gained on earlier expeditions, he was again, in 1912, placed in charge of field parties in Peru, Bolivia, and Chile, for the purpose of training new observers in making magnetic determinations under field conditions.

In the general plan of a magnetic survey of the Globe which constituted one of the major operations of the Department, the ocean work of the non-magnetic ship *Carnegie* was destined to play an important part. For the successful execution of this ambitious undertaking, Captain Ault, first as a member of the scientific staff under its first commander William J. Peters, and later

as commander of the vessel, has been largely responsible.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

ANNOUNCEMENTS OF MEETINGS

Wednesday, March 19 The Engineering Society

The Medical Society

Thursday, March 20 The ACADEMY

Friday, March 21 The Geographic Society
Saturday, March 22 The Biological Society
Wednesday, March 26 The Geological Society

The Medical Society

Friday, March 28 The Geographic Society
Saturday, March 29 The Philosophical Society
Tuesday, April 1 The Botanical Society

The Botanical Society
The Historical Society

Wednesday, April 2 The Engineering Society

The Medical Society

Thursday, April 3 The Entomological Society
Friday, April 4 The Geographic Society
Saturday, April 5 The Biological Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Physical Geography.—Peat profiles of the Everglades in Florida: the stratigraphic features of the "Upper" Everglades and correlation with environmental changes. Alfred P. Dachnowski-Stokes	89
United States. Clarence R. Shoemaker.	107
Proceedings	
The Entomological Society	114
The Philosophical Society	118
SCIENTIFIC NOTES AND NEWS	119
OBITUARY: JAMES PERCY AULT	120

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND BOILS

C. WYTHE COOKE
U. S. GROLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL BOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.

Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: This JOURNAL, the official organ of the Washington Academy of Sciences, publishes:
(1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$ 2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3.00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5.00	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100,

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	. 50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

APRIL 4, 1930

No. 7

GEOPHYSICS.—Note on temperature gradients in the Permian basin.¹ Walter B. Lang, U. S. Geological Survey. (Communicated by W. C. Mendenhall.)

It has been shown² that the isogeothermal surfaces in the Permian Basin of West Texas and southeastern New Mexico are depressed and that this subnormal condition appears to have some relationship to the distribution and thickness of the halite and anhydrite deposits. In the fall of 1929 an opportunity was afforded to make a temperature test in a well which was so located as to yield some evidence as to the factor or factors of a large group of variables which might be responsible for the effect. This well (Transcontinental-McWhorter No. 1, Sec. 6, T. 3 S., R. 22 E., De Baca County, N. Mex.) was drilled through rocks locally identified as the lower San Andres, Yeso, Abo (Permian). and Magdalena (Pennsylvanian) formations and into what are believed to be representatives of the pre-Cambrian schists and quartzites which outcrop in the Hills of Pedernal some 60 miles to the northwest. The San Andres and Yeso formations of this area are of interest because they are composed of limestone and anhydrite and therefore contain only one of those two prominent but characteristic sediments, halite and anhydrite, of the Permian Basin. This well by reason of its marginal position also has a stratigraphic range far greater than even deep wells in the basin proper. The geothermal gradient curve of this well began as representative of the region but on approaching the Abo formation began to take on a noticeably accelerated increase, so that on reaching a depth of 4,400 feet a temperature that would be high for the Permian Basin was recorded. It appears therefore that in-

[.] ¹ Published by permission of the Director of the U. S. Geological Survey. Received February 18, 1930.

² This Journal 19: 232. 1929.

ternal heat is being dissipated more rapidly by the upper anhydritebearing sediments of this section than it is being supplied by the lower.

If the thermal conductivity tables for rocks are consulted it is found that the majority of the more usual types have conductivities within the range of .002 to .008 calories (cm. sec. Grad.). Anhydrite and halite are reported to have conductivities of .0123 and .0137 calories, respectively. Now it is indicated by this test that anhydrite alone, present as alternate beds with limestone in the upper section of the well, influences the character of the gradient curve by depressing it. The previously noted apparent westward extension of subnormal temperatures beyond the halite boundary is thus also subject to explanation. Also the diathermanous property of halite is eliminated as a primary factor, for if this property of halite were the sole cause of subnormal temperatures in the basin the effect could not be recorded in this well. Anhydrite in association with even thicker beds of halite of still greater conductivity coefficient in the basin proper may be expected to conduct heat faster than it can be supplied by other sediments at greater depth. It is therefore reasonable to suppose that the depression of the isogeotherms of the Permian Basin are the direct result of the high thermal conductivities of these two prominent sedi-

Other sedimentary regions involving considerable halite or anhydrite not covered by too great an overburden of low conductivity rocks should yield low gradients, if the area in which they occur is not subject to other extraneous heat-producing sources. The Permian saline deposits of Germany have been so affected by tectonic disturbances as apparently to have counteracted the expectable high conductivity influences.

Radioactivity is proposed by some authorities as one of the principal sources of the earth's heat. Potassium is radioactive (Beta-ray) and even though the unit energy is low in proportion to uranium, the percentage of potassium present in the average rock is sufficient to produce heat equivalent to that of uranium.³ The saline deposits (late Paleozoic) of West Texas and New Mexico for an area of more than 40,000 square miles carry potash in disseminated and concentrated form. Local areas equivalent in size to a township have beds 6 to 15 feet thick analyzing 10 to 30 per cent of potash (K₂O). These deposits have remained undisturbed during all of Mesozoic and Ceno-

³ ARTHUR HOLMES and R. W. LAWSON, Potassium and the heat of the earth. Nature, May 1, 1926, pp. 620-621.

zoic time, yet in only one temperature test made in a well penetrating these beds is there the faintest suggestion of the possible influence of radioactivity and even in this case the variation may be explained on another basis. Despite this radiothermal heat the temperature gradients are excessively low. More powerful agencies than radioactivity control geothermal gradients in the basin. Perhaps radioactivity is also of minor importance in other areas of the earth.

A sphere of uniform composition heated at the center and cooling at the surface has perfect concentric isothermal zones. Wanting evidence to the contrary, it is assumed the inner portion of the earth is isothermally zoned. The crustal portion of the earth, variable in composition and relief, must have isothermal surfaces broadly expressing the influences of these variations.

An explanation of the varying behavior of the isogeotherms of any region is very likely to be dependent, in part or in whole, upon differential rock conductivities. Critical data of the sort necessary to determine the influence of rock conductivities in general upon temperature gradients do not exist. This is largely due to the fact that such determinations as have been made (industrial, building stones, etc.) were not made with a view to the solution of geological problems. Compaction, porosity, bedding, mineral orientation, degree of crystallization or cementation, water content, etc., are in only a few instances considered or noted. Nevertheless, these small factors sometimes yield enormous cumulative effects. Questions of conductivity parallel and perpendicular to bedding can not be decided by data now at hand. A dry sediment compacted by loading may have greater density across the bedding and therefore greater conductivity in this direction. However, the same rock saturated with water may have greater conductivity along the bedding. Whether or not oil-bearing anticlines owe their heat to exothermic reactions or stratified thermal conductivity is a question dependent upon more specific data. Mass orientation of minerals of ellipsoidal conductivity properties may be expected to give widely divergent results for different positions of the rock specimens.

Until supposition is supported by more exact basic criteria reasoning about geothermal problems is apt to rest on an unsound foundation. There is urgent need for data on the thermal conductivity of rocks as they exist under natural conditions.

⁴ Joseph Prestwich, Controverted questions in geology. Macmillan & Co., 1895, p. 241.

PHYSICAL GEOGRAPHY.—Peat profile studies in Maine: The South Lubec "heath" in relation to sea level. A. P. Dachnowski-Stokes, U. S. Bureau of Chemistry and Soils.

T

The following study, carried out principally south of Lubec at Carryingplace Cove in Maine, was made with two purposes in view. In connection wth field work regarding the quality and possible uses of moss peat in "heaths," it contemplated an intensive profile study of an exposed coastal highmoor which is being cut back by waves at a rapid rate. At the same time it was hoped that observations of sufficient precision concerning the position of the moor in relation to sea level would furnish the necessary data for determining, by comparison with later observations, whether or not the coast was subsiding.

Carryingplace Cove occupies the eastern extremity of Maine in Grand Manan Channel and lies close to the boundary line of New Brunswick, Canada. The general position and surrounding environment of its peat area are illustrated on chart No. 801 of the U. S. Coast and Geodetic Survey and on the maps accompanying the Eastport Folio No. 192 of the Geologic Atlas of the United States.

The topography of the deeply embayed coast has been recognized as giving evidence of normal drowned valleys and of indicating that the thin southern edge of the last continental ice sheet had not greatly altered the character of the valleys. At the time of the retreat of the ice the Eastport region is believed to have been at least 100 feet lower with reference to sea level than at present. This is indicated by numerous small deposits of marine gravel beds with delta structure fronting the ocean. Glacio-marine sands and clays were laid down in the extended sea of that period and eroded more or less as the ice retreated and the land rose to its present height.

The geology and botany of the region and adjacent portions of New Brunswick, Canada, have been investigated by American and Canadian scientists and from a summary of these studies, notably the work of Ganong (16, 17) Fernald (14), Bastin (3, 4) Johnson (18), and others, it is apparent that the general features have already been correctly interpreted. Accumulating evidence indicates, however, that certain

¹ Received February 15, 1930. The field work was done in September 1929 with the assistance of R. D. Knight. The map, photograph, and control data of elevations above sea level are contributed by R. J. Belton of the U. S. Geological Survey, to whom the writer desires to express his obligation and appreciation of the interest and aid rendered in furthering the work.

salient details have not been worked out. One of the most interesting questions to be considered concerns, on the one hand, the nature of the different layers of peat and the climatic conditions under which they were formed during the past period; on the other hand, the variations in sea level that may have taken place since that time, either a sinking of the coast to the northwest or a rise in sea level.

Postglacial deposits which began to form in late Pleistocene and have continued to the present day include areas of peat. Many of the beaches as well as peat deposits along the coast are fully exposed to the wave action of the Atlantic, and erosion is dominant at present. Bastin (4) reports on the shore of Moose Island due south of Carlow Island an area of peat which is now flooded by the sea at high tide and is thus being converted into a salt marsh. Bartlett (2) described a peat deposit on the shore of Quamanisset Harbor near Woods Hole, encroached upon by salt marsh. Dawson (13), Chalmers (5) and others have pointed out locations of submerged forests in Canada and Johnson (18) and Daly (12) have assembled much evidence to show that such changes are in progress elsewhere.

Significant in connection with this discussion are recent peat profile studies made on an eutropic lowmoor of the semi-arid region—the Delta Land in California (11). The area is a bay-like depression near the outlet of the Sacramento and San Joaquin Rivers and is located at sea level. In vertical structure the deposit represents essentially the successional stages of vegetation leading from open water to marsh, that is to say, it presents the aspects of a two-layered, limnogenic profile series characterized by a basal layer of finely divided sedimentary peat, derived from submerged and semi-aquatic, fresh-water plants, followed by a surface layer of fibrous peat originating from reeds (Phragmites sp.) and tule (Scirpus sp.). The shore line of the ancient lake is at present over 20 feet below sea level, from which it appears that a general downward movement has been in progress near San Francisco Bay. Such subsidence is indicated, moreover, by two feet of silty salt marsh overlying reed and tule peat near Fairfield in Suisun Bay, California. The Delta region is particularly interesting both because it is regarded as the best case of drainage in connection with irrigation, navigation, and flood control, and because of the fact that subsidence seems inevitable on account of the well-established oscillations along the Pacific Coast.

In striking contrast is the profile structure of an eutrophic lowmoor of the sub-tropical region, notably that portion of the Florida Everglades bordering the southern shore of Lake Okeechobee (10). A basal

layer of fibrous sawgrass (Cladium sp.) peat is succeeded by a surface layer of relatively dense, impermeable sedimentary peat, characterizing a two-layered, telmatogenic profile series. Lake Okeechobee is a body of water in a hydrostatic condition; it was impounded relatively recently to a height of more than 20 feet above sea level by the accumulation of the superimposed layer of sedimentary material and buoyancy of fibrous peat layers retarding the movement of inundating flood-The profile records obtained in the Everglades lead toward the conclusion that the area began as an autochthonous deposit with sedge peat accumulating over bedrock on an essentially stable shore line of the Atlantic Coast. It will be worth while therefore, to ascertain whether peat deposts on the sea coast in northeastern Maine offer convincing facts which may amplify or clarify those furnished by other investigators, and to test as well the theory, offered by geologists, and physiographers, of a general submergence of the North Atlantic Coast.

TT

The South Lubec "heath" at Carryingplace Cove, shown in fig. 1, occupies nearly all the neck of land connecting West Quoddy Head with the mainland. The deposit covers today only 20 to 25 acres and is protected on the south by a broad sandy barrier beach. On the north it is entirely unprotected from the action of ocean waves and exposed as a nearly vertical cliff, about 10 feet high, from which every storm causes the removal of masses of peat. According to residents over one-fourth of the present acreage has been swept away by the force of the waves during the last 25 years.

The peat area is of peculiar interest on account of the unusual assemblage of plants, native to both Europe and America, and the raised, dome-shaped configuration of its surface, rising 6 to 8 feet from margin to center (7, 20). The present vegetation is predominantly of northern range, with a number of arctic plants. A conspicuous example is the crowberry, *Empetrum nigrum*, which is abundant on the peat deposits along the Bay of Fundy but elsewhere and inland occurs only above timber line, as at Mt. Washington in New Hampshire, or Mt. Rainier in the State of Washington.

There is a marked similarity in vegetation between the different convex-shaped "highmoors" which extend in a widening belt from the northeastern coast of Maine into New Brunswick, Canada (16). An abundant development of sphagnum mosses grows in rounded hum-

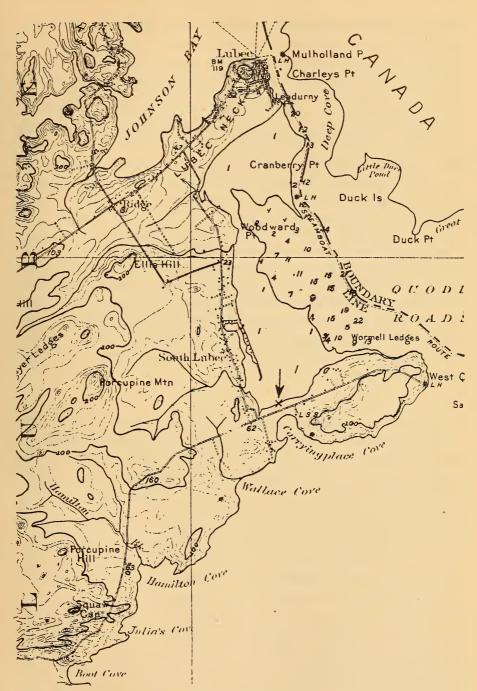


Fig. 1—Map showing location of South Lubec "heath" in Maine. The control data in relation to sea level were determined at the point marked by an arrow. The numbers in the shoal tidal flat indicate depths at mean low water.

mocks, of which Sphagnum fuscum, S. acutifolium, S. medium, and the bright red S. tenellum with S. imbricatum, topped by species of Polytrichum, make up the bulk of the ground vegetation. It is a common sight to see the moss carpet almost covered by Empetrum nigrum. Decidedly less abundant are sedges and the heaths which usually characterize the drier portions of a peat deposit. Runchospora alba, Eriophorum vaginatum, Scirpus caespitosus, and a golden rod (Solidago sp.) have only a limited, scattered foothold. The cloudberry (Rubus chamaemorus) with its few leaves from hidden stems dots the mosses, and the heaths such as Andromeda polifolia, Rhododendron canadense, Cassandra (Chamaedaphne) calyculata, Ledum latifolium, L. groenlandicum, species of Kalmia and Vaccinium, are scanty and greatly dwarfed. Drosera rotundifolia, Sarracenia purpurea, and several lichens (Cladonia rangiferina, C. uncialis) are common in hollows and moist places but not abundant. On the eastern margin occur stunted black spruce (Picea nigra) with possibly birch (Betula sp.) and a few small tamarack (Larix americana) which become larger toward the upland in an undergrowth of bushy heaths. The peat area at Carryingplace Cove may thus be considered as a successional stage in the boreal climax and as belonging to the region of northern conifers.

III

Regarding the procedure which is followed in peat profile studies and in the accumulation of data for correlating the various factors at each location, reference to earlier publications (8) is sufficient. The nearly vertical exposure facing the tidal waves on the north, and the profile sections which were made with the American peat-sampling instrument at various points on the heath moor, indicate that this deposit is made up of more than 10 feet of peat. Stratigraphically it represents three different layers which correspond to successional stages of vegetation passing from a marsh of sedges and Hypnum mosses into a conifer forest and finally into the raised bog of sphagnum mosses.

To determine the elevations of these layers and to lay the basis for future observations as to the extent to which earth movements may occur in this locality, measurements were made by means of the Beaman telescopic alidade. Starting at the bench mark of the United States Coast and Geodetic Survey in the city of Lubec, Maine, the elevation of which is 118.4 feet above sea level, and extending a line south about three miles to South Lubec, the elevations obtained at the point indicated on the accompanying map are as follows:

Mean sea level elevations of layers in South Lubec, Maine, peat profile:

Surface of sphagnum moss peat layer	13.0 1	feet
Surface of conifer forest peat layer	6.0	"
Surface of hypnum moss and sedge peat layer	4.5	"
Contact with underlying mineral soil	3.0	"
Total thickness of peat deposit at point of observation	10.0	"

The upper layer of sphagnum moss peat varies in thickness from 6 to 9 feet. The material contains a moderate quantity of stringyfibrous tufts from cotton-grass (Eriophorum sp.) but is rather free from roots and other impurities. The layer is reddish to yellowish brown in color, spongy-fibrous, and poorly decomposed. It shows a number of thin alternating bands of dark brown to gravish black, largely decomposed organic debris. Some of the narrow bands appear to be finely divided organic material which collected in shallow pools of water (Schlenken). Other bands are more convex in form and consist mainly of woody debris derived from heaths; they are probably due to short periods of drought that caused a temporary dominance of low ericaceous shrubs and favored an advanced stage of decomposition. The comparatively uniform texture of the well-preserved moss peat makes it plain that the growth of the sphagnum mosses was influenced by blankets of fog or cool-moist and maritime climatic conditions during that period. The accumulation of moss peat was slow but prolonged and completely buried an underlying forest of conifers. The inferred peat-forming processes are those primarily due to water saturation which had the effect of maintaining reduction processes (6:372) in both organic and inorganic material, instead of oxidation upon which decomposition depends. An alternation between an upper light-colored younger, and a darker, more decomposed, lower and older layer of moss peat, as traced in the cross sections of many European highmoors, does not occur in this locality.

Toward the bottom appears a buried forest of trees consisting of stumps with numerous roots, shown in fig. 2. The layer is about $1\frac{1}{2}$ feet thick and seems to be present over the entire peat area. The specimens examined were derived from pine, tamarack, spruce, and possibly fir. A similar basal layer of woody peat appears to prevail in the heaths at Veazie and Denbo (8), at Jonesport, Trescott, Columbia Falls, Pushaw Lake, and Hermon Center, and an abundance of roots and stumps has been reported also for the peat deposits of north-

eastern Canada. The recent account of Auer (1) describes layers of stumps at the bottom of cross sections in peat deposits which are being cut away and exposed by the action of the waves in the Gulf of St. Lawrence. As layers of woody peat are present also in peat areas farther inland, it is logical to assume an extensive development of forests, spreading over wide stretches of country under conditions of environment which no longer exist. The climate, and probably coastal marine currents of this period, must have been warmer. The whole region must have passed into a drier stage throughout, and climatic conditions must have set in that were in consequence more continental and southerly in character than it is now in Maine.

The layer of peat resting directly on the mineral soil below and forming the bottom of the whole deposit, consists of a compact, vellowbrown, felty-matted network of well preserved stems and leaves from Hypnum mosses (Amblystegium sp. and others) in which are embedded the rhizomes of sedges (Carex sp., Cladium sp.), black rootstocks of Equisetum sp., seeds of Menyanthes, the elytra of beetles, and other inclusions. Sedimentary organic debris, indicative of ancient lakes or ponds, is not present. The layer of basal peat is about 16 inches thick and in an advanced stage of decay only at the upper limit supporting the stumps of trees in situ. There is nowhere an indication for assuming that at one time the area constituted a part of a lake formed by the building of a barrier beach across a recess in the coastal shore line, or that it supported plants growing in brackish or salt water. It is very probable, therefore, that the layer began to form when the sea level had retreated sufficiently to expose the shore to glacial waters from the melting ice-sheet. Species of Hypnum mosses, such as Amblystegium, were more abundant at that early period than at present, and a variety of sedges with cattail and reeds, scattered freely throughout the ancient marsh, occupied the habitat. The evidence obtained by soundings from peat areas elsewhere in Maine and Canada points strongly to the fact that the land laid bare by the receding ice was occupied at first by extensive sedge and reed marshes which spread over the more open, level, and wet places where forests could not gain a foothold. The northward migration of these plant communities must have occurred at the waning stage and during the steady recession of the ice border when climatic conditions began to be warmer and were better suited than now to the growth of these plants.

Thus it will be seen that since the glacial period many evidences

and important records of unusual interest have been left in peat profiles. The layers reveal the history of the region and point to the existence of a distinct regional succession in vegetation. They suggest that the coast must have projected at that time far enough above sea level to enable many species of plants, referred to by Fernald (15) as characteristic of southern coastal regions, to have migrated into northern localities. The majority of the plant remains in the three-layered pro-

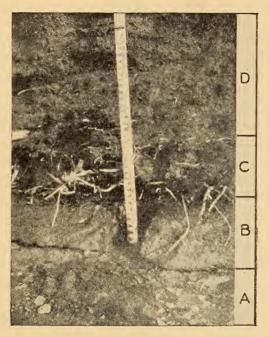


Fig. 2—Lower portion of the peat profile exposed by the action of tidal waves eroding the South Lubec "heath." In the illustration are shown (a) the contact of the underlying mineral soil with (b) the basal layer of peat derived from an ancient marsh of hypnum mosses and sedges, (c) the roots and stumps of a former conifer forest which spread over the country and (d) the superimposed layer of sphagnum moss peat. Photographed at low tide September 29, 1929 by R. J. Belton.

file of the South Lubec heathmoor are generically the same as those in the highmoors of Europe, of which the belt in Maine appears to be the western extension. Striking changes are recorded by the layers of peat, obviously indicating corresponding changes in climatic factors which condition the growth of plants and hence the regional characteristics and the distribution of broad groups of peatland.²

² For the general correlations between plant successions, stratigraphic features of peat profiles, and past climates, as recorded in moors, see "Reports of the conferences on cycles" Carnegie Institution of Washington, pp. 54-66. 1929.

The underlying mineral soil is a glacial gray bowlder clay, locally sandy to gravelly and stony where the material has been subjected to the action of marine currents and waves, as in the very shoal bay north of the peat area, showing a depth of one foot at mean low water.

Beneath the thick covering of peat the mineral soil is gray to bluish gray in color and resembles the "glei" horizon reported in descriptions of the moors of northern Europe. At the margin where the cover of peat is less thick and soil-forming processes are active owing to the influence of drainage and lower moisture conditions, the development of pedologic features may be observed. The mineral soil underlying the relatively thin peaty cover is characterized by a leached horizon which at the lower level is more or less sharply demarked by a brown horizon, below which a rust-colored, iron-stained and spotted horizon resembling "Ortstein" is recognizable. These features are especially well displayed in a peat area about $2\frac{1}{2}$ miles northeast of Jonesport, Maine, which is being cut away by the waves of Chandler Bay, exposing natural sections. Marbut (19) has pointed out in his scheme for soil classification that profile characteristics of this type are the effects of podsolizing processes. There is no evidence of either a conspicuous amount of decomposition, leaching, or enrichment in the overlying peat layers, due primarily to the high moisture content of the material, its great absorptive power for atmospheric water and its coldness under the prevailing climatic conditions. Corresponding differences in the chemical composition between the three main layers may be expected. The surface layer of moss peat exhibits the peculiarities common to this type of peat-material, namely relatively low content of available nitrogen, and of mineral salts such as lime, a generally high acidity, and comparatively large quantities of poorly decomposed crude fiber (celluloses and lignin-like constituents) and etheralcohol soluble substances. On the basis of these observations the belt of peatlands in northeastern coastal Maine, of which the South Lubec heath is the type locality, has been designated for convenience as "highmoors" of the oligotrophic group of peatlands, representing a telmato-ombrogenic, three-layered profile series (9).

IV

Comparisons in terms of economic uses show that none of the highmoors are under cultivation. They are practically a waste in the sense that they have no value for agricultural crops, for grazing of cattle and horses, or for afforestation under existing conditions. No

attempt is being made to utilize the moss peat commercially for the purposes to which the great quantities imported from Europe have long been employed. It is safe to state that at least 85 per cent of the "heaths" in the neighborhood of Jonesport, Maine, contain a quality of moss peat equal if not superior to the imported material. supply merits attention as a basis of local industries, partly because the location of some of the highmoors is unusually favorable for handling and shipment by vessels from adjacent harbors. The areas would furnish a large supply of moss peat for use as an absorbent in stables, bedding for poultry, mulch for certain evergreen shrubs and trees, organic filler for highgrade, concentrated, mineral fertilizers, and as packing material for storing bulbs, fruits and vegetables. A number of profitable uses of different kinds of peat have been enumerated in an earlier publication (6) and in Bulletin 802, issued by the U.S. Department of Agriculture. The present uses for which peat moss is especially adapted include composts as an organic manure, an ingredient of top dressing on golf courses and in greenhouses, and in the general improvement of soil texture. The different methods employed for excavating and handling peat and for preparing composts have been described in Circular 252 of the U.S. Department of Agriculture.

SUMMARY

- 1. To understand the nature of the dome-shaped "heaths" on the northeastern coast of Maine consideration is given to the structural features of vertical cross-sections in the existing environment, and to the history of the region after the retreat of the ice sheet.
- 2 The intrinsic characteristics of the South Lubec peat profile are due mainly to three major successions of vegetation, closely correlated, it seems, with differences in climatic conditions; the profile represents three distinct layers of peat, superimposed upon one another and derived from marsh, forest, and sphagnum moss plant communities.
- 3. The arctic alpine plants, such as *Empetrum nigrum* and others found in the present surface vegetation are not an early but a late stage of succession.
- 4. Evidence appears to point conclusively to a former extension of the South Lubec "heath" moor from its present termination at Carryingplace Cove as far probably as Woodward Point. Such a land connection affords the only possible explanation of the age, thickness, stratigraphy and other profile features which the peat area has in common with other coastal and inland highmoors, notably with the highmoors at Jonesport and Columbia Falls, Maine.

- 5. At one time probably a marine beach of sand and gravel projected for a long distance in a northwest direction across the shoal tidal flat, connecting the north shore of West Quoddy Head with the mainland. Shifting marine currents have doubtless caused the removal of a barrier beach and exposure of the highmoor to the cutting action of the waves. The sea has operated on the coast in this region since comparatively recent times.
- 6. The position of the South Lubec peat area in relation to sea level supports the conclusion, reached by investigators in other sciences, of a recent and progressively greater submergence of the coast toward the northeast.
- 7. It is probable that considerable areas of coastal plain existed in geologically recent times, possibly from New Jersey to Newfoundland, which have been worn away by a shift in marine currents and that a northward migration of plants took place when forests gained a foothold upon sedge marshes or lowmoors, and spread extensively under climatic conditions that were warmer than it is now in Maine.
- 8. The South Lubec "heath" is a member of the "highmoors" of the oligotrophic group of peatlands, and is characterized by a three-layered, telmato-ombrogenic profile series. The development of pedologic features at the margin of the heath indicates the effects of podsolizing processes active in this region.
- 9. The economic uses of the highmoors in Maine merit greater attention. The moss peat in the South Lubec "heath" and in the areas of peat around Jonesport, Maine, is equal if not superior to the imported material. Its use as a commercial product for various purposes can be made profitable in localities with facility for shipment by vessels.

LITERATURE CITED

- 1. Auer, V., Stratigraphical and morphological investigations of peat bogs of south-eastern Canada. Comm. ex. inst. quaest. forest Finnlandiae 12: 1-62. 1927.
- 2. Bartlet, H. H., The submarine *Chamaecyparis* bog at Woods Hole, Massachusetts. Rhodora 11: 221-235. 1909.
- 3. Bastin, E. S. and Davis, C. A., Peat deposits in Maine. U.S. Geol. Survey Bull. 376. 1909.
- 4. Bastin, E. S. and Williams, H. S., Description of the Eastport Quadrangle, U. S. Geol. Survey, Geologic Atlas of the United States, Eastport Folio No. 192. 1914.
- CHALMERS, R., Report on the surface geology of New Brunswick, Northwestern Nova Scotia, and a portion of Princé Edward Island. Geol. Surv. Canada, Ann. Rept., N. Ser. 7. 1895.
- 6. Dachnowski, A. P., Peat deposits of Ohio. Ohio Geol. Survey Bul. (4) 16, 1912.
- DACHNOWSKI, A. P., Profiles of peat deposits in New England. Ecol. 7: 120-135.
 1926.

- 8. Dachnowski-Stokes, A. P., The botanical composition and morphological features of "highmoor" peat profiles in Maine. Soil Sci. 27: 379-388. 1929.
- 9. Dachnowski-Stokes, A. P., Research in regional peat invéstigations. Journ. Amer. Soc. Agronomy: 1930.
- Dachnowski-Stokes, A. P., Peat profiles of the Everglades in Florida: the stratigraphic features of the "Upper" Everglades and correlations with environmental changes. This Journal 20: 89. 1930.
- 11. Dachnowski-Stokes, A. P., Peat profiles of the Delta Land of California. Proc. and Papers Second Intern. Congress Soil Sci., U. S. S. R. 1930. In press.
- Daly, R. A., A general sinking of sea level in recent time. Proc. Nat. Acad. Sci. 6: 246-250. 1920.
- DAWSON, J. W., On a modern submerged forest at Fort Lawrence, Nova Scotia.
 Quart. Jour. Geol. Soc. London, 11: 119-122. 1855. Amer. Journ. Sci. 2nd Ser. 1,: 440-442. 1856.
- Fernald, M. L., A botanical expedition to Newfoundland and southern Labrador. Rhodora 13: 109-162. 1911.
- Fernald, M. L., Persistence of plants in unglaciated areas of boreal America. Mem. Am. Acad. Arts & Sci. 15: 239-243. 1925.
- Ganong, W. F., Upon raised bogs in the province of New Brunswick. Trans. R. Soc. Canada 3: 131-163. 1897.
- 17. Ganong, W. F., The vegetation of the Bay of Fundy salt and dyked marshes: an ecological study. Bot. Gaz. 36: 161-186, 280-302, 349-367, 429-455. 1903.
- Johnson, D. W., The New England-Acadian Shoreline. John Wiley and Sons, New York. 1925.
- Marbut, C. F., A scheme for soil classification. Proc. & Papers First Intern. Congress. Soil Sci. 6: 1-31. 1928.
- 20. Nickols, G. E., Raised bogs in Eastern Maine. Geogr. Rev. 7: 159-167. 1919.
- BOTANY.—A new species of Esenbeckia from Texas.¹ C. V. Morton, U. S. National Museum. (Communicated by William R. Maxon.)

On April 15, 1929, Mr. Harvey Stiles noticed several trees on the banks of the Resaca Vieja in Cameron County, Texas, which he did not recognize. From one of these he made an herbarium specimen which he gave to Mr. Robert Runyon, of Brownsville, Texas, who subsequently sent it to the United States National Museum for identification. On examination it proved to belong to the genus *Esenbeckia* (Rutaceae-Pilocarpinae), a genus hitherto not known to be indigenous to the United States. Moreover, it is obviously distinct from any of the six or seven species of the genus known from Mexico and the West Indies.

Mr. Runyon, who has since made several visits to the locality, supplies the following note: "There are four small, round-topped trees of the *Esenbeckia* on the banks of the Resaca Vieja, three miles north-

¹ Published by permission of the Secretary of the Smithsonian Institution. Received February 15, 1930.

west of Los Fresnos. The leaves put out very late in the spring. In the last part of June they were about one-third grown, and on the second of July the flowers were fairly well open. The trees flower and fruit twice annually. The fruit bursts open and scatters the seeds at maturity."

Esenbeckia runyoni Morton, sp. nov.

A small round-topped tree nearly 5 meters high; twigs glabrous up to the inflorescence; leaves digitately compound, 3-foliolate; petioles 1-4 cm. long, pubescent; leaflets elliptic, rounded at base, short-petiolulate (2-5 mm.), obtuse at apex, 6-10 cm. long, green and glabrous on both sides, densely pellucid-punctate, entire, the margin thickened; inflorescence paniculate, dense, not exceeding 8 cm. in length, the branches of the panicle alternate, puberulent, the bracts subulate; pedicels 2-3 mm. long, each with a small subulate bract at the middle, pubescent; flowers cream colored, about 8 mm. broad; sepals deltoid, roundish at apex, pubescent, ciliolate, 1 mm. long, scarcely imbricate; petals oval, 3-3.5 mm. long, glabrous, glandular on the back; stamens 5, alternate with the petals; filaments shorter than the petals, about 2 mm. long. glabrous; anthers oval, 1 mm. long; ovary 5-lobed, the fleshy disk 2.5 mm. broad; style basal, short and fleshy, 1-1.5 mm. long, glabrous; stigma terminal, capitate; fruit a woody 3, 4, or 5-celled capsule, roughened on the exterior but without conspicuous tubercles; horny endocarp conspicuous, at maturity splitting elastically and ejecting the seeds, the capsule after splitting about 2 cm. long and 3-4 cm. wide; seeds dark brown, about 10 mm. long and 8 mm. wide, with a short curved beak.

Type in the U. S. National Herbarium, no. 1,438,940, collected on the bank of the Resaca Vieja, 3 miles northwest of Los Fresnos, Texas, July 8, 1929, by Robert Runyon (no. 177), a flowering specimen. Fruiting material collected from the same group of trees by Harvey Stiles, April 15, 1929, is mounted on

sheet no. 1,436,973.

Esenbeckia runyoni belongs to the section Hymenopetalae Engl. and is most closely related to E. pentaphylla (Macfad.) Griseb., of Jamaica and southern Mexico, from which it is distinguished by its 3-foliolate (never 5-foliolate) leaves and its smaller leaflets, and by other more important diagnostic characters, as shown in the following key. The key also distinguishes E. runyoni from its nearest geographical relative, E. berlandieri of northern Mexico. The other species of the genus which occur in Mexico (E. hartmannii, E. flava, E. nesiotica, E. macrantha, and E. collina) are not closely related.

KEY

Sepals scarcely imbricate, deltoid, pubescent; bracts of the inflorescence subulate. Disk 2.5 mm. broad; seeds with a curved beak... E. runyoni. Sepals strongly imbricate, much broader than long, and broadly rounded at apex; bracts of the inflorescence short, triangular-ovate.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

998TH MEETING

The 998th meeting, constituting the 59th annual meeting, was held in the Cosmos Club Auditorium, December 7, 1929, at 8:15 P.M.

The Treasurer reported expenditures of \$1182.92 for the year, and stated

that the active membership of the Society is 227.

The Secretaries reported that the following new members were elected during the year: R. R. Bodle, F. C. Breckenridge, E. J. Brown, G. S. Cook, M. J. Evans, R. E. Gould, W. D. Hershberger, C. S. Howard, C. J. Ksanda, H. E. McComb, H. B. Maris, R. F. Mehl, J. H. Taylor, B. L. Wilson.

The following deaths were reported: S. J. Mauchly, C. V. Hodgson, E. L. Jones, A. C. True, H. C. Frankenfield, Francis A. Tondorf, J. P.

AULT.

The following officers were declared elected for the year 1930: President, W. D. Lambert; Vice presidents, F. E. Wright; Corresponding Secretary H. L. Curtis; Corresponding Secretary, L. V. Judson; Treasurer, N. H. Heck; Members-at-large of the General Committee, E. W. Woolard, O. H. Gish.

At the conclusion of the business meeting Paul Sollenbeiger gave an illustrated address to the Society (by invitation) on The Naval Observatory

eclipse expedition to Iloilo, P. I.

999TH MEETING

The 999th meeting was held in the Cosmos Club Auditorium, January 4, 1930.

The address of the evening was given by the retiring President, Dr. Leason H. Adams, on *The significance of pressure in geophysical investigations*.

1000TH MEETING

The 1000th meeting was held in the Cosmos Club Auditorium, January 18, 1930.

The first communication in the celebration of the 1000th meeting was an illustrated address by W. J. Humphreys on *The Philosophical Society of Washington through a thousand meetings*. After a résumé of the history of the Society a number of the distinguished past presidents of the Society were shown upon the screen.

Reminiscences of the early days of the Philosophical Society were given by

J. H. Gore and by C. F. MARVIN.

1001st meeting

The 1001st meeting was held in the Cosmos Club Auditorium, February 1, 1930.

Program: H. L. DRYDEN and A. M. KUETHE, Effect of turbulence in wind tunnel experiments. A brief historical summary was given of the appearance of certain discrepancies in measurements of the air resistance of spheres and airship models in different wind tunnels. On the basis of qualitative experiments the discrepancies have in the past been attributed to turbulence, i.e.

the small ripples or eddies superposed on the approximately steady airstream. The Bureau of Standards in coöperation with the National Advisory Committee for Aeronautics has developed a method of measuring turbulence quantitatively and has given definite experimental proof that the discrepancies are to be attributed to an effect of turbulence. Further, it is possible to explain the effects as due to an effect of turbulence on the critical Reynolds Number of the boundary layer at which the flow changes from the

laminar to the eddying type. (Author's Abstract.)

W. F. Wallis, A comparison of magnetic disturbance at different stations. This paper states briefly some of the results of a discussion of the magnetic records obtained during the MacMillan Baffin Land Expedition of 1921-22, as compared with the results from several other observatories distributed over the Earth. As a suitable basis for comparison a short, well-defined, worldwide, magnetic storm (March 14, 1922) was selected, and departures from normal values were compiled and compared by three methods. The first method is based on the vector ΔR which is the difference between the disturbed and normal total-intensity vectors, F and Fo, referred to three rectangular coördinates. The second method involves the excess energy of the magnetic field due to the disturbance. The third method is based on a formula for magnetic activity proposed by Chree, namely, $C(R_1^2 + R_2^2 + R_3^2)$, where C is any convenient constant and R_1 , R_2 , and R_3 are absolute daily ranges in three rectangular components of the total magnetic intensity. Any one of these methods gives results which may be taken as measures of magnetic disturbance. The disturbance values, computed by the three methods, when plotted according to magnetic latitude, give three curves closely resembling each other, and resembling also the curve of auroral frequency in its relation to magnetic latitude. The conclusion is that the geographic distribution of magnetic activity during disturbance bears a close relation to the auroral zone. and there is evidence that the zone of maximum auroral frequency is also a zone of maximum magnetic activity. A diagram, giving hourly mean horizontal and vertical-intensity disturbance vectors during the 18 hours of the magnetic storm of March 14, 1922, shows that, during the progress of the storm, these vectors vary widely in both direction and amount. If, however, instead of dealing with a single disturbance, we take average values of the disturbance vectors over several months, including many disturbances both large and small, there is a marked regularity in the directions of these vectors for the individual stations, and for all stations the general direction of the horizontal-intensity disturbance vectors is southward. This indicates that the disturbing currents in the upper atmosphere flow in general from east to west around the Earth. (Author's Abstract.)

J. E. Willis, Recent experiments with timekeepers. An account was given of experiments with several electrical methods of impulsing clock pendulums, including a method utilizing the amplified current of a photoelectric cell, the illumination of which is controlled by the motion of the pendulum, to charge a condenser after passing through the impulse coil which reacts on a permanent magnet to give energy to the pendulum. Pendulums were driven at amplitudes less than a tenth and approaching a hundredth the customary amplitudes of clock pendulums, so that the circular error was theoretically of the order of one part in ten million. Such small amplitudes are not practical for mechanically driven pendulums. Since driving impulses of equal intensity occurred on each half-stroke of the pendulum and at the same point in space (neglecting lag of impulses), the epoch changes due to non-centering of impulses were balanced. The epoch changes due to lag of impulses were con-

sidered to be reduced to the order of one part in a million, and the variables concerned were measured. Observations with free pendulums indicated that the damping coefficient is less for small amplitudes than for large amplitudes. The observed timekeeping of the clocks of small amplitudes seemed to indicate that disturbances such as microseisms, by which such clocks are obviously more affected than are ordinary clocks, may be the limiting cause of inaccuracy in clocks with a single pendulum. Preliminary experiments with a pair of pendulums so connected that they keep a half cycle apart suggest the feasibility of the use of such a system in earthquake-proof clocks, which may have a higher order of accuracy than the clocks now in use. (Author's Abstract.)

OSCAR S. Adams, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

On February 25th the American Geographical Society awarded the Daly gold medal to Dr. N. H. Darton for extensive explorations in the western United States and Mexico, and the Cullum gold medal to Dr. C. F. Marbut for his work on the distribution of soils in the United States, South America, and Africa.

Miss Frederica de Laguna, a graduate student in Anthropology at Columbia University, who accompanied a Danish archeological expedition to Greenland last summer, recently spent a week in the Division of Ethnology of the U. S. National Museum, studying the Alaskan material excavated by Mr. Collins.

Mr. H. J. Reinhard, of the Texas Experiment Station, is spending several weeks at the National Museum, working on a group of muscoid flies.

Mr. Albert C. Smith, of the New York Botanical Garden, spent the month of January at the Division of Plants of the National Museum, assisting Mr. Killip in sorting the material they recently collected in Peru and Brazil. The work of mounting the National Museum's set of 9200 collection numbers has been started, and the duplicate sets will soon be ready for distribution.

The Council of the Fifteenth International Geological Congress, meeting in South Africa in 1929, accepted an invitation from the geologists of the United States to hold the Sixteenth Congress in this country. An organization committee has been formed, as required by the rules adopted by the Thirteenth Congress, held in Brussels in 1922, and plans are being made for the entertainment of the Congress. Nineteen hundred thirty-two has been agreed upon as the year in which the meeting will be held, and the principal sessions will probably be in Washington, with excursions to points of geologic interest in the United States. The petroleum resources of the world has been agreed upon as a major topic for discussion.

Lyman F. Kebler, for many years government specialist in drugs and medicines, dealing with the enforcement of food, drug, and mail order laws, has been made medical director of the Tennessee Products Corp., Nashville, Tenn., where his work will include assistance in the utilization of by-products, medicinally and otherwise, as well as many health matters connected with the corporation's activities. Doctor Kebler will take over his new duties April 1.

Doctor Kebler will continue to be medical director of the John McEntee Bowman health interests, identified with the Biltmore chain of hotels, and in addition to his general headquarters in Washington, D. C., will have offices in Nashville, Tenn., and New York City.

The Charles Lathrop Pack Forest Education Board, founded by the Charles Lathrop Pack Forestry Trust of Washington, D. C. announces a number of fellowships in forestry for the year 1930–31. The purpose of the fellowships is to encourage men who have shown unusual intellectual and personal qualities to obtain training that will best equip them for future leadership either in the general practice of forestry, in the forest industries, in the teaching of forestry, in forest research, or in the development of public forest policy.

The awards will be made to gifted men who demonstrate natural powers of intellectual and personal leadership, and who intend to make forestry their life work. The sum of \$10,000 is available the first year. The awards will range from \$500. to \$2500. or more in exceptional cases and will ordinarily be restricted to men of American or Canadian citizenship. No restrictions are made as to age, educational status or practical experience, but great emphasis will be placed on character, intellect, qualities of leadership, and similar

qualifications.

The administration of these fellowships has been placed in the hands of the Charles Lathrop Pack Forest Education Board, which is composed of the following: Chairman, Henry S. Graves, Dean, School of Forestry, Yale University, New Haven, Conn.; Secretary, Ward Shepard, United States Forest Service, Washington, D. C.; Samuel T. Dana, Dean, School of Forestry and Conservation, University of Michigan, Ann Arbor; John Foley, Purchasing Agent, Pennsylvania Railroad, Philadelphia; Arthur Newton Pack, Princeton, N. J., Director, Charles Lathrop Pack Forestry Trust; E. O. Sieck, Director, Texas Forest Service, College Station, Texas; Ellwood Wilson, Chief Forester, Laurentide Division, Canada Power and Paper Corporation, Grande Mere, Quebec; Hugo Winkenwerder, Dean, College of Forestry, University of Washington, Seattle; Raphael Zon, Director, Lake States Forest Experiment Station, St. Paul, Minn.

Application forms and other information can be obtained from the Secretary of the Charles Lathrop Pack Forest Education Board, 1214 Sixteenth Street, N. W., Washington, D. C. For the current year the completed applications must be in the hands of the Secretary not later than April 15.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

Announcements of Meetings

Friday, April 4 Saturday, April 5 Tuesday, April 8 Wednesday, April 9 The Geographic Society
The Biological Society
The Electrical Engineering Society
The Geological Society

Thursday, April 10 Friday, April 11 Saturday, April 12 Tuesday, April 15 The Medical Society
The Chemical Society
The Geographic Society
The Philosophical Society
The Anthropological Society

Wednesday, April 16

The Anthropological Society
The Historical Society
The Engineering Society

Friday, April 18 Saturday, April 19 The Medical Society
The Geographic Society
The Biological Society
The Helminthological Society

The programs of the meetings of the affiliated societies will appear on this page if sent-

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

to the editors by the eleventh and twenty-fifth day of each month.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Geophysics.—Note on temperature gradients in the Permian basin. WALTER B. LANG.	
Physical Geography.—Peat profile studies in Maine: The South Lubec "heath" in relation to sea level. A. P. Dachnowski-Stokes	124
Proceedings	
The Philosophical Society	137
SCIENTIFIC NOTES AND NEWS	139

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

MT. ROYAL AND GUILFORD AVES.
BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: This JOURNAL, the official organ of the Washington Academy of Sciences, publishes:
(1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively. issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

**Illustrations* in limited amount will be accepted, drawings that may be reproduced.

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$ 2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3.00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5.00	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100,

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	.50

Remittances should be made payable to "Washington Academy of Sciences," and

addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

APRIL 19, 1930

No. 8

CHEMISTRY.—The volumetric determination of fluorine by the use of ferric chloride.¹ John G. Fairchild, U. S. Geological Survey. (Communicated by R. C. Wells.)

INTRODUCTION

The volumetric determination of fluorine by means of ferric chloride given in Thorpe² and Sutton³, which was proposed by Knobloch⁴ in 1894, depends on the reaction:

$$FeCl_3 + 3NaF = FeF_3 + 3NaCl \qquad (1)$$

An excess of ferric chloride is used and the excess determined iodimetrically. Greef⁵ also uses ferric chloride but removes the fluorine as the compound Na₃FeF₆ by means of a concentrated solution of sodium chloride. The apparent simplicity of this method suggested its use in the determination of fluorine in phosphate rock. It was soon found, however, that the results were very erratic and far from correct and that variation in any one of several conditions independently was of decided influence on the results. It was therefore decided to investigate the several conditions controlling the method in the hope that accurate determinations of fluorine could be made, with the result that suitable conditions were finally found which make the method far more reliable than it was in its original form.

¹ Published by permission of the Director of the U. S. Geological Survey. Received February 18, 1930.

² Dict. Appl. Chem., vol. II, 590. 1912.

³ Volumetric Analysis, 10th ed. 1911.

⁴ Pharm. Ztg. 39: 558. 1894.

⁵ Ber. **46**: 2511. 1913.

REAGENTS

A carefully selected specimen of fluorite was used as the fluorine standard. A mixture of dicalcium phosphate, feldspar and fluorite (to simulate phosphate rock) was fused with sodium carbonate, the melt leached with water and the solution of fluorine obtained as described under "method for phosphate rock." The figures under "fluorine taken" in the tables below represent aliquot portions of this solution. The residue from the leaching was found to be free from fluorine as will be shown later.

The ferric chloride used was 0.08 molal and contained one volume of normal hydrochloric acid in each 5 volumes of the solution. More acid was added in some experiments, as stated in the table of results. The thiosulphate was 0.05 normal, of which 1 ml. = 0.002850 gram of fluorine.

PROCEDURE

Each portion taken for analysis was made just acid to litmus with about 2 N hydrochloric acid and mixed with the solution of ferric chloride in a 250 ml. glass-stoppered flask. The salts finally present in the flask—which were added if not already present—were: 2 grams of sodium chloride, and zinc chloride equivalent to 0.05 gram of zinc oxide. The volume was made up to 100 ml. and the flask placed in a water bath the temperature of which was controlled to 1°C. After the time specified the solution was cooled as quickly as possible and titrated with thiosulphate. The difference between the thiosulphate used and that equivalent to the ferric chloride taken represents the fluorine present.

Discussion of Controlling Conditions

Knobloch states that reaction (1) runs to completion even in the presence of hydrochloric acid and that the resulting mixture sets free no iodine from a soluble iodide. However, although ferric fluoride is practically without action on an iodide, it can easily be shown that the further addition of a small quantity of hydrochloric acid sets free some iodine. It would therefore seem preferable to titrate in a nearly neutral solution, but a solution of ferric chloride must be appreciably acid for complete reduction by potassium iodide. That these two require-

⁶ These are the quantities of sodium and zinc chlorides likely to be present in the final aliquot solution of a phosphate rock.

⁷ The larger quantities of hydrochloric acid recommended by Swift (Am. Chem. Soc. Jour., **51**, 2682. 1929) as permissible in the iodimetric determination of iron are quite out of the question in the determination of fluorine.

ments are directly opposed to each other is perhaps the explanation for the neglect of this method heretofore. The success of the method as finally worked out really depends on securing a definite balance among the several equilibria involved to yield correct results. When these conditions were learned it was found that the results were reliable and reproducible.

The conditions that affect the results to a greater or less degree are: (1) the acidity, (2) the concentration of potassium iodide, (3) the excess of ferric chloride, (4) the time, (5) the temperature, and (6) the quantity of sodium and zinc chlorides present.

The results are shown in table 1. Experiments 1, 2 and 17 show the marked effect of varying the acidity, and that too little acid yields high results. Experiments 3, 4, and 5 show that unnecessarily large quantities of potassium iodide yield low results. Experiments 6, 7, and 18 refer to variation of the excess of ferric chloride. When these results with an acidity of 5.5 ml. N HCl are compared with those just preceding (3, 4 and 5 with an acidity of 3.2 ml. HCl) it appears that sodium chloride is effective in raising the result. Perhaps this salt represses the ionization of the hydrochloric acid and hence decreases the speed of the reduction of the ferric chloride; however that may be, more acid can be used when sodium chloride is present.

The effect of the absence of sodium chloride is also indicated in experiments 13 to 16, which show in addition the large effect of temperature. Whereas Knobloch gives 35 to 40° as a permissible temperature range it is seen that control within practically 1° is essential for correct results. Knobloch does not specify any definite acidity or excess of iodide, which have also been shown to be extremely important factors.

Conditions Recommended

Four suitable conditions for the determination of fluorine may now be fixed as: (1) Potassium iodide, 0.5 gram; (2) sodium chloride, 2 grams, zinc chloride equivalent to 0.05 gram zinc oxide; (3) time, 30 minutes; (4) temperature, 38°C.

Experiments 20 and 21 show that accurate determinations may be made of as little as 5 mg. of fluorine. Such a quantity requires not

⁸ The known solution for these three experiments was prepared from sodium fluoride and contained no sodium and zinc chlorides. In most other experiments sodium chloride was added as shown in Table 1. Sodium fluoride was also used in Experiments 6, 7, 10 to 16, and 18. Its fluorine content was established by reference to fluorite under similar conditions.

more than 5 ml. of ferric chloride, but if the ferric chloride is cut down to this quantity the acidity must also be cut down to 2.2 ml. N HCl.9 Table 2 has been prepared to show suitable relations in the quantities of ferric chloride and hydrochloric acid. It seems probable, however, that an acidity of 5.5 ml. N HCl will hold for even larger quantities of fluorine and ferric chloride.

The starch-iodide end point is stable for several minutes in the presence of a few milligrams of fluorine, but with several centigrams it is stable for only about one minute.

The results of experiments 1 to 17 in Table 1 indicate the variations that occur under more or less incompatible conditions, whereas those in experiments 17 to 21 show the accuracy to be expected under a related set of definite and suitable conditions. It is hardly necessary to point out the advantages in time and accuracy of the volumetric method over the Berzelius method at least.

METHOD FOR PHOSPHATE ROCK

Half a gram of the powdered material is mixed with about 0.2 gram calcium oxide and ignited gently to remove organic matter. If the rock is low in silica and alumina, these must be supplied by the addition of about 0.75 gram of finely ground feldspar which is intimately mixed with the sample in a mortar. Fusion with about 6 grams of sodium carbonate is continued only to the point of quiet fluidity.

The melt is leached with hot water and the insoluble filtered off. The filtrate is next treated with about 5 grams of ammonium chloride and evaporated to about one-half volume when ammonium carbonate is added with more water and evaporation continued to precipitate alumina and silica. The addition of the carbonate and water should be repeated. This requires about 4 hours. The filtrate from the alumina and silica, about 150 ml. in volume, is nearly neutralized with 1-1 hydrochloric acid in the presence of a small piece of litmus paper, carbon dioxide is partially expelled by evaporating slightly, then an excess of zinc chloride solution (0.5 gram ZnO dissolved in a little HCl) is added to precipitate the phosphoric acid and possible vanadium. A few drops of ammonia may be added at this point to insure alkalinity of the solution when evaporated to about 100 ml. It is filtered cold and the precipitate well washed with cold water. This filtrate is then diluted to a definite volume, say 250 ml. The fluorine may be deter-

⁹ The acidities under discussion include the acid in the ferric chloride.

mined in 100 ml., made just acid to litmus paper with hydrochloric acid before being added to the solution of ferric chloride contained in a stoppered flask. The final procedure has been given under "conditions recommended." The first aliquot portion taken for titration is in the

Table 1. Effect of Variation in the Controlling Condition	TARLE 1	EFFECT OF	VARIATION	IN THE	CONTROLLING	CONDITION
---	---------	-----------	-----------	--------	-------------	-----------

Exp. No.	Acidity N HCl Ml.	Potassium iodide Gram	Ferric chloride Ml.	Sodium chloride Gram	Time minutes	Temp. °C.	Fluorine taken Gram	Recovery per cent fluorine
1	4.0	0.5	15	2	30	38	0.0243	120.5
2	5.0	0.5	15	2	30	38	0.0243	109.7
3	3.2	0.5	10	None	30	38	0.0290	96.9
4	3.2	0.7	10	None	30	38	0.0290	77.5
5	3.2	1.0	10	None	30	38	0.0290	62.7
6	5.5	0.5	30	2	30	38	0.0580	111.3
7	5.5	0.5	25	2	- 30	38	0.0580	108.6
8	5.0	0.5	15	None	30	38	0.0290	77.6
9	5.2	0.5	20	None	30	38	0.0580	87.3
10	3.2	0.5	10	None	15	38	0.0145	112.4
11	3.2	0.5	10	None	30	38	0.0145	97.2
12	. 3.2	0.5	10	None	45 ,	38	0.0145	93.1
13	3.2	0.5	10	None	30	33	0.0145	105.5
14	3.2	0.5	10	None	30	36	0.0145	99.3
15	3.2	0.5	10	None	30	38	0.0145	97.2
16	3.2	0.5	10	None	30	43	0.0145	76.6
17	5.5	0.5	15	2	30	38	0.0243	99.7
18	5.5	0.5	20	2	30	38	0.0580	100.0
19	5.5	0.5	15	2	30	38	0.0290	102.7
20	5.0	0.5	10	2	30	38	0.0071	98.6
21	2.2	0.5	5	2	30	38	0.0049	98.5

Table 2. Recommended Relations of Ferric Chloride and Hydrochloric Acid Used to Fluorine Present

Fluorine Gram	Ferric chloride Milliliters	Acidity, N HCl Milliliters
0.000-0.010	5	2.2
0.010-0.020	10	4.5
0.020-0.030	15	5.5
0.030-0.060	20	5.5

nature of a trial analysis which is to be checked by selecting the proper volumes of ferric chloride and acid for a second aliquot portion.

No fluorine was found in the insoluble residue of silica, calcium carbonate, alumina and zinc phosphate by the etching and hanging-drop tests. The presence of alumina, aided by fine grinding of the materials to an intimate mixture, promotes the extraction of fluorine.

A detailed study of the conditions that must be observed in the volumetric determination of fluorine has been made. Suitable conditions are recommended for quantities of fluorine ranging from 0.005 to 0.060 gram, which range may probably be extended in both directions.

Nearly perfect extraction of fluorine in phosphate rock has been accomplished by the aid of aluminum silicate, by fine grinding, and by removing calcium carbonate before adding ammonium carbonate.

Phosphoric acid is removed as zinc phosphate, thus preventing the formation of insoluble ferric phosphate with the ferric chloride.

CHEMISTRY.—The solubility of some rare-earth nitrates in ether.¹ R. C. Wells, U. S. Geological Survey.

In his well known work on the analysis of pitchblende Hillebrand² separated most of the rare earths from uranium by means of "oxalic acid and two or three drops of ammonium oxalate," but he states that the uranium thus obtained always contained some rare earths. One expedient that he tried for removing the last traces of rare earths from the uranium was to extract the uranium nitrate with ether. No information is given to show the efficiency of this treatment, but it is reasonable to assume that it must have been fairly effective.

The treatment with ether was also used by Boltwood³ and more recently by C. W. Davis4 to aid in the separation of uranium from the rare earths. Very recently a paper has been published by P. Misciattelli⁵ dealing with the special case of the separation of uranium from thorium by means of ether, in which attention is called to divergent results obtained by different investigators, as well as to the fact that the extent of separation obtained will depend on the temperature and on the composition of the mixture of salts treated. With uranyl nitrate alone at 20° Misciattelli finds the saturated solution to contain 8.8 per cent of uranyl nitrate, and similarly, for thorium nitrate alone, 1.5 per

¹ Received March 8, 1930. Published with the permission of the Director of the U.S. Geological Survey.

² W. F. HILLEBRAND. On the occurrence of nitrogen in uraninite and on the composition of uraninite in general. U.S. Geol. Survey Bull. 78: 47. 1891.

³ B. Boltwood. Am. J. Sci. [4] **25**: 269. 1908.

⁴ C. W. Davis. Am. J. Sci. [5] 11: 201. 1926.

⁵ P. MISCIATTELLI. Phil. Mag. 7: 670. 1929.

cent of this salt. However, if a large excess of uranium nitrate is present in the ether, at 20°, the solubility of thorium nitrate is greatly repressed.

The literature dealing with the solubility in ether of the nitrates of such elements as might contaminate uranium in mineral analysis is rather scanty. Uranium nitrate itself is very soluble. Lebeau⁶ gives the solubility as 5.9 grams of the hydrated salt in 10 grams of the solution at 7°C. He also refers to Péligot⁷ as the first to have purified uranium by means of ether. Comey's Dictionary of Solubilities gives as "easily soluble" the nitrates of yttrium (Cleve), and erbium (Höglund), and as "insoluble" the nitrate of didymium (Marignac). In view of the preceding facts it seemed highly desirable to check and extend the observations.

SOLUBILITY OF SOME NITRATES IN ETHER

Nitrate	Weight of oxide obtained from 10 ml. of solution (Stock material)	Weight of oxide obtained from 10 ml. of solution (Salt dried at 150°)
	Gram	Gram
Beryllium	0.0027	0.0002
Yttrium	0.0792	0.0803
Zirconium	0.0003	0.0004
Lanthanum	0.0002	0.0001
Cerium	0.0010	0.0139
Praseodymium	0.0004	None
Neodymium	0.020	0.267
Erbium		0.190
Thorium	1.122	0.367

This was done by covering a few grams of each of the various nitrates available with about 20 ml. of ether in small stoppered flasks, agitating the flasks from time to time, and allowing them to stand at about 20° at least over night, as is done in the well known method of separating calcium nitrate from strontium nitrate by means of a mixture of alcohol and ether. Finally, 10 ml. of the solution was withdrawn, filtered if necessary, evaporated, and the resulting salt ignited to oxide and weighed. The results are given in the second column of the table. After this extraction the remaining salts were freed from ether, dissolved in water and a few drops of nitric acid, evaporated to dryness at 150°C., and again extracted with ether, with the results given in the third column.

⁶ P. LEBEAU. Compt. Rend. 152: 439. 1911.

⁷ E. PÉLIGOT. Ann. Chim. Phys. [3] 5: 5. 1842.

The nitrates dried at 150° became more or less flocculent, when treated with ether, in the case of yttrium, neodymium, erbium, and thorium, and it is possible that addition compounds with ether were formed, but this was not investigated further. The solution of the anhydrous neodymium nitrate had a pronounced lavender color, and the results for the hydrated and dehydrated salts were different. Evaporation of the ether left beautiful prismatic crystals of erbium nitrate which, as soon as the ether was gone, appeared to begin to effloresce, but in a very short time became sticky by absorption of moisture from the atmosphere.

It is evident from the results found that the degree of dehydration of the nitrates greatly affects their solubility in ether, and it is well known that the different salts are not equally dehydrated by drying at any given temperature. The more soluble salts are those of thorium, yttrium, neodymium, erbium and cerium. As thorium nitrate is the most soluble of these it appears likely that the relations found for mixtures of uranium and thorium nitrates by Misciattelli⁵ will hold to some extent for mixtures of uranium and the other nitrates, though this remains to be determined.

As the treatment with ether appears to have some limitations in removing the rare earths from uranium it would appear best to use oxalic acid, but avoid ammonium oxalate, as ammonium oxalate is probably the cause of the appearance of thorium with uranium. The uranium may also be purified and later precipitated with cupferron.⁸

The results here described suggest that ether could perhaps find some application in separating the different rare earths from one another.

ETHNOLOGY.—Little-known tribes of the Salmon, New, and Trinity Rivers in northwestern California. C. Hart Merriam, Smithsonian Institution.

Probably no part of the United States is so little known from the standpoint of its aboriginal inhabitants as a small area in the mountains of northwestern California—an area restricted to the drainage basins of the Salmon and New Rivers with adjacent parts of the main Trinity and its South Fork.

⁸ Holladay and Cunningham. Am. Electrochem. Soc. Trans. 43: 329. 1923.

¹ Received March 8, 1930.

Within a radius of forty miles from Hoopa Valley there were in whole or in part the home lands of nineteen tribes of Indians, representing eight linguistic stocks. It is doubtful if in any other part of the world there are in so small an area so many tribes speaking different languages. Most of these tribes are fairly well known, but during the mining days of the fifties and early sixties several of them were practically exterminated by the onrush of gold seekers and the troops called in to help. Indeed, so complete was the destruction that in the case of four of the tribes the few survivors succeeded so well in remaining hidden from inquisitive eyes that not even the names of the tribes were ascertained by anthropologists. However, after repeated visits to the region I have been able to obtain these—in each case the correct name as spoken by its own people.

The tribal names in question are: For the tribe on New River, $Tlo-h\bar{o}m-tah'-hoi$; for the tribe on the upper branches of Salmon River $Hah-to-k\acute{e}-he-wuk$; for the tribe at the mouth of South Fork Trinity River, $Ts\bar{a}'-nung-hwah$; for a tribe higher up on South Fork Trinity, immediately south of the Chemareko and west of the Norrelmuk, Ni-i'-che. Still another tribe, the Ko'-no-me'-ho of lower Salmon River, has been known by name for some time, but the fragment of vocabulary published as Ko'-no-me'-ho by Dixon in 1907 is that of another tribe.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

994TH MEETING

The 994th meeting was held in the Cosmos Club Auditorium, October 12, 1929. Program: N. H. Heck presented a seismological motion picture. This picture was presented before the Philosophical Society as a matter of interest rather than the presentation of new information. The matter of special interest was the ability of a representative of the Pathe Corporation under the supervision of Prof. Kirtley Mather of Harvard University to make a complete representation of some of the principal physical phenomena of an earthquake as ordinarily conceived, so as to be instructive. The animated cartoon idea has been used to advantage.

H. E. McComb, Some recent instrumental investigations in terrestrial mag-

netism and seismology.

The primary function of the magnetic observatory is to furnish a continuous record of the variations of the earth's magnetic field both in magnitude and direction. Naturally, in spite of every precaution, instrumental problems arise from time to time and these must be solved at once at the field station if

possible. Major problems calling for special investigations in terrestrial magnetism in so far as it applied to the work of the Coast and Geodetic Survey

are attacked at the base station at Cheltenham, Maryland.

The problems connected with magnetic recording instruments are numerous and they are being investigated continuously. The vertical intensity variom-This instrument is essentially a permanent eter will be discussed first. magnet system mounted on pivots and resembles the beam of a very delicate Apparently the chief problem connected with this instrument has been in the pivots as the instrument is usually operated at a fairly high sensitivity. Three different types of pivot have been investigated. It is desirable that the instrument function at a constant sensitivity. This sensitivity is easily affected by the slightest mechanical disturbance. A new method of determining this sensitivity by the use of a large deflector at a considerable distance from the variometer has been adopted. As the magnet is affected by temperature changes a simple method of temperature compensation has been adopted. This consists in the attachment of a second magnet to the variometer in such a position and at such a distance that the resultant vertical component at the center of the recording magnet is just one-half the normal component of the earth's field.

The horizontal intensity variometers of this Bureau are with one exception torsion instruments. A small recording magnet is held in the magnetic prime vertical by torsion of a quartz filament varying in size from .004 to .006 cm. in diameter and about 15 cm. in length. The chief problem connected with this instrument has been in the attachment of the filament to the magnet and to the torsion head of the filament tube in such a manner as to prevent slipping or yielding at the junction. The present method, which shows some promise of success, consists in bending the tips of the filaments at right angles before

imbedding in shellac or solder.

The hourly ordinates of the three elements, horizontal intensity, declination and vertical intensity are scaled directly from the magnetograms. This is accomplished by the use of special scales which are graduated to suit the particular variometer. This method of direct scaling eliminates several steps

in the process of reduction of values for publication.

In coöperation with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington some very accurate determinations of the period of an oscillating magnet were made by use of the photo-electric cell and the chronograph. By using this method the accuracy of the determination of

the moment of inertia of a magnet was somewhat increased.

In the field of seismology old instruments of low magnification and mechanical registration have been replaced by modern instruments, such as the Milne-Shaw, the Wood-Anderson and the Wenner. The first two types are direct recording photographic instruments and are affected by tilting of the pier due to temperature changes or to other causes resulting in more or less loss of record due to overlapping of the lines. A method of tilt compensation for instruments of the Milne-Shaw type has been suggested which if put into actual practice might eliminate these troublesome effects. As the Wenner instrument is of the galvanometric registration type there is no trouble from tilt in spite of its very high magnification.

Quite recently one of the Bosch-Omori horizontal pendulums formerly in operation at Cheltenham has been modified for photographic registration. It has a normal magnification of about 75, oil damped and is compensated for

tilt by the use of an oil coupling device. There is need for an instrument of this type for the registration of severe earthquake disturbances or to supplement the records from high magnification instruments when these records might be difficult of interpretation due to the presence of heavy microseisms. (Author's Abstract.)

OSCAR S. Adams, Recording Secretary.

GEOLOGICAL SOCIETY

458TH MEETING

The 458th meeting of the Society was held in the Assembly Hall of the

Cosmos Club, January 8, 1930, President G. R. Mansfield presiding.

Informal communications: W. H. Bradley explained a method of determining amount of compaction of a marlstone in the Green River formation and original porosity of the limy mud before consolidation, by the differential compaction shown by the marlstone and by contorted sandy casts of mudcracks. These were shown by lantern slides. Discussed by Messrs. Mendenhall, Rubey, Meinzer, and Bradley, and by Miss Bascom.

C. S. Ross called attention to the kaolinization of quartz in quartzite and arkose in the southern Coastal Plain States. Lantern slides were presented which showed kaolin crystals formed inside quartz grains and also patches of quartz now separated by kaolin, but with identical optical orientation and

originally parts of a single grain. Discussed by Mr. Schairer.

Program: Josiah Bridge: Early structural history of the Ozark region. Discussed by Messrs. Ulrich, Rubey, and Goldman, with reply by Prof.

Bridge.

HAROLD T. STEARNS: Geological development of the upper Snake River Valley.

Discussed by W. C. Alden and G. R. Mansfield.

459th MEETING

The 459th meeting of the Society was held in the Assembly Hall of the Cosmos Club, January 22, 1930, President G. R. Mansfield presiding.

The Council announced the election of Mr. ARTHUR BARWICK, of the Cath-

olic University of America, to Active Membership in the Society.

Informal communications: W. C. Mendenhall announced that the next International Geological Congress will be held in the United States in 1932 or 1933.

W. B. Lang presented a new interpretation of the subnormal temperature gradients in the Permian Basin of West Texas and New Mexico, under which the low gradient is explained by high thermal conductivity of salt and anhydrite as compared with other rocks. Discussed by M. I. Goldman.

Program: H. E. MERWIN: The sulphides of copper and iron. Discussed by Messrs. Tunell, Lasky, Schairer, and Spencer.

H. G. Ferguson: Vein quartz of the Alleghany district, California.—Study of the texture of vein quartz from the Alleghany district, California, indicates that there has been at least partial recrystallization of the quartz, but it is thought likely that this recrystallization may be confined to the portions of the veins in which there is evidence of actual deformation. There is evidence that a portion of the vein quartz is the result of replacement of wall rock and gouge, but fissure filling also played a part in the vein formation. The relative importance of the two processes is uncertain. If the veins were formed

chiefly as the result of fissure filling and recrystallization has not been widespread, the texture of the vein quartz and the relation of the quartz to the arsenopyrite and to isolated foreign inclusions suggests that there was a stage prior to consolidation in which a viscous, gelatinous, or slushy condition prevailed. (Author's abstract.)

Discussed by Messrs, Gilluly, Goldman, and Lasky.

W. C. Alden: Columbia River terraces and their significance. Discussed by Messrs, Pardee, Gilluly, and Miller.

460TH MEETING

The 460th meeting of the Society was held in the Assembly Hall of the Cosmos Club, February 12, 1930, President G. R. Mansfield presiding.

The Secretary read a resolution from The Geological Society of America extending thanks to the Geological Society of Washington and other organizations for their contributions to the success of the 42nd Annual Meeting of

the Geological Society of America.

Informal communications: M. I. GOLDMAN exhibited a large crushed and fractured concretion from the Eagle Ford clay of Texas, 2 to 4 feet below the base of the overlying Austin chalk. Some smaller concretions collected from the phosphate zone at the base of the Austin were also shown. The origin of the large concretion as a transported "clay ball" was suggested. Discussed by Messrs. Rubey and Lang.

G. R. Mansfield exhibited some pebbles collected by Prof. J. H. Bretz from bars in mouths of creeks tributary to Snake River. The pebbles from one bar were angular, from another partly rounded but with broken faces. These were attributed to percussion while the pebbles were carried in rapidly moving water. The pebbles were exhibited as contributory evidence of the "Spokane Flood."

Program: G. W. Stose: Review of the peneplains and gravel terraces of the Northern Appalachians.—A historical sketch of the recognition and naming of the peneplains and terraces was given, followed by a statement of their present

status and ages assigned.

The conclusions reached were as follows: The Schooley peneplain, developed in the Highlands of New Jersey and the Piedmont, appears to be of Jurassic and early Cretaceous age. The Kittatinny peneplain, developed west of the Piedmont, is either the Schooley peneplain uplifted by fault movement on an old Triassic fault plane or it is an older and higher peneplain. The Weverton peneplain, developed west of the Piedmont, may be the same as the Honeybrook peneplain in the Piedmont and similarly uplifted by a fault, and it is probably of late Cretaceous age. Gravel is preserved on the plain at 720 feet above sea level on Hellam Hills, adjacent to Susquehanna The Sunbury peneplain, possibly of Eocene age, carries gravel at 620 feet above sea level in the vicinity of Columbia, Pa. The Bryn Mawr peneplain and gravel is correlated with the Harrisburg peneplain at 560 feet at Harrisburg, and is regarded as of Pliocene age. It carries gravel at 500 feet elevation near Columbia. The Brandywine strath and gravel, correlated with the 500-foot plain at Harrisburg, carries gravel at 420 feet near Columbia. The gravel is probably Jerseyan outwash. The Sunderland strath and gravel is the same as the Bridgeton of New Jersey and is correlated with the 380-foot gravel terrace above Columbia. It carries outwash of an Illinoian glacier near Sunbury. The Wicomico strath and gravel, the same

as the Pensauken of New Jersey is correlated with the 320-foot gravel terrace above Columbia. It carries outwash of an early or middle Wisconsin glacier. The Talbot strath and gravel, the same as the Cape May of New Jersey, is correlated with the 280-foot gravel terrace above Columbia. It carries outwash of a late Wisconsin glacier. (Author's abstract.)

Discussed by Miss Bascom and by Messrs. Rubey, Butts, and M. M.

LEIGHTON.

C. R. Longwell: Some problems of mountain structure and mountain history.

Discussed by Miss Jonas and by Messrs. Ferguson and Stose.

JAMES GILLULY and CARLE H. DANE, Secretaries.

THE ENTOMOLOGICAL SOCIETY

416TH MEETING

The 416th regular meeting of the Entomological Society of Washington was held at 8 p.m. Thursday, January 9, 1930, in the U. S. National Museum. The Corresponding Secretary-Treasurer read a letter from Mr. W. L. McAtee, Treasurer of the American Ornitholgist's Union, suggesting that the Entomological Society of Washington subscribe to or otherwise render financial aid to support the Zoological Record in its work of abstracting scientific literature. On motion of Mr. Rohwer it was voted by the Society that the name of Dr. L. O. Howard be placed in nomination by the Corresponding Secretary of the Entomological Society of Washington for honorary membership in the Washington Academy of Sciences. This action was taken in recognition of Doctor Howard's long and faithful service in our Society and in the cause of science.

Program: Dr. Walter Carter, of the Bureau of Entomology Laboratory at Twin Falls, Idaho, Some phases of the sugar-beet leafhopper problem. discuss the sugar-beet leafhopper problem as it is being studied at the present time is really to discuss the application of ecology to a problem in economic entomology, by which is meant the application of a certain point of view, which, when strengthened by the use of a certain technique, permits the detailed analysis of an insect environment and hence a clearer understanding of The sugar-beet leafhopper (Eutetix tenellus Baker) lives the insect's biology. in an environment of short vertical dimension being confined to short-lived annuals growing to a height of approximately three feet, or on low-growing Measurement of the temperature characteristics of this perennial shrubs. environment is possible therefore with relatively few instruments. Records of temperature at the soil surface, 6" and 24" above the soil surface, have been kept for the last three years. These records have been supplemented by records from the standard shade box of Weather Bureau type. For comparative purposes these standard shade records have been made at six stations distributed over the beet-growing area in southcentral Idaho. The usual records of humidity and precipitation have been obtained and, in addition, solar radiation data for the year as well as atmometer and soil moisture readings during the season.

Biological data have been obtained on the insect populations on the herb stratum. A quantitative measure of these populations that is beyond criticism is yet to be devised but a unit collection of fifty sweeps of a standard net is the standard method thus far used. Members of the staff are experimenting on samplers of various kinds, devised with a view to obtaining all the insects on a measured area of host plant. The objection to this type of sampler lies

in the fact that relatively very small areas can be included in the sample. The collections taken by sweeping are sorted, the common species counted out, and incidental material also counted and later determined. Further biological data are obtained by recording the growth and development of the insects' host plants. Since these data represent summaries of a great many factors, valuable comparative data between seasons can be obtained from this source. See in this connection Clements "Phytometer Method in Ecology." Each season's data therefore present a picture of the physical and biotic features of the environment. It is true that the picture is complicated and, like some other modern art, must be turned upside down in order to be interpreted. But to carry the analogy a little further, if the picture has been truly drawn and compounded of the best materials available, even the relatively uninitiated can obtain from it the more obvious generalizations while to the experienced critic detailed interpretations are possible, not only of the whole

picture but also of its component parts.

It may be of interest to discuss briefly some of the uses to which these data are being put, in connection with sugar-beet leafhopper studies. connection with prediction of outbreaks of tenellus, a rather definite correlation appears to exist between certain winter types and tenellus outbreaks the following season. Formal "predictions" have been issued for the last three beet seasons with the result that losses have been materially reduced in years of hopper injury, and acreage increased in the favorable years. The attitude of both growers and industry indicates that prediction of outbreaks is an established practice in the area in which it has been tried. Soil surface temperatures are being used in an attempt to predict time of migration. Since migration in greater or lesser degree occurs every year, a fairly rapid accumulation of data is possible. Indications are that it will be feasible to predict time of migration with resulting benefit to growers of truck crops who can vary somewhat the planting time for those crops. In connection with direct control measures against E. tenellus, the nature of the problem is such that ordinary contact sprays are ineffectual. A repellent, sprayed on to the beets just prior to migration should, on the other hand, offer considerable promise. Prediction of migration date would probably be of fundamental importance in this connection. Since collections are regularly made on a number of tenellus hosts, the insects from these collections are used in a study of insect associations. A brief discussion of this phase was presented at the Des Moines Meetings but without reference there to what is probably a logical and most significant inference. These insect associations are composed of a few common species and a large number of relatively rare or incidental species. The occasional rise of one of these incidental species to the numerical rank of a common species and its subsequent fall to a normal status in the association can frequently be related to climatic or weather types, and valuable data obtained on the limitations climate imposes on these species.

Since we are here dealing with indigenous insects, such data have no interest for quarantine officers. But data of precisely this same type could be obtained for all the insect species against which quarantines are in force by the establishment of laboratories in the countries of origin preferably where the insect in question occupies an incidental, spasmodic or periodic position in the association. With such a program the climatic and biologic limitations on the insects in question should soon be known and quarantine officers thereby enabled to set the boundaries of quarantines on a much more scientific basis

than they are of necessity compelled to use now and will continue to be compelled to use until data of the type mentioned are available. To return, however, to the particular problem in mind. The fact that tenellus is a virus carrier and migrates to sugar beets and other crops from the wild hosts introduces into the problem the effect of host-plant successions on the virus of curly top transmitted by the insect. No case could more forcibly illustrate the interdependence of entomology and pathology than this. An insect transmitter of a plant disease is here closely associated with a series of wild host plants any or all of which must necessarily be considered in connection with the virus. When the insect reaches the beet field, factors of the external environment influence insect, plant and virus. Agronomic factors also operate here in conditioning the plant's reaction to both insect and virus. The climatological data referred to previously can serve all the fields involved especially since the instrumentation is mobile enough to permit the taking of records in experimental plots close to the laboratory. The ecological point of view is essentially the naturalist's point of view but in its modern sense the former brings to the latter all the benefits that accrue from detailed measurement and the substitution of quantitative data for qualitative observation. If in this process the value of observation per se is not lost sight of, then the newer view point will no doubt add materially to the advancement of biology. (Author's abstract.)

This paper was discussed by Howard, Poos, Wadley, Balduf, Aldrich,

LARRIMER and ROHWER.

At request of the President a few words were spoken by Doctor Howard regarding the November Meeting of the Eastern Branch of the American Association of Economic Entomologists. Although he referred only to one morning's session he expressed gratification at the presence of some 150 people and contrasted it with a meeting of the whole Association, attended 35 years

ago in nearby Brooklyn at which only 17 individuals were present.

At request of the President brief remarks also were made by Doctor Campbell regarding the Christmas meeting of the A. A. A. S. at Des Moines, Iowa. He enumerated some of the more important papers in both the Entomological Society of America and the American Association of Economic Entomology, discussed the various presidential addresses and described the entomological dinner. Greetings to the Washington entomologists were conveyed from Dr. C. H. Richardson now located at Ames, Iowa. Doctor Campbell also presented to our society one of his associates Mr. Charles Lukens, to whom welcome was extended.

Dr. J. M. Aldrich presented a note on *Haematobia alcis* Snow, a dipterous parasite of moose, originally described by W. A. Snow in the Canadian Entomologist, v. 23, pp. 87–89, 1891, from material collected on moose in a cranberry swamp in northern Minnesota 39 years ago, and which just recently has been collected by Professor Gaige of Ann Arbor at Isle Royale, Michigan; this being the first reported collection of this species since that of the material

used in original description.

Mr. E. V. Walter of the Bureau of Entomology Laboratory at San Antonio, Texas, on invitation also greeted the Society and gave some personal

impressions of the Des Moines meeting recently attended by him.

Mr. O. E. Gahm presented a brief note on *Linopodes antennaepes* Banks, a mite on mushrooms. Since this mite has apparently never been recorded as a pest of cultivated mushrooms heretofore, I thought it might be of interest to present a few notes on its occurrence and distribution, together with notes and

photographs on the nature of its injury to mushrooms. During March, 1929, while inspecting mushroom houses in Pennsylvania, I found a house infested with a yellowish colored mite which appeared to be causing damage to the mushrooms. As I had never seen this mite before, specimens were collected, which were identified by Doctor Ewing as Linopodes antennaepes. Banks described this mite in 1915 and made the statement that it was common under pieces of wood, bark, etc., which had laid there for sometime. In going through the literature no record of its being a mushroom pest could be found. While the infestation in the house in Pennsylvania was rather light and no serious damage resulted, heavy infestations of this mite resulting in serious losses were found during the past summer in mushroom houses at Ashtabula, Ohio, Naperville, Illinois, and at St. Paul, Minnesota. In the plant at Ashtabula, Ohio, the yield was reduced about \(\frac{3}{4} \) pound per square foot of bed space over a range of 375,000 square feet, which constitutes a reduction of about 40 per cent in yield. The injury produced by this mite on mushrooms is characterized by destruction of the 'root system' (so to speak) and by a decided constriction at the base of the stalk or stipe as shown in the photographs. The 'root system' is often so completely devoured that the sporophore or mushroom is held to the surface of the bed by only a few withered filaments. The loss of the 'root system' results in small, immature mushrooms which reduce the total yield as well as the price received. The lower half of the stalk or stipe is also discolored which lowers the sale value, and in extreme cases the mushrooms are not fit for the market and have to be sent to cannery. I have not found this mite in any of the Pennsylvania houses this season, and just how general the distribution of the mite will become remains to be seen; but it will without question be one of the most injurious pests of the mushroom industry, in case it becomes general in its distribution. (Author's abstract.)

Mr. G. G. Ainslie of the Bureau of Entomology Laboratory at West Lafayette, Indiana, also made a few remarks reminiscent of attendance at meetings of our Society in years past and spoke appreciatively of some of the

older men who formerly were members of our Society.

J. S. Wade, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

Mr. George J. Hough of the U. S. Department of Agriculture spent four weeks last September and October visiting the ruins of archaeological interest in Yucatan. He obtained pictures of the ruined cities of Chichen Itza, Uxmal, and Chacmultoon. He noted that geologically the peninsula of Yucatan consists of flat-lying or slightly rolling limestone strata of apparently recent formation, and that the low mountain ranges or hills along the west coast were formed by a crumpling of the strata, due probably to lateral pressure, as no evidence of igneous intrusion was observed. The soil in most places is only a few inches deep, and very fertile, but the soft porous underlying limestone is partly decomposed to the depth of twelve inches or more. Nearly the whole country is covered with a dense almost impenetrable jungle.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

ANNOUNCEMENTS OF MEETINGS

Saturday, April 19 The Biological Society

The Helminthological Society

Wednesday, April 23 The Medical Society Saturday, April 26

The Philosophical Society Wednesday, April 30 Thursday, May 1 Saturday, May 3 The Geological Society The Engineering Society

The Biological Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

	Mge
Chemistry—The volumetric determination of fluorine by the use of ferric chloride. John G. Fairchild	
Chemistry—The solubility of some rare-earth nitrates in ether. R. C. Wells	
Ethnology-Little-known tribes of the Salmon, New, and Trinity Rivers in	
northwestern California. C. HART MERRIAM	
Proceedings	
The Philosophical Society	149
The Geological Society.	
The Entomological Society	100
SCIENTIFIC NOTES AND NEWS	156

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE U S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

Agnes Chase BOTANICAL SOCIETY HAROLD MORRISON ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

> BY THE WASHINGTON ACADEMY OF SCIENCES

> > MT. ROYAL AND GUILFORD AVES. BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an assential feature to manuscript reaching the adition of the scientific process. publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3.00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5.00	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100,

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

May 4, 1930 '

No. 9

CHEMISTRY.—On the equation for the reaction between invertase and sucrose.¹ Joseph Berkson and Franklin Hollander, Institute for Biological Research, Johns Hopkins University, and the Biological Laboratory, Cold Spring Harbor, Long Island, New York. (Communicated by Raymond Pearl.)

The equational representation of the reaction between enzyme and subtrate is still a problem requiring definitive solution. Among the many forms of mathematical function that have been attempted, none has as yet been applied to a sufficient variety of conditions to merit a good claim to generality, and furthermore most have suffered from an abundance of statistical constants that have rendered their value dubious. Under the circumstances any indication that a satisfactory function has been found seems exceedingly worth probing. Berkson and Flexner (1) have proposed a form of equation which they tested exhaustively for the particular case of gelatin and pancreatin with high success, and presented a certain amount of evidence that the general equation is applicable to other enzymes and subtrates as well. In this paper we wish to investigate its applicability to a case for which they did not present any results; the splitting of sucrose by invertase.

When the hydrolysis of sucrose is followed in time by the polariscopic method, and the percent of sugar estimated from the angle of rotation in the usual way, the function takes the following form

$$p' = \frac{K}{1 + Ce^{rt}}....(1)$$

This may also be written

¹ Received February 24, 1930.

in which

p' is the percentage of sucrose remaining unhydrolized.

t is the time after the beginning of the reaction when p' is observed.

$$C = \frac{K - 100}{100}$$

K is a constant representing the asymptotic limits of the function.

r is a rate parameter which is characteristic of any particular series of observations.

e is the Napierian base.

For the cases to be investigated K can be taken as twice the initial value of p', and we have resulting the simple form (2)

$$p' = \frac{200}{1 - e^{rt}}...(2)$$

We will not here enter into any discussion of the equation per se, our immediate problem being only its validity as a quantitative description of the reactions to be studied, and since also this ground has been covered elsewhere (1), (2). But it is appropriate to note that there is only one parameter to be determined from the observations, i.e., the rate parameter r, so that the number of "arbitrary" statistical constants is reduced to an absolute minimum.

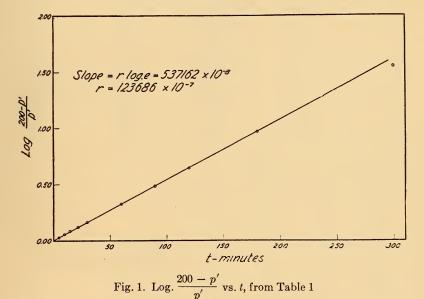
For any test of the equation to be critical, it is essential that a broad variety of experimental conditions be included, and that for each condition a representative range of the variables be comprehended. Experiments directed to this end seemed indicated, but in examining the literature we found in the published data of Nelson and his associates a series for yeast invertase that would serve the immediate purposes in hand about as well as any which we could ourselves produce. Accordingly, it was decided to use these as the basis of our investigation and our plan is to give, summarized, the results of a systematic application of the equation to them.

The method of procedure in each instance which we will examine will be uniform as follows. From the observations as recorded, log. $\frac{200 - p'}{p'}$ will be evaluated for each observed value of p' and this plotted vs. the corresponding value of t. A straight line fitted to these points has for its slope r log. e and from this r is determined as ex-

plained by Reed and Berkson (3). The parameter so evaluated will be written into equation (2) and the theoretical value of p' calculated for each value of t at which an observation was recorded. The goodness of fit will be expressed as the standard deviation, i.e., the root mean square of the deviations of calculated from observed values, and also as the coefficient of variation, i.e., the ratio of the s.d. to the mean p'.

I. A TYPICAL FIT FOR A USUAL REACTION

The fit to a usual case taken from Nelson and Hitchcock (4) is presented in detail in Table 1 and Figures 1 and 2.



The equation for example I becomes (3)

$$p' = \frac{200}{1 + e^{0.0123686 t}}...(3)$$

As can be seen from Table 1 and the corresponding graphs there is a satisfactory agreement between the observed values of p' and those calculated from the equation. Similar calculations for other experiments some of which are included in subsequent sections of this paper all show a comparably satisfactory agreement.

II. VARIATION IN ENZYME CONCENTRATION

For a study of the influence of enzyme concentration on the applicability of equation (2), it is obviously sufficient to compare but two

TABLE 1. A USUAL YEAST INVERTASE REACTION

NELSON AND HITCHCOCK (4), PAGE 2633. EXPERIMENTS B9 AND B10.

Sucrose concentration, 10 gm. per 100 c.c. Invertase 1, concentration 6.080 c.c. per 100 c.c. Temperature 25°C.

t min.	p inverted (means)	p' left observed %	$\log \frac{200 - p'}{p'}$	p' calculated from (3)
0	0.000	100.000	0.000	100.00
5	3.056	96.944	0.027	96.91
10	6.291	93.709	0.055	93.82
15	9.347	90.653	0.081	90.75
22	13.709	86.291	0.120	86.48
30	18.516	81.484	0.163	81.66
60	35.460	64.540	0.322	64.51
90	50.415	49.585	0.482	49.46
120	62.819	37.181	0.641	36.96
180	80.356	19.644	0.963	19. 4 8
300	94.481	5.519	1.547	4.78
2-4 days	100.000	0.000	į .	0.00

S. D. = 0.25%. C. of V. = 0.41%.

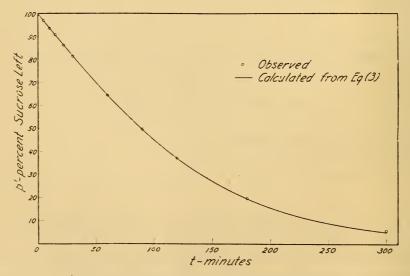


Fig. 2. Graphical presentation of fit for example I

typical experiments, provided these two cases differ sufficiently to include a wide range in concentration. In experiments B60, 61 and

B62 of Nelson and Hitchcock (4), two series are available in which the concentrations are 6 and 0.5 cc. per 100 cc. respectively. This is as great a variation in this factor as can be found in the literature. That equation (2) fits both of these is apparent from Table 2. The relation between r and concentration will be discussed below.

III. VARIATION IN SUBTRATE CONCENTRATION

Inclusion of the initial sucrose concentration as a variable has been a major difficulty in every effort to obtain a universal equation de-

TABLE 2. Extremes of Invertase Concentration nelson and hitchcock (4), page 2641. Sucrose and temperature as in table 1

Experiment number	I	360 and B6	1		B62	
Concentration of invertase 8	6 c.	.c. per 100	c.c.	0.5 c	.c. per 10	0 c.c.
r , from log. $\frac{200 - p'}{p'}$ vs. t	-	0.0456796			0.00371204	1
	t min.	p' % observed	p' % calculated from (2)	t min.	p' % observed	p' % calculated from (2)
	0	100.00	100.00	0	100.00	100.00
	5	88.25	88.62	60	88.55	88.91
	10	77.15	77.54	120	77.69	78.09
	15	66.82	67.01	180	67.60	67.78
	21	55.37	55.39	252	56.32	56.37
	28	43.62	43.53	336	44.93	44.64
	37	31.16	31.13	444	32.70	32.27
	52	16.74	17.00	624	18.46	17.96
	70	7.89	7.84	840	9.20	8.47
	1–7 days	0.00	0.00	11 days	0.00	0.00
S. D		0.20%			0.37%	
C. of V		0.41%			0.75%	

scribing the hydrolysis of sucrose by invertase. In order to test the applicability of the logistic function in this respect a series of experiments were chosen from the investigation of Nelson and Vosburgh (5) in which the substrate concentration was varied from 0.4 g. to 20 g. per 100 cc. of solution. The fits of equation (2) to these experiments are given in Table 3.

The fits for these experiments of Nelson and Vosburgh are seen to be

TABLE 3. Variation in Sucrose Concentration nelson and vosburgh (5) pages 796-7

		or 100	3058	bətaluələs % 'q (2) mori	100.0 91.5 85.1 81.0 76.9 72.9 0.0	20	, o
	25	20 gm. per 100 c.c.	0.000713058	b, % opsetned	0 100.0 20 85.1 10 80.9 30 77.1 0.0	0.23%	0.31%
		20 g	0.	.nim 3	2479858		
		ır 100	593	betallated % 'q (2) mort	100.0 92.4 85.0 80.2 75.4 70.7	0	0
	26	10 gm. per 100 c.c.	0.00167593	p, % observed	100.0 100 92.4 92 85.0 85 80.4 80 75.6 75 71.6 70 0.0 0	0.34%	0.47%
		10 g	0	.aim 3	0 180 240 300 360		
		r 100	388	b, % calculated (2) mori	100.0 84.6 77.1 74.7 72.3 0.0	,0	,0
	27b	gm. per 100 c.c.	0.00345388	b, % opsetned	100.0 84.5 84.5 77.5 77.5 72.9 0.0	0.40%	0.58%
		ئ ت ت	0.	.nim 3	0 90 135 150 165 8		
		100	339	descaled ated (2) (2) (2)	100.0 90.9 81.9 76.1 74.2 72.3		
	28b	4 gm. per 100 c.c.	0.00406339	b, % opsetved	100.00 91.2 81.7 76.0 74.3 72.4	0.16%	0.23%
		4 gr	0.	.nim 3	0 45 90 1120 130 0 140		
on grant (c) ununggo.		. 100	122	betalcalated % 'q (2) mori	100.0 84.6 77.1 71.7 68.1 0.0		
	29c	2 gm. per 100 c.c.	0.00777122	p, % observed	100.0 84.6 76.9 71.5 68.5 0.0	0.19%	0.28%
- 1		2 gm.	0.0	.nim 1	0 40 60 75 85		
THE WOOD THE		100	22	bətaluəlas % 'q (2) mori	100.0 89.1 78.6 73.4 0.0		
	30b	1 gm. per 100 c.c.	0.0108922	b, % opsetved	100.0 100 88.8 89.8 78.9 78 73.8 73 0.0	0.28%	0.41%
		1 gm.	0.	.nim 1	0 20 20 8		
		r 100	46	p, % calculated (2)	100.0 88.6 81.2 73.9 70.4 0.0		
	31b	0.4 gm. per 100 c.c.	0.0152546	p, % opsetved	100.0 89.1 80.6 74.2 70.6 0.0	0.33%	0.48%
		0.4 gn	0.	.aim 3	0 115 225 340 8		
	:		78. t				
	aber	ratic	, <u>d</u> ,				
	unu	cent	200 -				
	ment	100 6	log.				
	Experiment number	Sucrose concentration.	r, from log. $\frac{200 - p'}{p'}$			S. D	C. of V
1	É	Su	7,			\overline{\sigma}	0

good and, considering the size of the standard deviation, comparable with experiments utilizing 10% sucrose. However, while the range in variation of substrate concentration is fairly wide, the individual experiments are carried only to a point of about 30% hydrolysis. It is desirable to test the equation for comparable cases in which the hydrolysis has continued more nearly to completion. For this purpose three experiments in the series of Nelson and Vosburgh (5) in which the observations were continued up to within 95% hydrolysis are included here and given in Table 4.

TABLE 4. Variation in Sucrose Concentration Nelson and vosburgh (5), page 794

Experiment number		3			8			13	
Sucrose concentration	5 gm.	per 10	00 c.c.	10 gm	. per 1	00 c.c.	20 gn	n. per 10	00 c.c.
r , from log. $\frac{200 - p'}{p'}$ vs. t	0	. 016279	90	0	.003611	1	0	.0034769	90
	t min.	p' % ob- served	p' % calcu- lated from (2)	t min.	p' % ob- served	p' % calcu- lated from (2)	t min.	p' % observed	p' % calcu- lated from (2)
	0	100.00	100.00	0	100.00	100.00	0	100.00	100.00
	12	89.95	90.26	20	91.69	91.71	55	90.28	90.47
	24	79.90	80.71	45	81.31	81.51	125	78.16	78.60
	51	60.18	60.72	105	58.83	58.92	250	58.49	59.08
	85	40.07	40.08	175	37.89	37.84	392	40.20	40.75
	130	21.65	21.50	265	19.91	19.89	636	19.95	19.75
	234	4.90	4.34	450	5.15	4.63	1350	3.92^{a}	1.81
	∞	0.00	0.00	∞	0.00	0.00	∞ •	0.00	0.00
S. D		0.42%			0.20%			0.36%	
C. of V		0.85%			0.41%			0.66%	

^a Omitted in calculation of S. D.

IV. VARIATION IN TEMPERATURE

Nelson and Hitchcock (4) give data from the experiments of Vosburgh and Nelson in which the temparature was varied. The fits of equation (2) to these are presented in Table 5.

V. A SPECIAL CASE OF "ABNORMAL" INVERTASE

Nelson and Hitchcock (4) give data for reactions with invertase which they call "abnormal" by virtue of a criterion employed by them. The fit of equation (2) to one of these is given in Table 6.

TABLE 5. Variation in Temperature

NELSON AND HITCHCOCK (4), PAGE 2642.	i), PAGE		SUCROSE	CONCI	SNTRATI	ом, 10 с	IM. PEF	з 100 с.с	INVE	RTASE	8, conci	SNTRATI	ом, 1 с	SUCROSE CONCENTRATION, 10 GM. PER 100 C.C. INVERTASE 8, CONCENTRATION, 1 C.C. PER 100 C.C.	100 c.c.
Experiment number		11B	10		15B			11B			5B			7B	
Temperature		15°C.			20°C.			25°C.			30°C.			35°C.	
r, from log. $\frac{200-p'}{p'}$ vs. t		0.00446347	23	0	0.00607385	35	0	0.00809619	19		0.0103361			0.0128674	41
	t min.	p' % ob-	p' % calculated from (2)	t min.	p' % ob- served	p' % calculated from (2)	t min.	p' % ob-	p' % calculated from (2)	t min.	p' % ob- served	p' % calculated from (2)	t min.	p, % op-	p' % calculated from (2)
	0 89	100.00	100.00	0 16	100.00	100.00	0	100.00	100.00	0 6	100.00	100.00	0 8	100.00	100.00 94.86
	110	75.61	75.93	38 55	88.13	88.51	36	85.40 75.20	85.53	29	84.93	85.12	24	84.24	84.68
	250	49.52	49.36	120	65.10	65.09	105	60.30	59.88	717	64.95	64.87	09	63.09	63.21
	350 441	34.96 24.93	34.67 24.51	061	30.32 48.60	50.12 47.95	105 235	42.01 24.76	41.04 25.96	153	34.66	34.12	120	35.37	35.19
	286	14.12	3.62	254	36.08	35.23	360	11.16	10.29	190	24.93	24.61	155	23.98	23.96
	8	0.00	0.00	320 420	25.82	25.05	8	0.00	0.00	246	15.07	14.58	195 ∞	15.07	15.07
				8	0.00	00.00									
S. D. C. of V.		0.33%			0.48% 0.86%			0.61%			0.31% 0.58%			0.21% 0.38%	

The sample of invertase used in the above experiment was one which Nelson and Hollander (7) found to undergo destruction during the course of the reaction. It is to be noted that the standard deviation of observed values of p' from those calculated from (2) is in this instance significantly greater than in the typical case as exemplified in Table 2. Other experiments with this sample of invertase are shown in Table 8.

The survey presented above is taken to demonstrate that an equation of form (2) gives a good quantitative description of the course of reaction between sucrose and yeast invertase. The deviations of the

TABLE 6. A Case of "Abnormal" Invertase nelson and hitchcock (4) page 2643. Experiments $\rm B12-15.~$ sucrose and temperature as in table 1

Invertase 3,	conc.	1.905	c.c.	per	100	c.c.	r,	from	log.	$\frac{200 - p'}{p'}$	vs.	t =	0.0120745	;
--------------	-------	-------	------	-----	-----	------	----	------	------	-----------------------	-----	-----	-----------	---

t min.	p' % observed	p' % calculated from (2)
0	100.00	100.00
5	96.80	96.98
10	93.65	93.77
15	90.56	90.97
22	86.35	86.79
30	81.54	82.08
60	65.04	65.28
90	50.62	50.45
120	38.52	38.03
180	21.19	20.43
300	6.42	5.20
	0.00	0.00

S. D. = 0.51%. C. of V. = 0.85%.

quantities observed from those estimated by it are small in all cases, small enought to warrant the conclusion that basically the reaction follows this equation. However, there is in the deviations a feature calling for further comment. Whereas they are nowhere large, there is in every case a notable progression in their character. This takes such a form that if the equation be fitted to the early observations, the later observations expressed as per cent substrate left tend to overshoot the estimates made from the equation. The deviations at first increase and then decline, the observed and calculated quantities

approaching each other as the reaction nears completion. In all the reactions studied this characteristic can be discerned, but it is more marked in some than in others. We conclude from these facts that the equation (2) is not the completely correct one for all reactions between invertase and sucrose, but that subsidiary small corrections varying in amount with different conditions must be made to render it so. What mathematical form will best represent these corrections we are not ourselves decided. This much however may be advanced. The deviations in question are manifested in the graphs of log. $\frac{200 - p'}{p'}$ vs. t as a small but perceptible curvature concave towards the t axis, i.e., the slope of this function decreases as t increases. To show this we have

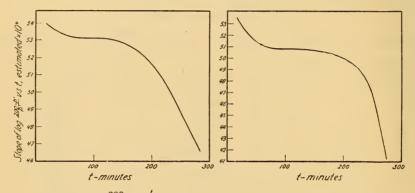


Fig. 3. Slope of log. $\frac{200-p'}{p'}$ vs. t as estimated graphically, vs. t. Example I left, example VI right.

estimated the slope for different values of t by a graphical method and in Figure 3 the estimates so obtained are shown as smooth curves against t for the experiments of examples I and VI. Now if the logistic function (2) held strictly, these slopes should be constant, and, if they were subject only to random experimental variation, they should vary normally about some mean value. The fact that they decrease progressively may be accounted for by a progressive decrease of r. What the chemical mechanism of the reduction is, one can not say from an examination of these experimental results alone. But whatever its cause, quantitatively its effect is small as is shown by the fact that the values of p' approximate closely the values calculated from (2) which assumes r constant.

Relationship of the Rate Parameter r, and Other Variables

If equation (2) is really definitive of the reaction between yeast invertase and sucrose the one parameter in it which, by hypothesis, can change, should bear a regular relationship to conditions which affect the reaction, i.e., r should be a function of the variables which measure such conditions.

In the experiments available here it is possible to examine the relationship for concentration of enzyme, concentration of substrate, and temperature. These will be presented briefly seriatim in graphic form.

I. CONCENTRATION OF INVERTASE

In the series of data given by Nelson and Hitchcock (4) two are available for testing the relationship of r to concentration of invertase.

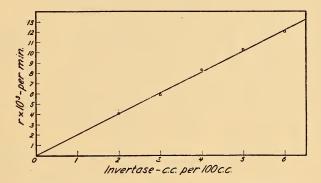


Fig. 4. r vs. concentration of invertase, from Table 7

In Tables 7 and 8 the fits of equation (2) to these data are presented in the same way as for the examples given above. In Figures 4 and 5 the r's obtained from these fits are shown plotted vs. the concentration of invertase.

It is seen that a relationship of constant proportionality exists between r and concentration of invertase. This is in agreement with the findings of Berkson and Flexner for other enzymes (6).

II. CONCENTRATION OF SUCROSE

In the experiments of Nelson and Vosburgh given in Table 4 above, the conditions were identical except for concentration of sucrose. Below in Figure 6 is shown graphically the variation of r with concentration of sucrose.

NELSON AND HITCHCOCK (4), page 2640, shores concentration 10 ar per $100 \circ c$ TABLE 7. Varying Concentrations of Invertase

	NELSON	AND H	ТСНСОС	(4),	PAGE ZO	- SUC	CROSE	CONCENT	NELSON AND HITCHCOCK (4), PAGE 2040. SUCROSE CONCENTRATION, 10 GR. PER 100 C.C.	10 GR	PER I	on c.c.			
Experiment number		10			6			∞			7			9	_
Invertase A concentra-		2 e.e. per 100 e.e.	.o.o.	3 c.c	3 e.e. per 100 e.e.	0 c.c.	4 c.c	4 c.c. per 100 c.c.	0 c.c.	5 c.c.	5 e.e. per 100 e.e.	0 c.c.	9 0.0	6 c.c. per 100 c.c.) c.c.
r, from log. $\frac{200 - p'}{p'} vs. t$		0.00406339	69	0	0.00587638	<u>&</u>	0	0.00831901	01)	0.0102425	5		0.120135	
	t min.	p, % op-	p' % calculated from (2)	t min.	p' % ob- served	p' % calculated from (2)	t min.	p' % ob-	p' % calculated from (2)	t min.	p' % ob-	p' % calculated from (2)	t min.	p' % ob-	p' % calcu- lated from (2)
			100.00	33	100.00	100.00	0 20	100.00	100.00	0 22	100.00	100.00	0		100.00
	221	79.86	57.89	150	79.51 58.50	79.72 58.58	45	81.31 58.83	81.50 58.90	96	79.85 56.79	79.80 56.92	2 8	82.08 60.15	82.17 60.27
	315	43.90 39.96	43.51 39.50	250 376	37.56 19.91	37.42 19.78	175 265	37.89 19.91	37.82 19.87	138 215	39.02 19.70	39.14 19.91	120	38.10 19.41	38.26 19.55
	570	18.40	17.96	099	4.72	4.05	450	5.15	4.62	373	4.96	4.29	320	5.03	4.19
	8	0.00	00.00	8	B	9	8	00.0	0.00	8	3	00.0	8	90.00	0.00
S. D. C. of V.		0.46%			0.26%			0.20%			0.26% 0.54%			0.31%	
						-				-					

TABLE 8. VARYING CONCENTRATIONS OF INVERTASE NELSON AND HITCHCOCK (4), PAGE 2650. SUCROSE CONCENTRATION, 10 GM. PER 100 C.C. TEMPERATURE 37°

Experiment number	B58	and B	59	Bā	54 and	B55	В5	66 and	B57	
Invertase 3, concentration					. per 10	00 c.c.	6 c.c	6 c.c. per 100 c.c.		
r , from log. $\frac{200 - p'}{p'}$ vs. t	0.0	0290853		(0.01828	52	C	0.03658	55	
	t min.	p' % ob- served	p' % calcu- lated from (2)	t min.	p' % ob- served	p' % calcu- lated from (2)	t min.	p' % ob- served	p' % calcu- lated from (2)	
	0		100.00	0		100.00		100.00		
	60	90.92		10		90.88		88.72		
	120 195	82.20 72.05		20 30	81.66 73.12			77.98		
	270	62.55		45	61.13			67.95 55.73		
	360	52.58		70	44.09		35	43.62		
	450	43.44		100	28.31			29.67		
	540	35.67		120	20.77		65	17.03		
	1101	10.92		150	12.88		85	8.72		
	7-12 days	0.00	0.00	∞	0.00	0.00	∞	0.00	0.00	
S. D		. 60% . 00%			0.45% 0.21% 0.88% 0.44%					

^a Omitted in calculating S. D.

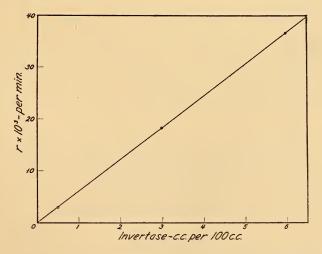


Fig. 5. r vs. concentration of invertase, from Table 8

III. TEMPERATURE

In the experiments of Nelson and Hitchcock presented in Table 5 above, temperature alone was varied. Below in Figure 7 is shown the variation or r with temperature as indicated by these experiments.

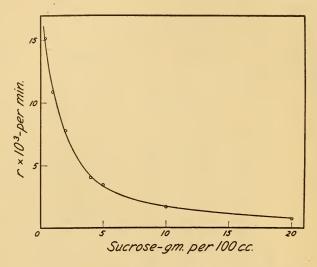


Fig. 6. r vs. concentration of sucrose, from example III

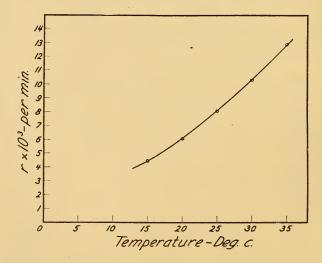


Fig. 7. r vs. temperature, from example IV

SUMMARY

1. The course of the reaction between sucrose and yeast invertase can be quantitatively described under representative conditions of

temperature, concentration of enzyme, and concentration of substrate by the function $p' = \frac{200}{1 + e^{rt}}$, where p' is the percentage of sucrose remaining unhydrolized, t is the time after the beginning of the reaction when p' is observed, r is a rate parameter which is characteristic of any particular series of observations, and e is the Napierian base.

- 2. The relation between the rate parameter r of the above equation and concentration of invertase is linear; the correlation line passes through the zero origin, resulting in a constancy of the ratio of concentration to r.
- 3. The parameter r changes regularly with concentration of sucrose; the correlation is a non-linear.
- 4. The parameter r changes regularly with temperature; the correlation is non-linear.

REFERENCES

- 1. Berkson, J. and Flexner, L. B. On the rate of reaction between enzyme and substrate. Jour. Gen. Phys., 11: 433-457. 1928.
- 2. Reed, L. J. and Berkson, J. The application of the logistic function to experimental data. Jour. Phys. Chem., 33: 760-779. 1929.
- 3. Reed, L. J. and Berkson, J. Idem, 767.
- 4. Nelson, J. M. and Hitchcock, D. I. Uniformity in invertase action. Jour. Amer. Chem. Soc. 43: 2632-55. 1921.
- Nelson, J. M. and Vosburgh, W. C. Kinetics of invertase action. Jour. Amer. Chem. Soc. 39: 790-811. 1917.
- 6. Berkson, J. and Flexner, L. B. Idem, Appendix.
- 7. Nelson, J. M. and Hollander, F. Uniformity in invertase action. Jour. Biol. Chem. 58: 291-304. 1923.

SCIENTIFIC NOTES AND NEWS

Dr. Leland Ossian Howard, on the nomination of the Entomological Society of Washington, has been elected an Honorary Member of the Washington Academy of Sciences. This action was taken in recognition of his distinguished contributions to entomology, his intimate connection with scientists and scientific work in Washington, and especially for his services to the Academy as member and officer since its foundation.

The First International Congress on Mental Hygiene will convene in Washington on May 5. Sessions will continue until noon, May 10. Sessions of general interest will be held in the evenings at Constitution Hall, Eighteenth and D streets, NW. The President of the Congress is Dr. William A. White, Superintendent of St. Elizabeths Hospital; the Secretary-General is Clifford W. Beers, founder of the mental-hygiene movement; Dr. Frankwood E. Williams is Chairman of the Committee on Program; Thomas W. Lamont is Treasurer.

At the same time and place as the International Congress will be held the annual meetings of the American Psychiatric Association and the American Association for the Study of the Feebleminded.

Prof. W. G. Woolnough, Geological Adviser to the Commonwealth Government of Australia, is spending several months in the United States for the purpose of observing American methods and practices in the petroleum industry and in the administration and technique of official surveys.

An impromptu gathering of geologists at the Geological Survey on April 18 was addressed by Dr. G. S. Hume, geologist in charge of oil and gas investigations of the Geological Survey of Canada, on *The geological structure of Turner Valley*, *Alberta*; by E. E. L. Dixon, Esq., of the Geological Survey of Great Britain, on *Dolomitization and the development of chert*; and by Prof. W. G. Woolnough, Geological Adviser to the Commonwealth Government of Australia, on *Major structural features of Australia*.

Obituary

Commander Asaph Hall, Corps of Professors of Mathematics, U. S. Navy, died, after a brief illness, on January 12, 1930. He was a resident of Upper Darby, Pennsylvania, at the time of his death and was engaged in postretirement astronomical work at the Flower Observatory. Professor Hall was born in Cambridge, Massachusetts, on October 6, 1859; received his A.B. at Harvard in 1882, and his Ph.D. at Yale in 1889. Brought up amidst astronomical surroundings, he began his astronomical career as an assistant at the United States Naval Observatory, whence, after three years, he proceeded to the Yale Observatory as an assistant, and thence to the University of Michigan Observatory as Director. In 1908, he was commissioned in the Corps of Professors of Mathematics of the United States Navy and was assigned to the Naval Observatory for duty. There he took. charge of the great telescope of that institution, the same instrument with which his distinguished father of the same name discovered the satellites of Mars. After his formal retirement as an officer on the active list of the Navy in 1923, he was continued on active duty at the Naval Observatory until June 30, 1929. Professor Hall was widely known for his work in connection with the satellites of the planets. His latest published work appears in Volume XII, Part I, Publications of the U. S. Naval Observatory, which contains the results of his observations on the great equatorial from 1908 to 1926.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

ANNOUNCEMENTS OF MEETINGS

Tuesday, May 6
Wednesday, May 7
Thursday, May 8
Saturday, May 10
Tuesday, May 13
Wednesday, May 14
Wednesday, May 14
The Botanical Society
The Medical Society
The Philosophical Society
The Electrical Engineers
The Geological Society
The Medical Society

Saturday, May 17 The Biological Society

The Biological Society

The Helminthological Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Chemistry—On the equation for the reaction between invertase and sucrose. JOSEPH BERKSON and FRANKLIN HOLLANDER.	
Scientific Notes and News	

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN
BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered

serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers

bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$ 2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3,00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5.00	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers	. 50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made

within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

May 19, 1930

No. 10

BOTANY.—Haitian mosses collected by E. C. Leonard.¹ R. S. Williams, New York Botanical Garden. (Communicated by William R. Maxon.

The following list enumerates some 75 species of mosses obtained in the Republic of Haiti by E. C. Leonard in November and December 1925 and January and February 1926, at elevations ranging from near sea-level to about 1,200 meters, also two species collected in the Dominican Republic by W. L. Abbott in 1922. About half the specimens were in fruit. A portion were determined by Mrs. E. G. Britton.

FISSIDENS ACICULARIS C. M. Near Marmelade, 800 m., on limestone (8085). Near St. Michel de l'Atalaye, 350 m., on soil (7586). This species has previously been attributed only to Brazil. The specimens are all sterile but seem to belong here.

Fissidens garberi L. & J. Near Dondon, about 400 m., on roots (8690a). Fissidens kegelianus C. M. Near Port au Prince, about sea-level, on damp soil (10112). This with two exceptions is the only moss collected near sea-level.

FISSIDENS MOLLIS Mitt. Near Caye-la-Croix, about 700 m., on damp soil (7934); det. E. G. B. Near Marmelade, about 800 m. (8190).

DICRANELLA HERMINIERI Besch. Near Plaisance, about 400 m., on clay bank (9367); det E. G. B.

Campylopus angustiretis (Aust.) L. & J. Near Marmelade, about 800 m., on rotten stump (8234). This species previously credited only to Florida and fruiting specimens still unknown.

Leucobryum antillarum Schp. Near Marmelade, about 800 m., on rotten log (8290) and in thicket (8218). Near Plaisance, about 400 m., on soil (9351); det. E. G. B.

Octoblepharum albidum (L.) Hedw. On rotten log, near St. Michel de l'Atalaye, 350 m. (7486). On tree, near Caye-la-Croix, about 700 m. (7885). On rotten log near Marmelade, about 800 m. (8283).

¹ Received March 17, 1930.

Weisia viridula amblyodon (Brid.) Bry. Eur. On damp soil near Plaisance, about 400 m. (9704). Appears to be this variety or very near it.

TRICHOSTOMUM JAMAICENSE (Mitt.) Jaeg. On damp walls near Dondon, about 400 m. (8613 and 8629a). Near Ennery, 825–900 m., on earth and damp rock (9028 and 9099); det E. G. B.

Hyophila tortula (Schwaegr.) Hpe. On limestone soil and rock near St. Michel de l'Atalaye, about 350 m. (7045 and 8466).

Barbula agraria (Sw.) Brid. On limestone, near St. Michel de l'Atalaye, 350 m. (7120, 7234, 7783); det. E. G. B. Near Dondon, 400 m. (8716b). Near Ennery, 325–900 m. (8945, also 9052); det. E. G. B. All on limestone.

Barbula crugeri Sond. On damp lime-soil, near St. Michel de l'Atalaye, about 350 m. (7042a).

Barbula subulifolia Sull. Near St. Michel de l'Atalaye, on wet rocks, about 350 m. (7805).

Tortella caespitosa (Schwaegr.) Limpr. On base of tree near Marmelade, about 800 m. (8337). Near Ennery on stumps, 325–900 m. (9451a).

Funaria calvescens Schwaegr. Near Ennery on damp soil, 325-900 m. (9469). On burnt stump, same locality, (9451) and near St. Michel de l' Atalaye about 350 m., on damp wall of limestone (7138).

Splachnobryum obtusum (Brid.) C. M. Near St. Michel de l'Atalaye on lime-soil, 350 m. (7044).

BRYUM ANDICOLA Hook. Near Ennery on damp soil, 350–900 m. (9017). BRYUM CORONATUM Schwaegr. Near St. Michel de l'Atalaye, about 350 m., on rotten wood (8023 and 7508). Near Caye-la-Croix, about 700 m., crevice in coral rock (7966); det. E. G. B.

Bryum leonardi Williams, sp. nov.

Fig. A, 1-6.

Evidently dioicous: growing in dark green, rather loose tufts with weak stems 10-12 mm. long, radiculose below and often bearing very short branches; leaves distant, often decurrent, not imbricate, more or less plicate and much contorted when dry, when moist widely spreading, often slightly recurved, the upper stem-leaves about 1.75 mm. long, broadly obovate, bordered all around and serrulate about one-third the way down; costa in upper leaves mostly slightly excurrent into a short apiculus; lowest stem-leaves mostly very small, obtuse, entire, with costa vanishing well below apex; median leaf-cells more or less hexagonal, from scarcely elongate to about twice longer than wide, up to $12-16\mu$ wide by $25-30\mu$ long, with thin walls, the basal cells becoming rectangular and much longer than those above; leaf-borders slightly browner than within, of mostly about 3 rows of very narrow, elongate cells with walls somewhat thickened; archegonial flowers with outer leaves much like those of upper stem but with longer, narrower base and more numerous rectangular cells, the inner leaves very small, rather lanceolate, more or less serrulate and costate; archegonia 8-10, with 12-15 filiform paraphyses; fruit unknown.

Haiti: Vicinity of Dondon, at about 400 meters, on damp wall, E. C. Leonard, Jan. 7, 1926 (8629b).

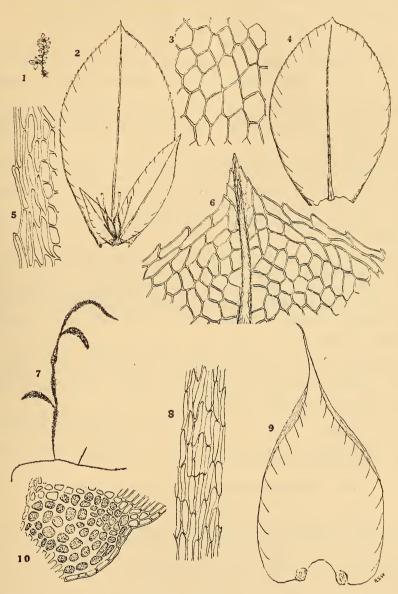


Figure A.—1–6, Bryum leonardi Williams, sp. nov. 1, Moistened plant, about natural size. 2, Outer and inner perichaetial leaves, etc., about \times 30. 3, Median leaf-cells, \times 180. 4, Upper stem-leaf, about \times 30. 5, Border one-half way down leaf, \times 180. 6, Apex of stem-leaf, \times 180. 7–10, Renauldia subpilifera Williams, sp. nov. 7, Plant, about natural size. 8, Median leaf-cells, \times 280. 9, Upper stem-leaf, about \times 180. 10, Alar cells, \times 180.

This species seems to be nearest the Brazilian *B. ocdiloma*, but the border is narrower, the leaves are rather larger and more strongly serrulate, and the inner perichaetial leaves are lanceolate-acute.

Rhodobryum swartzianum (C. M.) Par. Near Ennery, on damp soil, 325-900 m. (9122 and 9131); det. E. G. B.

Philonotis gracillima Ångstr. Near St. Michel de l'Atalaye, on damp soil and limestone, about 350 m. (7018).

PHILONOTIS SPHAERICARPA (Sw.) Brid. Near St. Michel de l'Atalaye, on lime-soil, 350 m. (7043 and 7551). Near Plaisance, about 400 m. (9396); det. E. G. B.

PHILONOTIS TENELLA (C. M.) Besch. Near Caye-la-Croix, on clay-bank, 700 m. (7884). Near Plaisance, on damp soil, 400 m. (9398a).

ERPODIUM DOMINGENSE (Brid.) C. M. Near Gros Morne, about 235 m., on soil and roots of trees (9871, 9883, and 9891).

Macromitrium husnoti Schp. Near Marmelade, on tree, about 800 m. (8372).

Macromitrium mucronifolium (Hook. & Grev.) Schwaegr. Near Ennery, 325-900 m., on damp wood (9133); det. E. G. B.

Macromitrium schwaneckeanum Hpe. Near Laguna, Dominican Republic, 100 to 500 m., chiefly on Pilón de Azúcar (*Abbott* 2331a).

Macromitrium tumidulum Mitt. Near St. Michel de l'Atalaye, on rotten log, about 350 m. (7507).

RHACOPILUM TOMENTOSUM (Sw.) Brid. Near St. Michel de l'Atalaye, on limestone, 350 m. (7487). Near Dondon, on tree and soil, 400 m. (8543 and 8609a). Near Plaisance, on rotten log, 400 m. (9216c). Near Caye-la-Croix, on rock, about 700 m. (7999); det. E. G. B.

Acrocryphaea coffeae (С. М.) Par. Near St. Michel de l'Atalaye, 350 m., on tree (7244a).

PSEUDOCRYPHAEA FLAGELLIFERA (Brid.) E. G. Britton. Near Caye-la-Croix, about 700 m., on tree (7899a).

Renauldia subpilifera Williams, sp. nov.

Fig. A, 7–10.

Inflorescence unknown: Plants with wiry, trailing stems bearing a few more or less erect, flexuous, distant, scarcely branching secondary stems, 4–5 cm. long with few or no branches and scattered, often scarcely evident tufts of radicles; leaves from a heart-shaped base, rather short-ovate, the blade about 1.5 mm. long and 1 mm. wide, entire or mostly so, concave, ecostate, the margins above incurved, rather gradually narrowed into a hair-like apiculus up to about one-fifth of length of entire leaf; cells of leaf very uniform to near base, the median about 30μ long and $4-5\mu$ wide, with unequally thickened and slightly pitted walls, the alar cells forming a very distinct, convex, brownish cluster.

Dominican Republic: Polo, Prov. de Barahona, 600–1200 meters, Feb. 26–March 12, 1922 (Abbott 1879c).

Nearest R. cochlearifolia of Mexico, but much less branched, the leaves with much longer points, the alar cells forming a more distinct cluster and cells above with much more irregularly thickened walls.

Pireella Cymbifolia (Sull.) Card. Near Caye-la-Croix, on shaded rock, about 700 m. (7991). Near Marmelade, in thicket, about 800 m. (8271).

Pterobryum angustifolium (C. M.) Mitt. Near Dondon, on shrub, about 400 m. (8744).

Papillaria nigrescens (Sw.) Jaeg. The most abundantly collected of any of the species, growing on both trees and rocks, being represented by 14 packets: Dondon (8544, 8670, 8689); Caye-la-Croix (7871a, 7894); Ennery (9155); Marmelade (8126a, 8268); Pilate (9603); Plaisance (9212, 9230, 9252a, 9257); St. Michel de l'Atalaye (8463). The elevations run from 325 m. at Pilate to 800 m. at Marmelade.

Meteoriopsis patula (Sw.) Broth. Near Marmelade, on shrubs, 800 m. (8383). Near Ennery, 325-900 m. (8994, 9112a); det. E. G. B.

PHYLLOGONIUM FULGENS (Sw.) Brid. Near Ennery, on rock, 325-900 m.

(9140): det. E. G. B.

CALYPTOTHECIUM MORITZII (Hpe.) Broth. Near Marmelade, on rock, 800 m. (8280). Not before credited to the West Indies.

NECKEROPSIS UNDULATA (Palis.) Hedw. Near Caye-la-Croix, on tree, about 700 m. (7899). Near Plaisance, on tree, about 400 m. (9256).

PINNATELLA MINUTA (Mitt.) Broth. Near Dondon, on rock, about 400 m. (8702).

CYCLODICTYON ALBICANS (Sw.) Broth. Near Caye-la-Croix, about 700 m.,

on rock (7880 and 7881).

Callicostella colombica Williams, Bryologist 28: 61. 1925. Near Ennery, on limestone, 325-900 m. (9024). Specimen sterile but apparently this.

Callicostella depressa (Sw.) Jaeg. Near Plaisance, on rock, 400 m.

(9187); det. E. G. B.

Callicostella subfissidentoides Broth. Near Port au Prince, on damp soil, near sea level (10099).

LEPIDOPILUM AMPLIRETE (Sull.) Mitt. Near Marmalade, about 800 m., on rock (8385).

Crossomitrium sintenisii C. M. Near Ennery, 325-900 m. (9141); det. E. G. B.

Helicodontium capillare (Sw.) Jaeg. Near Ennery, 325-900 m., on tree (9548a). Near Plaisance, about 400 m., on tree (9209); det. E. G. B.

Helicodontium tenuirostre Schwaegr. Near Dondon, on rotten wood, about 400 m. (8725).

HAPLODONTIUM MICROPHYLLUM (Sw.) Broth. Near Pilate, on rock, about 325 m. (9632).

THUIDIUM ACUMINATUM Mitt. Near Ennery, on damp bank and stump,

325–900 m. (9132 and 9149); det. E. G. B.
THUIDIUM INVOLVENS (Hedw.) Mitt. Near Marmelade, on rock, about 800 m. (8171). Near Dondon, on rock, about 400 m. (8724).

THUIDIUM URCEOLATUM Lorentz. Near Marmelade, on rock and rotten

log, about 800 m. (8274 and 8282).

Brachythecium stereopoma (Spruce) Jaeg. Near Dondon, about 400 m., on damp wall (8628). Near Pilate, 325 m., on damp soil (9639).

RHYNCHOSTEGIUM SERRULATUM (Hedw.) Jaeg. Near Ennery, 350-900 m., on rotten log (9001b). Near Dondon, about 400 m. (8609). Near Plaisance, about 400 m. (9253). Near Marmelade, about 800 m. (8091). The last specimen is perhaps a variety of R. serrulatum, having broader, shorterpointed, and more strongly serrulate leaves, with the outer leaves of the flowerbuds broadly rounded or very obtuse. It may prove a distinct species.

OXYRRHYNCHIUM CLINOCARPUM (Tayl.) Broth. Near Ennery, on damp

banks, 325-900 m. (9535a). The first record for the West Indies.

ERYTHRODONTIUM CYLINDRICAULE (C. M.) C. M. Near Caye-la-Croix,

on mango tree, about 700 m. (7894a). Near Ennery 325–900 m. (9523). Entodon beyrichii (Schwaegr.) C. M. Near Caye-la-Croix, on rock, about 700 m. (7999a); det. E. G. B. Near Ennery, on rock, 325–900 m.

(9048); det. E. G. B.

ENTODON MACROPODUS (Hedw.) Mitt. Another abundantly collected moss of this list, growing on rocks and wood: Near Dondon (8669); Ennery (8996); Marmelade (8126, 8174 and 8195); Pilate (9609); Plaisance (9246); St. Michel de l'Atalaye (8467). The elevations range from 325 to 800 meters.

Stereophyllum cultelliforme (Sull.) Mitt. Near Plaisance, 400 m.,

on rock (9374); det. E. G. B.

STEREOPHYLLUM LEUCOSTEGUM (Brid.) Mitt. Near St. Michel de l' Atalaye, on trees and rotten wood, about 350 m. (7240, 7259, 7488, 7748,

7749, 7749a, 8023b, 8488 and 8493).

STEREOPHYLLUM RADICULOSUM (Hook.) Mitt. Near Dondon, on tree (8546). Near Plaisance, on tree (9256a). Near St. Michel de l'Atalaye, on rotten wood (7485 and 8023a).

Pilosium serrulatum Williams, sp. nov.

Fig. B

Autoicous, the male flowers with about 4 large antheridia (some 0.35 mm. long) and a few filiform paraphyses, enclosed by rather broadly lanceolate leaves minutely serrulate at apex: plants growing in loose, glossy green mats, the stems (up to 4 cm. high) with few radicles, bearing short, irregularly placed, complanate branches; stem-leaves complanate, ecostate, the lateral spreading-incurved, about 1.5 mm. long and 0.65 mm. wide, not quite symmetric, rather ovate, the apex broadly acute and minutely serrulate; leaves on upper side of stem for the most part slightly smaller and symmetric; leafcells elongate to near base, the median very narrow, about 4μ wide by 100μ long or more, the basal cells in lateral leaves broad, 20-25 μ wide, more or less rectangular and usually much more numerous on one side of the base than on the other, in the leaves on upper side of stem these basal cells often scarcely present; archegonial flowers with outer leaves short, the rather broadly lanceolate and serrulate apex slightly spreading, the inner leaves twice longer or more, with narrowly lanceolate, serrulate apex mostly somewhat recurved, enclosing 8-10 archegonia with rather few, filiform paraphyses; fruit not known.

HAITI: Vicinity of St. Michel de l'Atalaye, at about 350 meters, on dead wood, Nov. 20, 1925 (Leonard 7248).

This species differs from other members of the genus in having the apex of most of the leaves, both of stems and flowers, minutely but sharply serrulate; the perichaetial leaves also are unusually slenderly pointed and the median leaf-cells very narrow.

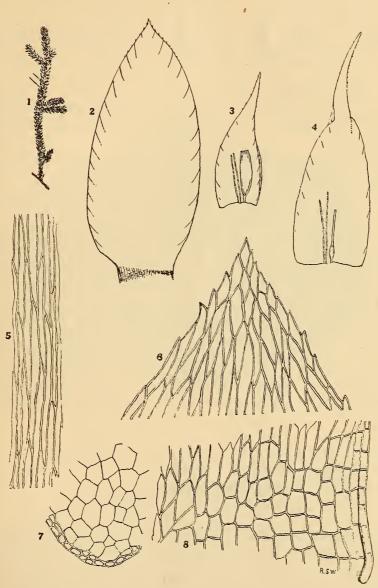


Figure B.— $Pilosium\ serrulatum\$ Williams, sp. nov. 1, Plant, about natural size. 2, Stem-leaf, about \times 30. 3, Inner perigonial leaf, etc., about \times 30. 4, Inner perichaetial leaf, etc., about \times 30. 5, Median leaf-cells, \times 280. 6, Apex of stem-leaf, \times 180. 7, Partial cross-section of stem, \times 180. 8, Basal cells about one-half way across leaf, \times 180.

SEMATOPHYLLUM ADMISTUM Sull. Near Ennery, 325-900 m., on rotten log (9001) and on tree (9510). Near Marmelade, about 800 m., on shrub (8299).

Near St. Michel de l'Atalaye, on palm stumps (8460).

SEMATOPHYLLUM GALIPENSE (C. M.) Mitt. Near Dondon, on rotten wood, about 400 m. (8686b). Near Marmelade, on rock, about 800 m. (8250). Near St. Michel de l'Atalaye, about 350 m. (7624a and 7779); det. E. G. B. Near Plaisance about 400 m. (9381); det. E. G. B.

SEMATOPHYLLUM LOXENSE (Hook.) Mitt. Near Pilate, on trees, about 325 m. (9587 and 9594c). Near Caye-la-Croix, about 700 m. (7974); det. E. G. B. Near Plaisance, 400 m. (9210 and 9211), on trees and on rock (9341).

SEMATOPHYLLUM SUBPINNATUM (Brid.) E. G. Britton. Near Marmelade on shrub, about 800 m. (8185). Near Plaisance, on rotten log, about

400 m. (9304).

TAXITHELIUM PLANUM (Brid.) Mitt. Near Dondon, on wood, about 400 m. (8690 and 8692). Near Marmelade, on shrub, about 800 m. (8164). Near Plaisance, about 400 m. (9224 and 9216); det. E. G. B.

ISOPTERGIUM MICANS (Sw.) R. & C. Near Plaisance, about 400 m., on

rotton log (9325), and on bamboo (9413).

Isopterygyium tenerum (Sw.) Mitt. Near Dondon, on wood, about 400 m. (8578, 8685, 8697). Near Marmelade, on tree, about 800 m. (8097). Near Pilate, on tree, about 325 m. (9594). Near Plaisance, on rotten log, about 400 m. (9216a and 9333).

Taxiphyllum planissimum (Mitt.) Broth. Near Marmelade, on base of

small tree, about 800 m. (8139).

Vesicularia crassicaulis (Mitt.) Broth. Near Caye-la-Croix, about 700

m., on damp soil (7930); det. E. G. B.

Vesicularia vesicularis (Schwaegr.) Broth. Near Marmelade, on earth, about 800 m. (8150). Near Port au Prince, on rock, near sea-level (10107 and 10110). Near St. Michel de l'Atalaye, about 350 m. (7279). Near Plaisance, about 400 m. (9397); det. E. G. B.

MICROTHAMNIUM DIMINUTIVUM (Hpe.) Jaeg. Near Dondon, on rotten log, 8691 and 8695). Near Ennery, on rotten log, 325-900 m. (9005). Near Marmelade, on rotten log, 800 m. (8265). Near St. Michel de l'Atalaye,

about 350 m., on rotten wood (7248a and 7778); det. E. G. B.

MICROTHAMNIUM REPTANS (Sw.) Mitt. Near Dondon, on damp walls,

about 400 m. (8627). Apparently not before collected in Haiti.

MICROTHAMNIUM THELISTEGUM (C. M.) Mitt. Near Marmelade, about

800 m. (8269a).

Pogonatum tortile (Sw.) Brid. Near Plaisance, on clay bank, about 400 m. (9366); det. E. G. B.

PALEONTOLOGY.—Hoploparia westoni Woodward.¹ Mary J. RATHBUN, U. S. National Museum.

A second specimen of this species, found at the Geological Museum, University of Alberta, by Prof. P. S. Warren, has been referred to the author for description. It was collected by Dr. J. O. G. Anderson in Alberta from the Bearpaw shale, 236 feet above the base, L. S. 4, Section 32, Range 22, Township 6, west of the 4th meridian, Catalogue No. 409.

¹ Received March 21, 1930.

Hoploparia westoni Woodward

Figs. 1-3

Hoploparia westoni Woodward, Geol. Mag. [ser. 4] 7: 433, pl. 17, fig. 1 a, b, c. 1900; type-locality, Red Deer River, Alberta, Range 15, Township 23, west of the 4th principal meridian; Upper Cretaceous.

Measurements.—Lateral length of carapace (incomplete) 40.2 mm.,

dorsal length of abdomen 86 mm.

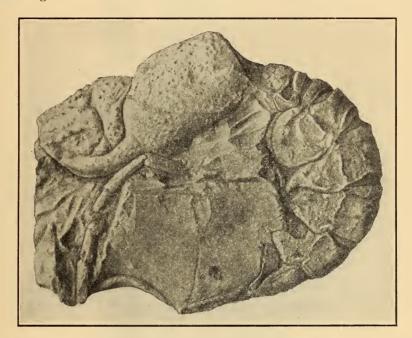


Fig. 1. Hoploparia westoni. Left profile.

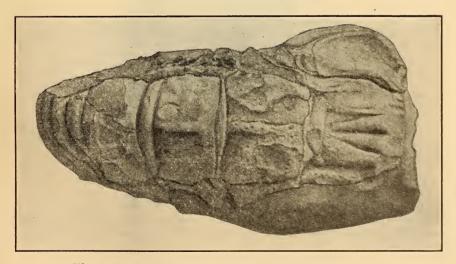


Fig. 2. Hoploparia westoni. Dorsal view of posterior end.

A large part of the carapace and abdomen is preserved. The carapace is rough with abundant, conical, acute or subacute spines (mostly broken off) of different sizes, well separated and arranged with only a partial bilateral symmetry. Interspaces smooth or nearly so. The cervical suture is oblique



Fig. 3. Hoploparia westoni. Dorsal view of carapace.

and arcuate forward in profile (Fig. 1); in front of it, the carapace lacks the rostrum and hinder median part. Either side of the median line (Fig. 3) there are two longitudinal rows of spines; outside the anterior part of the second row there are two short oblique rows of 3 each, converging toward it. A

slightly elevated ridge seems to terminate in a suborbital spine (Fig. 3 o), while a much stronger, longer and rougher ridge leads to the antennal spine (Fig. 3 a). The cervical suture at its lowest extremity bends forward in a curve subparallel to the lower margin of the carapace; from this curve a deep, irregular nearly transverse groove runs upward to within a short distance of the median line; it has a shallow branch above, and below a deeper one enclosing a triangular, unispinose area (Fig. 1). Behind the cervical suture a broad, shallow, longitudinal furrow with 2 or more distant spines appears to be median; it is bordered by a blunt multispinose ridge which is continued a ways along the posterior margin of the cervical suture. Otherwise the spines of the surface are irregularly scattered. The hinder end of the carapace

is missing.

The surface of the first five segments of the abdomen is for the most part smooth (non-tuberculate) and is finely and closely punctate. The fourth and fifth segments have a low, blunt median carina (Fig. 2). The sixth segment has an uneven dorsal surface; its median carina is rough with tubercles, perhaps spine-tipped; on either side just behind the articulation with the preceding segment there is a ridge projecting outward and armed with 5 jointed spinules; further back and nearer the middle are a number of very fine spinules. The pleura (Fig. 1) are separated from the tergum by very uneven ridges; pleura 1, 2, and 6 are longer, in the direction of the axis, than high; while 3, 4, and 5 are higher than long. All are uneven, and rough with tuberculated ridges; 1 is small, short, subtriangular, 2 is broadly rounded, subcircular, 3, 4, and 5 are elongate, subtriangular, more or less falcate, 6 is produced in a triangle in its anterior half. The telson (Fig. 2) is as broad as long, sides arcuate, extremity less so, meeting the lateral margins at an obtuse angle: 5 nearly longitudinal grooves, a deep median one along which the surface is pitted in addition to the fine punctae; on either side another groove convex outward and an outer groove subparallel to the margin. Extremity of telson thin, translucent. The uropods are detached from their base but probably in life do not reach farther back than the telson; the terminal articles are broad-oval; the upper surface of the inner one is concave and there is an indication of a row of spines along the posterior end of the outer half.

Of the appendages a cross-section of perhaps the carpus of the cheliped is

exposed, also portions of two slender legs.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1002ND MEETING

The 1002nd meeting was held in the Cosmos Club Auditorium, February

15, 1930.

Program: W. F. Roeser: Thermoelectric pyrometry. The International Temperature Scale adopted in 1927 by the Seventh General Conference of Weights and Measures was discussed in detail. The full text of this scale is given in Bureau of Standards Journal of Research, vol. 1, No. 4, 1928.

given in Bureau of Standards Journal of Research, vol. 1, No. 4, 1928.

The thermoelectric part of the International Temperature Scale is the fourth such scale used by the Bureau of Standards since 1912. The other three were each described and differences between each of them and the International Scale were given. None of these differences exceed 0.3°C.

The suitability of the copper-silver eutectic alloy was discussed and a value given for it, which is considered good to 0.1°C.

Some difficulties commonly encountered in measuring temperatures were discussed and the conditions stated under which the indicated emf of a number of thermocouples connected in parallel will correspond to the average temperature of the hot junctions.

The general problem of measuring surface temperatures was discussed and two types of contact pyrometers designed and built at the Bureau of Standards

were described in detail. (Author's abstract.)

Discussed by Messrs. White, Tuckerman, and Mueller.

H. T. Wensel: Optical pyrometry.

There is a limit above which we cannot measure temperatures without employing methods based on the laws of radiation. Various laws available for this purpose, the Stefan-Boltzman law, the Wien Displacement law, and the Wien-Planck Distribution law, were briefly discussed.

The International temperature scale above the melting point of gold is

defined by means of the following equation:

$$\frac{1}{\theta} = \frac{1}{1336} + \frac{\lambda \log R}{1.432}$$

Where R is the ratio of brightness at wave-length λ cm. of the radiation from a black body at the melting point of gold (1336°) to the radiation of the same wave-length of a body at the temperature θ °K.

Practical methods of determining R and λ were discussed in detail, and methods of obtaining the value of λ when a filter is used were contrasted with

the use of a spectral pyrometer using a dispersion device.

Examples of the precision attainable with a laboratory form of optical pyrometer were given. Bearing in mind that at 1000°K and wave-length 0.65 micron, a precision of 0.1% in the measurement of the ratio of brightness corresponds to a precision of .004% in the absolute temperature, the precision attainable is 0.1° to 0.2° at 1100°C., 0.5° at 1500°C., 1° at 2000°C. and about 5° at 3000°C. The accuracy, of course, depends on other factors than simply the precision of photometric matching and is somewhat less than the figures given. (Author's abstract.)

Discussed by Messrs. Crittenden, Tuckerman, and White.

Two short informal communications were given by Messrs. White and Tuckerman.

1003RD MEETING

The 1003rd meeting was held in the Cosmos Club Auditorium, March 1, 1930. It was called to order at 8:15 P. M. by Vice President Curtis.

Program: L. S. Taylor: Standardization of X-ray dosage.

In giving X-ray treatments for cancer, it is very necessary to carefully control the X-ray dose given the patient just as the doctor must carefully regulate the amount of a drug that he administers. This is particularly important where it is necessary to give the greatest possible dose of X-rays for, should the dose be too great, burns or more serious injuries might result. Likewise it is necessary for the doctors to use some standard dose so that it may be easily duplicated in all parts of the country and all over the world to measure the dose in the same unit, so that their treatments may be reproduced and repeated. At present many doctors use small portable measuring instruments called dosage meters and it is necessary that these be calibrated accurately in the agreed unit. At the Second International Congress of Radiology, held in Stockholm, Sweden, July, 1928, an international unit of X-ray in-

tensity was agreed upon and called the "r" unit. A series of studies at the Bureau of Standards has led to the establishment of the unit in this country. The method of measurement consists essentially in allowing an X-ray beam to pass between two metal plates, one of which is connected to a high voltage battery and the other to a sensitive measuring instrument. The X-rays cause the air between the plates to conduct electricity so that a very small electric current flows through this air and is measured by the sensitive meter. This small current of electricity is proportional to the intensity of the X-rays. Thus an accurate knowledge of the X-ray dose may be obtained by measuring this electric current. Having thus established the standard, the dosage meters used by all doctors can be calibrated at the Bureau of Standards in the accepted unit. (Author's abstract.)

Discussed by Messrs. Curtis, Humphreys, Priest and Tuckerman. L. B. Tuckerman, S. N. Petrenko and C. D. Johnson: *The strength of*

metal tubing for structural purposes.

Hooke's law, "ut tensio sic vis," states that in an elastic structure the stress is proportional to the strain. This law is approximately valid for sufficiently low stresses but for stresses high enough to cause failure in ductile materials, it ceases to be even a rough approximation.

As a consequence the strength of a structure cannot, in general, be related to the strength of a test specimen of the material by the theory of elasticity based on Hooke's law. It is necessary to resort to experiment, using the

theory of elasticity merely as a qualitative guide.

The necessity of high strength combined with light weight in aircraft structures has increased the demand for accurate knowledge of the relation between the strength of structural tubing and the specified strength of the material.

In coöperation with the National Advisory Committee for Aeronautics, the Bureau of Aeronautics of the Navy and the manufacturers of structural tubing, the Bureau of Standards has for the past few years, been carrying out an extended series of experiments on the strength of the tubing under combined axial and transverse loads.

The test procedure was outlined and the methods of combining the results

into design charts were described.

These methods were partly empirical and partly theoretical, based upon previous work on columns under pure axial load. A full description of the work is given in National Advisory Committee for Aeronautics Technical Note No. 307. (Authors' abstract.)

Discussed by Messrs. Liferock, L. H. Adams, and Humphreys.

OSCAR S. Adams, Recording Secretary.

ENTOMOLOGICAL SOCIETY

417TH MEETING

The 417th regular meeting of the Entomological Society of Washington was held at 8 p.m. Thursday, February 6, 1930, in Room 43 of the new building of the U.S. National Museum. Dr. L. O. Howard, Honorary President,

presided.

Program: Floyd F. Smith: Studies of the black vine weevil.—The black vine weevil, Brachyrhinus sulcatus Fabr., is widely distributed and is occasionally a serious pest of many plants. Although known as a pest of greenhouse plants and of grapes for many years, very little study of the biology and control of this weevil was made until Feytaud carefully observed it for three years in the vineyards of Oleron, France.

The studies reported here by the author extend over a period of three and one-half years—from 1925 to 1929. Observations were made on the life cycle in greenhouses as well as in the nurseries and control experiments were conducted under both situations.

From these studies it is evident that the insect has one annual generation in Pennsylvania. The winter is passed rarely as adults but usually as prepupae or as immature larvae in the soil. The latter begin feeding in March and most of them will reach maturity to pupate with the over-wintering prepupae in May. After about three weeks as pupae the insects transform to adults in the cells and lie inactive for 5 to 10 days during which time the skeleton becomes darkened and hardened. The adults then emerge from the soil in early June and begin to feed on foliage. After four to six weeks, usually in mid-July, they begin to oviposit. The oviposition period usually ends rather abruptly in late August or early September but some eggs may be laid until early October. The eggs laid late in the fall produce larvae which are overtaken by cold weather before attaining full growth. These continue their development in the early spring and may produce adults as late as mid-July. The adults at the end of the oviposition period in the fall seek hibernation quarters and die during the winter except a very few which may emerge the following May. These begin to oviposit in about three weeks and continue, during the second summer, until September. Their early-spring-laid eggs will produce larvae which form prepupal cells in late August and lie inactive until the following spring. A few of these larvae maturing in August may pupate and emerge as adults during the same fall and these will enter hibernation. Out of doors the adults laid from 0 to 488 eggs during the first season. The number varied greatly with the host, fewer eggs being laid by adults confined on strawberry or yellow dock and the greater number by adults confined on primroses or plantain.

The insect may live continually in the greenhouse but probably, in the majority of cases, the adults come into the greenhouse from an outside source and oviposit during July and August. The eggs laid during this period hatch into larvae which mature in November or December as they cut off the roots and burrow into the crowns to the destruction of the host plants which are just coming into bloom for the Christmas market. Should these plants, with the larvae-infested soil, be left on the bench or thrown beneath it as is sometimes done by the florist, the larvae pupate in January or February and emerge about one month later. These adults will begin to oviposit during April or early May on favorable hosts, such as young cyclamen, and continue to lay eggs until September. The adults have laid as many as 1065 eggs during the first season. Normally they seek hibernation quarters, probably outside the greenhouse, and but few emerge in the spring. If confined in cages in the greenhouse these adults will remain sluggish for two or three months but become active and begin to oviposit in December or January. The second period of oviposition usually dwindles during the following midsummer but may continue until September. These adults lived for several weeks after the last eggs were laid and dissection at death showed that no eggs were present in the ovaries. The largest number of eggs laid by a single caged adult in the greenhouse was 1681, and the greatest age of a single adult at death was 816 days. The average number of eggs laid in this series was 1072 and the average age of adults at death was 454 days. The eggs hatch in the greenhouse at extremes of 11 and 22 days, depending upon the temperature,

the average being 15-16 days both in and out of doors.

The prepupal stage may be as short as three weeks at warm soil temperatures and has been known to be as long as eight and one-half months at cool temperatures. Pupation did not take place until the soil temperature exceeded 55°F. Soil temperature at 55–65°F. is apparently the optimum for the development of this insect. At higher temperatures the mortality is very high in the prepupal stage; this is due to the attacks of fungi, Fusarium sp. and Isaria sp. The pupal stage is about 18 days in length with extremes

of 16 and 27 days.

The larvae pass through 5 or 6 instars during their period of growth evidently depending upon the abundance of food. Since molting follows a reduction in the amount of available food the number of instars may be increased to 7. The larvae mature in 72 to 110 days in the greenhouse. A few adults were found to emerge in the fall from early-spring-laid eggs. The shortest period of development, from egg hatching to adult emergence, in the greenhouse, was 116 days while out of doors the maximum was 380 days. The maximum life span may then total 1190 days or three and one-quarter years according to these studies.

Usually the florist, being economical with soil, discards the infested plants and dumps both larvae and soil on the compost heap as soon as he notices the decline of the plants. The larvae have been shown to lie dormant in this situation and to pupate and emerge as adults at approximately the same time as do those developing entirely outside. The adults then merely return to the greenhouse and oviposit during July and August to renew the infestation

without the necessity of some outdoor host.

The adult oviposits by dropping her eggs wherever she may be, but it is

evident that she also occasionally places them in soil or plant crevices.

The larvae during the first 3 or 4 instars feed on the small rootlets and cause no noticeable harm to the plants, but during the later instars growth is rapid and the larvae cut and devour the larger roots and crowns or corms. This accounts for the sudden destruction of the plants which were not suspected of being infested. On woody-stemmed plants the fine rootlets are attacked by the younger larvae but the bark and cambium are devoured by the later stages. Evidence of larval damage to plants in the nursery usually becomes noticeable in April or May while in the greenhouse plants show injury in November or December.

The adults prefer flowers to foliage of a given plant species and will eat out characteristic notches in both. Leaf petioles are also cut and twigs may be girdled. The adults are nocturnal and hide during the day. Their protective coloring blends them into almost any background so that they readily

escape observation.

Feytaud found no males in his studies of *B. sulcatus*, but did not prove, by isolation, that parthenogenesis actually occurred. In the present studies the writer has reared, in isolation, 6 generations of this insect and all produced fertile eggs. No males have been found among the thousands of individuals examined externally or among the 1200 adults dissected. Economically this point is important since the reproductive potential is thus increased in geo-

metrical proportions.

Few parasites or predators have been recorded for this insect. The writer found that skunks, mice, and toads ate the adults. Larvae of a ground beetle (Harpalus caliginosus) were found attacking the larvae of B. sulcatus and readily devoured 2 to 4 larvae per day when supplied with them in confinement. The fungi, Fusarium sp. and Isaria sp. attack the larvae in the greenhouse, especially during the summer months when the soil temperature is high.

Literature contains many notes suggesting materials for control of *B. sulcatus* either in the adult or immature stages. These materials were tested in the present studies and nearly all were found to be ineffective against the insect at dilutions sublethal to the host plants. From the control studies it was found that the mixing of powdered acid lead arsenate in the soil was the only material which proved toxic to the larvae and unharmful to the host plants—cyclamen and primroses. Other plants were found to be severely injured by small quantities of lead arsenate in the soil so that the general use of this material as a soil insecticide can not be advised. To be effective one ounce of this material to one bushel of potting soil should be used. The amount was not found harmful to the cyclamens and primroses, the usual host plants in the United States.

A sweetened, poisoned bran bait, previously recommended for related weevils, was found to be effective against the adult *B. sulcatus* weevils and is preferable to any other material tested if the staining of foliage is objectionable. If not objectionable a dust composed of equal parts of calcium arsenate and of hydrated lime may be used and gives a slightly higher kill than does the bran bait in tests on *Taxus* in the nursery. Probably the bran bait should

be used in the greenhouse and the dust in the nursery.

In these studies tests were made to check on as many host plants as were available. The results point to the probability that B. sulcatus has sometimes been confused with other insects, especially the Fuller's rose beetle (Pantomorus godmani) and other species of the genus Brachyrhinus. The black vine weevil is evidently not a grass feeder, as has been previously suggested, but thrives on several of our grass-infesting weeds such as docks, sorrel (Rumex spp.), dandelion (Taraxicum spp.), and plaintain (Plantago spp.). These plants are sufficiently common to be a potential source of an infestation about any greenhouse and should be eliminated.

The digestive and nervous systems of the larvae and adult, and the reproductive systems of the adult female were discussed. (Author's abstract.)

A number of slides were shown. This paper was discussed by Howard,

BÖVING, WOOD, ROHWER, SPRESSARD, POOS, and CAMPBELL.

Remarks were made on invitation by a visitor, Dr. Frank E. Lutz, Curator of Insects of the Division of Zoology and Zoögeography of the American Museum of Natural History, New York City, who expressed pleasure at being with us, extended greetings from the New York Entomological Society and an invitation to our membership to attend its sessions on the first and third Tuesdays of each month. He also discussed in some detail observations he had recently made on one of the New York "movietone" production companies in making commercial records of the chirping of crickets, and illustrated his remarks by blackboard diagrams of methods of calculating the pitch of a cricket's tone and making comparative analysis of this with vibrations per second of an ordinary piano.

Another visitor, Professor H. J. Reinhard of the A. & M. College of Texas, also was asked to address the society. He referred briefly to some special research work he was conducting in the Museum with Doctor Aldrich on the Tachinidae genus, *Winthemia*, and discussed some of the variations in local problems between entomologists in widely separated sections of the country. He invited all the membership of the society in travel status in

Texas to visit his station.

Professor John Gray, Professor of Plant Pathology and Economic Entomology of the College of Agriculture and Agricultural Experiment Station of the University of Florida, a visitor, on invitation addressed the society,

referred humorously to recent tourist conditions in Florida, and outlined briefly the organization and work of the various scientific organizations in his State. He expressed pleasure at the opportunity to visit Washington and its scientific organizations as he used every opportunity to learn more about what Government and State men are doing. Many of his students expect later on to enter upon Government or State work, and unless properly guided, often have a hard time of it getting started.

L. O. Howard spoke briefly of the lives of F. W. Hutton, Thomas Brown and W. M. Maskell, prominent New Zealand entomologists of the last century. Their lives, he pointed out, were strangely coincidental in some

respects.

Some remarks were made by Dr. W. V. Balduf regarding a recent article by A. Häse, which contains an account of the use of a mite (Tyroglyphus siro) in manufacture of a cheese, Milbenkäse, in Lautenburg, Germany. The curd of cow's milk is shaped into form resembling an O'Henry candy bar; it is dried in the open air, then placed in a jar containing a culture of the above mite. The mites consume the surface superficially, leaving a flaky cover consisting, beside cheese particles, of mite exuviae and mite castings and bodies. After 6 to 12 weeks the cheese is eaten, with the mites intact or after jarring some of them off. Sometimes pathogenic effects are produced in persons eating too much for the first time. Molds do not develop on this cheese, and it is believed that the mites are in some way responsible for failure of the mold to grow. The absence of mold where mites occur is believed by the author to be the reason why mites came to be employed in the manufacture of this cheese. (Author's abstract.)

R. E. SNODGRASS submitted a brief note regarding certain functions of the beak of scale insects and compared their mouth parts with those of some other

Hemiptera.

Mr. Rohwer called attention to the recent infestation of the pink bollworm in the Salt River Valley in Arizona, stating that since the initial discovery of the infestation, which was called to the society's attention at the November meeting, the infested area had been delimited and arrangements were being perfected to clean up the fields. In connection with delimiting the infested area, all the cotton-producing regions in Arizona and California had been carefully scouted. As a result of this survey, it is believed that the present infestation is confined to that portion of Salt River Valley east of Tempe and to a small area on the Indian Reservation near Sacaton. Infestation has been discovered at twenty-five different points in the Salt River Valley and is heaviest in the eastern portion of the valley. In this area 45 per cent of the bolls in some fields were infested.

The non-cotton zone which has been established by the State contains 144,400 acres and extends two miles from the outermost points of infestation. Within the non-cotton zone there are about 35,000 acres which, for the crop of 1929, were planted to cotton. The non-cotton zone is surrounded by a protective, or buffer, zone which extends three miles beyond the non-cotton zone. In this buffer zone restrictions are placed on the date when cotton can be planted. For the crop of 1930, pima, or long stable cotton, can not be planted before April 1. Acala and other of the shorter staple varieties can not be planted before April 15.

The menace this infestation presents to other cotton-producing regions in Arizona and California, as well as the danger of infestation to the main cotton belt of the east, prompted the Department to request funds to undertake clean-up of the cotton fields throughout the non-cotton zone and in

some parts of the buffer area. A joint resolution appropriating \$587,500 for such clean-up passed the Senate today. In addition to this appropriation, the act authorizing Federal participation in compensating farmers, for actual and necessary losses because of the enforced non-production of cotton, has been amended by both the House and the Senate. The amendment reduces the amount of the appropriation authorized and provides full Federal compensation for the crop of 1930, conditioned on the Federal Treasury being reimbursed for one-half of the amount paid. It is hoped that this appropriation for clean-up and the proposed arrangements for compensation for the crop of 1930 will enable the Department to carry out its program and eradicate the pink bollworm from the Salt River Valley.

Mr. Rohwer also referred to previous work on this pest, pointing out that it had been eradicated from considerable areas in eastern Texas and

Louisiana. (Author's abstract.)

J. S. Wade, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

Dr. ALEXANDER WETMORE, Assistant Secretary of the Smithsonian Institution, in charge of the National Museum, has been elected an honorary member of the Deutsche Ornithologische Gesellschaft.

H. G. Ferguson and M. I. Goldman have been appointed assistant secretaries of the Sixteenth International Geological Congress, which will be held in the United States in 1932.

Dr. Remington Kellogg, Assistant Curator, Division of Mammals of the National Museum, is spending two or three months in an examination of the types of fossil cetaceans in various European museums.

M. W. STIRLING, Chief of the Bureau of American Ethnology, recently returned to Washington from Florida, where he excavated a large shell mound near Safety Harbor. He obtained a large amount of skeletal material as well as a good collection of objects representative of the culture of the period.

Miss Frances Densmore, a collaborator of the Bureau of American Ethnology, is spending several weeks in Washington in connection with her studies of the music of the indians.

Miss Julia Gardner has resumed field work on the Tertiary formations of Texas in connection with the proposed geologic map of the State.

Dr. L. W. Stephenson, who is working on the Cretaceous formations near Uvalde, Texas, will return to Washington the latter part of May.

Obituary

HILBERT A. C. JENISON

Early in the morning of his birthday, February 28, HILBERT A. C. JENISON, mining geologist and engineer, for some years a member of the U. S. Geological Survey, died at his apartment in New York.

Of distinguished Irish descent on his mother's (Caulfield) side and of Danish ancestory on his father's side, and with high military records in both families, Jenison was a native of San Francisco. Due to lack of financial resources, much of his education was received at home under guidance of intelligent parents. Meager opportunities were, however, compensated by very unusual precocity and brilliancy of mind. He was far ahead of his school fellows and was most comprehensive in his early reading, with a distinct preference for history and biography. After four and one-half years in the public schools he entered Mount Tamalpais Military School, where he was a student for three years, during which he made an outstanding record.

In his personnel record he is entered as having studied at the University of Washington for two years, and in the following two years at the University of California, where he showed brilliant ability in mathematics and mining geology, though he left the University without thesis and graduation.

Ardently patriotic, he enlisted as a volunteer when the United States entered the World War, and at its close he left the Army slightly disabled and sought a position in the U. S. Geological Survey, in which he was appointed Associate Mineral Geographer in the summer of 1919. In 1921

he was appointed geologist.

While a member of the geologic staff of the Survey (September 23, 1919 to November 27, 1923) Captain Jenison was engaged first in gathering information regarding the copper resources of the Americas and, with D. F. Hewett, in the compilation of the statistics of production of manganese. Later he took over from B. S. Butler the preparation of the annual mineral resources reports covering copper, and this opened the way to a compilation and review of the information regarding world resources of copper, on which a somewhat extensive manuscript was compiled. For this work he was especially well fitted, due to his remarkable memory, keenness of mind, and power of concentration, combined with a marked interest in the economics of the mineral industry. Due to the latter he was, in 1923, prior to his resignation, detailed to coöperate with the Chairman of the Senate Committee on Mines and Mining in the study of the cost of production of silver and its associated metals in the western States.

For a short time after severing his connection with the Survey, Captain Jenison was occupied with commercial examinations of manganese and other metalliferous deposits in North America, in the course of which he was appointed mining specialist on the staff of the Guaranty Trust Company of New York, for which he examined many mining properties in several coun-

tries of Europe as well as in the United States.

In 1921 Captain Jenison married Miss Loree O'Connell, a graduate of the University of Nebraska. She, together with his parents and a sister, resident in California, survive him. Captain Jenison was buried in Arlington National Cemetery March 3, 1930.

DAVID WHITE.

CLAUDE ELLSWORTH SIEBENTHAL

Dr. Claude Ellsworth Siebenthal, specialist on lead and zinc for the U. S. Geological Survey, died at Daytona Beach, Florida on March 1 after a long illness.

Both as geologist and economist Doctor Siebenthal received wide recognition as an authority on lead and zinc. Born at Vevay, Ind., April 16, 1869, a descendent of John Francis de Siebenthal, a founder of Vevay and Switzer-

land County, Ind. (1801), he studied at Indiana University (1889–1891), was graduated from Stanford University in 1892, and received the degree of A.M. there in 1893. From 1889–1893 he also served as assistant geologist on the Arkansas Geological Survey under Dr. John C. Branner, later President of Stanford. He then returned to Indiana, serving on the State Geological Survey until 1897, where with T. C. Hopkins he prepared a report on the Indiana oolitic limestone. He was a fellow at the University of Chicago 1897–1901.

He joined the U. S. Geological Survey in 1901 and after several seasons devoted to studies of ground waters in Wyoming and Colorado was transferred to the mineral fields of the Mississippi Valley. In 1907 he was placed in charge of investigations relating to lead and zinc and in 1915 published his classical report on the origin of the lead and zinc deposits of the Joplin district. From 1907 until 1924 he was responsible for the Survey's annual reports on lead and zinc and contributed several articles to the technical press and the Zinc Institute on the economics of those metals.

He was a member of the Geological Society of America, the American Institute of Mining and Metallurgical Engineers, local scientific societies, and

the Cosmos Club.

Doctor Siebenthal was an effective influence for the best in human relations, through the manifestation of his genuine interest in his fellows generally, and particularly in those afflicted by illness or adversity. He was distinguished among his friends for an innate gentleness and courtesy, and a keen sense of humor which continually enlivened his conversation.

In 1904 he was married to Miss Myrtle Madden of Olney, Ill., who, with

his sister, survives him.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

ANNOUNCEMENTS OF MEETINGS

Tuesday, May 20 Wednesday, May 21 Saturday, May 24 Wednesday, May 28

The Anthropological Society
The Medical Society
The Philosophical Society
The Geological Society
The Medical Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS ORIGINAL PAPERS

Botany-Haitian mosses collected by E. C. Leonard. R. S. WILLIAMS	Page 173
Paleontology—Hoploparia westoni Woodward. Mary J. Rathbun	180
Proceedings	
The Philosophical Society	183
The Entomological Society	185
SCIENTIFIC NOTES AND NEWS	190
OBITUARY: HILBERT A. C. JENISON, CLAUDE ELLSWORTH SIEBENTHAL	190

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



OF THE



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN
BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves. Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This Journal, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered

serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers

bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$ 2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3.00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5.00	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (13, 14, 15: July, August, September)	

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies a filiated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

June 4, 1930

No. 11

PHYSICAL GEOGRAPHY.—Peat profiles in the Puget Sound Basin of Washington.¹ Alfred P. Dachnowski-Stokes, U. S. Bureau of Chemistry and Soils.

T.

The purpose of the present paper is to set forth the relationship between peat materials, profile features, and certain events recorded in peatlands of the Puget Sound Basin. The desire to study further the evidence of recent changes of sea level observed in the Delta peatlands of California (6) led to a continuation of field work in Washington, with the view to compare and if possible to connect it with the evidence obtained from peat deposits in Florida (4), North Carolina (3) and Maine (5). This paper is chiefly an account of the order of occurrence of the different layers of peat in profile sections because a record of this kind enables coördination between peatlands and represents also the history of the succession of past vegetation and of the former conditions of the region, in part very unlike those now existing. A general description of the present vegetation of these areas, as well as their environmental conditions is to be published elsewhere in this journal by Rigg.² The agricultural practices and purposes and the economic aspects of the different types of moors studied it is hoped to set forth in another paper.

The geologic history of the Puget Sound Basin has been reported by several writers (1, 7, 14) and is summarized in the Tacoma folio No. 54 of the Geologic Atlas of the United States (15). Puget Sound occupies

¹ Received April 23, 1930.

² The soundings and general examination of most of the peat areas were carried out together with Prof. G. B. RIGG of the Department of Botany, University of Washington, Seattle, and with Messrs. C. H. BERGSTROM and C. W. NORTON of the County Extension Service. The author takes this opportunity to express his appreciation and indebtedness for the coöperation and helpful assistance rendered.

an ancient depression parallel to the Pacific coast. Mountain ranges lie on either side of the trough-like depression, the Olympic Mountains on the west and the high Cascade Mountains on the east.

The geography and the soils of this region have been described in a reconnaissance soil survey made by Mangum (8). The principal topographic features are peculiar in that they fall naturally into two distinct sections. The major depressions consist partly of a branching system of land-locked, narrow lakes and sounds and partly of valleys of the larger streams, flowing in ill-defined channels and emptying into Puget Sound. The elevations are ridges of the plateau type, essentially flat topped, bounded by rather steep slopes, and standing out as islands and peninsulas with the long axis trending north and south. Lakes occupy many depressions upon the plateaus. It is probable that the principal topographic features conform to an older topographic relief and are a part of the sequence of events which developed during the Glacial period. Willis and Smith (15) state that along many stretches of Admiralty Inlet in the Puget Sound "there is a terrace about 20 feet above the present sea level. In some places it appears to be a wave-cut bank; and elsewhere it is a delta terrace built out by a tributary system. This 20 foot terrace probably represents an earlier relation to the sea level, when it stood 20 feet higher against the land than it now stands. Other benches have been observed varying from 60 to 100 feet above sea level." Interpreting a group of facts Willis and Smith infer that since the last Glacial period the land stood high enough above sea to permit rivers to cut as deeply as the bottom of the sound, and that the land has subsided, submerging the valleys to the present depth. According to Kimball (7) the postglacial crustal movements have been an elevation and a subsidence followed by a more recent re-elevation.

The nearness of the high mountains condensing the moisture of the prevailing western winds, and the warm Japan ocean current of the northeastern Pacific are the chief factors which profoundly affect the climate of this region. Although Puget Sound lies in the latitude of Newfoundland, it has been described as having a mean temperature which corresponds to a latitude like that of Chesapeake Bay on the Atlantic Coast. The rainfall varies but the averages range probably from 40 to 55 inches per annum. The precipitation is distributed throughout a mild, rainy winter season, with a cool summer of little rainfall. As a result of the equable, maritime climate many plants which normally inhabit cold or humid and even arid climates have migrated into the Puget Sound Basin. A northern vegetation merges by a narrow transition belt into the southern zone of plant life and con-

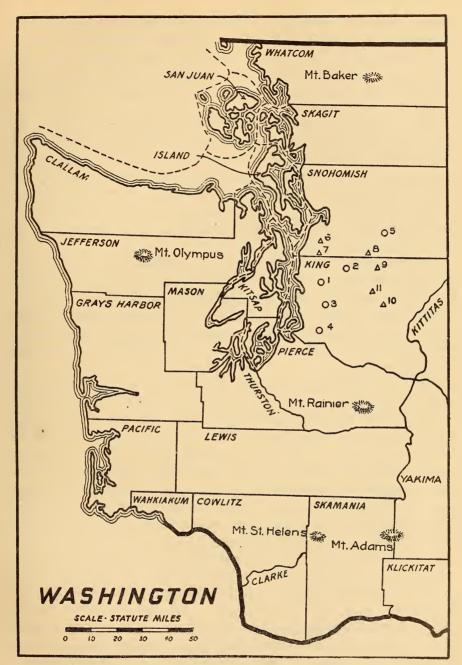


Fig. 1.—Map showing the location and numbers of peat-profile soundings in the Puget Sound Basin of eastern Washington and the principal volcanic peaks that are now extinct.

sequently the overlapping of northern and southern species is more extensive in this region than in any other part of the Pacific Coast.

In order to describe the moors or peatlands of the Puget Sound region and to establish relationships between them, it will be necessary to state briefly the conspicuous features of general significance which can be used for grouping areas of peat.

The correlation of the details of different peatlands or moors depends upon the recognition of certain natural geographic relationships of the region, upon topographic relief and drainage conditions, and upon the character and sequence of the different layers of peat derived from corresponding vegetation units. Some of the outstanding differences between classes of peat material and the structural features of profile sections have been described in Bulletin 1419 of the U. S. Department of Agriculture.

Conforming with the procedure of the United States Soil Survey, the separation of peatlands into type units is based on the texture and botanical composition of the peat materials at the surface, and on the essentially similar sequence of layers and morphological characteristics in the vertical cross-section from the surface to the underlying mineral substratum. These divisions usually bear a geographic or locality name.

When the stratigraphic and morphological features of similar peatland profiles indicate a sequence most closely associated with the layer of parent peat overlying the mineral substratum, the vertical crosssections constitute units of series. The serial units are differentiated mainly on the basis of the shape and character of the bottom topography in intimate relation to the water table, drainage conditions, and corresponding features in the layers of peat producing variation in color, and stage of decay. The series are grouped, therefore, into units beginning as lakes, as marshes, or as forests; they are designated by the terms *limnogenic*, *telmatogenic*, and *terrestrogenic*, to indicate the origin and mode of development of the respective profiles as well as the additional changes which express successions in the vegetation and the degree and depth of decomposition of the respective peat layers.

Series of peatland profiles are differentiated also on the basis of physical, chemical and microbiological characteristics which they have in common under the influence of environmental processes active in different regions and climates. The concentrating effect of evaporation in arid climates, the diluting and leaching effect of rainfall in humid regions, often completely removing certain constituents from the surface of the profile, the solutes contributed with ground- and

flood-waters, very different in their saline composition from tellurial waters, lead to characteristics that can be given a regional expression. The wide range in cold, temperate, and tropical environment under which peatlands originate and become transformed from the virgin condition; the stages marked by profile features associated with decomposition and the direction in which the process is proceeding, these require recognition of geographic relationships. No names have yet been suggested to designate the characteristics of this group of serial units because they are not clearly enough defined, owing to the lack of accumulated facts regarding them.

The several units of moors are further grouped on the basis of relationships associated with differences in the regions dominated by major divisions of the natural vegetation and by the peat soils supporting them. Although peat profiles show in their past history much variation in the character of the plant communities that were supported from time to time and succeeded one another as stages, yet the natural vegetative cover is generally the expression of interrelations with many factors in the environment. It provides often a better basis for regional distinctions between moors than any one set of factors and processes. In their present development the peatlands or moors of different latitudes are characterized by dominant forms of vegetation units, vast in extent and of great permanence, such as tundra, forest, shrub, and marsh. However the corresponding larger units of peat soils have not yet been defined or correlated because ecological and pedomorphic data have not been fully worked out and suitable concepts of vegetation units are not yet well established.

A final grouping is based on the reaction of peatlands in different regions, regardless of the character of the parent peat layers in the profile section. The terms *eutrophic* and *oligotrophic* have been used for regional groups of moors to designate more specifically the presence or absence of certain mineral salts, including carbonate of lime and essential plant food constituents in the peat soil solution.

Enough is known to indicate that a preliminary scheme of classification can be used for moors or peatlands such as that worked out by Marbut (9) for mineral soils. Categories corresponding in their major aspects to Marbut's divisions should be practicable for peat soils if they are accepted on the same basis of inherent profile characteristics and general environmental relationships. Regional investigations along these lines are being continued.³

³ For a map showing regions in which the major groups of peatland occur in the United States, see Journ. Amer. Soc. Agronomy 22: 352-366. 1930.

With this viewpoint in mind the peatlands in the Puget Sound Basin may be described separately as follows:

II

PROFILES OF PEATLANDS IN THE VALLEY FLOOR

A number of lakes lie scattered over the valley floor, of which the largest are Lake Washington and Sammamish Lake, occupying elevations of 22 and 35 feet above sea level respectively. Lingering tongues of stagnant Vashon ice probably occupied hollows or valleys of earlier origin. Subsequent melting of the buried ice left the depressions occupied by water which was later ponded by alluvial deposits of drift. Streams and tributaries flow into the lakes, forming a connected drainage system which empties into the Puget Sound.

The water supplies from the Duwamish, Puyallup, and Snohomish Rivers reported by Byers carry only a small amount of mineral matter in solution (2). Van Winkle (14) states in his account of the average chemical composition of the river waters, that "all the waters belong to the calcium carbonate type,—that is, the alkaline earths calcium and magnesium, and carbonates or bicarbonates predominate. The content of sulphate is not large and chlorine is very low. Silica, though not present in very great quantity, consitutes a large proportion of the mineral matter in such dilute solutions. Iron is generally so low as to be almost inappreciable."

Fine silt from the glaciers of Mount Rainier is occasionally laid down close to the main river channels. By this means natural dikes are being built up which in places are bordered by bodies of quiet water, swamp and marsh. Large areas of the valley floor are subject to inundation by spring and autumn rains. Although the water carries salts in solution which serve as plant food constituents, the river beds being higher than the plain present problems of flood control.

The primeval vegetation in the valleys was a forest of cedar (*Thuja plicata*), white fir (*Abies grandis*) and deciduous shrubs such as alder, willow, maple and other associates. The wetter ground was inhabited by extensive marshes resembling the "tule" land of southern Oregon and California. They are of rather uniform floristic character in which reeds, tule, cat-tail, sedges, buckbean, arrow grass, burr reed, marshlocks and aquatic plants form the chief components.

The peat soils at the surface may have a loose, gray brown mulch but the subsurface material varies in texture from a woody-fibrous sedge peat or a light-brown, coarse, fibrous-matted to a heavier type of sedimentary-fibrous sedge and reed peat which contains a high percentage of diatomaceous earth and silt at a shallow depth below the surface. Truck gardening has become the important type of peatland agriculture. Most of the valley land between Seattle and Tacoma, including large areas of peat, is now generally cleared, improved, and traversed by railroads.

1. The Mercer Slough type profile

About 7 miles east of Seattle, on the eastern shore of Lake Washington, is Mercer Slough. The form and area of the peat deposit are shown on the Seattle topographic sheet of the United States Geological Survey. It lies in T. 24 N., R. 5 E., along sections, 5, 8, and 17, and is reached from Seattle by a circuitous road around the northern end of Lake Washington. The peat deposit is a grass-sedge lowmoor and occupies a flat but gently sloping depression, limited by relatively steep banks. It is about half a mile wide and contains a finger-shaped, narrow lake extending northward and in turn passing into a small stream that flows down from the plateau. Southward the peat area continues along the margin of the lake toward Newcastle Landing.

The stratigraphic features of the peat profile are comparatively simple. Broadly speaking the cross section consists of two layers. The upper layer is yellow-brown, poorly decomposed owing to a high water table, and is composed of matted, fibrous peat from interwoven rhizomes and roots of tule (*Scirpus* sp.), sedges (*Carex* sp.), and reeds (*Phragmites* sp.) In thickness the layer is about 8 to 9 feet and lies superimposed upon a basal layer of grayish-brown, finely-divided sedimentary peat. This, in turn, is underlain by gray sand at the depth of 43 feet below the present surface.

In morphological detail of structure the Mercer Slough peat profile presents some interesting facts.

The organic material at the bottom is firm, dark-brown, in a compacted and nearly dry condition, and sharply demarked from an overlying sheet of cream-colored volcanic ash at the 40 foot level. In its early postglacial history Lake Washington and vicinity must have received a large amount of pure volcanic ash which fell directly into the lake and brought to a close the accumulation of peat from the older vegetation growing at the shore. Pressed by the accumulation of later masses of peat above, the ash cover now measures a thickness from 3 to 8 inches and extends for miles, varying but slightly in thickness in different areas of peat. It was probably ejected from one of the craters of the Olympic Mountain range.

Three bands of soft, sedimentary peat are encountered with a moderate admixture of fibrous tule and reed material at depths of 14 and 17

feet, and between the 20 to 24 foot level. They alternate with diatomaceous sedimentary material that probably relates to conditions in which small forms of plankton life multiplied and developed more rapidly than the larger semi-aquatic marsh plants.

At a shallow depth of about 8 inches below the surface, the partly decomposed tule-reed peat is underlain by a thin band of sphagnummoss peat. Islands of mosses appear to have followed a shrub stage, the remnants of which are a black woody debris, charred by fires and derived from ericaceous heaths such as *Ledum* sp. The band of moss peat is not extensive but forms lenses and in places overlies a thin layer of diatomaceous sedimentary peat. At depths of 7 and 9 feet below the surface an admixture of darker partly decomposed woody material is encountered. These variations are probably the result of local changes in water level. The plant remains are fresh-water forms, and throughout these changes the waters appear to have generally remained fresh rather than brackish or salty.

2. The Redmond peat profile

The Redmond record was obtained at the north end of Sammamish Lake in an area under cultivation in lettuce, located in T. 25 N., R. 5 E., section 2. The profile is similar to the one encountered at Mercer Slough and consists of two layers. The surface layer is partly fibrous, more or less decomposed reed-sedge peat over a band of diatomaceous sedimentary material below the surface 14 inches. Between the 3 and 10 foot levels the material is composed of fibrous yellowish-brown matted tule-reed peat, which contains at the 6 foot level a thin band of plant remains from hypnum mosses and at the 7 and 9 foot levels a quantity of partly decomposed woody fragments from deciduous shrubs, such as alder and birch.

The basal layer of finely divided sedimentary peat extends to a depth of 14 feet below the surface and corresponds in character to the plant remains which accumulated in Lake Washington. A bluish-gray find sand forms the underlying mineral substratum. An alternation of diatomaceous material is lacking and no sheet of volcanic ash was encountered. Although there is no interruption or change in the sequence such as that which marked the conditions at Lake Washington, it is inferred that the sedimentary peat at both localities is the same and was laid down under corresponding conditions. However, during its earlier period the valley floor of the Sammamish was being covered by deposits of sand and silt which the water carried at times of overflow. Eventually depressions formed in which water collected

and stood for long periods. The deeper water was filled with organic debris from hydrophilous vegetation until the mud flats became exposed, and reed and sedge marshes began to flourish in the drier portions of the basin. The bands of diatomaceous material at the shallow depth below the present surface as well as the woody material at the greater depths indicate that during the period of fibrous peat formation the depth of water changed and was accompanied by well-marked differences between plant communities, just as at Lake Washington.

3. The Renton type profile

At a point where the Duwamish and Cedar Rivers form a broad alluvial plain, deltas of sand occur at low levels along the eastern edge of the valley. They are bordered by an ill-defined swamp of shrubs and trees much of which is now under cultivation. One of the oldest agriculturally developed areas of shrub moor lies about 3 miles south of Renton in T. 23 N., R. 5 E., section 30. It may be reached from Seattle by railroads and electric car lines.

The peat layers of the Renton profile appear in a two-fold sequence and were observed in exposures along open ditches. Soundings obtained about 50 feet west of the main highway gave the following cross-section: The cultivated surface material consists of gravishbrown, crumbly, somewhat woody and silty sedge-reed muck, grading sharply into a brown, fibrous, compacted reed and sedge peat which contains rhizomes of Equisetum sp. The layer is usually found overlying a band of bluish-gray silt in which occur diatoms and rootchannels stained vellow from iron salts. The mineral material rests upon a layer of brown woody-fibrous sedge-and-reed peat and contains the plant remains from species of tule and Equisetum. Irregularly distributed are logs of timber which may be driftwood or may indicate the occurrence of wooded islands in a wet marsh. layer is essentially sedimentary peat material derived from aquatic plants and contains diatoms. The deposit is relatively shallow and usually about 5 feet thick. It rests on gray compact fine sand.

4. The Auburn peat profile

In the outer portion of the delta formed by White and Green Rivers, a deposit of peat occupies an isolated shallow water basin. It forms a divide with two divergent creeks, one flowing northward and the other southward. The area of peat is under cultivation, producing a variety of vegetables. It is located in T. 21 N., R. 4 E., section 23, about 1 mile southwest of Auburn near the western bank of the valley floor.

In stratigraphic features the profile resembles the Renton peat. The upper portion is generally well decomposed grayish-brown diatomaceous tule-reed muck and contains at the lower level woody fragments from conifers and deciduous shrubs. The basal portion of the profile consists of sedimentary diatomaceous peat and overlies a compact gray sand, somewhat clayey, containing occasionally ferruginous minerals. The deposit averages probably between 3 and 4 feet in thickness. The band of silty diatomaceous material corresponding in character to that near the surface at Renton, is missing or probably worked over and mixed by cultivation.

5. The Monroe type profile

Areas of peat occupy the valley floor along many stretches of the Snohomish River. The depth of these shrub and tree moors can not be inferred; it may be considerable. A main excavation in T. 27 N., R. 6 E., section 1 southeast of Monroe, afforded a considerable length of exposure for measurement indicating a three-fold sequence in the profile. The area is under cultivation, chiefly head lettuce being grown for eastern markets. The following features were noted in exposed cross sections averaging 3 to 4 feet in thickness.

The upper ten inches consist of cultivated dark grayish-brown largely decomposed woody sedge-and-reed muck. This overlies a yellowish-brown compacted, coarsely fibrous and matted tule-reed peat containing flattened root-stocks of water lilies, arrow-grass, seeds of buck bean and others and a thin seam of sandy clay at the 18-inch level below the surface. The bed of mineral material usually directly overlies brown to dark-brown fibrous tule-reed peat, but a sharp separation from the latter is not always in evidence. A layer of woody peat with cedar and fir stumps in situ attains a thickness of 6 to 10 inches and forms a well defined stratum between levels of 26 to 32 inches below the surface. The basal layer is greenish-gray silty and clayey sedimentary peat in which are embedded rhizomes of several species of Equisetum, with roots of marsh plants extending downward into greenish sand below.

III

PROFILES OF PEATLANDS ON THE PLATEAUS

The plateaus comprise the greater part of the Puget Sound region. They are comparatively level to rolling uplands and contain depressions at irregular intervals which represent former basins of lakes and ponds. The natural drainage of the peat areas of kettle-hole topography is usually very poor and the water holds as a rule only small amounts of mineral salts in solution which serve as plant food. The broader depressions are drained by small streamlets flowing in a tortuous course.

Although the peat areas are quite disconnected and miles apart, they have very much the same character of surface vegetation. The plant communities are northern in range and consist chiefly of a ground cover of sphagnum mosses with sundew and cranberry, clumps of ericaceous heaths such as swamp laurel, labrador tea, and a dwarf birch (Betula glandulosa). A detailed account of this type of vegetation has been given by Turesson (13) and Rigg (10). A domed surface or "highmoor" contour is only very slightly evident in one or more places.

The extinction of the small ponds in sphagnum moors is usually accomplished by filling with fine flocculent organic debris forming sedimentary peat. The material is made up of ubiquitous forms of plankton and fragments derived from the encroachment of a floating margin of semi-aquatic vegetation. The plant communities representing submerged or floating stages in the open water are dominated by pond weeds, bladderwort, water lily and water shield. The shore is occupied by purple marshlock (Comarum palustre) buck bean (Menyanthes trifoliata) and sedges whose strong fibrous rhizomes afford a frame-work for the support of mosses growing forward as floating islands. Near the rolling hills and ridges surrounding these depressions is the wooded portion of which the characteristic trees are cedar, fir, scrubby hemlock (Tsuga heterophylla) and occasionally Sitka spruce between mosscovered hummocks. They are fore-runners of the evergreen conifer forest.

The surface peat soils are mainly poorly decomposed spongy-fibrous sphagnum-moss peat. The results of the analyses reported by Rigg (11) and Thompson et al. (12) indicate that both the water and the moss peat of the bogs studied appear to be as leached and acid as the class of similar peat materials of the northeastern United States.

No agricultural use is made at present of these deposits and little or no study has been made of the differences of podsol-like characteristics developed in the underlying mineral substratum.

6. The Ronald type profile

The area occupied by the Ronald bog lies in T. 26 N., R. 4 E., section 8, of Snohomish County. This moss moor is not shown on the

Seattle topographic sheet. It is evidently a broad depression occupied by a three-layered accumulation of peat nearly 26 feet thick on a bed of drift sand and clay.

Examining the nature of the profile from the bottom upwards it appears that an outlet of the former lake was established relatively early. This is confirmed by the thin layer of sedimentary peat which averages only 3 feet in thickness. Diatomaceous material overlies the sandy substratum and an olive-brown colloidal detritus is found in the upper portion of the basal layer.

The course of development continued through a stage of plant succession no longer represented on the mainland at present. This is seen from the layer of yellow-brown poorly decomposed hypnum-moss peat. The plant remains accumulated to a thickness of 4 feet and overlie the lower layer of amorphous sedimentary peat.

From the stage of predominating hypnum mosses the area became subsequently a marsh inhabited by reeds, tule, and sedges. The peat material derived from them is coarsely fibrous, brown, matted to felty, and only partly decomposed. The thickness of the layer is nearly 16 feet and bears witness to accumulation over a considerable period of time.

A sheet of volcanic ash several inches thick found about 9 feet below the surface, denotes a critical stage in the history of the region. It does not appear, however, that the original flora had been wholly destroyed by the heavy fall of ash which covered the surface of the ancient marsh. The plant remains above the bed of volcanic ash indicate that the vegetation survived under the conditions following the volcanic activity. The soundings are not sufficient to indicate the direction of the wind-blown ash but the eruption was situated probably to the west on the coastal range of mountains.

Following the marsh stage, the course of development culminated in the invasion of sphagnum mosses. The surface layer of peat consists of over two feet of reddish-brown fibrous moss peat in which are embedded roots of heaths. A thin seam of black charred organic material separates the moss peat from the underlying sedge peat. The exact cause of the fire is difficult to conjecture. The replacement of the sedge marsh by the sphagum mosses denotes changes in the level and character of the ground water. The mosses succeeded in suppressing the marsh plants and established themselves in relatively recent times.

7. The Esperance type profile

The Esperance bog is an area of peat near the boundary line between Snohomish and King Counties and is located in T. 27 N., R. 4 E., section 31, south of the Ronald bog. It surrounds a small pond of open water.

The most striking feature of the profile is the complete absence of any layer of sedge or reed and tule peat. Floating mats of sphagnum mosses, supported by rhizomes of a few sedges and by the branches of ericaceous shrubs, have reached out to the open water. Test borings were made near the margin of the pond. They indicate that a nearly pure growth of sphagnum mosses, sinking down by continual growth, has filled the water basin with loose, soft and spongy-fibrous moss peat to a depth of nearly 20 feet. Methane gas was observed to escape from various levels below the surface. The moss peat grades more or less sharply into oozelike diatomaceous sedimentary peat 12 feet thick at the point examined. The mineral substratum varies from bluishgray clay to gray sand.

The occurrence of a sheet of volcanic ash at a depth between the 28 and 29-foot level is of interest as indicating the former extent of the ash cover. The volcanic material is of the same color, composed of similar fine-grained minerals resembling crushed glass, and is seemingly related to the ejected material in peat profiles north and east of this locality.

8. The Hooven peat profile

The Hooven bog is another one of many typical "kettle hole" moss moors in the Puget Sound region. The peat area is shown on the Seattle topographic sheet, and lies about 2 miles southwest of Maltby in Snohomish County, in T. 27 N., R. 5 E., section 35. The general shape of the pond in the bog is circular. It has neither an inlet nor outlet. In its general aspects the zonal arrangement of the plant communities is very much like that described above; submerged and floating stages with many species of aquatic plants merge with the encroaching shore-line vegetation, and the zone of sphagnum mosses together with the ericaceous associates and clumps of shrubs continues into the boggy woodland of evergreens.

The maximum depth of the test borings exceeded 28 feet. The morphologic features of the two-layered water-logged profile bear the closest resemblance to the cross section of the Esperance bog. The upper layer is a relatively pure reddish to yellowish-brown spongy-

fibrous and poorly decomposed sphagnum-moss peat. The lower layer consists of sedimentary peat which contains numerous diatoms and a sheet of volcanic ash between the 23 and 24-foot level below the surface. The underlying mineral substratum is sand and clay.

9. The Cottage Lake type profile

The location, form, and dimensions of this area of peat are shown on the Seattle topographic sheet in T. 26 N., R. 6 E., section 17 of King County. It is drained by a small streamlet emptying into Sammamish Lake. A shallow excavation has been dug just west of the highway, making a section about 2 feet deep and over 50 feet square.

The excavation and additional soundings show that this portion of of the peat area consists of a four-layered profile. The surface layer is composed of 6 feet of brown fibrous sphagnum-moss peat penetrated by roots and stems of woody perennials. Alternating bands and thin streaks of dark partly disintegrated moss peat are of frequent occurrence and the material is somewhat more compact toward the lower level.

There appear to be no stumps except in a single layer of woodyfibrous peat which contains partly decayed logs of fallen and submerged timber between 6 and 7 feet below the surface.

Underlying the layer of woody-fibrous peat follows a brown to yellow-brown fibrous layer of tule-reed peat 8 feet thick which emits methane gas at different levels. In places the sounding instrument penetrates thin beds of woody material which represent the remains of alder thickets and ericaceous shrubs; they indicate temporary drier stages of the marsh.

A thin sheet of volcanic ash lies near the bottom of the tule-reed peat, about 15 feet below the surface.

The underlying basal layer consists of olive-green diatomaceous sedimentary peat. At a considerable distance below, approximately at the 25-foot level, appears a second sheet of volcanic ash overlying a firm olive-brown flocculated organic sediment. The bottom is clay and is reached at a depth of 41 feet.

10. Lake No. 12 peat profile

The typical occurrence of the four-layered sequence in the Cottage Lake peat profile may be observed also in the peat area bordering Lake No. 12 east of Auburn in T. 21 N., R. 7 E., section 7 of King County.

Soundings about 100 feet east of the western border of the peat area yielded complete sections for detailed comparison.

There are resemblances in the upper layer of sphagnum-moss peat and in the underlying woody material with its stumps of conifers which bear evidence of fire, and their later disappearance and burial by the invasion and establishment of sphagnum mosses.

From the 8 to the 21-foot level of the cross section is a massive layer of sedge-and-reed peat with beds of hypnum-moss peat near the 15 to 17 and the 18 to 20-foot levels. A thin sheet of ochreous-yellow mineral occurs in the fibrous sedge peat at the 14-foot level, which must have been washed in by the action of water. Over the top section of the mineral material sedimentary organic debris is embedded in fibrous plant remains derived from sedges.

The basal layer is sedimentary diatomaceous peat and underlying it is light gray, compact sandy clay.

11. Evans Creek type profile

This area of peat is a heath moor with an open growth of conifers. It lies southeast of Redmond in T. 25 N., R. 6 E., Section 22 of King County, and is traversed by Evans Creek which empties into the northern end of Sammamish Lake.

Test borings made south of the highway show that the cross section presents a three-fold sequence of peat layers. The upper layer is 6 feet thick. It consists of a thin cover of dark-brown largely decomposed sphagnum-moss peat containing dry leaves of heath shrubs, charred debris from occasional fires, and slender rootlets of the growing surface vegetation; this grades sharply into brown to yellow-brown, spongy-fibrous, more or less poorly decomposed moss peat in which water stands approximately 18 inches below the surface. Below the moss peat follows a layer of woody-fibrous dark-brown heath peat, 1½ to 2 feet thick, in which are embedded coarse fragments of woody material from conifers, and a large proportion of partly fibrous sedge peat. Obviously at some time before the sphagnum mosses established themselves, heaths such as Ledum, Kalmia, and islands of scrubby conifers, were growing upon a thin mat of sedges that had closed by encroachment a senescent lake. The basal layer is diatomaceous sedimentary peat underlain by coarse gray sand. The total thickness at the points sounded measures 13 to 15 feet. A close examination showed no evidence of the presence of seams or sheets of volcanic ash.

SUMMARY

- 1. In the Puget Sound region two different groups of peatland or moors can be distinguished. Both arise and develop from an initial aquatic vegetation, followed by marsh-plant communities; both may culminate in the coniferous climax forest of the region. In other respects, however, there is no parallelism between the two groups. The first group continues in so far as the marsh stage is concerned and may be succeeded by a mixed deciduous-shrub and conifer-tree growth. The second group deviates from the first one by the stage developing from the spreading of sphagnum mosses which eliminate and ultimately supplant both the marsh and shrub vegetation units.
- 2. Pedologically the areas of peat may be broadly divided into two groups and 7 types. In the first group are the relatively productive mesotrophic lowmoor peatlands which have fibrous or woody-fibrous reed-and-sedge peat at the surface. They occupy the broad valleys of streams in which temporary floods occur during the wet seasons favorable to a luxuriant growth of herbaceous grasses and sedges and ligneous deciduous-shrub vegetation. The peatlands are characterized by two- and three-layered limnogenic peat profiles. In the second group are the comparatively unproductive highly acid oligotrophic areas of peat which contain a surface layer of fibrous sphagnum moss peat in varying thicknesses. They occupy depressions upon rolling uplands into which water entered of necessity by rainfall and seepage and consequently remained deficient in the mineral salts that are so effective in the flood plain. The peat areas are moss-and-heath moors characterized by two-, three-, and four-layered, limnogenic peat profiles, having a high water table.
- 3. The deeper depressions show evenly distributed sheets of pure cream-colored volcanic ash which forms a well defined and sharply separated cover over the plant remains of the remoter period. The ash cover extends for miles and must have fallen directly upon the ancient lakes and marshes. It did not bring to a sudden close the vegetation of that period; the same variety of forms and the same succession of generations of plants appear to have continued in the open water basins and marshes.

The layer of volcanic ash seems to diminish in thickness in an east-ward direction and suggests the presence of active volcanic vents along the western border of the Puget Sound Basin from which showers of erupted material were drifted by the action of prevailingly westerly winds. The data at hand are not sufficient to place in their proper

chronological order the sheets of volcanic ash recorded at different depths in the widely separated peat deposits.

4. No evidence has been obtained in the profile features of the Puget Sound peat areas to indicate a sinking of the land. The conditions appear to be favorable for assuming an appreciable re-elevation in geologically recent time.

LITERATURE CITED

- Bretz, J. H. Glaciation of the Puget Sound region. Wash. Geol. Surv. Bul. 8, 1913.
- Byers, H. G. The water resources of Washington. Wash. Geol. Surv. Bul. 1, PartV: 1-11. 1901.
- 3. Dachnowski-Stokes, A. P. and Wells, B. W. The vegetation, stratigraphy and age of the "Open Land" peat area in Carteret County, North Carolina. This Journal 19: 1-11. 1929.
- 4. Dachnowski-Stokes, A. P. Peat profiles of the Everglades in Florida: the stratigraphic features of the "upper" Everglades and correlations with environmental changes. This Journal 20: 89-107. 1930.
- DACHNOWSKI-STOKES, A. P. Peat profile studies in Maine: The South Lubec "heath" in relation to sea level. This JOURNAL 20: 124-135. 1930.
- 6. Dachnowski-Stokes, A. P. Peat profiles of the Delta Land of California. Proc. and Papers Second Internat. Congress Soil Sci., U. S. S. R. 1930. In press.
- 7. Kimball, J. P. Physiographic geology of the Puget Sound Basin. Am. Geol. 19: 225-237, 304-322. 1897.
- 8. Mangum, A. W. Reconnaissance soil survey of the eastern part of the Puget Sound Basin, Washington. Field Operations of the Bureau of Soils, U. S. Dept. of Agric. Eleventh Report (1909): 1517-1600. 1912.
- 9. MARBUT, C. F. A scheme for soil classification. Proc. and Papers First Internat. Congress Soil Sci. 4: 1-31. 1927.
- Rigg, G. B. Some Sphagnum bogs of the north Pacific coast of America. Ecology 6: 260-278, 1925.
- 11. Rigg, G. B., Thompson, T. G., Lorah, J. R., and Williams, K. T. Dissolved gases in waters of some Puget Sound bogs. Bot. Gaz. 84: 264-278. 1927.
- 12. Thompson, T. G., Lorah, J. R., and Rigg, G. B. The acidity of the waters of some Puget Sound bogs. Journ. Am. Chem. Soc. 49: 2981-2988. 1927.
- Turesson, G. Lysichiton camtschatcense (L) Schott, and its behavior in sphagnum bogs. Am. Journ. Bot. 41: 189-209. 1916.
- 14. Van Winkle, W. Quality of the surface waters of Washington. U. S. Geol. Survey Water-supply Paper 339: 1914.
- 15. WILLIS, B., and SMITH, G. O. Tacoma Folio 54, U. S. Geol. Survey, Geologic Atlas of the United States, 1899.

PALEONTOLOGY.—Trophocrinus, a new Carboniferous crinoid genus.¹ Edwin Kirk, U. S. Geological Survey.

Carboniferous crinoids of minute size have long been known but have not attracted the attention they deserve. It is hoped that with the present intensive study of micro-faunas a special effort will be made to discover and study these forms. In material kindly placed in my hands for study by Dr. G. H. Girty of the United States Geological Survey was found a crinoid showing unique structural modifications, which is here described as a new genus. In all 25 or more well-preserved specimens of the type species are available for study, comprising an unusually complete ontogenetic series. The specimens range in height from 0.75 millimeter to approximately 1.3 millimeters. There are smaller specimens, probably belonging to the species, but they can not be determined with certainty.

Trophocrinus, new genus

The orientation of the theca is based on the position of the largest, hydropore-bearing oral, which is posterior.

Basal elements three in number, the smallest unfused plate being the left

anterior.

Radials five in number, varying considerably in width and somewhat in height. But one radial, the left anterior, has an arm facet. The outstanding structural peculiarity of the type species is an extraordinary hypertrophy of the left posterior and left anterior radials. The inner portions of these plates are produced upward, outward, and then inward to form a pouchlike chamber, opening toward the tegmen. Because of its close association with the single brachial appendage and by analogy with other echinoderms it is thought that this chamber may have served as a brood pouch. It will so be styled in this description. There is an associated crinoid with a single arm facet on the left anterior radial but without the brood pouch. This suggests the possibility that we have to deal with a sexually dimorphic type, but as this is obviously impossible of verification with fossil material the brood pouch is here held as one of the major distinguishing generic characters.

In common with many of the Carboniferous crinoids the plates of the theca are minutely pitted. In the case of *Trophocrinus* and some other Allagecrinidae these pits seem to have a more or less regular arrangement on the radials and to be connected with structures within the plates. When a radial plate is somewhat eroded a definite pattern is visible within the plate. In *Trophocrinus* as seen this is not as well shown as in some related forms, possibly owing to differences in erosion. In general within the plate may be seen a median series of vertical light and dark lines, running lengthwise of the plate. To either side are series of similar lines arranged horizontally and normal to the common suture between adjacent radials. As seen under various lighting conditions and immersed in different clearing media it would appear that there are series of tubules within the body of the plate, possibly

¹ Published by permission of the Director of the U. S. Geological Survey. Received April 30, 1930.

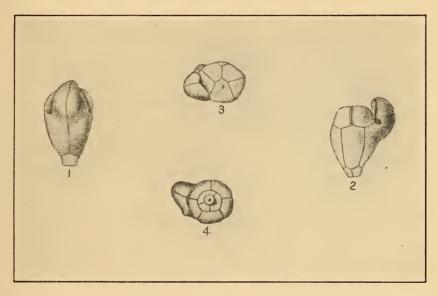
connecting with the external pits. Their general similarity to hydrospirefolds and pore-rhombs is suggestive. Isolated plates examined on both sides show no signs of folds in the stereom, and whatever these structures are they

seem to lie within the substance of the plate proper.

Of the five orals the posterior is the largest and has a sharply defined pimple near the apex, which is undoubtedly the site of the hydropore. The posterior oral as in *Allagecrinus* meets only the right and left anterior orals at the center of the tegmen. The right and left posterior orals are much smaller and do not reach the center.

Trophocrinus is referred to the family Allagecrinidae.

The genotype is *Trophocrinus tumidus*, new species, from the Sycamore limestone (Mississippian) of Oklahoma.



Trophocrinus tumidus, n. gen., n. sp.

Figure 1. × 20. Viewed from left posterior interradius.

Figure 2. × 18. Same specimen. Anterior view.

Figure 3. × 18. Same specimen. Tegminal view.

Figure 4. × 18. Same specimen. Basal view.

Trophocrinus tumidus, new species

Figs. 1-4

Owing to the small size of the crinoids, details of structure can only be worked out and verified by the examination of a number of specimens. The individual here illustrated, one of the cotypes, is one of the largest and the only one in which the remarkable pouchlike structure is completely preserved. The magnification of Figure 1 is approximately 20 x, while that of the other three figures is approximately 18 x. The drawings were made by using a camera lucida attached to a binocular microscope and although semi-diagrammatic give an excellent idea of the crinoid.

The specimen here figured has a height to the apex of the orals of slightly more than 1 millimeter and to the crest of the brood pouch of 1.2 millimeters. The posterior-anterior diameter is 0.6 millimeter, and the maximum diameter from the right anterior radius to the left posterior interradius is 0.9 millimeter. This specimen would appear to be of average adult size, comparing it with a dozen of the largest specimens found.

The theca is subpyriform in shape and usually is somewhat asymmetrical in outline, not considering the great asymmetry introduced by the brood pouch. The relative proportions of the cup and tegmen may readily be seen

in the figures.

All the interbasal sutures are seldom shown in a single specimen. Examination of a number of specimens, however, proves that there are three

basal elements and the small unfused basal is the left anterior.

The radials vary widely in size. The left anterior and left posterior radials are by far the largest. The anterior is usually the smallest. arm facet is on the left anterior radial, lying to the left of and at the base of the brood pouch. The brood pouch itself lies in the left posterior interradius and is formed by an upward extension of the left posterior and left anterior radials. The suture between the plates can clearly be followed to the free margin of the pouch. The shape and size of the pouch may readily be seen in the figures. As preserved in this specimen the free margin appears smooth and unbroken, and apparently the complete structure is preserved. The wall of the pouch is of about the same thickness as the remainder of the radials. It constitutes then a chamber of considerable size opening toward the tegmen. In specimens where the pouch has been broken off the subtriangular area is exposed which lies within the pouch and at the intersection of the radials and the left posterior oral. This space is filled with subcrystalline calcite. It appears that this space was not a simple opening into the theca. The imbedded horizontal tubules of the radials extend out into this calcite, and it is probable the space was filled with stereom but not as dense as that of the thecal plates proper.

The median portion of each oral shows as a subtriangular depression raising the areas along the sutures into rounded ridges. This is not well shown in the specimen figured, the tegmen of which is somewhat eroded. Near the apex of the largest oral is a well defined round protuberance, which

undoubtedly marks the site of the hydropore.

Horizon and locality.—The specimens of Trophocrinus tumidus, together with other Allagecrinus-like crinoids and a minute Catillocrinus, were found in material collected by G. H. Girty, C. L. Cooper, and others in a shale immediately below the main limestone ledge of the Sycamore limestone in a railroad cut south of Ada, Okla., in sec. 27, T. 3 N., R. 6 E.

OFFICERS OF THE ACADEMY

President: William Bowie, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Physical geography.—Peat	profiles i	n the	Puget	Sound	Basin	of	Washington.	Page
ALFRED P. DACHNOWSKI	STOKES.	••••		• • • • • • •				193
Paleontology, -Trophocrinus	s, a new (Carbon	if e rous	crinoid	genus.	E	DWIN KIRK	210

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries

OS 1433



OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS
CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3.00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5. 0 0	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences," and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C. Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge, provided that claim is made

within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

June 19, 1930

No. 12

PHYSICAL CHEMISTRY.—The compressibility of rubber.¹ L. H. Adams and R. E. Gibson, Geophysical Laboratory, Carnegie Institution of Washington.

Although many of the elastic properties of rubber have been investigated with very interesting results, no measurements have been made, so far as we know, of its cubic compressibility at high pressures. Those measurements which have been made at low pressures yield results varying from 93 × 10⁻⁶ obtained by Clapeyron² to an estimate of the order of the compressibility of bronze (about 1 × 10⁻⁶) given by Amagat.³ As the compressibility of rubber enters as a minor correction into most compressibility measurements at high pressures, it is very desirable to have a reliable estimate of its value. In this communication we propose to give the results of experimental determinations of the compressibility at 25° of three samples of rubber which were furnished to us by Messrs. H. L. Curtis and A. H. Scott of the U. S. Bureau of Standards.

The samples are described as follows:

Sample A. Hard rubber from panel made by the Goodrich Company. It is a rubber-sulfur compound containing no inorganic fillers. The total sulfur amounts to 27.4 per cent of which 0.21 per cent is free sulfur. The density is 1.149 at 27°C.

Sample B. A rubber-sulfur compound containing 90 per cent smoked rubber and 10 per cent sulfur and vulcanized 105 minutes at 300° F. Density = 0.990 at 25° .

Sample C consists of pale crepe rubber 90.75 per cent, zinc oxide 5 per cent, sulfur 4 per cent, tetramethylthiuram disulfide 0.25 per cent. It was vulcanized for 30 minutes at 260° F. Density = 0.990 at 27° .

¹ Received March 26, 1930.

² Compt. rend. 46: 208. 1858.

³ See Lundal, Ann. Physik 66: 741. 1898.

Samples B and C were called soft rubber.

The samples of rubber were cut into discs and built up to form cylinders approximately 20 cc. in volume. On such specimens were the compressibility measurements made. The technique employed for such measurements in this Laboratory has already been described in detail,⁴ and may be summarized as follows. The rubber was placed in a heavy-walled steel cylinder and completely surrounded by a suitable liquid. The volume of the liquid was then diminished by forcing a special piston into the cylinder and the pressure so generated read to one bar⁵ by an electrical resistance gauge. The travel of the piston which was a function of the decrease in volume was measured by a dial micrometer gauge. The apparatus was calibrated at frequent intervals with a substance whose compressibility is accurately known—viz. cold rolled steel.⁶ In this way adequate corrections for the compressibility of the pressure-transmitting liquid, for the stretching of the bomb, and for the distortion of the packings were made.

All readings were made by adhering rigorously to a definite procedure. The pressure was first raised to 12,400 bars and then lowered to about 50 b. below 12,000. A pause was made for temperature readjustment and then the pressure slowly raised to as near 12,000 b. as possible. After the piston displacement had been read, the pressure was lowered to 10,950 b. and after a pause brought back to 11,000 b. A reading was made and the process repeated for successively lower pressures at intervals of 1000 b. Unless a definite procedure is followed in all the experiments, serious errors from hysteresis in the bomb and packings are apt to be introduced. Especially necessary is it that the runs with the specimen under investigation be made exactly like those with the standard steel.

Results. The experimental observations which consist of two series of pressure and piston displacements, one for the rubber and one for the steel, are converted by a calculation which has already been described to a single table of pressures (Table 1) and the corresponding values

⁴ Adams, Williamson and Johnston. Journ. Am. Chem. Soc. 41: 12. 1919; Adams and Williamson. Journ. Franklin Inst. 195: 475. 1923.

⁵ 1 bar (b.) = 10⁶ dynes/cm.² = 0.987 atmosphere. According to the International Critical Tables this is the only internationally accepted use of the word "bar," although it has been used to mean 1 dyne per sq. cm. We advocate the more general use of the word bar instead of megabarye, which we have hitherto employed, to indicate 10⁶ dynes/cm.², particularly because of the convenience of the term "kilobar" which denotes one thousand bars (approximately 1000 atm.) and is the logical high-pressure unit.

⁶ P. W. Bridgman. Proc. Am. Acad. Arts Sci. 58: 166. 1923.

ADAMS and WILLIAMSON. Journ. Franklin Inst. 195: 475. 1923.
ADAMS and GIBSON. Proc. Nat. Acad. Sci. 12: 275. 1926.

of $-\frac{\Delta V}{V_0}$, the fractional change in volume of the rubber, $-\frac{\Delta V}{V_0}$ being zero at 2000 b. Column A refers to the hard rubber, Column B to the rubber containing 10 per cent sulfur, and Column C to rubber with 4 per cent sulfur.

In order to smooth the results and to determine the volume change and compressibility at any pressure it is our custom to express $-\frac{\Delta V}{V_0}$ as a function of pressure—usually as a function of (p-2000). With most solids this is comparatively simple, as a linear or quadratic equation fitted to the data by the method of least squares represents the observations very exactly.

TABLE 1.—EXPERIMENTAL RESULTS $-\frac{\Delta V}{V_0} \times 10^2 \; (\mathrm{Obs.})$

Pressure in bars (p)	A	В	C
12000	10.085	10.463	11.222
11000	9.442	9.864	10.608
10000	8.733	9.217	9.922
9000	7.994	8.528	9.200
8000	7.177	7.780	8.410
7000	6.267	6.967	7.535
6000	5.255	6.010	6.498
5000	4.129	4.925	5.233
4000	2.903	3.566	3.779
3000	1.514	1.940	2.056
2000	0.000	0.000	0.000
1000	-1.692	-2.442	-2.682

The volume changes produced when rubber is compressed hydrostatically can not be represented by a quadratic equation. Indeed, the compressibility of rubber is more like that of a liquid than of a solid. At low pressures the compressibility is very high but it falls off rapidly at the higher pressures, the behavior being closely akin to that of a liquid. Up to the present no satisfactory equation has been devised for expressing $-\frac{\Delta V}{V_0}$ for liquids as a function of the pressure over any considerable range of pressures.

Among others, three equations involving four constants each were tried: (a) a cubic, (b) an hyperbola, (c) an exponential function. These three equations will now be discussed.

⁸ Several other types of equations, based on the published equations of state, were tried but the results were not as good as those for the three equations which are discussed here.

(a) Cubic Equations. The first equation tried was of the form:

$$y = a + bx + cx^2 + dx^3 \tag{1}$$

where, as throughout this paper, $y = -\frac{\Delta V}{V_0} \times 10^5$ and $x = \frac{p-2000}{1000}$.

It was fitted to the three sets of results by the method of least squares. The results are summarized in Table 2 where the figures in the column labeled "obs.-calc." refer to the difference between the observed value of y (Table 1) and those calculated by the following equations:

$$y = -4 + 1603.4x - 80.67x^2 + 2.121x^3 \tag{1A}$$

$$y = 18 + 2075.0x - 169.52x^2 + 6.677x^3 \tag{1B}$$

$$y = 8 + 2199.3x - 170.15x^2 + 6.2535x^3$$
 (1C)

TABLE 2.—Representation of Results by Means of Cubic Equations

	Samp	le A	Samp	le B	Sample C	
p	$-\frac{\Delta V}{V_0} \times 10^2$ (Calc.)	ObsCalc. × 10 ⁴	$-\frac{\Delta V}{V_0} \times 10^2$ (Calc.)	ObsCalc. × 10 ⁴	$\frac{-\frac{\Delta V}{V_0} \times 10^2}{\text{(Calc.)}}$	ObsCalc. × 10 ⁴
12000	10.084	0.1	10.493	-3.0	11.240	-1.8
11000	9.439	0.3	9.830	3.4	10.579	2.9
10000	8.746	-1.3	9.188	2.9	9.914	0.8
9000	7.995	-0.1	8.527	0.1	9.211	-1.1
8000	7.170	0.7	7.807	-2.7	8.430	-2.0
7000	6.261	0.6	6.990	-2.3	7.532	0.3
6000	5.255	0.0	6.033	-2.3	6.483	1.5
5000	4.137	-0.8	4.897	2.8	5.244	-1.1
4000	2.897	0.6	3.543	2.3	3.776	0.3
3000	1.520	-0.6	1.930	1.0	2.043	1.3
2000	-0.004	0.4	0.018	-1.8	0.008	-0.8
1000	-1.690	0.2	-2.233	-20.9	-2.367	-31.5

Equation 1A represents the observations on hard rubber very satisfactorily. The deviations are so small that it was felt that no further computations were necessary for the hard rubber results.

It appears, however, that a cubic equation does not give a good representation of the volume changes under pressure for the two samples of soft rubber, the worst feature being the apparent failure of the equations at the top and bottom of the table. The large deviation at 1000 b. illustrates this clearly and if $\frac{dy}{dx}$ obtained by differentiating equation B is plotted against x it will be seen to pass through a minimum at 10,000 b., a circumstance which is most improbable.

We might conclude by saying that a cubic represents the fractional change in volume of hard rubber as a function of pressure very well, but that a cubic equation may only be used as a short interpolation equation with the two soft rubbers. (b) Hyperbolic Equations. An equation of the type

$$y (x + \text{const.}) = a + bx + cx^2 \tag{2}$$

was applied to the data for samples B and C. The results, given in Table 3 and calculated with the following equations are disappointing:

$$y(x + 8.0) = 293 + 17290.4x + 145.83x^2$$
 (2B)

$$y(x + 8.0) = -206 + 18883.8x + 130.61x^{2} \tag{2C}$$

(c) Exponential Equations. The large decrease in volume at lower pressures which diminishes at high pressures suggests an equation of the type

$$y = A + Bx + C(1 - e^{-})$$
 (3)

As x gets large the last term of the equation approaches zero and we are left with the equation

$$y = A + Bx$$
.

TABLE 3.—Representation of Results for Two Types of Soft Rubber by a Hyperbola

	Sample B		Sample C		
<i>p</i>	$-\frac{\Delta V}{V_0} \times 10^2 (\mathrm{Calc.})$	ObsCalc. × 104	$-\frac{\Delta V}{V_0} \times 10^2 \text{ (Calc.)}$	ObsCalc. × 10 ⁴	
12000	10.432	3.1	11.205	1.7	
11000	9.866	-0.2	10.608	0.0	
10000	9.247	-3.0	9.951	-2.9	
9000	8.565	-3.7	9.225	-2.5	
8000	7.806	-2.6	8.414	-0.4	
7000	6.953	1.4	7.498	3.7	
6000	5.982	2.8	6.452	4.6	
5000	4.861	6.4	5.238	-0.5	
4000	3.546	2.0	3.808	-2.9	
3000	1.970	-3.0	2.090	-3.4	
2000	0.037	-3.7	-0.026	2.6	
1000	-2.407	-3.5	-2.708	2.6	

The value of D may be estimated graphically as follows. It will be seen that the logarithm of the second derivative of y with respect to x is

$$\log \frac{d^2y}{dx^2} = \log \left(-CD^2\right) - Dx$$

or that the logarithm of $\frac{d^2y}{dx^2}$ is a linear function of x whose slope is -D.

From a table of x as argument and y as entry we determined the second differences which corresponded to the second derivative. The logarithms of the second differences were plotted against x and the plot was approximately a straight line whose slope gave us an estimate of D. Using this value of D we were able to get tentative values of A, B and

C (A', B' and C') by substituting three of the observed values of x and y in equation 3, and hence calculating values of y at all pressures. The differences between y obs. and y calc. (Δy) were plotted and a smooth deviation curve drawn. This curve was represented by the equation:

$$\Delta y = a + bx + c \left(1 - e^{-Dx}\right)$$

where D is the same as in the above calculation.

It may easily be shown that by adding a, b and c to A', B' and C' an equation is obtained which gives the fairest representation of the data possible with an equation of this type.

The final equations were as follows:

$$y = -9 + 482.2x + 5967 (1 - e^{-0.29x})$$

$$y = -45 + 484.85x + 6890 (1 - e^{-0.27x})$$
(3B)

Calculations made with equations 3B and 3C are tabulated in Table 4.

TABLE 4.—Representation of Results for Two Types of Soft Rubber by an Exponential Equation

	Samp	le B	Sample C		
p	$rac{-\frac{\Delta V}{V_0} \times 10^2 (\mathrm{Calc.})}{\mathrm{ObsCalc}}$		$-\frac{\Delta V}{V_0} \times 10^2 (\text{Calc.})$	ObsCalc. × 104	
12000	10.452	1.1	11.231	-0.9	
11000	9.859	0.5	10.602	0.6	
10000	9.230	-1.3	9.929	-0.7	
9000	8.549	-2.1	9.198	0.2	
8000	7.804	-2.4	8.390	2.0	
7000	6.969	-0.2	7.484	5.1	
6000	6.016	-0.6	6.445	5.3	
5000	4.905	2.0	5.235	-0.2	
4000	3.581	-1.5	3.800	-2.1	
3000	1.975	-3.5	2.070	-1.4	
2000	-0.009	0.9	-0.045	4.5	
1000	-2.498	5.6	-2.666	-1.6	

Here, again, the magnitude of the residuals is greater than our estimated experimental error and undoubtedly equation 3 does not represent the soft rubber results as well as the cubic equation represents those for the hard rubber. We would emphasize that the trend in the deviations of both the exponential and the hyperbolic equations, which is obvious from a study of Tables 3 and 4, should be taken as a warning that extrapolation with these equations is dangerous and that at best they are empirical interpolation formulae. On the other hand, we

found that the course of $\frac{dy}{dx}$ as calculated from equations 3B and 3C agreed very well with the course of the first differences of the observations from 1000 to 11,000 b., and, moreover, the value of $-\frac{\Delta V}{V_0}$ between 1 and 2000 b. calculated from the equations 3B and 3C and corrected by the deviation curves agreed very well with our most reliable estimate obtained from a cubic passed through the points at 1000, 2000 and 3000 b.

Of all the equations fitted to the soft rubber results we prefer the exponential one. It represents the results as closely as does the hyperbola and is easier to handle.

For the hard rubber, smoothed reliable values of $-\frac{\Delta V}{V_0}$ reckoned from 2000 b. may be obtained at any pressure by application of equation 1A, but as, up to the present, we have found no equation which represents the data to the order of the experimental error and even the course of the deviation curves is doubtful, we have no way of obtaining smoothed and accurate values of $-\frac{\Delta V}{V_0}$ for the samples of soft rubber. If it is desired to calculate this at intermediate pressures, equations 3B or 3C may be used, which will give approximate values of $-\frac{\Delta V}{V_0}$ when used alone, and accurate ones when combined with the deviation curves.

In Fig. 1 we have plotted values of the relative decrease in volume, $-\frac{\Delta V}{V_0}$, reckoned from atmospheric pressure, against the pressure, for the three samples of rubber examined. These curves serve to illustrate the volume changes undergone by each type of rubber under hydrostatic pressure and, moreover, indicate the consistency of our determinations. The points plotted in Fig. 1 are the observations taken from Table 1 to which has been added the average value of the volume change from 0 to 2000 b. estimated by all the equations and their deviation curves.

For sample A, the hard rubber, the values of $-\frac{\Delta V}{V_0}$ reckoned from atmospheric pressure and corresponding values of the compressibility, β , are given by the equations

$$-\frac{\Delta V}{V_0} = 19.515 \times 10^{-6} \ p - 9.34 \times 10^{-10} p^2 + 2.121 \times 10^{-14} p^3$$

$$\beta = 19.515 \times 10^{-6} - 18.68 \times 10^{-10} p + 6.36 \times 10^{-14} p^2$$

where the pressure p is expressed in bars. These equations may be used directly to calculate the change in volume or the compressibility at any pressure.

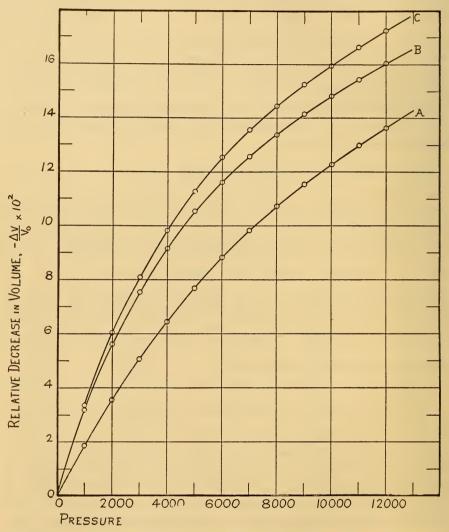


Fig. 1. Relation between percentage change in volume and pressure for three samples of rubber.

Equations 4B and 4C give very close approximations to the compressibilities of samples B and C respectively.

$$\beta_{B} = \frac{dy}{dx} = 482.2 + 1730 e^{-0.29x}$$

$$\beta = \frac{dy}{dx} = 484.5 + 1860 e^{-0.27x}$$
(4B)

$$\beta = \frac{dy}{dx} = 484.5 + 1860 e^{-0.27x}$$
 (4C)

Over the range from 2000 to 11,000 b. they are reliable, but if more accurate values are desired deviation curves may be constructed by plotting the figures in Columns 3 and 5 of Table 4 against the pressure x, determining the slopes at the required pressures and adding them to the values of β calculated by 4B and 4C. As x is equal to $\frac{p-2000}{1000}$, where p is in b., we may convert equations 4B and 4C to a form in which the pressure is given in b.

$$\beta_{\rm B} = 4.822 \times 10^{-6} + 30.90 \times 10^{-6} e^{-0.00029p}$$

$$\beta_{\rm c} = 4.845 \times 10^{-6} + 31.92 \times 10^{-6} e^{-0.00027p}$$
(4'B)
(4'C)

Discussion of Results. The main results about the compressibility of rubber containing various amounts of sulfur are recorded graphically in Fig. 2, where they are compared with the compressibilities of a liquid, amyl alcohol; of a highly compressible solid, potassium; of sodium chloride, and of steel. As might be expected, the compressibility-pressure curves for the two types of soft rubber are closely akin to the curve for amyl alcohol, the liquid, and show little in common with the curve for NaCl or even for potassium. It is true that the compressibility of potassium is the same as that of soft rubber at zero pressure, but the compressibility-pressure curves are radically different, resulting in the compressibility of rubber at 12,000 b. being approximately one-third of that of potassium. The compressibility-pressure curve of hard rubber (A) seems to be similar to that of potassium, being more like the curve of a compressible solid than that of a liquid.

Unavoidable differences in the volume of rubber washers used in the piston of the high pressure apparatus result in the substitution of a small volume of pressure-transmitting liquid for rubber, or vice versa. We have just seen that the compressibility of rubber is not much less than that of organic liquids and so the magnitude of the correction introduced by the substitution of a few cubic millimeters of butyl ether for rubber is practically negligible.

It is interesting to note that while soft rubber, sample B, is almost twice as compressible as hard rubber at atmospheric pressure, it is less compressible than the hard rubber at pressures above 5000 b. Undoubtedly the large amount of sulfur, 27 per cent in the hard rubber, has a decided influence on its compressibility, lowering it at

⁹ P. W. Bridgman. Proc. Am. Acad. Arts Sci. 49: 53. 1913.

¹⁰ P. W. Bridgman. Proc. Am. Acad. Arts Sci. 58: 204. 1923.

¹¹ Adams, Williamson and Johnston. Op. cit.

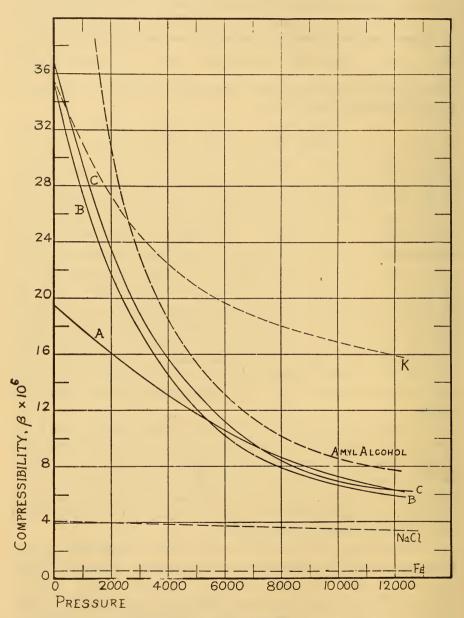


Fig. 2. Change of compressibility of rubber with pressure as compared with that of liquids and solids.

the lower pressures and keeping the value large at the high pressures. In fact, curve A might well be regarded as composed of two curves, the first similar to curve B and the second a straight line cutting the y-axis at 13.1 and of slightly negative slope. The compressibility of sulfur is 13.1 at 1 mb. 12 and it probably exhibits the normal diminution with pressure. Fig. 1 shows that if the volume of a piece of hard rubber is 100 cc. at atmospheric pressure, its volume at 12,000 b. is only 85.4 cc. and that under a similar pressure change the volume of a piece of soft rubber containing 10 per cent of sulfur would decrease from 100 cc. to 82.8 cc. These figures emphasize in a striking way the very large changes in volume which are produced when a solid like rubber is subjected to large hydrostatic pressure.

ZOOLOGY.—A new pocket mouse from southern Lower California.¹ E. W. Nelson and E. A. Goldman, Biological Survey.

The occurrence of the large pocket mouse, *Perognathus baileyi*, in Lower California was first made known by Elliot (Field Columb. Mus., Publ. 74, Zool. Ser., vol. 3, April, 1903, p. 167) who described *P. b. rudinoris* a dark form from San Quintin. *Perognathus knekus* Elliot, from Rosarito, San Pedro Martir Mountains, which was published at the same time (l.c. p. 169) was based, as comparison shows, on an unusually large specimen of *rudinoris*. A pallid subspecies was described from San Felipe, northeastern Lower California by Nelson and Goldman (Proc. Biol. Soc. Washington, vol. 42, March 25, 1929, p. 104). Specimens from localities in the central and southern part of the peninsula had been referred to *rudinoris*, but more critical comparisons indicate the desirability of segregating the subspecies described as follows:

Perognathus baileyi extimus subsp. nov.

Southern Peninsular Pocket Mouse

Type.—From Tres Pachitas, 36 miles south of La Paz, Lower California, Mexico (altitude 700 feet). No. 146672, ♀ adult, U. S. National Museum (Biological Survey collection), collected by Nelson and Goldman, December 25, 1905. Original number 18785.

Geographic distribution.—Low elevations in Lower California from the type locality south of La Paz north to near Latitude 30°, intergrading to the northward with Perognathus baileyi rudinoris and P. b. hueyi.

¹² T. W. RICHARDS. Journ. Am. Chem. Soc. **37**: 1646. 1915.

¹ Received April 28, 1930.

General characters.—A light, buffy subspecies with nearly pure white forearms and grayish ears. Similar to $P.\ b.\ rudinoris$, but lighter, more buffy, the upper parts in general less heavily overlaid with black, and the sides decidedly lighter; outersides of forearms white, or nearly pure white, instead of distinctly suffused with plumbeous; ears clothed with grayish, instead of dusky hairs, and tail grayer above near base; skull slightly different. Darker and more buffy than $P.\ b.\ hueyi$, and skull differing in minor details.

Color.—Type: Upper parts near pinkish buff (Ridgway, 1912), the top of head and dorsum moderately overlaid with black-tipped hairs, becoming thinner and less conspicuous on sides; a narrow, buffy lateral line present; under parts, fore limbs and hind feet white; ears thinly clothed with fine grayish hairs; tail above grayish brown near base, becoming purer brown toward tip, dull white below.

Skull.—Closely resembling that of P. b. rudinoris, but braincase narrower, the narrowing mainly in the parietals and interparietal; mastoids and auditory bullae rather small, but closely approaching those of rudinoris. Very similar to that of P. b. hueyi, but braincase and interparietal narrower; mastoid and auditory bullae slightly smaller.

Measurements.—Type: Total length, 198; tail vertebrae, 107; hind foot, 25. Average and extremes of three adult male topotypes: 194 (183–203); 108 (99–114); 25 (24–27). Skull (type): Greatest length, 29; greatest mastoid breadth, 14.3; zygomatic breadth, 15.5; interorbital breadth, 6.9; length of nasals, 10.2; width of nasals (in front of incisors), 2.9; interparietal, 6.1×3.4 ; maxillary toothrow (alveolar length), 4.5.

Remarks.—The range of P. b. extimus, embracing the lower elevations in the central and southern part of the peninsula, marks the extreme southern limit of the distribution area of the species as a whole. The new form differs mainly in light, buffy color from the distinctly darker subspecies rudinoris of the northwest coast region, and from the grayer race hueyi, inhabiting the desert region east of the San Pedro Martir Mountains. The cranial characters are slight and comparatively unimportant. Specimens from as far north as the Vizcaino Desert west of San Ignacio may be regarded as nearly typical. Those from farther north grade, along the eastern and western sides of the peninsula respectively, toward the more northern forms. Specimens from Punta Prieta on the western side near latitude 29° are rather dark and indicate an approach to rudinoris, but seem more properly assignable to the present form. Specimens from Calamahue and Onyx on the eastern side of the peninsular are near typical extimus in general color, but in somewhat broader skulls tend toward hueyi.

Specimens examined.—Total number, 54, all from Lower California as follows: Calamahue, 11; Calmalli, 3; Comondú, 1; Matancita, 1; Onyx, 1; Punta Prieta, 5; San Bruno, 2; San Francisquito, 1; San Ignacio, 18; San Ignacio (20 miles west), 4; San Jorge, 1; Santa Rosalia (10 miles west), 1; Tres Pachitas (type locality), 5.

^a Two in collection San Diego Society of Natural History.

^b Collection San Diego Society of Natural History.

^o Thirteen in collection Museum of Vertebrate Zoology; two in San Diego Society of Natural History.

ZOOLOGY.—The demanian vessels in nemas of the genus Oncholaimus; with notes on four new Oncholaims. N. A. Cobb, Bureau of Plant Industry.

Continuing the work of deMan, 1884, and zur Strassen, 1896, observations have been made on Adoncholaimus fuscus (Bastian), Metoncholaimus pristiurus (zur Strassen) and other Oncholaims (listed on p. 227) with particular reference to the system of tubular organs discovered by deMan. Building on the foundation laid by these eminent observers, it has been possible to define the demanian system, and, within limits, assign it a function. The following definition and table of homologous terms, together with the accompanying text appreciably advance our knowledge of this remarkable system of organs.

DEFINITION

Demanian Vessels:—In adult female nemas (Oncholaims) a complicated double system of efferent tubes; connecting, (1), with the middle or posterior part of the intestine through an osmosium (see p. 230), and (2), with the uterus (or uteri); these two efferents being confluent at a special glandular "gateway," the uvette (see p. 229), and emptying thence backward and outward, through one or two ducts having more or less moniliform affluent glands (see p. 228, Fig. 1). Normally, the ducts lead to exit pores in the body wall, usually laterad, one or more on each side, near the base of the tail.

In certain cases at least, apparently homologous tubular organs connect with the gonad of the male near the beginning of the vas deferens. For example, in Metoncholaimus pristiurus, Adoncholaimus fuscus and Oncho-

¹ Investigations carried on in part at the U. S. Fisheries Biological Station, Woods Hole, Mass. The abbreviations used are mostly self-explanatory; e.g. onch dsl, (onchium dorsale), dorsal tooth. Received May 15, 1930.

laimium appendiculatum I observe a tubular glandular vessel, outstretched forward and emptying backward into the vas deferens, that appears homologous with parts of the better known demanian system of the females. See Fig. 2.

In female nemas the functioning demanian vessels (e.g. pristiurus) elaborate a copious, elastic, sticky, non-water-soluble, nearly colorless secretion, possibly utilized ("spun"?) during agglomeration and copulation, and also presumably to protect and preserve the batches of eggs after deposition and during segmentation.

The demanian organs seem to prevail in mud-inhabiting, and sand-inhabiting oncholaims,—i.e. those of stagnant habitat; and to be absent or less prevalent in oncholaims living in more thoroughly oxygenated water,—on the surface of eelgrass, and among algae, e.g. in *Prooncholaimus* Micoletzky, 1924.

Origin. As to the primitive nemic tissue from which the demanian vessels may have originated, we seem driven to accept the primitive gonadic tissue as the probable source. The histology of the demanian system reminds one most strongly of the structure of nemic gonads; most of the histological elements known in the demanian system have homologues in the gonadic system of nemas;—while on the contrary there is no such tunic, and there are no such forms of nuclei, known in connection with the enteron.

Equivalent terms of various authors

·				
Author, de Man	Author, zur Strassen	Author, present		
Röhrenförmiges Organ Organe tubiform	Röhrenförmiges Organ	Demanian System		
Hauptrohr (fuscus) Canal principal (albidus)	Stammrohr	Enteric efferent		
Verbindung zur Stütze Blindes Vorderende				
Verbindungsröhrchen zwischen Warze und Uterus Tube de communication	No mention	Uterine efferent		
Ausführungsgang in den Uterus	Blindgeschlossener Sack	Demanian intake (uterine)		
Warze Papille ovulaire	Rosette	Uvette		
Rothbraune drüsen (fuscus) Tubes latereaux (albidus)				

DIAGNOSES OF THE GENERA AND SPECIES MENTIONED HEREIN

ONCHOLAIMINAE Filipjev, 1918 and 1925

(but without Anoncholaimus, Pelagonema, Anoplostoma, Trilepta, Krampia, Filipjevia.)

ONCHOLAIMIUM, n. gen.

Monodelphic Oncholaiminae with demanian system, whose males have a versatile, preanal, ventral appendicule. See Figs. 2 and 3.

Oncholaimium appendiculatum, $\frac{1.5}{1.7}$, $\frac{6.6}{2.3}$, $\frac{16.}{2.5}$, $\frac{25^{\circ}74.}{3.5}$, $\frac{94.2}{2.5}$, $\frac{2.5}{3.5}$ $\frac{2.5}{3.5}$, $\frac{2.5}{3.5}$,

Oncholaimus nigrocephalatus 0.6 7.4 16 32465. 97. 97. 97. 97. 97. 98. Oncholaimus with very 1.4 0.9 16 2.2 0.5 3.4 mm slightly compound, non-refractive uvette, pigmented head, and hemispheroid, immobile, preanal, ventral male supplement; demanian system with two rather inconspicuous exit pores, each laterad; cells of the rouleaux (moniliform glands) oblique, little flattened.

Oncholaimus serpens, n.sp. On- $\frac{0.7}{0.9}$ / $\frac{5.1}{1.5}$ $\frac{11}{1.4}$ $\frac{25^{\circ}72.}{1.2}$ 96.5 >4.5 mm cholaimus whose moniliform $\frac{0.7}{0.7}$ / $\frac{1.2}{1.2}$ $\frac{25^{\circ}1.2}{1.2}$ 97.6 >4.1 mm glands are vaguely seriated but not $\frac{0.6}{0.6}$ / $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1.7}{1}$ $\frac{1}{1}$ >4.1 mm in rouleaux. Compound uvette not condensed and refractive.

Metoncholaimus pristiurus (z. 0.8 5.9 13. $^{$1'65}$. $^{$96.2}$ $^{$5.6 \text{mm}}$ Str.). Specimens from Woods 0.8 5.3 11. $^{$2$}$ 1.5 0.7 5.6 mm Hole gave the opposite measure- $^{$0.8/1.2$}$ 1.5 0.7 5.6 mm ments. Moniliform glands 64-fold.

Adoncholaimus panicus, n. sp. 1.1 7.7 17. '53.' 95.5 2.4 1mm Adoncholaimus having a transverse row of seven demanian exit pores on each side. See Fig. 7.

Adoncholaimus fuscus (Bast.). Moniliform glands 8- or 16-fold,—see Fig. 1.

One soon appreciates the weight of zur Strassen's words where he says, in speaking of the demanian system of various oncholaims,—"In fact, the differences are such that, were they equally pronounced in any other system of organs, they would lead to the proposal of separate genera, or even families."

In this connection the present studies lead to the belief that the demanian system not only varies markedly in the different groups of oncholaims, but that in all probability the system is present but has been wholly overlooked in many of the forms described. Hence it seems premature to attempt a complete subdivision of the oncholaims into genera and subgenera. It may be doubtful whether the genera and subgenera so far proposed are natural ones. In particular, *Oncholaimus*, the group connected with the type species attenuatus, seems chaotic; yet no better course appears, at present, than to leave serpens and nigrocephalatus in this ill defined group.

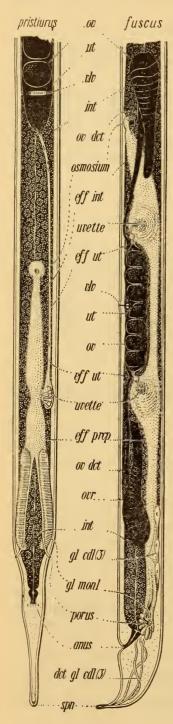


Fig. 1. Amended diagrams of the demanian system of Metoncholaimus pristiurus (dorsal view) and Adoncholaimus fuscus (side view), modified from the diagrams of zur Strassen and deMan respectively. eff int, enteric or intestinal efferent; eff ut, uterine efferent; vlv, vulva; ov dct, oviduct; gl cdl (3), the three caudal glands; gl monl, the moniliform glands; porus, exit pores of the demanian system. Notice that in each case the uvette empties through a minute pore, the uvette pore. The moniliform glands in pristiurus are 64-fold; in fuscus 8- or 16-fold.

Uterine Efferent. An examination of Metoncholaimus pristiurus (zur Strassen) furnishes convincing evidence that the interesting female organ described by zur Strassen is connected not only with the intestine, as he discovered, but also with the uterus by means of a tube (see eff ut, Fig. 1) extending forward from the uvette,—i.e. from the "rosette" of zur Strassen. The evidence is as follows: In many female specimens it is possible behind the vulva to follow backward from near the vulva a long, narrow, apparently (not really) vacant space, reminiscent of the uterine efferent of Oncholaimium appendiculatum (see Fig. 3) which on more careful examination proves to be a duct. This duct, however, is not so refractive or of such uniform diameter as in appendiculatum, and is even more difficult to see. It varies slightly in diameter. Here and there throughout its length it can be seen to have a thin, double-contoured wall containing small definite, much elongated nuclei. This tube is usually in a collapsed condition, more often presenting its edge toward the observer, but sometimes not. When it is presented edgewise, one may often detect in its thin wall the scattered elongated nuclei, especially in specimens fixed and stained in acetic acid methyl green; occasionally nuclei can be seen also in other views Examining the requisite number of specimens leads to the conclusion that from the uterus near the vulva the duct arises dorsad as a broad tube, directed backward, which narrows rapidly and extends along the right side of the nema,—approximately along the right lateral chord though not necessarily exactly opposite,—and, expanding, joins and envelopes the uvette. See Fig. 1

Uvette*. The "warze" of deMan,—i.e. the "rosette" of zur Strassen,—is the structure to which I apply what seems the more appropriate name "uvette." Comparisons show that, notwithstanding the very marked differences in form, the various organs herein called uvettes are homologous; the same is true of those called moniliform glands.

The uvette of Adoncholaimus fuscus (Bastian) as illustrated by deMan probably presents 32 elements (Körnchen, deMan's Fig. 29) as does that of *M. pristiurus*; these elements have been outlined by deMan and figured somewhat more in detail by zur Strassen (deMan's Figs. 24, 29; zur Strassen's Figs. 13, 14).

In favorable specimens I have seen the uvette of fuscus to be a "radial" structure made up of about 32 elements surrounding a minute pore, somewhat as in the uvette of pristiurus, (See Fig. 1) but the elements here are far less refractive. Rarely can one see the appearance illustrated by deMan in his figure 29; whereas the appearance he does not satisfactorily illustrate,—a very complicated one, by the way,—is the usual appearance; and when this appearance is more pronounced, commonly the minute refractive "Körnchen" that deMan figures are not to be seen, or only some of them faintly. DeMan's "Kugel," figured by him as if nearly round, I find seldom round or ball-shaped; frequently it is so "collapsed" (?) as to be difficult to see at all, and it is more likely to be elongate or ellipsoidal, or perhaps flattish-ellipsoidal, than to be equidiametral as shown in deMan's Fig. 29.

DeMan does not give a thoroughly satisfactory description or figure of his "Warze." In one of his figures (Fig. 29) I count 33 minute, circular, dotlike elements where he makes his "Verbindungsröhrchen" join the "Warze." Occasionally I also see this appearance, and with about the same number of elements (32?). It is difficult to say as yet what the exact function of the uvette is, but it seems a regular, doubtless glandular, component of the demanian system. In Oncholaimium appendiculatum the uterine vessel. extending backward from the uterus, nearly as described for pristiurus, finally expands a trifle into a small, often rather indefinite, ampulliform uvette of the very simplest character, which joins the right subdorsal of the two longitudinal series of cells,—the moniliform glands,—by means of a minute refractive pore,—the uvette pore. See uv, Fig. 3. In Oncholaimus nigrocephalatus the uvette, which in O. appendiculatum appears as a simple ampulla, becomes somewhat compound; that is to say, two additional or subordinate elements occur, one on either side of the main "ampulla," so that the whole is rather obscurely triplex.

In another oncholaim, *Oncholaimus serpens* n. sp., the uterine tube extends backward just as definitely as in *Oncholaimium appendiculatum* and joins the rest of the demanian system in the form of an expanded and much larger

^{*} Uvette; a diminutive cluster. From latin, uva, a cluster of grapes.

uvette, rather closely resembling one of the uvettes of

set cph.10

ppl.

det,3

Osmosium. Moniliform alands. In addition. have established to my satisfaction that the main tube of the demanian system in Adoncholaimus fuscus, which was described by deMan as probably being merely fastened anteriorly to the intestine, and therefore regarded by him as probably merely a holdfast, is in reality in communication with the intestine by means of what I have osmosium.* It called an has much the same structure as that described by zur Strassen for Metoncholaimus pristiurus and M. deMani (zur Strassen, Figs. 4 to 12),—and which I have examined in pristiurus,—except that there is communication. open There are no essential differences in the structure of the enteric junctions of the

*Osmosium; that part of an culatum n.g.,n.sp., drawn from a fixed emunctorium or analogous or-atg and stained balsam specimen. The gan through which, mainly by locus of the cross section drawing is osmotic action, soluble matter shown at locus x-sec. ac gon, accessory is transferred from one organ to myond to gonad; al'm'nt, food material; another. The osmosium is appndl, appendicule; chrsm hap 14, here not emunctorial. It is and haploid number of chromosomes; jnc still doubtful whether the osan set 1st, junction of testes; ncll spmct, motic cells in this particular nucleolus; ncl spmtd, nucleus of case are of enteric or demant subm.!? spermatid; org inq, organs of uncertain ian origin. While the staining function; os ac gon, mouth of accessory of these cells seems to favor de-set ym to gonad; spmct, spermatocyte; tst manian origin, the structure *175 ant,-front testis; r, its cross-section. seems to favor enteric origin.

· · · chrd hit

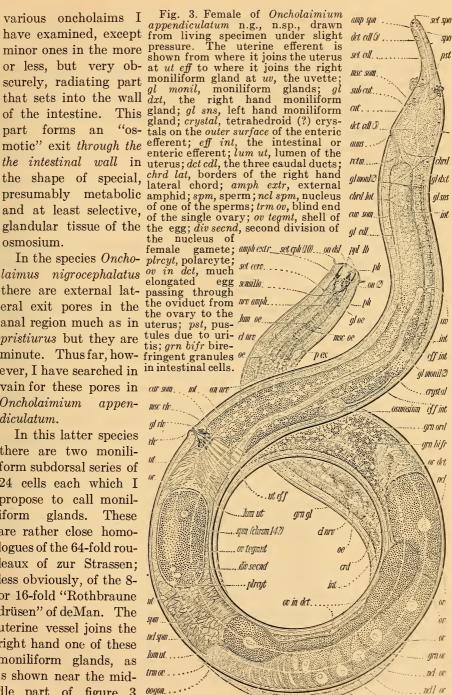
sub-cut

osmosium.

In the species Oncho- plrcyt, polarcyte; laimus nigrocephalatus ov in dct, much elongated egg there are external lat-passing through eral exit pores in the the oviduct from mr amph. anal region much as in uterus; pst, puspristiurus but they are tules due to uri- dmv tis; grn bifr bireminute. Thus far, how-fringent granules 00 ever, I have searched in inintestinal cells. vain for these pores in Oncholaimium appendiculatum.

In this latter species there are two moniliform subdorsal series of 24 cells each which I propose to call monilglands. iform These are rather close homologues of the 64-fold rouleaux of zur Strassen; less obviously, of the 8or 16-fold "Rothbraune drüsen" of deMan. The uterine vessel joins the right hand one of these moniliform glands, as is shown near the middle part of figure 3 on this page, at uv.

×175



In O. appendiculatum at the posterior end of the two 24-cell moniliform glands, however, a number of the cells of each organ seem loosened from the series; opposite these I am unable to find any outlet whatever;—that is to say, the organs appear as if in a deteriorated condition. See gl dxt, gl snst, Fig. 3.

Perhaps causally connected with this is the extraordinary fact that the examination of hundreds of females of Oncholaimium appendiculatum over a number of years has failed to disclose a single healthy specimen. Every female is attacked by a disease that often results in necrosis of the posterior portion of the nema. (See section Uritis, p. 240). The disease (uritis) breaks out on the tail in the shape of minute pustules having an internal radiated, or linear and "parallel-fibered," structure, pst, Fig. 3, sometimes extending forward for a considerable distance into the nema,—in extreme cases, as far forward as the vulva. There may be one, two, three, or even as many as a dozen of these pustules irregularly scattered on the posterior part of the female. The pustules are minute, exude, inter alia, an insoluble material, and frequently exhibit surface bacteria, though it seems doubtful if the bacteria thus far seen are connected with the disease. The uniform occurrence of this disease in females of Oncholaimium appendiculatum may perhaps be connected with the deteriorated (?) condition of the demanian system. On a later page attention will be called to the fact that other oncholaims possessing the demanian system have what appear to be similar diseases of the posterior extremity; but in none of them is there any such extraordinary condition as in O. appendiculatum, where examination has failed to disclose a single adult female free from uritis.

Enteric Efferent. Against the idea that in Adoncholaimus fuscus the anterior junction of the demanian system with the intestine is merely a hold-fast, as suggested by deMan, it may be urged that of other elongated organs known to lie loose in the body cavity of nemas, none are secured in this particular way to the intestine. Why an exception in this case? If it is merely a matter of security, it would seem more in harmony with known nemic anatomy that the attachment be to the body wall rather than to the intestine, and especially that it be effected along a lateral chord. It is not unheard of for a nemic organ of this general form to be attached to a lateral chord.

From a mechanical point of view the idea that the connection of the demanian system with the intestine is merely a holdfast seems to have all the less to recommend it in the case of the monodelphic species, such as *pristiurus* and *serpens*, where this connection is so far caudad that such a holdfast seems rather needless.

DeMan's idea that his main tube is simply and only fastened to the intestine seems not borne out by facts; and his figure 25, if I understand it, admits of a different interpretation. I find his "main vessel" anteriorly to be hollow to

its very end,—the "blind end" of deMan,—and that the freely moving contents of the tube are visible clear to what might be called the surface tissue of the intestine (tissue of the intestine altered, to be sure). DeMan's figure 25 seems easily to admit of this interpretation. I find the cells of the wall of the intestine (if they be really intestinal) are altered where the vessel is attached, and this fact suggests that we have here modified selective tissue,—the osmosium,—the function of which is to extract from the intestine and usher into the demanian system, presumably mainly by osmosis, a product utilized by the latter.

May not the evidence offered by zur Strassen for an open communication between the enteric efferent and the intestine in pristiurus,—i.e. the evidence of his microtome sections,—be capable of a different interpretation? Could zur Strassen's sections have been deceptive? The published figures of his "open connection" between the demanian system and the intestine are not satisfying, in that they appear to show a large portion of the cell walls missing. Now pristiurus ingests mud, and, in consequence, its intestine normally contains much fine grit. Is it not likely that this grit, acting as it naturally would during the sectioning, would damage, or even destroy, delicate cells that, before being broken, might have closed the aperture which zur Strassen shows and describes as an open connection? The suggestion is that this might occur, at the time the sections were cut, through the combined abrasive action of the grit and the coincident dulling of the microtome knife. All zur Strassen's figures show the intestinal lumen more or less open; but when the intestine is entirely empty and free of grit it is collapsed, not open, so that the lumen, in well made sections, is closed and difficult to see. May not this indicate that the vacant lumenal spaces shown in zur Strassen's illustrations probably did contain grit at the time of fixation, and hence, no doubt, at the time of sectioning?

Pristiurus, fuscus and some other mud-inhabiting Oncholaims can be kept alive in pure running sea water for days, or even weeks, and when so kept evacuate the intestine very completely. Sections may then be made without the interference of the grit normally present in the intestine. I have not found such sections to present the appearance figured by zur Strassen.

In an examination of very many specimens, alive and sectioned, I have never been able to convince myself of the existence of an open communication between the intestine and the demanian system.

Any such open connection would seem a grave menace to the well-being of the organism. For if the enteric intake were of the nature figured and described by zur Strassen, there would seem to be little or nothing to prevent the entrance into the demanian system of undigested detritus contained in the intestine, together with numerous living microorganisms which normally

constitute a very appreciable part of the feces. No such detritus is ever seen in the demanian system.

Furthermore, on examining living pristiurus and fuscus, both of which I find to occur along Cape Cod, U. S. A., I find that when the food in the intestine is moving rapidly back and forth opposite zur Strassen's supposed open connection, no portion of it ever enters the enteric efferent. There is not even the slightest corresponding disturbance of the contents of the lumen of the enteric efferent close by, which, as zur Strassen also points out, can be seen in the end portion of the demanian tube where it joins the surface of the intestine.

Possibly the analogous connection with the uterus is hardly to be taken as a very distinctly open one. True, I have seen cases in pristiurus where, when the diseased uterus was filled with microorganisms (microorganisms causing the disease*), the continuous mass of them also filled the nearby part of the corresponding demanian vessel in such a way that there was a direct "tubular" connection between the uterus and the vessel. Normally, however, the conditions are as follows:—One traces the uterine demanian vessel directly forward to the uterus, where its lumen continues for a short distance into a glandular tissue in the posterior end of the uterus,—zur Strassen's so-called "blind end, behind the vulva,"—and there ceases in the midst of a large number of uterine cells somewhat similar to many of those constituting the main portion of the wall, i.e. what seems to be a special collection of glandular uterine cells. In fuscus this same thing occurs where the oviducts join the proximal ends of the two uteri, not, as in pristiurus, at the posterior portion of the single uterus close to the vulva; the histology of this junction, however, is much the same in these two species. It is as if special uterine cells were devoted to secreting material to be delivered to the demanian system through the uterine efferent.—the "tube de communication" of deMan.

In *pristiurus* the long tubular vessel connecting the uterus with the demanian system,—the uterine efferent,—often is difficult to see, especially in its entirety. No better proof of this could be required than that it escaped so keen an observer as zur Strassen.

Even in Adoncholaimus fuscus, while the two short uterine efferents can sometimes be followed from the uteri to the main vessel of the demanian system, often it is practically impossible in a given specimen to follow them throughout their course. Knowing their locality and structure, one can usually determine how they lie and their probable limits, but that is about all. Of course, in a small minority of favorable specimens quite the contrary is true;—the entire tube can be made out satisfactorily as was first done by deMan.

^{*} This disease appears to have nothing to do with uritis (see p. 240); uritis seems an entirely distinct disease.

Direction of Flow in the Demanian System. Evidently a considerable amount of matter is contributed by the intestine to the demanian system. Zur Strassen had no difficulty in assuming the *entire* amount to be so contributed in *pristiurus* (for he appears to have been unaware of the connection in *pristiurus* of the uterus with the uvette, and hence with the demanian system).

However, quite frequently in the contents of the enteric efferent of living *Metoncholaimus pristiurus* near and in front of the uvette pore, refractive, curved, wave-like effects are seen such as would be produced by the gradual mixing of two viscid fluids of unequal refractiveness,—an appearance that might readily be produced by the flowing of a liquid through the uvette pore from the uterine efferent into the enteric efferent in such quantity that some of it passed slightly forward,—perhaps through cover glass pressure.

On various occasions, I have seen a considerable quantity of matter in the main enteric vessel close to its junction with the intestine. While this is no proof that this matter was actually derived from the intestine, it is favorable to that conception. Such matter never contains intestinal debris,—nor sperms (see F. H. Stewart, 1906), nor pseudo eggs,—"balls of finely granular substance," (see zur Strassen.)

If the demanian system emptied *into* the intestine, it is to be expected that it would do so through an aperture, pore, similar to those of other affluent enteric glands,—those emptying into the oesophagus for instance. In nemas such pores are extremely small, have a definite refractive lining, and are adapted to check any "backwash" due to movement of the contents of the enteron,—e.g. just such a structure as occurs in the uvette of *pristiurus*. But no such pore has been seen in connection with any *enteric* demanian vessel.

Moreover, against the flow of any of the demanian fluids being toward the enteron, it may be urged that in pristiurus a special secretion is at times actually seen issuing rather copiously from the pores near the tail,—the external outlets of the demanian system,—and there is not the slightest reason to suppose that in this region the flow is ever anything but backward and outward. There is no evidence that the demanian system is, for instance, a water-vascular system; or that sea water is taken in through the antecaudal lateral pores.

Again, there is little if any reason to believe the demanian system accessory to digestion, because whatever digestive function would be advantageous to adult females would seem also to be advantageous to the young nemas; yet there are no such organs in young oncholaims, for they come into existence at the last moult. The same may be said of any supposable ordinary excretory function.

But if it be supposed that, for some unexplained reason, adult egg-producing females require to *excrete* (not secrete) matter peculiar to them, in other words that the demanian system, or some part of it, be a sort of temporary mal-

pighian system,—a rather violent supposition,—it would seem that the excretion, as such, if poured into the intestine at all, should be poured in posteriorly. But in didelphs,—fuscus, panicus,—such a supposition would pour it in near the anterior end. Or, if it be supposed that the demanian system is simply an emunctorium accessory to the intestine and emptying outward and backward, then why the attachment to the fore part of the intestine as in fuscus?

If the demanian system is excretory, then it is necessary to assume that the necessities of adult females in the way of excretion are different from those of the male or the young female. No reason has been advanced for such an assumption.

Deduction by Elimination. In the demanian system of O. pristiurus three ducts come together at a single point, indicated by X in 1 figure 4,—ducts in each of which a fluid may conceivably flow in either direction; i.e., there are six different paths along which fluid may be conceived to flow. The assumption is, of course, that, when the organs are functioning normally, fluid passes constantly in one direction only in each of the three tubes, 1, 2, 3, Fig. 4.

Indicating the six possible paths by arrows lettered a, b, c, d, e, f (Fig. 4), mathematically, there are twenty possible combinations in groups of three as follows:

abc, abe, acd, acf, adf, bde, cde, cef, bef, bcf. abd, abf, ace, ade, bcd, bdf, cdf, aef, bce and def; this is according to the formula for combinations,

3
Fig. 4. Diagram of the six possible currents.

$$\frac{n(n-1) (n-2).....(n-r+1)}{r!} = \frac{6 \times 5 \times 4}{3 \times 2 \times 1} = 20, \text{ when } n = 6 \text{ and } r = 3.$$

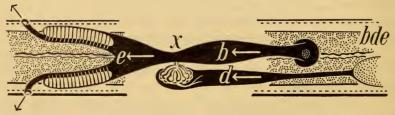


Fig. 5. Diagram showing the direction of flow of the fluid in the demanian system. The intestine and the posterior end of the uterus are shown near bde. The backward flow of the fluid in the enteric and uterine efferents is indicated at b and d, and the backward flow of their combined products at e. The outward flow of the fully elaborated secretion after it has passed the moniliform glands is shown by the two oblique black arrows.

It is evident that a combination containing a and b represents a physical impossibility, i.e. represents opposite currents simultaneously in the same duct,—duct number 1; and so with combinations containing c and d, and e

and f. (It is theoretically possible, of course, that the same tube might have a flow in one direction at one time and in the opposite direction at another time, but, physiologically speaking, this is an unusual occurrence, and practically an unheard of thing in a tubular organ "open" at both ends). We may therefore eliminate from the 20 possibilities, 12 of the combinations, leaving eight,—acf, adf, bcf, ade, bce, bde, bdf and ace.

But there are also two more combinations that obviously must be left out, as involving physical and physiological impossibility, namely ace and bdf, i.e., the cases where the three currents would simultaneously come to, or radiate from, the point X; bdf,—(no outlet, or reservoir), and ace,—(no obvious source of supply). This leaves six combinations possibly worthy of discussion, acf, adf, bcf, ade, bce and bde. These six possibilities are diagrammed in figures 5 and 6. Five of these possibilities (Fig. 6) are rendered

- I. No exit pore for a; pore of uvette indicates reverse of c; f doubtful because entrance of sea water is possibly involved, while outflow of secretion is known from lateral pores, p.
- II. No exit pore for a; f doubtful as in I; moniliform glands are believed here to empty outward because of their form and location in O. fuscus; only outlet of d and f would be through a.
- III. c doubtful as in I; f very doubtful as in I and II; the only outlet for f and b would be through the uvette and c,—reverse of direction indicated by structure.
- IV. No exit pore for a; the only source of a would be d and the uvette.
- V. c doubtful as in I; c may also be reasoned against on the basis of homologous structures in O. nigrocephalatus and O. appendiculatum.

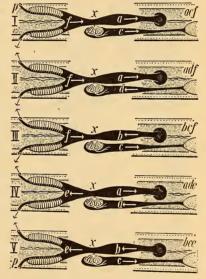


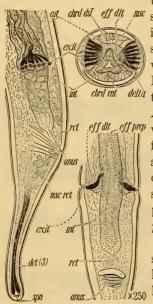
Fig. 6. Five diagrams of supposed currents in a demanian system. Objections to each supposition are listed opposite its diagram. Compare with Fig. 5.

exceedingly improbable by the physiological and morphological considerations listed opposite their diagrams. We may therefore safely deduce, even from this single discussion, that the flow is almost certainly as shown in Fig.5.

The significance of seven exit pores on each side in *panicus* (see Fig. 7) is an interesting subject for speculation. It can hardly be said that the existence of seven pores is for the purpose of furnishing a large outlet; it would seem much simpler to attain such a result by having a larger single pore. Nor

does it seem that the multiple outlet would have anything to do with the quality of the secretion that is prepared. The most reasonable supposition is that, in use, the demanian secretion is rendered more effective through a multiple delivery, and it is not difficult to reason out why this might be so.

Take, as a basis of reasoning, the fact that spiders have multiple spinneret tubes. This plurality is an advantage in that if some tubes of the spinneret apparatus do not act, or are restrained from acting, the remaining ones may continue to act, an economy of a kind often seen in nature. Thus threads of varying size and composition can be "spun." It seems not unlikely



AdoncholaimusFig. the posterior portion of the point where it forks to prodelta is shown at delta and

that the multiple thread of the spider may have drd del eff dit mex structural advantages; at any rate it is a fact that, in some cases at least, the thread can be artificially split into components harmonizing in number with the elements of the spinneret apparatus. If these be advantages, it is quite conceivable that they may apply in some way to the multiporous Adoncholaimus panicus, and this would harmonize effpro with the previous conclusions concerning the function of the demanian system;—for presumably the secretion in panicus is like that of other oncholaims, i.e. a copious, sticky, non-watersoluble, elastic material;—at least these are its properties after it is delivered into sea water by pristiurus.

The location of the outlets of the demanian system is always well caudad, and the oncholaims having the system are agile and limber, all of which harmonizes with the belief that the system elaborates material used with some degree of "skill."

All oncholaims having the demanian system panious n.sp. Side, ven- All onenolalms having the demanian system tral and sectional views of have a habit of coiling and uncoiling and can with same female. eff prcp, the the greatest ease place the exit pores of the system principal efferent at the against any part of the body except the tail and duce the two deltic effer- its immediate vicinity, and this habit, no doubt, ents, eff dlt; the seven-fold is correlated with the function of the secretion. the seven exit pores at exit. Females of such oncholaims have relatively short tails,—as if longer ones would perhaps be in the way.

Conceivably, of course, the demanian secretion might have properties attractive to the other sex (odor, etc.), but the idea does not seem to appeal so strongly as that of having something to do with other matters.

In this connection it may be recalled that, opposite the demanian exit pores of Metoncholaimus albidus (Bastian), deMan described and figured a persistent girdle of left-over yellowish brown secretion.

Oncholaims having the demanian system, pl.6 at least most of them, have a way of collecting together in masses when artificially assembled in sea water. Conceivably this habit may have some connection with the demanian secretion, but it is not obvious why only adult females should secrete for this purpose alone.

The demanian system appears more distended when the uterus is full or nearly full of eggs. For instance, at this time the uterine efferent and portions of the uterus of pristiurus may contain an abundance of colorless, transparent, rather structureless-looking matter, resembling, under the microscope, partially am mu dissolved shavings of gelatin.

The question arises as to what becomes of the Chrd Int. secretion of the accessory gland of the male, Fig. 8. Profile of head end of male oncholar minum appendiculatum. The three onchia are shown; the the demanian system in the female. No reply left ventral submedian is the to this question has occurred in connection with these investigations except the possibility. which seems remote, that the "gum arabic- the scattered darker ones are like" mixture sometimes seen in the uterus of nuclei of the lateral chord, the width of which is pointed out pristiurus might possibly have been derived at chrd lat. wholly or in part from the male. It should

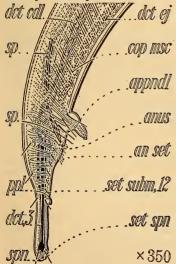
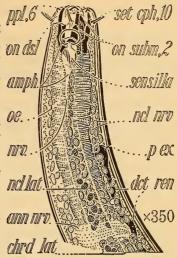


Fig. 9. Tail, male Oncholaimium appendiculatum. ppl, single ventral papilla; dct (3), caudal ducts leading to spinneret; appndl, ventral, erectile appendicule; an set, anal setae; set subm (12), submedian setae on male only.



longest,-see on dsl and on subm (2). The sensilla and amphidial nerve are shown. Nuclei shown mostly central nervous system;

perhaps be mentioned that in the nemic genus Rhabditis, glands accessory to the male gonad are known that secrete a copulatory cement; but no such cement is vet known in connection with any oncholaim.

Of course, the mere presence of this material in the uterus and in the portion of the uterine efferent nearby does not of itself indicate the direction of the flow, but the structure of the organs distinctly suggests that the flow is caudad, i.e. from the uterus toward the external openings near the tail. Were the entire flow of the demanian system toward the uterus, it would seem strangely circuitous.

While the fact that no external exit pores have been discovered in Oncholaimium appendiculatum makes conceivable a flow from its enteric vessel and the moniliform glands through the uvette to the uterus, yet the structure of the uvette pore seems as distinctly adapted to a flow in the opposite direction, i.e. caudad, in this species as in the others. Moreover a different explanation of this exceptional case seems more plausible, namely, that in O. appendiculatum the demanian organs are in a deteriorated condition. The fact that this species is the only one that almost invariably presents disease in the posterior extremity of the adult females may harmonize with the supposition that the demanian system of this species is in a deteriorating and perhaps useless condition. The nonconsecutiveness of the posterior cells of the moniliform glands in O. appendiculatum, and the appearance of crystals on the outer surface of the enteric efferent, (Fig. 3) suggest decadence in this anomalous species.

In O. appendiculatum the uvette is reduced to a mere ampulla; and is almost as greatly reduced in nigrocephalatum. In neither of these is it at all likely that the uvette itself could produce any very appreciable secretion flowing into the uterus, and yet in both species the uterine tube is better developed (or at any rate more obvious) than it is, for instance, in pristiurus, where the uvette is strongly developed.

I have not seen sperms, or anything remotely resembling them, in the demanian system, as reported by Stewart and zur Strassen.

Uritis. It is interesting that the females of a number of oncholaims shown to possess demanian vessels seem unusually subject to disease.

Among such oncholaims, allusion is made to the following typical cases:

Name	Location	Lesions	Regeneration	
?	Woods Hole, Mass., U. S. A.	"tailless"	Undoubtedly healed over	
O. appendiculatum	Woods Hole, Mass.	From tail end to half of nema necrotic	No signs of regenera- tion	
M. pristiurus	Woods Hole, Mass.	Tail end gone; no anal opening; no spinneret	Merely healed over no openings	
A. fuscus	1. Cape Cod, Mass. 2. Miss E. Horsman Univ. College of Wales	Former uritis (?) Former uritis (?)	Terminus regener- ated; no spinneret	
New Oncholaim	Florida, U. S. A.	Former uritis (?)	Imperfect spinneret and anal opening regenerated	

An interesting morphological problem is thus disclosed. As the table indicates, one not infrequently finds oncholaims, especially females, with highly peculiar caudal extremities,—sometimes without spinneret or anus, sometimes with these organs present but apparently abortive, or at least peculiar in form,—abnormalities probably due to specific disease. Apparently the disease is sometimes combated by the nemic organization, so that the posterior end of the nema heals over, and in some cases it seems as if a new

anus is formed, and possibly even a new spinneret! Just how this occurs is not yet clear,*but I have seen both deformed anal openings and deformed spinnerets of female oncholaims that appeared to give evidence of having been imperfectly regenerated after some accident, or, more likely, after uritis.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

461st meeting

The 461st meeting of the Society was held in the Assembly Hall of the Cosmos Club, February 26, 1930, President G. R. Mansfield presiding.

The Secretary announced the election of Mrs. Charles D. Walcott and Miss M. D. Foster, the latter of the U. S. Geological Survey, to Active

membership in the Society.

Informal communications: E. F. Burchard showed lantern slides of a lens of intraformational conglomerate in the Cambrian Conesauga limestone in Alabama. This consists of flat plates of limestone, variously oriented in a matrix of more siliceous limestone. The plates of limestone are sharp edged and apparently have suffered no abrasion or transportation, but were cemented nearly in situ, soon after they were broken apart. He suggested that this deposit may have originated as talus filling of a small gully and showed a lantern slide of the present-day deposition of similarly shaped blocks of sandy clay at the base of an overhanging cliff in the Ackerman formation of Eocene age in Mississippi.

T. S. Lovering described the three possible types of surfaces of no distortion and maximum strain obtained by compressing a sphere of reference into a strain ellipsoid. He pointed out that T. A. Link in a recent discussion of the strain ellipsoid used a sphere of reference, the diameter of which shortened with the compression to equivalence with the intermediate axis of the strain ellipsoid. With this "Link" sphere of reference, the surfaces of no distortion can be at any angle to the applied force. Link's treatment seems without

mechanical or geological significance.

Regular Program: T. S. Lovering: The Tertiary history of the Front Range. Discussed by Messrs. Gilluly, Mertie, Lovering, Rubey, Werner and Goldman.

Robert Balk, Structural survey of the Adirondack anorthosite. (illustrated). The pre-Cambrian rocks of the Adirondack Mountains, New York, consist of an oldest system of marbles and schists—the Grenville formation—and three igneous rocks—an anorthosite, a gabbro and a syenite series. The anorthosite forms a central massif which is surrounded by the syenite, and the gabbros form hundreds of small round areas in the whole region. The Grenville formation appears as isolated fragments in the intrusive rocks.

The geologists of the New York State Geological Survey have held that the three igneous rocks crystallized from three independent molten magmas and that the order of intrusion was (1) anorthosite, (2) syenite series, (3) gabbro.—In 1917, N. L. Bowen maintained that anorthosite and syenite are co-mag-

^{*} Regeneration seems to be uncommon in nemas. Additional articles consulted—see zur Strassen's bibliographic list, 1896.

matic rocks, the anorthosite representing a residue of solid crystals which had precipitated in the parental magma, while the syenite was considered the The resulting controversy in the literature indicates a certain scarcity of structural data which the speaker has tried to supply through spe-

cial studies in the field. The results of his studies are:

The anorthosite, the gabbro and the syenite series are all members of one and the same parental magma. Forty-seven examined gabbros grade into anorthosite or syenite, and no intrusive contacts have been seen. Gabbros have developed in the parental magma through clustering and accretion of solid ferromagnesian minerals, due to frictional forces between the individual crystal grains. The process begins with small lumps, leads to lenses and layers, and ends with spherical bodies as large as two miles in diameter. The larger gabbros have settled with reference to the surrounding magma, the smaller ones have not.

The anorthosite originated through accumulation of solid labradorite crystals in the magma chamber, as Bowen has maintained. The syenite is not, as a rule, intrusive into the anorthosite but grades into it; there is good evidence that it is the mother liquor of the parental magma which has been squeezed out from a central crystal-filled chamber into the surrounding Grenville formation where the syenite forms a multitude of sill-like masses.

The anorthosite is very likely a lens tilted to the northeast at 30°.

indirect and direct observations point to this fact.

It is believed that a parental magma of unknown composition, but possibly resembling that of a quartz diorite, advanced from "under the edge of the Canadian Shield" obliquely to the southwest into the Grenville formation. This magma must have carried considerable quantities of solid labradorite crystals in suspension, and the following processes are thought to have occurred at the same time: (1) clustering and gathering of dark silicates forming spherical gabbros; (2) compacting and clustering of solid labradorite crystals, coalescing finally into a large lenslike mass (the anorthosite massif), with portions of mother liquor enclosed here and there; (3) ejection of the syenitic mother liquor into the Grenville formation, possibly as far as 30 miles away from the anorthosite.

The arrangement of the primary joint systems is in harmony with this general conception of the origin of the intrusive rocks. (Author's abstract.)

462ND MEETING

The 462nd meeting of the Society was held in the Assembly Hall of the Cos-

mos Club, March 12, 1930, President G. R. Mansfield presiding.

The Council announced with regret the deaths of Claude E. Siebenthal, former geologist of the U.S. Geological Survey, and Capt. H.A.C. Jenison, formerly of the U.S. Geological Survey, both Active Members of the Society.

Informal Communications: David White exhibited samples of brine from a bore hole in San Mateo, California, which have been shown to contain living bacteria, (Micrococcus littoralis) in sufficient abundance to give a brownishwine color to the brine. A possible similar organic source is suggested for the

reddish color of some salt deposits. Discussed by M. I. Goldman.

Regular program: G. R. Putnam: Isostasy. Discussed by Messrs. Lover-ING, SWICK, WHITE, RUBEY, A. C. LANE, and SPENCER, with reply by Mr.

PUTNAM.

D. F. Hewett: Genesis of iron-manganese carbonate concretions in Central South Dakota.—Recent explorations on a zone of iron-manganese carbonate concretions in Central South Dakota not only indicate the existence of a large quantity of low-grade manganese-bearing material but throw light on the chemical processes involved in their genesis. Natural exposures indicate that the zone persists for at least 40 miles along the Missouri River, but explorations have been confined to about nine townships near Chamberlain, Brule The zone is 38 feet thick and lies in the Pierre shale about 130 feet above the Niobrara limestone. Within this zone, the nodules range from 1 to 8 inches in diameter and tend to occur in persistent layers. Most of the nodules have grown around organic remains, largely shells of *Inoceramus*, but, in part, fragments of plants and of bones belonging to marine as well as terrestrial vertebrates. Explorations include 12 shafts that range from 32 to 48 feet deep and one open cut. In excavating these shafts, all of the nodules were separated from each 5-foot zone of shale, crushed, sampled, and analyzed. From five shafts, average samples of shale were collected from successive 10-foot zones and analyzed. On the average, each cubic yard of material excavated yielded 164 pounds of concretions containing 15.7 per cent manganese and 11.1 per cent iron.

In reviewing this large amount of analytical data, it was found that (1) the combined percentages of iron and manganese tended to be constant at 28 to 30 per cent and (2) as the weight of nodules recovered per cubic yard of shale increased, the percentage of iron in the sample of the nodules increased also. From this relation, it was inferred that the outer zones of the nodules contained more iron than the inner and this was confirmed by analyses of four carefully selected samples from a nodule. The ratio of the iron to the manganese content was about twice as much in the outer zone as in the inner zone. Further, for four of the shafts for which analyses of shale were also available, after calculating the amount of iron and manganese in the combined nodules and shale for successive zones, it was found that, although the amount of manganese per unit section was about half that of iron, the percentage of the total amount of manganese now found in the nodules was about twice the

per cent of the iron.

In considering the genesis of concretions rich in iron and manganese carbonate, it may be assumed that either (1) the concretions grew on the bottoms of bodies of water by accessions of iron and manganese from salts in solution or (2) the concretions formed in the sediments after burial by the local reduction and migration of iron and manganese present as oxides in the sediments.

From the thermal relations of the oxides and carbonates of iron and manganese established many years ago by Dieulafait, it appears that less heat is absorbed by the reduction of manganic to manganous oxides than of ferric to ferrous oxides and more heat is evolved by the formation of manganous carbonate than of ferrous carbonate. The relations described above, when viewed in the light of these thermal data, indicate that the concretions have grown after burial by accessions of carbonates formed by reduction of the higher oxides of iron and manganeses present in sediments. (Author's abstract.)

Discussed by Messrs. Burchard, Spencer, Bradley and Hewett.

(To be continued)

SCIENTIFIC NOTES AND NEWS

The Smithsonian Institution announces that a perfect sphere of flawless crystal, believed to be the largest in the world, is now the property of the United States National Museum, thanks to the generosity of Mrs. Worcester Reed Warner. Mrs. Warner made the gift as a memorial to her late husband, whose own outstanding achievements were largely in the manufacture of astronomical instruments from quartz.

The crystal ball measures $12\frac{7}{8}$ inches in diameter and weighs $106\frac{3}{4}$ pounds. Perfect spheres of as much as 6 inches in diameter are great rarities, prized alike by emperors and museums, so that the uniqueness of the National

Museums's acquisition may be realized.

The block of quartz from which the ball was cut is said to have come from Burma and must have weighed over 1,000 pounds. It was cut in China and polished in Japan. Eighteen months were required for this delicate and laborious task. According to Dr. George F. Kunz, the Japanese workmen first round the rough mass of crystal by careful chipping with a small steel hammer, forming a perfect sphere with the aid of this tool alone. For grinding they use cylindrical pieces of cast iron, about a foot in length and full of perforations, in which the ball is kept constantly turning. The abrasive material used in this first grinding is powdered emery and garnet. The final polishing is effected with crocus or rouge (finely divided hematite), giving a splendid lustrous surface.

The ball came to this country in 1925 and was immediately placed on temporary deposit in the National Museum. The officials of that institution express their pleasure that Mrs. Warner's gift makes it the permanent property of the nation. The late Mr. Warner, to whom the gift is a memorial, was a member of the firm of Warner and Swasey, instrument makers. Mr. Warner designed and constructed three of the largest telescopes in use in this hemisphere, including the 36-inch instrument of the Lick Observatory, the 40-inch telescope of the Yerkes Observatory and the 72-inch telescope for the Domin-

ion of Canada.

DR. WARD B. WHITE, for the last eight years director of the bureau of chemistry, New York State Department of Agriculture and Markets, has accepted an appointment as chief of food control, Food, Drug, and Insecticide Administration, to fill the vacancy caused by the death of R. W. BALCOM.

OFFICIAL COMMUNICATIONS THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. TUCKERMAN, Bureau of Standards.

Recording Secretary: CHARLES THOM, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Physical chemistry.—The compressibility of rubber. L. H. Adams and R. E. Gibson	
Zoology.—A new pocket mouse from southern Lower California. E. W. Nelson and E. A. Goldman	
Zoology.—The demanian vessels in nemas of the genus Oncholaimus; with notes on four new Oncholaims. N. A. Cobb	225
Proceedings	
The Geological Society	241
SCIENTIFIC NOTES AND NEWS	244

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the ss ue of the Journal for the following fourth or ninéteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.95	\$1.90	\$2.38	\$3.00	2.50
150	1.50	2.87	3.50	4.33	3.00
200	1.88	3.60	4.31	5.25	3.50
250	2.40	4.24	5.00	6.00	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

^{*} Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20 July 19, 1930 No. 13

GENERAL SCIENCE.—The Philosophical Society of Washington through a thousand meetings. W. J. Humphreys, U. S. Weather Bureau.

Tonight, the one thousandth on which we have foregathered to learn of new discoveries in the limitless field of science, we turn aside from discussions of the outer world to a few minutes of self-contemplation—to recall how, as a society, we came to be, and, lest we forget, to relate again a little of our own history since that natal day some 59 years ago.

Before considering ourselves specifically, however, it will be interesting to review briefly our immediate antecedents. From records kindly examined by our fellow member, Mr. F. E. Brasch, Chief of the Smithsonian Division of the Library of Congress, and from other sources, especially Bulletin 101 of the United States National Museum by the late Richard Rathbun, a former president of this Society, it appears that the spirit of philosophical inquiry came to the Nation's Capital almost with its founding. Washington himself had envisaged the establishment here of a great National University, and Joel Barlow writing to Jefferson, then vice president, from Paris on Sept. 15, 1800, urged that Washington's hope be realized in the establishment of an adequately endowed institution for both collecting and disseminating knowledge, and that "the Institution be called the Philosophic Society." Nothing came immediately of this suggestion. In February 1806 Jefferson and Barlow collaborated in drafting a bill for the establishment of a National Academy and University in Washington, but again there were no tangible results. In this connection Jefferson, then President of the American Philosophical Society, said that he wished there might be a Philosophical Society or Academy at the seat of government with affiliated Academies in each state.

¹ Address before the Philosophical Society of Washington, January 18, 1930.

Such keen interest in science and philosophy, shared also by Fulton, Law, Cutbush, Meigs, Adams and others, inevitably led to the forming of societies holding stated meetings and following announced programs. The earliest of these, the Columbian Agricultural Society, was very ephemeral—founded in 1810 and disbanded in 1812—and had many elements of the County Fair, holding exhibits and awarding premiums for things raised on the farm or made in the home. next in order, and really the first learned society of Washington, the Metropolitan Society, was formed June 15, 1816, but on the adoption of its constitution, Aug. 8, 1816, changed its name to the Columbian Institute for the Promotion of Arts and Sciences. Its activities were largely agricultural and horticultural together with the collection and display of museum specimens. In 1817 the Medical Society of the District of Columbia was formed, as was also (on March 13) the Washington Botanical Society. The latter, devoted mainly to the study of the plants of the District of Columbia, became inactive in three or four years and quietly vanished in 1826. The Columbian Institute, too, soon became moribund, despite the interest of a few faithful spirits, and in 1837 ceased entirely to exist as an active organization. Perhaps its most conspicuous product was the creation and maintenance for nearly 20 years of a botanic garden, at the very place where thirteen years later the present United States Botanic Garden was established.

On May 15, 1840 the National Institution, later changed to National Institute, was organized in Washington in the expectation, it appears, of controlling and using the Smithsonian bequest, not narrowly and selfishly, but in a broad and liberal spirit, the spirit the Smithsonian Institution, though never controlled by this important and influential organization, was thus enabled more easily to adopt. The National Institute held meetings for about 20 years and published its proceedings in the form of Transactions and other papers. It was disbanded near the beginning of the Civil War, and from 1861 to 1871 the only meetings of scientific men in the city were those of the Saturday Club and the Potomac Side Naturalists' Club. Such then, in merest outline, were the careers of our worthy predecessors.

At the end of this time the many learned men then living here, where life again had become normal, were anxious for the benefits to be derived from the regular meetings of a formal organization, and so it came to pass that the Philosophical Society of Washington, embracing all sciences save those, if they be sciences, of speculative thought, had its origin in the following initiatory letter, dated, it appears, March 12, 1871:

Prof. Joseph Henry, LL.D.

The undersigned respectfully request you to preside at a meeting which they propose to hold for the purpose of forming a society, having for its object the free exchange of views on scientific subjects, and the promotion of scientific inquiry among its members.

M. C. Meigs,
BENJAMIN PEIRCE,
THEO. GILL,
PETER PARKER,
F. В. Меек,
T. R. Peale,
WM. B. TAYLOR,
CHAS. A. SCHOTT,
E. B. Elliott,
THOMAS ANTISELL,
J. J. Woodward,
J. S. Billings,
J. K. Barnes,
C. H. CRANE,
George A. Otis,
ALBERT J. MYER,
A. A. Humphreys,
Asaph Hall,
SIMON NEWCOMB,
WM. HARKNESS,
B. F. CRAIG,
J. H. C. Coffin,

F. V. HAYDEN, J. E. HILGARD, J. H. LANE, S. F. Baird, Walter L. Nicholson, WM. H. DALL, B. FRANKLIN GREENE, S. V. BENÉT, HORACE CAPRON, THORNTON A. JENKINS, George H. Elliot, W. T. SHERMAN, GEORGE C. SCHAEFFER, THOS. LINCOLN CASEY. JNO. G. PARKE, B. F. SANDS, A. B. Dyer. J. B. Wheeler, A. B. EATON, ELISHA FOOTE, SALMON P. CHASE.

The Signers of this letter represented, we see, every branch of both the natural and the exact sciences.

The Society was incorporated in the City of Washington, District of Columbia, in 1901. The letter requesting incorporation was dated May 15, 1901, and signed as follows:

Wм. I	I. Dali	L, Founder, (L.S.)		
Тнео.	GILL,	Founder, (L.S.)		
SIMON NEWCOMB, Founder, (L.S.)				
Cyrus Adler,	(L.S.)		(L.S.)	
MARCUS BAKER,	(L.S.)		(L.S.)	
Louis A. Bauer,	(L.S.)	John F. Hayford,	(L.S.)	
FRANK H. BIGELOW,	(L.S.)	GEO. W. LITTLEHALES,	(L.S.)	
F. W. CLARKE,	(L.S.)	CHARLES F. MARVIN,	(L.S.)	
WM. A. DE CAINDRY,	(L.S.)	H. M. PAUL,	(L.S.)	
ROBERT FLETCHER,	(L.S.)	J. W. Powell,	(L.S.)	
G. K. GILBERT,	(L.S.)	RICHARD RATHBUN,	(L.S.)	
GEO. M. STERNBERG,	(L.S.)	J. E. Watkins,	(L.S.)	
OTTO H. TITTMANN,	(L.S.)	CHARLES K. WEAD,	(L.S.)	
F. W. TRUE,	(L.S.)	ISAAC WINSTON.	(L.S.)	
CHAS. D. WALCOTT.	(L.S.)	., 1102 011	(/	

This letter was acknowledged before Henry E. Cooper, Notary Public, May 18, 1901, and filed May 20, 1901.

The presidents of the Society, representing various sciences, have been:—

*Joseph Henry 1871–'78	G. W. LITTLEHALES	1905
*Smov Newcomp \$1878-'80	*Cleveland Abbe	1906
*Simon Newcomb	*John F. Hayford	1907
*J. J. Woodward 1881	L. A. Bauer	1908
*W. B. TAYLOR 1882	*C. K. Wead	1909
*J. W. Powell 1883	*R. S. Woodward	1910
*J. C. Welling 1884	A. L. Day	1911
*Asaph Hall	*E. B. Rosa	1912
*J. S. Billings 1886	С. G. Аввот	1913
*Wm. Harkness	*L. A. Fischer	1914
*Garrick Mallery 1888	W. S. Eichelberger	1915
*J. R. Eastman	L. J. Briggs	1916
*C. E. Dutton	E. Buckingham	1917
*T. C. Mendenhall 1891	G. K. Burgess	1918
*G. K. GILBERT 1892	W. J. Humphreys	1919
*G. Brown Goode 1893	R. B. Sosman	1920
*Robert Fletcher 1894	R. L. Faris	1921
*W. H. Dall	E. C. CRITTENDEN	1922
F. W. Clarke	W. P. White	1923
*Marcus Baker	D. L. Hazard	1924
*F. H. Bigelow	J. A. Fleming.	1925
O. H. TITTMANN	W. Bowie	1926
*G. M. Sternberg. 1900	*J. P. AULT.	1927
*C. D. WALCOTT 1901	Paul R. Heyl.	1928
*RICHARD RATHBUN 1902	L. H. Adams	1929
J. H. Gore	Walter D. Lambert	1930
C. F. Marvin	WADIER D. LAMBERI	1000
O. F. MARVIN 1904		

^{*} Deceased.

Returning now to the earliest meetings, we have, quoting from Volume I of the Society's Bulletin:

1st Meeting.

March 13, 1871.

Prof. Joseph Henry in the Chair.

In response to this call [the letter quoted above of March 12, 1871, to Joseph Henry] a meeting of the subscribers thereto was convened and held at the Smithsonian Institution, in the Regent's room, on Monday, March 13, 1871. The outline of a Constitution was adopted, and under it the following gentlemen, who collectively should constitute a GENERAL COMMITTEE for the transaction of the business of the Society, were elected officers:—

PRESIDENT.
Joseph Henry.

VICE-PRESIDENTS.

M. C. Meigs, J. E. Hilgard. Horace Capron, Wm. B. Taylor.

TREASURER.
Peter Parker.

SECRETARIES.

B. F. Craig,

Theodore Gill.

MEMBERS AT LARGE OF THE GENERAL COMMITTEE.

Thomas Antisell, J. H. C. Coffin, S. Newcomb, S. F. Baird. E. B. Elliott, W. T. Sherman, T. L. Casey, T. A. Jenkins,

J. J. Woodward.

The Constitution was then referred to the General Committee for verbal expression; and the Committee was also empowered to propose Rules and By-Laws for the Government of the Society.

2nd Meeting.

March 18, 1871.

The President in the Chair.

Professor S. F. Baird communicated to the Society, on behalf of the author, a copy of a memoir entitled—

OFFICIAL REPORT OF THE YELLOWSTONE EXPEDITION OF 1870, BY LIEUT. G. C. DOANE, 2D U. S. CAVALRY

Thus, organized in the city of Washington, District of Columbia, on March 13, 1871, the Philosophical Society promptly began, March 18, 1871, its scientific career, which it has pursued ever since with much of that quiet dignity and singleness of purpose that characterized its founders.

In his anniversary address, November 18, 1871, Professor Henry spoke on the character and object of this society. Several passages are here quoted from this address. They give us first hand information on our subject, and at the same time reveal to us something of the personality of this great character, the most scholarly of gentlemen and the most gentlemanly of scholars. "Man," he says, "is a sympathetic being, and no incentive to mental exertion is more powerful than that which springs from a desire for the approbation of his fellow men; besides this, frequent interchange of ideas and appreciative encouragement are almost essential to the successful prosecution of labors requiring profound thought and continued mental exertion. Hence, it is important that those engaged in similar pursuits should have opportunities for frequent meetings at stated periods."—"Furthermore, a society of this kind becomes a means of instruction to all its members, the knowledge of each becoming, as it were, the knowledge of the whole."

He then discusses the desirability of publishing a Bulletin. This was done with the aid of the Smithsonian Institution, to and including the 378th meeting, Dec. 19, 1891, of the Society as a whole, and the 64th

meeting, April 1, 1891, of the mathematical Section. The resulting eleven volumes contain, in addition to lists of members, officers, bylaws, et cetera, the programs of all meetings, abstracts of many papers, and a few articles in full. Four additional volumes of the Bulletin were published by the Society, bringing its records down to and including the year 1910. On April 22, 1911, it was agreed to defer the further publication of the Bulletin and instead thereof to publish to the extent of 70 pages per year, if so much be needed, in the Journal of the Washington Academy of Sciences and to subscribe to this Journal for all members of the Society who may not at the time also be members of the Academy. This arrangement appears to have been reasonably satisfactory and still is in force.

Professor Henry also comments in his first address to the Society on the relatively large number of scientific workers in Washington, and on the extent of instrumental and library facilities then available.

"With so many facilities," he says, "as exist in the city of Washington for the pursuit of science, this Society would be derelict of duty did it fail to materially aid, through communion of thought and concert of action, the advancement of the great cause of human improvement."

In this recognition of the fact that opportunity implies duty Henry was right. Many centuries ago the same idea was most forcefully expressed in the parable of the trees and their fruit, and it is eternally true. Since that time, more than 58 years ago, when Joseph Henry, the first president of our Society, spoke so wisely, the scientific facilities and opportunities in Washington have vastly increased, and with them have equally grown our imperative duty to produce abundant and good results. Our tree, the Philosophical Society, still bears plenteous fruit of the finest quality and in addition to that, it has furnished many scions that have grown into independent trees, until where once there was but a single tree now there are twenty, or more, each sturdy and an annual bearer of copious crops. Indeed the Society early in its career made the way easy for such a spread and independent development by adopting the following as a standing rule—a rule it long retained:

Sections representing special branches of science may be formed by the General Committee upon the written recommendation of twenty members of the Society.

Under this authority J. E. Hilgard and nineteen other members of the Society requested on Jan. 27, 1883, that a Section in Mathematical Science be formed, and such a section was organized on March 29, 1883, and for nearly ten years held independent and successful meetings. After a time, however, when the Society had become more and more mathematical through the loss of the anthropologists, 1879; the biologists, 1880; the chemists, 1884; the entomologists, 1884; and the geographers, 1888—when there was left only mathematics and its more or less immediate dependents, physics, astronomy, geodesy and geology—the mathematical Section ceased to exist as such, its last meeting being the 68th, Nov. 30, 1892. In truth the Society and this Section had become so nearly one and the same that independent meetings on their part were no longer desirable. However, that was by no means the end of the establishment of new scientific societies in Washington.

Still another scion sprang from this original tree, a scion that grew mightily and that had something of the properties of all the others as well as characteristics distinctly its own. It early (1878) came into being in this fashion. After the formal presentation of scientific papers had been completed, whether in some office or elsewhere, it often happened that many of those present fell into pleasant and profitable discourse on various topics, a discourse that out of regard to a janitor's endurance, or for some other reason, had to be broken off abruptly, or continued on the street or, and often, in some favorite rathskeller. This was the origin of that other scion, sprung from the desire for free and friendly discourse between scholars, and known the world over as the Cosmos Ciub.

And the times have changed. In the earlier days of the Society the universe was its province and every science a congenial topic. The knowledge and the interest of the Henrys and the Newcombs was broad and comprehensive; ours is attenuated. The entomologist's father, for instance, knew bugs, he himself knows a bug, while his son may perhaps, know only a particular flea that lives on that bug! Nor is the physicist any exception to this involution or devolution process. Once he knew something of the phenomena about him, and was happy in that knowledge. Today, well, all too frequently he gets into a metaphysical muddle over the eighteen hundredth portion of a hydrogen atom. Of course the electron is a mighty important thing and is fully worthy of all the attention it is receiving, but one does wish that there were enough good physicists to give many other things the attention they also deserve. Often we look at our program, I fear, and say: "Humph, nothing here about the eighteen hundredth portion of the hydrogen atom. One paper is on the proton, in which I am not interested; and the other on the photon, and that bores me. I shall stay at home." Well, the proper time to come is every time, and the most urgent time to come is when the subject under discussion is the one you know least about.

And the times have changed in another way too. Only a quarter of a century ago, a mere yesterday it seems, the meetings of the Society had the air of formal dignity. The presiding officer always, or nearly always, honored the occasion by appearing in evening dress, and so too on many, if not most, occasions did the speakers; though of course it always was what a man said, and not what he wore when he said it, that really counted. Nor was this the only formality we of the older generation recall regretfully, or amusedly, as our mood may determine. Who, we wonder, when a Woodward was presiding or a Newcomb speaking, would have had the temerity to burn, even for a moment, incense on the altar of the goddess Nicotine; or in any other way mar, or ease, again as our mood may suggest, the formal dignity of the occasion? Why, Sirs, we as lief would have gone to a wedding in our shirt sleeves, or puffed a pipe in church!

The activity of the Society is well shown by the fact that to catalogue only the first 310 of its regular meetings, and the first 35 meetings of the Mathematical Section, required 61 double-column octavo pages in fine print. Nor has the Society been any less active latterly than formerly, though more restricted in its scope. Here, A. B. Johnson, J. C. Welling, and others, told of the anomalies of sound signals, in which Joseph Henry, John Tyndall, and Lord Rayleigh were so greatly interested. Here, Alexander Graham Bell told of his interesting experiments on the photophone. Here, that fascinating shibboleth, isostasy, was first given to the world, April 27, 1889, in an interesting paper on the problems of Physical Geography by C. E. Dutton. Here, isostasy had much of its development under John F. Hayford, and still flourishes under the constant care of William Bowie. Here, in 1896, a decade before there ever was an aeroplane in the sky, Albert F. Zahm presented a paper on skin friction that is a classic in the science of aviation. Here, C. G. Abbott has kept us informed of all the work of himself and others on solar radiation. Here, E. B. Rosa brought to our knowledge the measurements of extreme accuracy which he, N. E. Dorsey, and their colleagues, were making of fundamental electrical units.

Here, too, many another outstanding paper was presented, for these are only excellent examples to illustrate the sustained activity of the Society through a thousand meetings, and the earnest of what the next thousand, and the next and next, will be.

IMPORTANT DATES IN THE SOCIETY'S HISTORY

- 1871, March 13, Society founded.
- 1874, June 6, adoption of the rule that in the official records of the Society no title except "Mr." shall be used.
- 1883, January 27, Mathematical Section formed.
- 1887, March 26, 300th meeting of the Society, and its first in the Assembly Hall of the Cosmos Club, H. Street and Madison Place, where it has met ever since, except occasionally, and then usually in conjunction with some other society and for special reasons. For a number of years previous to this date the meetings had been in the library of the Surgeon General's Office, old Ford's Theater, east side of 10th Street, between E and F, N.W.
- 1893, February 18, 400th meeting of the Society, held at the Corcoran, corner Fourteenth and K streets Northwest, and consisting of a banquet, with toasts and reminiscences; reported in Volume 12 of the Bulletin. Eight founders and 81 other members and guests were present.
- 1899, April 15, celebration of the 500th meeting by a dinner at Rauscher's, Connecticut Ave. and L. Street, with 39 persons present.
- 1901, May 20, Society incorporated in the city of Washington, District of Columbia.
- 1911, April 22, decision adopted to defer the further publication of the Bulletin, and to publish in, and subscribe to, the Journal of the Washington Academy of Sciences.
- 1925, December 12, 55th annual meeting, at which the last surviving founder, William H. Dall, spoke on "Some Recollections of the Founding of the Philosophical Society," and James H. Gore and William H. Holmes gave accounts of the early days of the Society. Unfortunately none of these addresses was preserved.
- 1930, January 18, 1000th meeting, as per copy of program below, at which the foregoing historical sketch was read, supplemented by 31 lantern portraits of deceased prominent members of the Society, and followed by interesting reminiscences by Messrs J. H. Gore and C. F. Marvin.

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 1000th Meeting will be held in the Cosmos Club Auditorium at 8.15 P.M., Saturday, January 13, 1930.

Program:

- W. J. Humphreys—The Philosophical Society of Washington through a Thousand Meetings. (Illustrated).
- J. H. Gore and C. F. Marvin—Reminiscences of the Early Days of the Philosophical Society of Washington.

Recently elected to membership: James H. Taylor, George Washington University; Bruce L. Wilson, Bureau of Standards; Robert F. Mehl and H. B. Maris, Naval Research Laboratory.

L. V. JUDSON and O. S. ADAMS, Secretaries.

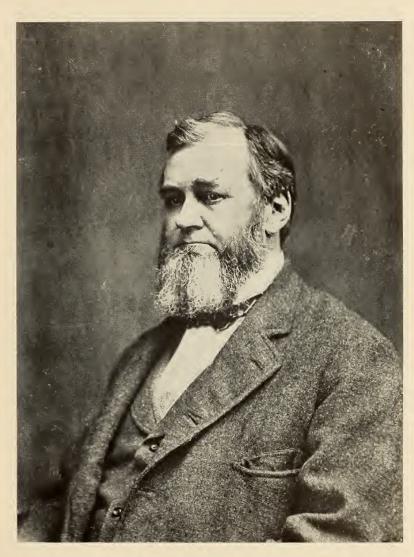
Committee on Communications: Walter D. Sutcliffe (Coast and Geodetic Survey); W. G. Brombacher (Bureau of Standards); George R. Wait (Department of Terrestrial Magnetism).

PORTRAITS

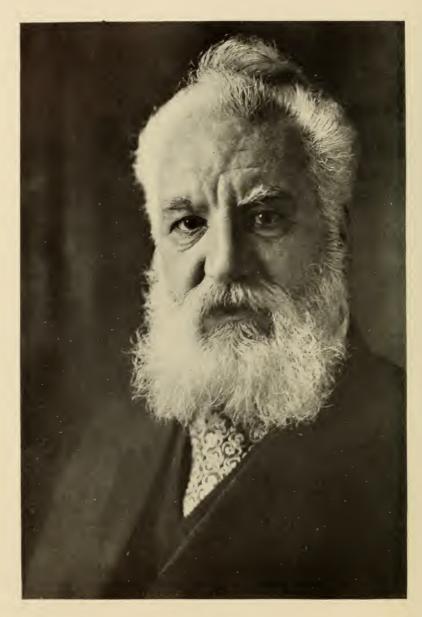
Eight deceased eminent members, typical of the many intellectual giants who have adorned the society.

The several presidents, in their order of incumbency.

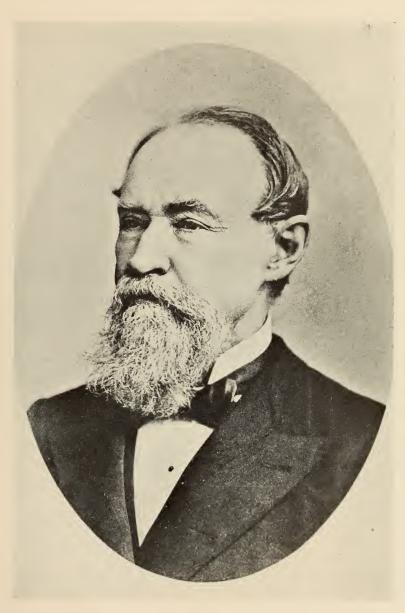




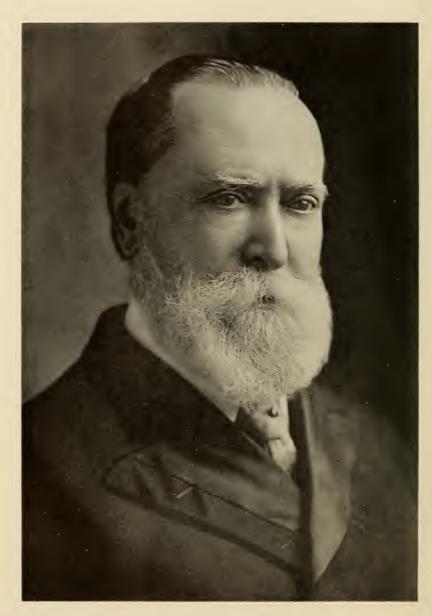
SPENCER FULLERTON BAIRD 1823-1887



ALEXANDER GRAHAM BELL 1847-1922



WILLIAM FERREL 1817-1891



Theodore Nicholas Gill 1837-1914



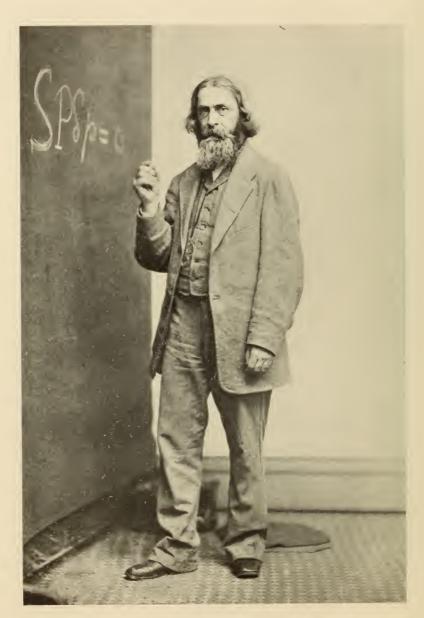
Julius Erasmus Hilgard 1825-1891



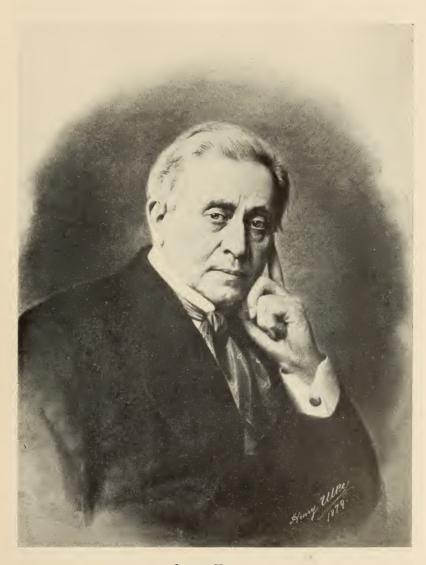
JONATHAN HOMER LANE 1819–1880



SAMUEL PIERPONT LANGLEY 1834-1906



Benjamin Peirce 1809–1880



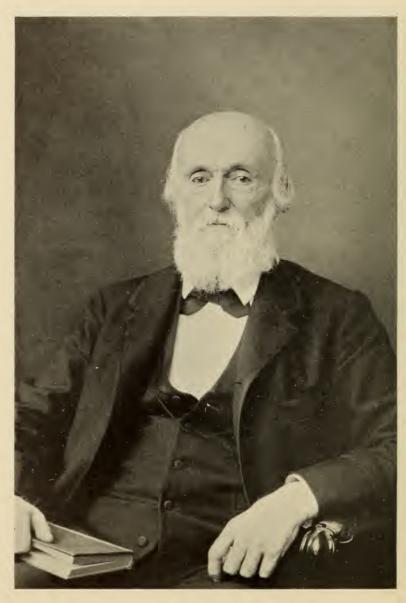
Joseph Henry 1871-1878



Simon Newcomb 1878–1880 1909



J. J. Woodward 1881



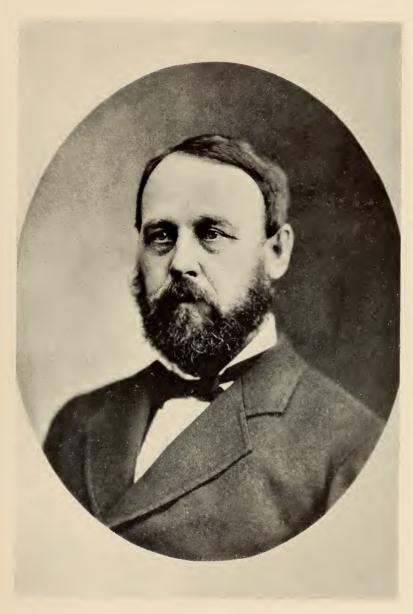
W. B. TAYLOR 1882



J. W. Powell 1883



J. C. Welling 1884

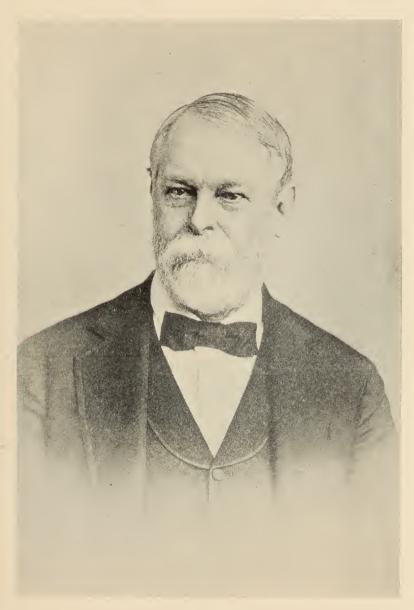


ASAPH HALL 1885





J. S. Billings 1886



Wm. Harkness 1887



Garrick Mallery 1888



J. R. Eastman 1889



C. E. Dutton 1890



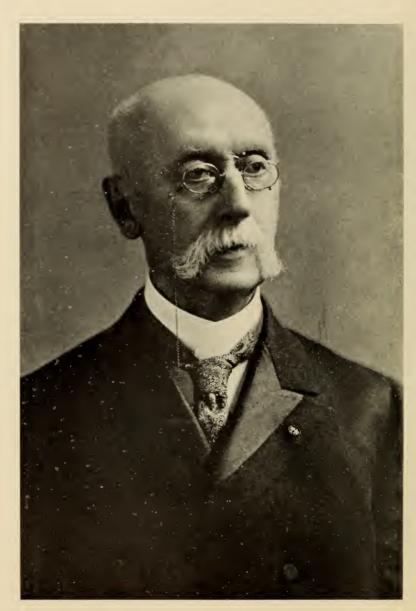
T. C. MENDENHALL 1891



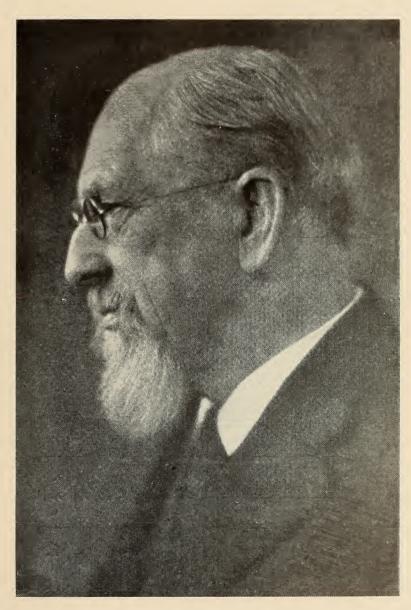
G. K. GILBERT 1892



G. Brown Goode 1893



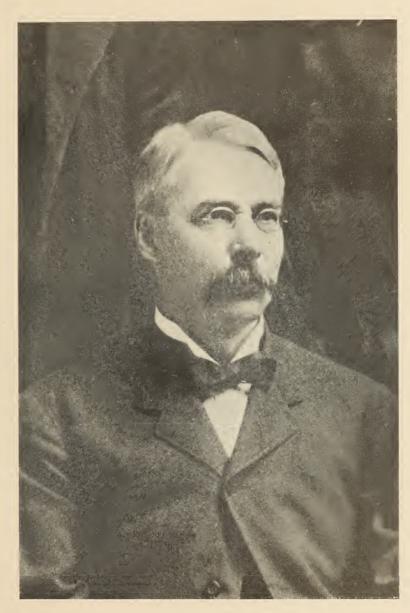
ROBERT FLETCHER 1894



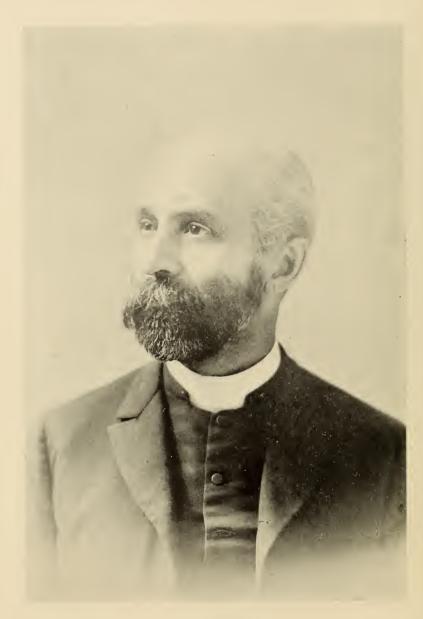
W. H. Dall 1895



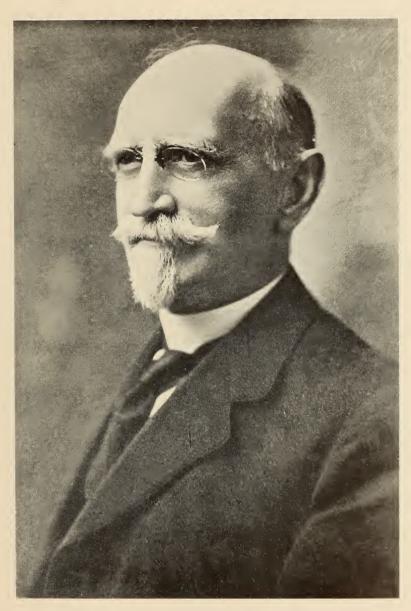
F. W. Clarke 1896



Marcus Baker 1897



F. H. Bigelow 1898



O. H. TITTMANN 1899



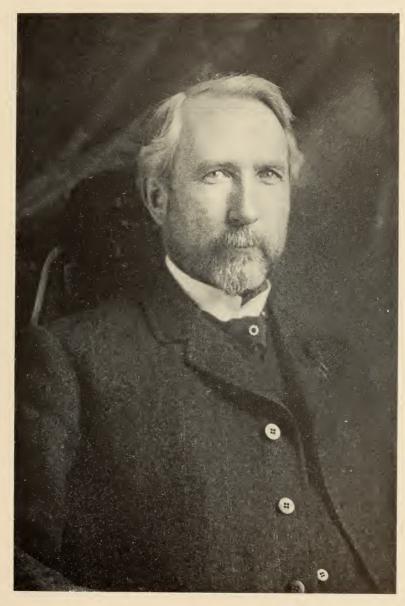
G. M. Sternberg 1900



C. D. WALCOTT 1901



RICHARD RATHBUN
1902



J. H. Gore 1903



C. F. Marvin 1904



G. W. LITTLEHALES 1905



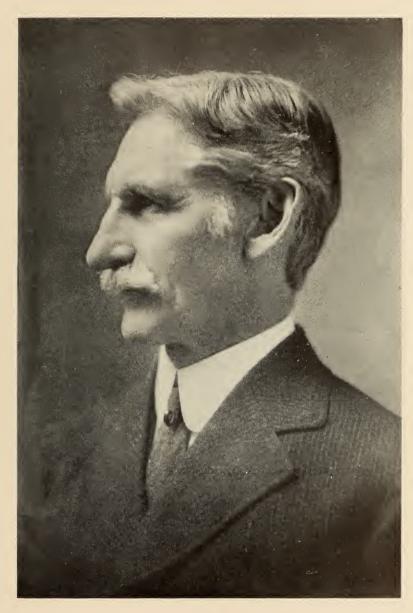
CLEVELAND ABBE 1906



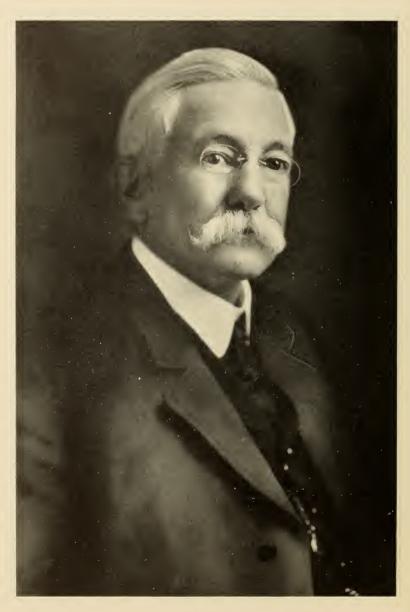
JOHN F. HAYFORD 1907



L. A. BAUER 1908



C. K. Wead 1909



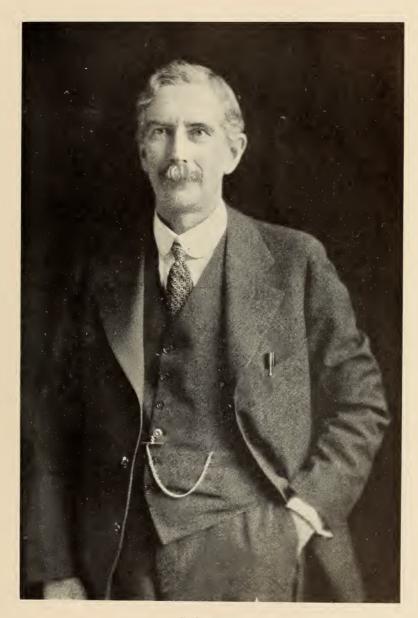
R. S. Woodward 1910



A. L. Day 1911



E. B. Rosa 1912



С. G. Аввот 1913



L. A. FISCHER 1914



W. S. EICHELBERGER 1915



L. J. Briggs 1916



E. Buckingham 1917



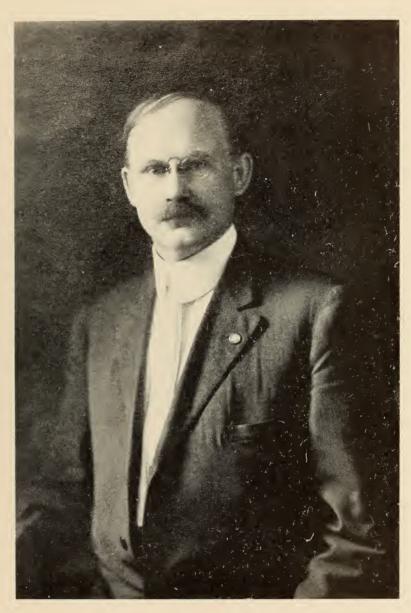
G. K. Burgess 1918



W. J. Humphreys 1919



R. B. Sosman 1920



R. L. Faris 1921



E. C. Crittenden 1922



W. P. WHITE -1923



D. L. HAZARD 1924



J. A. FLEMING 1925



Wм. Bowie 1926



J. P. AULT 1927



P. R. Heyl 1928



L. H. Adams 1929



W. D. Lambert 1930

OFFICIAL COMMUNICATIONS THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

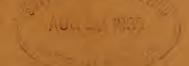
Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves.
Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proof events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the ssue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices: ance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers.	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates
are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

August 19, 1930

No. 14

EVOLUTION.—The mechanism of organic evolution. Charles B. Davenport, Department of Genetics, Carnegie Institution of Washington. (Communicated by W. J. Humphreys).

As we look over the world today we see, as the ancients did, the marvellous phenomenon of a world populated not only by humans but also by many hundred thousand so-called species of animals and plants existing in uncountable individuals whose number can no more be expressed by the ordinary system of numbering than astronomical distances can be readily expressed in miles. A cubic millimeter of the blood of a leucaemic mouse may contain over a million white corpuscles; and there may well be 1,000 such cubic millimeters of blood in a mouse. This gives us a billion white corpuscles in one mouse, not to consider the other cells of the mouse's body. These white corpuscles are essentially organisms, with powers of food-gathering, assimilation, excretion, locomotion, sensation, etc. And this is but one mouse. Even if we assume so few as $2\frac{1}{2}$ house mice to a human being on the earth (and mice are ubiquitous) we shall have 5 billion billion white blood corpuscles in house mice alone. But probably the pathologist might have as many bacteria in one of his test-tubes.

I have sometimes speculated on the number of organisms visible to the low power of the microscope that are in our Inner Harbor at the end of August, when it has a creamy, soup-like consistency. Assuming 1 per cubic millimeter, which is certainly far too small, there would be a quadrillion individuals in this space which would occupy only a square millimeter in the one-millionth map of the world, which has over half a billion square millimeters.

¹ Presented before the 233rd meeting of the Academy, as one of the series of papers on Origin and Evolution. Received for publication April 28, 1930.

Pardon me for wearying you with figures. I have wanted to put you in a position to grant my first point that the number of individual organisms on the globe is essentially infinite, though the number of kinds that naturalists have been able to count and describe in the past 150 years is still finite.

Next, I would call to your attention that most of these individuals have a short life and are quickly replaced by others, even if we leave out of account the unicellular organisms which retain their individuality only for the few hours or minutes necessary to reorganize and divide again. Even if we assume that the average length of life of an individual is a year—and it is probably not over a day—then we have to consider the remarkable phenomenon of an annual wiping off of the slate, as it were, of this infinitude of individuals each year and their re-formation the next year. This is possible owing to the immense reproductive capacity of certain species. Thus one oyster may lay 50,000,000 eggs during a few days in the summer and one sea urchin 20,000,000 eggs. These are samples, merely, of reproductive capacity of individuals. Perhaps now we have gained some conception of the number of individuals that have been produced each year on the earth, during we do not know how many millions of years.

If now you are willing to admit that the problem of organic evolution is that of the evolution of an organic mass consisting of an infinitude of individuals reproduced during an infinitude of generations, that may serve as a starting point to our inquiry as to the mechanism of organic evolution. Thank you!

Now, each individual has a certain recognizable form and acquires it through a certain course of development, be it more or less complex. The center of control of this form is largely, if not chiefly, in the chromosomes of the organic cells,—in its genes, to be more precise. In fact the soma of organisms, what we see, is just an index of the form-producing and maintaining factors of the genes—always, of course, recognizing that the end result is a sort of reaction between gene and environment. Now if the world of organisms is composed of an infinitude of kinds it is because the germ plasm is of an infinitude of kinds. The course of organic evolution has been, and is, what it is because the germ plasm has undergone and is undergong the changes that it has undergone and is undergoing. This change of the germ plasm is called mutation. Mutation is one of the great factors in organic evolution.

Now what do we know about mutation? First, we know that it is wide-spread. This knowledge has first become precise, as organisms have been studied in successive generations, under controlled conditions.

Such mutations have long been known among domesticated organisms like potatoes, poultry, guinea pigs and dogs. Mutations have been so long known among domesticated organisms that it was natural for Darwin to discuss "Variation under Domestication" and for him and others to consider what quality of domestication it is that induces mutation. During the past 25 years in several species of animals taken from the wild, many generations have been followed. And in consequence we now know that mutation has not necessary relations to domestication; but only that domestication enables us to see and perhaps preserve such mutations. Rather, I should say, the product of such mutation, for the mutation has occurred in the germ plasm before it has become visible in the soma of the organism that develops under the control of the mutated germ plasm.

Let us now consider some of the facts of mutation that experimental study has revealed.

First, mutation is probably universally occurring in all germ plasms. Thus, in various mammals that have been reared so that they can be observed, mutation has occurred in all visible parts, in internal organs, and in resistance to disease. In man, which, is the mammal that has been most thoroughly studied, we have mutations in hairiness, pigmentation, skin growths, appendages and digits, teeth, sense organs, form of internal organs, like the iliocecal valve, size and functioning of the endocrines, structure and functioning of the nervous system, of the blood and of the reproductive system. Finally, we have mutations in disease-resistance, due to obscurer morphological or bio-chemical idiosyncrasies.

Among pigeons, mutations in color, form of beak, nervous behavior have arisen in the Whitman-Riddle series. In poultry, I have in the course of 10 years got apparently new mutations in toes, wings and nervous reactions. And any poultry fancier knows of the mutations that have occurred in the past 75 years in color and pattern, in comb, in cerebral hernia and crest, in feet, wings and beak, and in egg-laying capacity.

In the insects which have been bred for rapidity of generations mutation has been repeatedly found. In *Drosophila*, Muller computes that among 500 factors in the X-chromosome of *Drosophila* each, in the average, mutates at the rate of 1 mutation in 4 years. This would seem to mean that, if you followed a single chromosome and when it divided considered one of the daughter chromosomes and so proceeded through the generations, then at the end of 4 years the

expectation is that in this line of chromosomes some one gene will have mutated and at the end of 4 more years that gene, or some other in the chromosome line we are following, will have mutated again. But there is an infinitude of chromosomes in the totality of all *Drosophila melanogasters*. The number in a single gonad is vast; the number of gonads in the world of Drosophilas that swarm in the autumn over every mass of decaying fruit in a million of orchards as elsewhere is practically infinite. One sees that just *Drosophila melanogaster* is producing an infinitude of mutations each season, and it has been producing this infinitude annually for a long time; but time does not count for much, for infinity times a finite number remains infinity. *Drosophila* throws upon the world each year, a vast number of kinds of mutations in inconceivably great numbers.

And Drosophila is not exceptional. Let us take a small water crustacean, one of the Daphnids. Banta has reared lines of these in captivity and examined the progeny daily. In one line of Moina macrocopa, carried parthenogenetically, a dominant mutation has occurred, on the average, at least once in 50 generations, but many more recessive mutations have occurred and been phaenotypically unexpressed. Now the number of Daphnids, which crowd any suitable pond in both hemispheres during each spring and autumn, is beyond conception. For a single circular pond a hundred feet in diameter may well contain during the season many million Daphnids, if 1 is allowed to the cubic centimeter. The total of mutations that occur in one year in Moina macrocopa must be inconceivably great.

Certain of the lower forms are mutating even more strikingly. At least such would seem to be the case if the remarkable variations shown by Leonian in the fungus, *Fusarium*, may be regarded (as seems most probable) as mutations. Here scores of strains arise, in but a few years, even in a uniform culture medium, and perpetuate themselves. The strains vary in their rate of growth, pigment formation, type of fruiting, kind of spores, and reactions toward temperature, acids, dyes, and toxic substances. Apparently such mutation is going on all the time in nature.

As we consider these best known cases of mutation and realize that all of the countless chromosomes and genes are undergoing occasional change we are appalled by the universality of mutation and are caused to wonder how any species remains constant in nature to the extent that it is possible for a second naturalist, 50 years later, to identify in nature the species already described; we are less surprised that the

reviser of a genus a generation or two later will find twice as many species as his predecessor. We gain a lot of sympathy for the much abused species-splitter who, observing nature without the restriction of tradition, finds vastly more species than had been previously described by his predecessors. [Slides of variations in feral species (speciesgroups) were shown. These are probably cases of mutations that have established or may establish biotypes or incipient species.]

Organisms seem to be producing mutations at an inconceivably rapid rate, in infinite quantity. The wonder is that there are such things as species. One is led to inquire if, in describing species, taxonomists are not merely inventing transient, evanescent categories.

Such a conclusion is unjustified. Every taxonomist will tell you that the things he describes and others have described before him are real entities. If I am studying thrips and wish to secure a species described 50 years ago as living in a certain composite plant in eastern Russia, then if I go to the designated locality and look in the designated species of flower I will find the species with all the characters described 50 or 100 thrips generations ago. How is such an experience in constancy to be harmonized with universal mutation? This is perhaps the heart of the problem of evolution.

In considering the fixity of some species it must first of all be recognized that a species is a complex of morphological and physiological characters that can not exist alone but is absolutely dependent upon the external world for its existence. The organism must live in a medium of such and such physical qualities, at such a temperature, in the midst of such radiant energy, with access to such and such food stuffs which it is capable of taking in and utilizing for its metabolism. Every organism is extraordinarily closely fitted to its environment. And that environment may be very complex.

I will illustrate this principle by reference to the almost microscopic Collembola that live on the beach at Cold Spring Harbor (Fig. 1). They live in an area of apparently washed sand and pebbles in a region that is covered twice a day several feet deep by sea water and then exposed to the air, in a region swept by strong winds, overlaid by ice in winter, and exposed to the hot sun's rays in summer (Fig. 2). A region where the sandy substratum is caused to shift by the action of waves, and its pebbles to roll. The region looks unpropitious for any organism, yet of one species of Collembola in an area a kilometer long and 5 to 8 meters broad there are probably in the middle of summer a hundred million individuals. And they are meeting successfully the

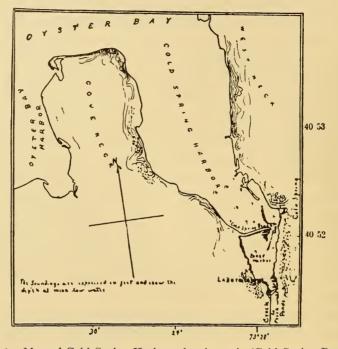


Fig. 1.—Map of Cold Spring Harbor, showing spit (Cold Spring Beach)



Fig. 2.—Photograph of north side of sand spit, near the western end, at low tide. In the central foreground is the high tide line, marked by a mass of débris. On the left is the gravelly lower beach; the middle beach and storm bluff are at the right.

difficult and complex conditions imposed by that particular habitat. If the habitat be compared to a most intricate lock, the organism is a most intricate key that fits that lock completely. How has this key come to fit this lock?

First of all, it is to be said that the Collembola in question is the only larger organism that is found in any huge numbers on and in the great portion of the beach. Worms there are that live in the sand of the beach; crustacea and insects there are that feed on the débris that

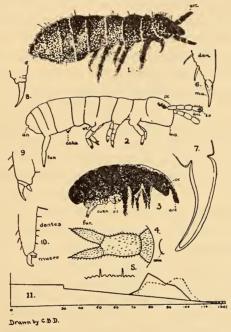


Fig. 3.—Drawings of 3 species of Collembola on the beach, (1), (2), and (3), with some details of their structure. (11) shows the relative frequency of *Isotoma* on the beach; the abscissae represent distances from the beach line on top of the beach; the ordinates, the proportional frequency of occurrence.

is thrown up by the sea at the high tide line; but it is only the Collembola that swarms over the beach (fig. 3).

Why are the Collembola the only organisms that make such use of the beach? The answer seems to be that they are the only group that holds a key approximating the needs of the beach lock. Two other species of Collembola live on the edge of the beach, in relatively small numbers. But one, *Isotoma berselsii*, has the combination of small size, slender form and greater capacity for jumping that are demanded for successful life on the beach. Another species which has a chunkier

form and is less successful as a jumper is found on the beach but is much less numerous than the first. Now the Podurid Collembola have, in general, a structure and reactions that lead them to live in situations not so very different from those occupied by *Isotoma*. They are found on water or in humid earth or in moist caves, or in crevices of moist walls. If anything is to survive in the sand of the sea beach it must come out of a group with instincts and structure that make it possible and preferable to live in such places. However, the interstices of the sand of the beach are especially fine and the period of exposure to the air is so brief that the insect must have movements and responsiveness of such sort as will ensure adequate exercise and oxygenation of the tissues during the brief time that it is exposed to the air. Collembola, in general, have the right form of key; *Isotoma berselsii* has precisely the appropriate notches to fit the precise lock of the beach.

I have dwelt at length on the Collembola of the beach because they may serve to illustrate the principle that mutations become the characters of species and play a part in evolution *provided* they meet some demand of the environment; or, the other way round, a new mutation persists as a species character if it can find an environment to which it is suited.

This general principle is of wide application. In Banta's daphnids there appeared a female whose young died on a cool day in the autumn. It was found that subsequent broods could be kept alive in an incubator at a higher temperature than that of the room. In short, an investigation of the temperature relations of these cold-sensitive young and their equally cold-sensitive descendants showed that there had arisen by mutation a thermal clone—a parthenogenetically reproducing strain —whose optimum temperature was about 10°C. higher than that of the ordinary daphnids. This mutation was fatal at the ordinary room temperature; it had important survival value for the environment of an incubator; it would have had an important evolutionary value had there been a warm spring near by into which the strain could have been transplanted. This experience, indeed, shows the probable method by which aquatic animals have come to inhabit hot springs. It is not by gradual change wrought on the germ plasm by the direct action of the high temperature of the water, but rather the fine opportunity for survival afforded by the high temperature to any chance thermal mutant.

Again, as has long been known, many of the animals that live in caves are blind and much speculation has been offered to account for this blindness. The old idea was that, through disuse and the parsi-

mony of nature that would prevent it from continuing to form useless organs, the useless organs were no longer formed. On the other hand, Eigenmann, through his extensive knowledge of fishes, was able to point out that the blind fish of caves belonged to just one family of fishes, a family that had mutated in the direction of blindness in various parts of the continent. Now, some of these mutations in the direction of blindness have survived even where there are no caves, but where there are waters running through densely wooded swamps and characterized by dark holes where poor sight is no handicap to the fish. When a blind mutation arose in that family of fishes living in the region of limestone caves of Indiana and Kentucky, that mutation was no handicap to its possessor. For the possessor had other sense organs sufficient to secure its prey. The waters of the cave, indeed, removed competition; and in other ways afforded an extraordinarily favorable environment for this genus of fish.

Another illustration may be afforded by still another group of animals. As you know there are vast numbers of molluscs living in the sea and in fresh waters; clams, oysters, periwinkles, cuttle fishes, squids are familiar marine molluscs. But there is a group of molluscs that has a history quite as striking as that of the cave fish. This group lives on the land, and sometimes, in very dry situations, even semi-deserts. In this situation the molluses breathe by lungs instead of gills. How have the land molluscs—the pulmonates, including the snails and slugs come to live on the land? One explanation that has been offered is that some marine ancestors gradually moved into streams and higher up into ponds which dry up periodically and there became gradually modified to breathe air. The matter is not quite so simple. The river mussels live in streams and ponds that occasionally go dry; they perish under these circumstances by the million; and yet they have never become adapted to land life—the appropriate mutations have never been afforded. Our land snails are the end result of a long series of mutations that have permitted life on the land. The first mutations in this direction occurred in certain marine snails with a gill chamber whose opening is so small that it can readily be closed to prevent the ingress or egress of water. Any mutation in this direction would enable its possessor to enter into the between-tides zone.

Actually, there live on our shores shore snails, belonging to the family of Littorinidae inhabiting a level where they are exposed to air for 12 to 20 hours of the day. Indeed, among the Littorinas one finds species that differ greatly in their emancipation from the sea. During

the recession of the tides the Littorina keeps the opening to its mantle chamber closed; so its gills are held in a medium of saturated air (fig. 4).

Now, it is out of this general group to which the Littorinas belong that the land snails have arisen. Any continued mutation in the direction of gill reduction or enclosure of the mantle cavity would have been in the direction that would have permitted the possessor to pass to dryer parts of the shore line and, incidentally, to escape from its enemies. The point is that not just any group of marine snails was able to adjust itself to land life, but only a group in which favorable mutations arose. The land crabs and the lung fishes represent the end stages of a similar evolutionary history to that of the land snails.

While it appears from these considerations probable that adjust-

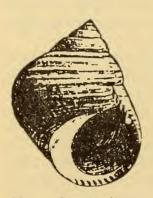


Fig. 4.—Littorina litorea.

ment to extreme conditions of life has been rendered possible by favorable mutations, it still remains to consider what light modern genetical studies throw upon the details of this process.

We have seen that reproduction is unlimited and that mutation is constantly occurring; not to be sure in infinite amount in all directions equally but abundantly in certain genes; more rarely in others. We have now to consider in turn what induces mutations; what gives direction to mutations; how are the adaptations in nature brought about?

First, the causes of mutation are clearly determined, in part, by the unstable nature of the gene itself. The genes are very complex molecules, or rather groups of molecules. Now, many complex molecules are known in chemistry that are so labile that they break down almost spontaneously. How many compounds have to be kept in the dark, at a low temperature, undisturbed in order that they may "keep" at all. In time they "spoil", even under the best of conditions. The rate of change may be accelerated by heat, light and irradiation. The genes are not exceptions to the rule of change in labile substances. While the nature of the process of mutation in the genes has shown itself little influenced by external agents the velocity of spontaneous change is readily altered. Thus Muller, Hanson and others find the speed of mutation accelerated by increase of temperature, and by X-rays. No new mutations have been brought forth by the X-rays, but mutation occurs more rapidly. The X-rays do not direct evolution,

or even mutation, qualitatively, but afford opportunity for more rapid evolution by providing, in larger amount, one of the factors—mutation—necessary to evolution.

The fact that X-rays may accelerate the process of gene mutation has led some to the conclusion that all mutation is due to radiations. No doubt conditions compatible with the life of the soma may be found that will not permit of mutation, but it does not seem probable that this will ever be the case. Just the conditions essential to life probably provide the conditions for gene mutation.

Second, what gives direction to mutations? It is obvious that the organic world is far from being the infinitely diverse collection of haphazard and meaningless variants that we might expect were mutation entirely uncontrolled. It seems probable that, under ordinary conditions, genes break down or disintegrate in orderly fashion dependent on the nature of the gene. An illustration, which may be more than a mere illustration, is afforded in the rare earths where uranium breaks down into radium and radium into lead. Each stage, in turn, is determined by the immediately preceding stage.

So, in organisms, the mutations are usually of a recessive nature, which seems generally to imply that they are produced by a loss of something from the parental gene. In the different species of one genus the same kind of mutations occur. Thus between *Drosophila melanogaster*, *D. simulans* and *D. virilis* quite parallel mutations occur and are identified in many cases with genes occupying comparable loci in the chromosomes. Among mammals with which we are naturally best acquainted certain mutations occur again and again. Thus albinism, coat-color-pattern, hairlessness, elongated hair, reversed hair, taillessness, abnormal hands and feet, particularly digits, horns or hornlessness, achondroplasia. The recurrence of these mutations in various species of mammals, as tabulated by Osborn (1912), indicates that mutations are far from haphazard in origin, but probably depend upon the same genes with the same structure and capacity for change.

Finally, the mutations with which we are familiar constitute only a fraction of those that occur. Every student of intra-uterine stages of mammalian development is familiar with the phenomenon of intra-uterine deaths. So far as our observations go, it appears that in mammals more young die *in utero* than are born. Every student of development of sea urchins and other marine organisms knows that a large proportion of those that start to develop do not proceed far. We

see that early developmental stages are those in which great selection takes place; probably because the embryos carry non-viable mutations. From this point of view the individuals that reach maturity constitute the fraction that have undergone no *lethal* mutation.

The fact of lethal mutations (for they have been demonstrated in many cases) helps us to understand the other fact that in the midst of the world of mutations the organisms that come through are more or less well fitted to survive; they are not always the best, but they are good enough to pass the censorship of environment.

And this brings us to a consideration of the phenomenon which Darwin stressed, namely, of adaptation to environment. We have already seen that such adaptation is partly brought about through the selection by the organism of an *environment* that is adapted to it. We may now consider the case of selection by the environment of *organisms* that are adapted to it. In general, the organism must be able to play properly its part in the flow, in and out, of the chemical agents, water and food stuffs, upon which its life and activity depend. It must be capable of meeting emergencies of climate and organic enemies. It must pass the censor at every stage or be squelched.

A little experience of my own, on which I published some years ago, will serve to show how strict is this censor. I reared a large number of chickens to the one pound stage and had about 300 running over a grassy plot on about the tenth of May, at a time when crows are feeding their nestlings and hunting especially meat for them. About 40 per cent of the birds had a white plumage, 40 per cent a black (or nearly black) plumage and 20 per cent a plumage in pencilled, or striped markings, more or less like that of the ordinary game, or the jungle fowl. Of these the crows killed 24. Expectation, on the basis of random attack on the birds, was that about 9.6 would be white, 9.6 black and 5 pencilled. Actually there were killed ten white, thirteen black or prevailingly so, and one coarsely mottled gray and buff. No truly pencilled bird was killed. This observation tends to illustrate the principle that the self-colors in wild birds tend to be eliminated because conspicuous to their enemies; birds with mixed pattern are relatively immune from attack because relatively inconspicuous.

Now, though it has not been experimentally proven, yet the hypothesis may be entertained, that the presence of light colored mice in limestone regions and of dark colored mice on lava beds may result from an elimination of mutations that are in disharmony with the background. To nocturnal predaceous animals, like the owls which catch

mice, a white or light yellow mouse on a black lava bed would be seen and captured before a black one.

One further fact must be taken into account in considering the adjustment of organisms to their environment, and that is that change of environment may well cause, and apparently has in the past often caused, the elimination of species over the whole extent of their area of destruction.

Consider how wide-spread must have been the consequences on the fauna of the northern hemisphere as far south as Long Island and even further south of the great ice sheets that covered the circumpolar territory in glacial epochs. Many poorly clad species of mammals must have found the icy conditions insupportable; just as the mastodon and mammoth did. The change in environment may be of a more subtle Thus the great size and herd instincts of the bison enabled it to develop enormously on the extensive plains of North America and rendered it more than a match for the Amerinds living in a stone age. Just this size and number wholly unfitted these mammals for the new environment of the agressive, agriculturally inclined white man, armed with a rifle. Agriculture and free-ranging bisons could not coexist and the rifle eliminated the mammals. So today the great size and aggressiveness of the large mammals of Africa are a challenge to the sportsman and the future seems to spell extinction for them. Here we have to do with elimination resulting from what may be called a cultural evolutionary "mutation"—the rifle.

But man's part in evolution is not merely in the elimination of his large enemies, which he has all too thoroughly mastered, but in his struggle with the small and innumerable insects that threaten his agriculture as it becomes more intense. The more successful and prolific an insect injurious to agriculture is the more certainly will it arouse man's destructive energies and the greater the certainty that the all too favorable mutation that is the cause of its success will be the cause of its elimination in whole, or part.

But mutations of a still more dangerous sort are threatening mankind—mutations in the world of organisms that live as parasites on the human protoplasm. With the more conspicuous of these parasites, external and internal, man has learned to cope. One by one the pathogenic bacterial diseases are being eliminated or reduced in frequency. But now we face still smaller parasitic particles—the filterable viruses—which are, at present, practically inaccessible to man. There seems to be reason to conclude that they are mutating, also, and

perhaps rapidly. The waves of influenza epidemics that pass round the world in periodic fashion assume slightly different aspects—show somewhat different symptoms—in successive visits. Those who are resistant to the one visitation may show slight resistance to the next. The selections of the past have left the stocks of the more crowded continental areas a hardy resistant people—far more so than the peoples of distant oceanic islands that had not undergone selection for resistance to the ultra-microscopic parasites. When one contemplates the high mortality of the influenza epidemic of 1918 one realizes that notwith-standing this high resistance it is quite within the range of possibility that at some future time a mutation shall arise in these viruses such that no human protoplasm is protected against it or can protect itself against it. Then our boasted skyscrapers might become inhabited by bats and the safe deposit vaults of our cities become the caves of wild animals.

Whether or not this will occur in the future, the possibility brings home a realization of the fact that man is not merely looking on the process of evolution taking place around him but, as an organism, he is a part of that evolution; he is acting upon other organisms and being acted upon by them as well as by the inorganic world in which he lives. He is attempting a mastery of that world; and, indeed, upon such mastery his fate may depend. His ability to master that world depends upon his superior gifts of intelligence to see relations and to idealize new ones. How much farther man can go in this direction depends upon the capacity for development of the intelligence. There are those who warn us that we are approaching the limit and must sometime in the future wait for further human evolution to make further fundamental progress. To wait until nature affords the desired mutation may mean indefinite postponement. Can not man himself control his evolution? Two methods are open; one the production of new and better combinations of traits by appropriate matings. is the method of the applied geneticist interested in creating new and improved varieties. This is the method that is open to man also, if only some change in the social order may make it feasible to apply our knowledge to the improvement of the genetical combinations in mankind.

But still another way may be opened in the future; that is the acceleration of mutation by irradiation. The method is fraught with tremendous difficulties. The commonest effect of irradiation of the gonads is the production of defective, often happily non-viable individ-

uals. Whether the production of scores of defective strains to secure one line with a superior mutation is justified will have to be considered. But if man is to evolve he must not decline to use nature's tools of mutation, cross-mating, selective elimination while he seeks to become fitted to meet the requirements of an ever changing and ever more-demanding environment.

To sum up, then, the mechanism of organic evolution, as I see it, consists of the following processes:—

- 1. Infinite capacity of the germinal material for reproduction.
- 2. Infinite capacity for mutation.
- 3. An infinitude of kinds of environments.
- 4. Extensive opportunities for dissemination of the mutant individuals over earth, permitting some of them to find an environment for which they are especially fitted.
- 5. As for the rest of the infinitude of individuals, non-mutant and mutant (beyond the number required for replacement) elimination.

In a sentence, nature's mechanism of evolution includes the elements of: an infinitude of kinds of environments, infinite reproduction, infinite mutation, infinite opportunity for new mutants to find appropriate environments and elimination of all of the infinitude of other individuals that are not required for replacement.

Homo sapiens is only a natural species with a highly evolved hand and brain. This species has reached its lofty position in evolution by the processes described. It is proud of its control of nature in certain directions. Let it beware lest it think it can evolve further by a man-made formula that may suit its perverted desires but must eventually fail of permanent progress if opposed to the formula of nature.

PALEONTOLOGY.—Remarks on Dr. George G. Simpson's work on the Pleistocene paleonotology of Florida. OLIVER P. HAY, Washington, D. C.

Recently Dr. George G. Simpson, of the American Museum of Natural History, New York, has published a number of papers on the Pleistocene paleontology of Florida. They are important communications, and with the activity of this author and others now interested in this subject the paleontology of Florida must soon become much better understood. It is with regret that I must present some criti-

¹ Received May 12, 1930.

cisms on Dr. Simpson's conclusions. I shall be concerned especially with his paper entitled: The extinct land mammals of Florida,² and with another having the title: Pleistocene mammalian fauna of the Seminole Field, Pinellas County, Florida.³

In this latter paper Dr. Simpson discusses the correlation of he Pleistocene deposits; and he credits the present writer with having expressed the most definite opinions on the subject. He states that these opinions seem largely to rest on three assumptions, of which the following is the first: That each local fauna studied is actually an assemblage of contemporaneous mammais.

Dr. Simpson⁴ says that this is illustrated in the case of the so-called Peace Creek fauna, "elements of which were largely derived from both Pleistocene and older deposits." My list of the mammals collected near Arcadia is found on page 381 of Publication No. 322 of the Carnegie Institution of Washington. Of that list of 15 mammals there is, I believe, only one, Hipparion ingenuum, whose Pleistocene age can be fairly questioned; and that this Hipparion may have continued on even into the Aftonian is again suggested by the recent discovery by Simpson⁵ of the "three apparently Pliocene species Hipparion ingenuum, H. plicatile, and Serridentinus sp.," along Itchatucknee River, Florida, associated with Pleistocene fossils.

Dr. Simpson recalls also my reference of the fossils of the Alachua clays to the Nebraskan stage. In this case there are involved Gomphotherium floridanum, Procamelus, two species of rhinoceroses, Hipparion, and Parahippus. Dr. Simpson declares these genera are certainly not younger than Middle Pliocene. Now I am willing to admit that I was probably wrong in this assignment; but for this action I gave my reasons; and, whatever the probabilities, nobody ought to express himself as certain that these genera, or some of them, did not continue on into the first glacial stage, where I put them. The Pleistocene climate of Florida has been inordinately extolled and it was probably as "congenial" during the last half of the Pliocene as it was later, or more so.

I am further supposed to have nurtured the assumption that the Pleistocene mammalian sequence is certainly known, if only in part,

² State Geol. Survey, 20th Ann. Rept. 1929: 229-279.

³ Bull. Amer. Mus. Nat. Hist. 56: 561-599. 1929.

⁴ Bull. Amer. Mus. Nat. Hist. 56: 569. 1929.

⁵ Amer. Mus. Novitates 406: 13. 1929.

⁶ Carnegie Inst. Wash. Publ. 322: 375-378.

⁷ Bull. Amer. Mus. Nat. Hist. 56: 568, 1929.

for other regions of North America, and "especially along the margins of the drift." This assumption Dr. Simpson grants is partially justified; and then he follows with a sequence that I wholly repudiate,—one which I have never before heard expressed. The first phase is said to embrace the time from the earliest Pleistocene to just before the close of the epoch. During this phase *Hipparion* was absent, "Equus occurred, tapirs and camels were present, and most of the smaller animals and all of the larger ones were of now extinct species."

Now, there was no such natural phase or stage of evolution or extinction. There was no known time in the Pleistocene, at least after the Nebraskan, when most of the smaller animals and all of the larger ones belonged to now extinct species. According to Simpson, some of the ground sloths and peccaries continued on into his second phase, and certainly he might have mentioned many other mammals. This phase was partly late Pleistocene, partly "post-glacial," which is Recent. What important biological or geological events happened to distinguish this phase from the first; and what occasion is there for recognizing a third phase which does not belong to the Pleistocene? And what authority has he for saying that no elephant, no mastodon, no tapir, no peccary, no ground sloth lived on into the Recent?

Cope is credited with contributing to this history of paleontology. Cope and Marsh and Dall instinctively avoided such an allocation of the faunas of the Plains, of Texas, and of Florida, and put them in the Pliocene, until G. K. Gilbert convinced them of their error. It was left for a younger generation to rush to the other extreme and to accept the doctrine that any Pleistocene animal may be found at any stage of the Pleistocene and in any locality.

Dr. Simpson's first phase occupied some 400,000 years and glided into his second and third phases without having ushered in any critical event.

I regard it as incontestable that any adequate assemblage of Pleistocene fossils collected anywhere outside of the glaciated regions, west or south, will contain a much higher percentage of extinct species and genera than will be found in any deposit overlying any drift after the Nebraskan. During the Kansan glacial stage is probably where a paleontological break occurs. The pre-Kansan fauna, varying somewhat with latitude, longitude, elevation and climate, embracing ground sloths, glyptodonts, megatheres, numbers of horses, camels, Elephas imperator, E. columbi, and Stegomastodon, extends from the Atlantic to the Pacific and from the Gulf to the south border of the

drift. As long as geologists, paleontologists and anthropologists stand on glaciated lands they are held down to definite periods of time, but once outside the drift deposits they feel free to refer any long-ago extinct animal to a time within a few hundred years, especially if its presence menaces the theory of the late appearance of man.

Dr. Simpson adds that it is especially along the margins of the drift that I believe that the mammalian sequence is known.8 Quite the contrary. The drift sheets and the drift margins simply conceal the ancient fauna, the Aftonian, from view. In deposits lying on the Kansan drift, and Illinoian drift and the Wisconsin, from Cape Cod to the Rocky Mountains, are found the extinct members of the late In these deposits occur Mylodon, Megalonyx, Canis, bears, the American mastodon in abundance, Elephas boreus in abundance, one or two horses only, a few bison, peccaries, and possibly any species now living in the glaciated region; but so far as yet discovered. no megathere, no Nothrotherium, no Glyptodon, no long-jawed mastodon, no Elephas imperator, no Stegomastodon, no large number of species of horses, no camels. If the Kansan and succeeding drifts were swept away, the early fossils would probably come into view. For when you pass the margins of the drift sheets or even before, where erosion has cut down to the the first interglacial deposits, you are likely to meet with the forms not found on the drift.

I take no account of the margins of the drift, except to note that south and west of them occur remains of a very rich fauna containing a high percentage of extinct animals, while north of them is found, usually near the surface, a much more improverished assemblage of mammals. In western Iowa have been collected from first interglacial beds *Elephas imperator*, *Stegomastodon*, *Camelops*, and species of *Equus*. If now these forms continued to exist during later stages in that region, can anybody explain why they so carefully avoided leaving any traces of themselves in any glacial or interglacial deposit east of Missouri River, while leaving abundant records of their existence west of the river?

I am also said to assume that the sequence of mammalian forms was essentially the same in Florida as in other regions of North America. I have presented reasons for adoption of this view and nobody has yet undertaken to disprove my positions in a comprehensive manner. I do not see why Florida formed a special case.

⁸ Op. cit., p. 568.

In arguing against this so-called assumption, Dr. Simpson states that the Florida mammals, when well known, generally prove to be of different species from those of the north and west. When his list of land mammals of Florida, existing and extinct is examined it is seen that 63 species are listed in the Pleistocene; 38 of these are animals found north and west of Florida; and 25 species peculiar to Florida. This amounts to 61 per cent of the mammalian forms that are found outside of Florida and 38 per cent that belong in Florida alone. It is doubtful if the peculiar forms occurring there are more numerous than would be found in any other region where the smaller species have been collected and studied; and no doubt many of these Floridian species will hereafter be discovered elsewhere. On studying Barnum Brown's list of fossils found in Conard fissure, Arkansas, I find little difference.

It is a pleasure to find that Dr. Simpson is so closely in agreement with me on the similar composition of all the collections that have been assigned to the Aftonian stage in Florida. We disagree only on the time of the deposition of these fossils. I hold that those animals were buried there during perhaps the whole of the Aftonian and perhaps a part of the Kansan stage; Dr. Simpson argues against the probability of this.

As regards the deposit No. 3, there may be indeed extraneous fossils in it. I was led to refer it to the Kansan stages because the geologists insisted that deposition had been continuous with bed No. 2, and this bed I hold is first interglacial. In No. 3 there are certainly both extinct and yet existing species, but it is hardly fair to declare the extinct species as having been derived from No. 2 unless there is evidence of that origin. Deposition went on very slowly during the formation of this bed and apparently during the whole Pleistocene in this region.

In his paper on the fossils of the Seminole Field¹⁰ Dr. Simpson regards it as important that the Melbourne collections contain so many species quite indistinguishable from those still living in the same region. He finds no evidence in any group of more than subspecific advance from that time to this. In this observation he again supports what I have more than once asserted, namely, that since the Aftonian stage there has occurred little or no evolution of specific forms. And I am permitted by Mr. Gerrit S. Miller, Jr., associate curator of mammals in the U. S. National Museum, to say that he has seen no evidence

⁹ State Geol. Survey 20: 251.

¹⁰ Bull. Amer. Mus. Nat. Hist. 56: 571. 1929.

that during the Pleistocene there has been, among the mammals, any development beyond that of subspecies. If there has occurred since early Pleistocene times the rapidity of development of new species implied by Dr. Simpson, I ask him what kinds of mammals lived during the early Pleistocene and where they have been collected? My belief is that the Melbourne fossils are those early Pleistocene mammals and that our existing species lived at that time. I might be willing to admit that some early forms may have undergone some of the minute changes which we think justify new specific names, but which other persons might not recognize as sufficient. Evolution is a slow process.

Dr. Simpson states that it has been genera rather than species that have survived. That is true, for the simple reason that a genus usually embraces more than one species and as long as one of these survives the genus continues. He also thinks that it is very exceptional that all the species of a genus in an area as large as North America should become extinct simultaneously. I do not see why this may not have sometimes happened, especially in the cases of genera including few species.

On another page, Dr. Simpson grants¹¹ that as high as 70 per cent of the Melbourne mammal fossils belong to extinct species. Usually such a high percentage of extinct species is accepted as an evidence of antiquity. On the next page he claims that it is no solution of the question to say that this extinction took place between the early and middle Pleistocene rather than between the late Pleistocene and the Recent. However, no one has claimed that all that 70 per cent of extinction occurred during that early stage. Not all the extinct mammals found in the Melbourne beds became extinct at that Aftonian time; comparatively few of them. The others perished at various later times, even up to the Recent. The common mastodon and Elephas columbi and Castoroides and many others of that fauna continued on until after the last glacial stage. My contention is that some of the species, as Elephas imperator and the few camels and the saber-tooth tiger and Megatherium and Chlamytherium died out then, for they have never been found in deposits whose later age can be demonstrated. And it would be strange surely if all those species had lived on through three or four glacial stages and then perished without any adequate explanation. Now, can Dr. Simpson or anybody else say anything against this statement?

¹¹ Op. cit., p. 570.

But that is exactly the doctrine that Dr. Simpson is supporting: That all the species of horses found in Florida, all of the tapirs, all of the great sloths of various genera; all of the armadillos, all the elephants and mastodons; all of the capybaras, all the bisons, and all the species of several genera of peccaries; all of these lived on until in the late Pleistocene or to the Recent and then, in a time geologically brief, were swept out of existence. This is not all. There are those who apply this late existence and rather recent extinction to these genera over the whole of North America. *Elephas imperator*, and the camels are reported to have lived possibly within a few hundred years.

At this point reference may be made to Dr. Simpson's statement in his foot-note on Bison.¹² I am unaware who has so positively asserted that the occurrence of an extinct species of Bison is indicative of an early Pleistocene age.

It seems necessary to discuss again the climate of Florida during glacial stages. Dr. Simpson adheres to the idea that this state furnished an asylum where obsolescent groups survived beyond the time of those farther north. I have considered the statement that the climate of Florida has been more favorable for animal life than the northern states. ¹³ I have shown that the state of Illinois has harbored within historical times quite as many species of mammals as Florida; while the mountainous region of Colorado has offered an asylum to a considerably greater number than Florida.

Some of our vertebrate paleontologists appear to have evolved their theories of the glacial stages from the depths of their unaided consciousness, instead of from the writings of geologists and explorers and from personal exploration. On page 485 of Chamberlin and Salisbury's Geology is a fine discussion of the climatic conditions in front of a continental glacier. Further definite information can be secured from an examination of Pirsson and Schuchert's glacial map on page 945 of their Text Book of Geology. There it is shown, that, at some time, or at some times, during the Pleistocene, local glaciers far more extensive than those of the Recent epoch occupied the great range of the Andes, even on the equator; also in the Himalayas, and on the equator in Africa. It is evident that during a glacial stage the temperature of the whole world was lowered. It is evident, too, that in front of the continental glacier there was an arctic climate; farther away, a subarctic, a subtemperate, etc., each extending south for hundreds of

¹² Op. cit., p. 569.

¹³ This Journal 19: 469. 1929.

miles. That map ought to bring conviction to even those paleontologists who were the promoters of the idea that in Iowa, during the Nebraskan or the Kansan stage, camels, elephants, ground sloths, horses, and musk-oxen lived together in the immediate front of the glacier. It has been suggested that at least these animals migrated thither during the warm summers; but on what food did they appease their appetites? Did they all alike subsist on rock-lichens and moss?

The writer does not object to the most complete investigation of the geology and paleontology of Florida; but that alone will probably not furnish a solution of the age of the Melbourne fauna. The problem is a more general one. The mammals of North America during the Pleistocene did not consist of three, or even more, distinct assemblages occupying different tracts of the continent. They were of triple origin, but they formed one faunal assemblage. This varied somewhat in composition according to temperature, moisture, kind and abundance of food, the stage of the epoch, and the like, but there were almost everywhere many genera and not a few species which ranged from the Atlantic to the Pacific, and from the Aftonian to the close of the Wisconsin. There were also subregions, occupied by peculiar genera and species, as there are today.

On the other hand, there was one wide-prevailing cause of disaster which operated at four or five times simultaneously on this whole assemblage of mammals. This was the occurrence of continental glaciations and the consequent lowering of the temperature, disturbance of weather conditions, general expatriations and repatriations of the mammalian inhabitants, and the extinction of many important genera and species.

If the glacialists are correct in their conclusions, the arctic climate was transferred at one time from its present limits to the Ohio River at Louisville, a distance of about 1,600 miles. From this border to central Florida is about 800 miles. We know that at our own day winter storms penetrate this interval and produce severe damage on vegetation and doubtless on animals also; but how much more injury and suffering and death must have been inflicted by storms starting over the ice fields at a high elevation, and sweeping as far south as Florida.

Dr. Simpson describes¹⁴ a species to which he assigns the name *Boreostracon floridanus*. He also gives an abstract of the discovery and naming of previously collected materials which were referred to

¹⁴ Bull. Amer. Mus. Nat. Hist. 56: 581. 1929.

the genus Glyptodon, as G. petaliferus and G. rivipacis; and he ends by declaring that these names are nomina nuda. 15 Accordingly these species and the genus are excluded from his lists of Florida fossils. Here Dr. Simpson is mistaken. A nomen nudum is a name only, one without description, figure or a reference to one or all of these. Both of the names mentioned are based on type specimens which are preserved, on descriptions, and on figures, and these names must therefore be respected. I am reproached with failure to provide diagnoses as required by the nomenclatural code. On the contrary, in citing the original descriptions and figures, I did all that code requires. It may be that the fossils do not belong in the genus Glyptodon, but the specific name petaliferus for Cope's specimen and rivipacis for the one found in Florida must be retained. On any day some lucky collector may gather materials that will reinstate these species to their proper position. As for the other specimens found in Texas and Oklahoma, if Dr. Simpson can withdraw them from the genus and species to which I assign them, he is at liberty to do so. Otherwise they must stand until somebody can define them to his satisfaction.

In referring to the age of the fossils found by J. W. Gidley and Kirk Bryan in the San Pedro Valley, southeastern Arizona, Dr. Simpson sustains the assignment of the formations and fossils to the Pliocene. The present writer has always doubted the correctness of this action. Whether this doubt is justified or not, the deposit must be very close to the parting between the Tertiary and the Pleistocene. The presence of two or three well developed, but as yet undetermined, species of Equus attests to this; and I believe that the existence of any species of this genus in the Pliocene has not been demonstrated. As to the evidence on the part of geology on this point, it is improbable that any geologist can distinguish in that region, between late Pliocene deposits and those of the Nebraskan stage of the Pleistocene. Gidley details the reasons why the choice might be in favor of the Pleistocene and those why the Pliocene received the preference. The mastodons are said to be of distinctly Pliocene type; but certainly Stegomastodon is well known in the first interglacial stage. Also all of the species of rodents belong to existing genera and, although no existing species is recognized, several are admitted to be close to modern forms. The decisive elements in the correlation are for Gidley the presence of the genera Hipparion, Pliohippus, Pliauchenia, Merycodus and Glyptotherium. On Hipparion as having furnished one or more Pleistocene

¹⁵ Op. cit., p. 583.

species I have given my opinion more than once, that it came up into the Pleistocene. *Pliohippus* has been referred with doubt more than once to the Pleistocene. *Merycodus*, as well as the genera *Pliohippus* and *Pliauchenia*, are fertile of species in the Pliocene and that they should continue to live in the earliest Pleistocene would not be surprising. It will be necessary for vertebrate paleontologists to recognize the existence of a Nebraskan stage of the Pleistocene, and no good reason has been presented why only a very few genera of large Pliocene animals should pass the line.

We come now to the genus Glyptotherium. The type of the genus was described from the Upper Pliocene formation, the Blanco. I think that no good reason can be assigned why the genus may not have continued on also into the beginning of the Pleistocene. Dr. Simpson has expressed the view that the correlation of a collection ought to be based on the more recent genera involved. In the present case it appears that he and Gidley have reversed the principle, inasmuch as they lay more weight on the Tertiary genera Hipparion, Pliohippus, Merycodus, Pliauchenia than on the on-coming genera Equus, Lama, Odocoileus, and the on-coming genera of rodents.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

228TH MEETING

The 228th meeting was held in the Assembly Hall of the Cosmos Club on the evening of Thursday, December 19, 1929. The meeting was the first of a series devoted to Genesis and Development, or Origin and Evolution. The purpose and plan of the series of addresses on this subject were first explained by W. J. Humphreys, Chairman of the Committee on Meetings. The principal speaker of the evening, Dr. L. H. Adams of the Geophysical Laboratory, then gave the first of the series, entitled The Creation of the Earth. The Earth revolves around a sun which is merely one of many millions of stars in our galaxy, which in turn is only one of a very large number of similar galaxies, or spiral nebulae, scattered throughout space. The individual stars are in constant motion but the average distance apart is so great that not often will two stars collide or even approach near to each other. There is little doubt, however, that this rare event did happen about two thousand million years ago, the close approach of another star to the Sun being the first step in the origin of the Earth. The gravitational attraction caused tidal phenomena on a grand scale. Great protuberances were finally pulled entirely away from the Sun, and these masses after subsequent cooling to a liquid and then to a solid state became the Earth and the other planets of the solar system. During the last stages of crystallization the water of the oceans and the gases of the primitive atmosphere were evolved. Geologic history was then about to begin. (Author's abstract.)

229TH MEETING

The 229th meeting, being the 32d annual meeting of the Academy, was held in the auditorium of the National Museum on the evening of Tuesday, January 14, 1930. The meeting was called to order by Vice-President Adams. The retiring President, Dr. Aleš Hrdlička, delivered his presidential address, the subject being Organic Evolution, its Problems and Perplexities. This address has been published in Science for February 28, 1930.

At the close of the address there was a short intermission, after which the

business meeting was called to order by the President.

The Recording Secretary, W. D. LAMBERT, read the minutes of the 31st

annual meeting, which were ordered approved.

The Corresponding Secretary, L. B. Tuckerman, presented his report for the preceding year. The deaths of eighteen members were reported during the year, namely:

James P. Ault R. W. Balcom Erich Becher Emile Berliner A. W. Boswell H. C. Frankenfield J. Goldberger Carey V. Hodgson E. Lester Jones D. S. LAMB
G. P. MERRILL
JOHN F. MORAN
C. W. RICHARDSON
ROBERT RIDGWAY
PHILIP S. ROY
E. E. SLOSSON
FRANCIS A. TONDORF

P. A. Yoder

On January 1, 1930, the membership consisted of 15 honorary members, 3 patrons and 551 members, one of whom was a life member. The total membership was 570, of whom 363 reside in or near the District of Columbia, 173 in other parts of the continental United States, and 34 in foreign countries.

The Board of Managers held three meetings which considered, in addition to routine business, the proposed revision of the By-Laws, the proposed series of lectures on Origin and Evolution, and the policies of the Journal.

The report of the Corresponding Secretary was ordered accepted.

The annual report of the Recording Secretary was presented by him. Five public meetings were held. The names of the speakers and their subjects

were given. The report was ordered accepted.

The annual report of the Treasurer, R. L. Faris, was presented by him. Receipts during the year were \$8,315.06, including \$2600 of investments paid off. Total disbursements were \$7,509.30, including \$3000 of investment and reinvestment. The cash balance on Dec. 31, 1929, was \$2,798.70, with current accounts payable estimated at \$400. The value of investments of the Academy was \$18,936.37, the total assets \$21,882.45, and the estimated net worth \$21,209.95.

The report of the Auditing Committee, consisting of Messrs. O. H. Gish, W. D. Sutcliffe and R. E. Gibson, was presented by Mr. Gish. The report showed the accounts of the Treasurer to be correct and the securities on hand

as stated in his report.

The reports of the Auditing Committee and the Treasurer were ordered accepted.

The report of the Board of Editors was presented by the Senior Editor,

J. B. Reeside, Jr.

Volume 19 of the Journal consisted of 490 pages, a smaller number than in previous years. The cost of the Journal, including the Academy's share

of the expense of reprints, was \$6.73 per page, an increase of \$0.13. The volume was illustrated by 27 half-tones and 30 line cuts. The report showed the distribution of articles among the various sciences and stated that there had been no changes in policy. The report was ordered accepted.

The Corresponding Secretary presented the proposed revised By-Laws. These By-Laws were submitted at a meeting of the Academy held May 18, 1928, and have been considered by the Board of Managers and been recommended by them for adoption in amended form, as printed in the Journal for

December 19, 1929.

It was moved, seconded and carried that the new By-Laws, as recommended by the Managers, be adopted, to take effect on March 1, 1930, with the understanding that all officers elected under the present By-Laws hold office until their successors are elected. It was stated that this form of motion was intended to avoid possible confusion due to changes made in the new By-Laws regarding the qualifications for holding office in the Academy.

The report of the Committee of Tellers for the Annual Election, consisting of K. S. Gibson, W. D. Lambert and L. V. Judson, was presented by the Corresponding Secretary. In accordance with the report the following officers

of the Academy for 1930 were declared elected:

President, William Bowie

Non-Resident Vice-Presidents, Waldemar Lindgren, Harlow Shapley Corresponding Secretary, L. B. Tuckerman

Recording Secretary, Charles Thom

Treasurer, H. G. AVERS

Managers for the term of three years ending January 1933, P. R. Heyl and G. N. Collins

Manager for the term of two years ending January 1932 (to fill vacancy), J. B. Reeside, Jr.

Manager for the term of one year ending January 1931 (to fill vacancy), G. R. Putnam

The new President was escorted to the chair by Past President Humphreys. He thanked the Academy for the honor of the election.

The Corresponding Secretary reported that the following members of the Academy had been nominated by the affiliated societies for Vice-Presidents:

Archeological, Dr. Walter Hough Bacteriological, Dr. A. C. Hunter Electrical Engineers, Dr. M. G. Lloyd Entomological, Dr. A. G. Böving Geographic, Dr. F. V. Coville Geological, Mr. S. R. Capps Helminthological, Capt. C. S. Butler Mechanical Engineers, Mr. H. L. Whittemore Medical, Dr. H. H. Kerr Military Engineers, Col. C. H. Birdseye Philosophical, Mr. Walter D. Lambert

In accordance with a motion duly made, seconded and carried, the above nominees of the affiliated societies were declared elected Vice-Presidents.

There being no further business presented, at 9.55 P.M. the meeting adjourned.

Walter D. Lambert, Recording Secretary.

230TH MEETING

The 230th meeting of the Academy was a joint meeting with the Geological Society, held in the Assembly Hall of the Cosmos Club on Thursday, January 30, 1930. The meeting was called to order at 8:15 P.M. by the President, Dr. William Bowie, who presented Dr. G. R. Mansfield, President of the Geological Society, as the active chairman of the meeting. Dr. Mansfield introduced the speaker of the evening, Mr. R. H. Sargent of the U. S. Geological Survey, as one whose many years of personal acquaintance with the geography and topography of Alaska had made him the natural leader and adviser in the development of an air survey of that territory.

Program: R. H. SARGENT: Photographing Alaska and its glaciers from the

air (illustrated by three reels of pictures).

The Alaskan Branch of the U. S. Geological Survey, which is entrusted with the geologic and topographic mapping of Alaska, has already completed 46 per cent of the territory. The topographic mapping has been accomplished by the regular ground methods, but within the past few years, aerial photographs as aids in mapping have come into use. The members of the Geological Survey realized their value in supplementing ground methods especially in Southeastern Alaska where the country is covered with a heavy mantle of timber and brush, the topography is rugged and irregular, and the climatic conditions are very unfavorable. Accordingly the Navy Department was requested by the Interior Department to make aerial photographs of this section of Alaska.

In 1926 the Navy Department sent an expedition under the leadership of Lieutenant Ben H. Wyatt to the Territory for this purpose. Again in 1929 a similar expedition, under the command of Lieutenant Commander A. W. Radford, was sent to continue this work. Each of these expeditions consisted of an airplane tender, a covered barge which was used as living and working quarters for the aerial and photographic sections, and four amphibian planes. The personnel included 110 officers and enlisted men.

In Southeastern Alaska there are over a dozen Federal Agencies which it was considered might be aided by these airplane photographs. In turn, these agencies have boats and other equipment which could be of aid to the Navy expedition. Accordingly a coördinated coöperative agreement was entered into by all of these Federal agencies. The results of this coöperation were

most gratifying.

The mapping cameras used have 4 lenses, 3 of which are in one huge case while the 4th is in a small box attached to the rear of the main case. The A, C and D lenses are set at an angle with the B lens in order to cover more country. In making an exposure all four shutters work in unison and four pictures are made at the same instant. Because of the obliquity of the three lenses, A, C and D, the negatives of these lenses are distorted and they must be corrected by printing them in a peculiar type of printer known as a transforming printer. The transformed print is keystone shaped. The B print is joined with these keystone prints to make one large photograph.

From these pictures the cartographic data is taken by a special method. Over 13,000 of these combined photographs, covering an area of over 23,000 square miles, will be in the possession of the Geological Survey when they have been printed. As an aid to topographic mapping they are invaluable.

In addition to these mapping photographs, many excellent and valuable oblique pictures were taken over the side of the planes. These photographs

were taken as part of the coöperative scheme. They included many views of areas of timber for the Forest Service, water power for the Federal Power Commission, views along the International Boundary for the Interstate Boundary Commission, of lighthouses for the Light House Service, and mountains and glaciers for the Geological Survey. These are all of economic and scientific value.

The members of the Forest Service, which bureau is entrusted with the administrating and development of the Forest of Alaska, have found these pictures most valuable. The mapping pictures assist them in estimating and evaluating the timber of the district. The oblique photographs serve for detailed studies of particular stands of timber, mountain passes, water power, harbors and other items of economic importance.

There is no way of evaluating the worth of these expeditions but it is certain that it is great. There are concrete instances of an actual saving having been made of many thousands of dollars in addition to the scientific value of

the photographs. (Author's abstract.)

231st meeting

The 231st meeting was held in the auditorium of the National Museum February 20, 1930. Dr. W. D. Lambert called the meeting to order at 8:15. Professor E. W. Berry of Johns Hopkins University gave an address entitled

"The Origin and Evolution of Plants."

The speaker began by defining plants as "catchers and preservers of energy" in contrast to animals as expenders of energy. Hence, he concludes that the plants must have preceded animals. He referred briefly to the generally accepted view that the earliest forms must have been marine and delicate and that practically no record occurs to cover the very early periods, then passed to the presentation of his series of slides showing geologic remains, restorations and distribution charts. Although a few of the lower forms were mentioned, the slides were selected to show continuity throughout geologic time in the developmental series from Lepidophytes, Arthrophytes, Pteridophytes, Pteridosperms, etc., toward early and recent conifers. He concluded by showing distribution charts, both geologic and recent, for such forms as sassafras and tulip tree. Stress was put upon continuity as a dominant feature of the plant world.

232ND MEETING

The 232nd meeting of the Academy was held in the auditorium of the National Museum at 8:15 P. M. on Thursday, March 20, 1930, with about 125 persons present. President Bowie introduced Dr. Paul S. Galtsoff who gave the fourth address of the series upon the general subject of *Origin and evolution*.

Program: Dr. Paul S. Galtsoff: Old and new concepts of the organism in the light of experimental studies on sponges. The cellular theory of organisms advanced in 1834–35 by Schleiden and Schwan had an enormous influence on the development of biology in the 18th century because it brought under a single point of view such different biological disciplines as embryology, heredity, physiology, and evolution. According to this theory, the key to the solution of various problems of these branches of biology is looked for in the cell which is regarded both as an anatomical and physiological unit of the organism. From this point of view the organism is comparable to a colony of cells or "cell state" in which by physiological division of labor and differentiation the various cells acquired different features and specialized in perform-

ing different functions. This point of view is severely criticized by the advocates of the theory of the "organism as a whole" who regard the fact that the organisms are built of cells of secondary importance and that the "whole"

dominates over its parts.

The author's experiments on regeneration of sponges from completely separated tissue cells uphold the first point of view and may shed light on the nature of living organisms. In the experiments the tissue cells of a sponge are separated by squeezing a piece of sponge through fine silk. Then the disjoined cells are placed in sea water in which they sink, begin to creep on the bottom, coalesce and form an aggregate which in about 10 days regenerate into a new sponge. The regeneration is accomplished by the process of sorting out of the cells or their rearrangement so that every cell occupies again its right place in the organism. Superficially, at least, it seems as if an outside force or "intelligence" was directing the orderly rearrangement of the destroyed individual, but the experiments prove that the behavior of the cells depends on physical and chemical properties of their protoplasm and the surrounding medium. For instance, no development takes place if the aggregates are placed on a greasy substance upon which the cells are unable to spread. It has been demonstrated also, that the development of the aggregate is due to a slow motion of the cells and that the cells of different species, when mixed together, fail to form a compound aggregate because the protoplasm of cells of two different species fails to coalesce.

Experiments on sponges uphold the "cell-state" theory of the organism since they show that the regeneration of the individual organism is brought about by the combination of individual cells; during the process there is no multipli-

cation of cells but merely their rearrangement. (Author's abstract.)

233RD MEETING

The 233rd meeting of the Academy was held in the auditorium of the National Museum at 8:15, Wednesday, April 16, 1930. President William Bowie introduced Dr. Charles B. Davenport, Director of the Department of Genetics of the Carnegie Institution of Washington, who delivered an address entitled "The Mechanism of Organic Evolution." About 100 persons were present.

The mechanism of organic evolution, as I see it, consists of the following

processes:-

1. Infinite capacity of the germinal material for reproduction.

2. Infinite capacity for mutation.

3. An infinitude of kinds of environments.

4. Extensive opportunities for dissemination of the mutant individuals over earth, permitting some of them to find an environment for which they are especially fitted.

5. As for the rest of the infinitude of individuals, non-mutant and mutant

(beyond the number required for replacement) elimination.

In a sentence nature's mechanism of evolution includes the elements of: an infinitude of kinds of environments, infinite reproduction, infinite mutation, infinite opportunity for new mutants to find appropriate environments and elimination of all the infinitude of other individuals that are not required for replacement.

Homo sapiens is only a natural species with a highly evolved hand and brain. This species has reached its lofty position in evolution by the processes

described. It is proud of its control of nature in certain directions. Let it beware lest it think it can evolve further by man-made formula that may suit its perverted desires but must eventually fail of permanent progress if opposed to the formula of nature. (Author's abstract.)

234TH MEETING

The 234th meeting of the Academy was held in the Auditorium of the National Museum at 8:15 P.M. on Thursday, May 15, 1930. President WILLIAM BOWIE introduced the speaker, Professor Maynard M. Metcalf of Johns Hopkins University who spoke upon the "Origin and Evolution of the

Higher One-celled Animals." About 60 persons were present.

The speaker referred to the three major groups of protozoa: Sarcodina, crawling forms, which reproduce by division in any direction; Flagellata, forms which swim by means of whip-like flagella, and reproduce by longitudinal splitting; Ciliata, forms which swim by hairlike cilia and reproduce by transverse division. He then discussed the origin and the evolution of the Ciliata, animals which are unique among living things in having in each cell, two nuclei, one enlarged and occupied with chemical activities, metabolism, the other unmodified and reserved for transmission of inheritance. The most primitive family of the Ciliata, the Opalinidae, are intermediate in many regards between the Flagellata and the Ciliata and show how the latter were derived from the former. Details were described which showed the change of the uninucleate Flagellata through temporarily binucleated Opalinidae into permanently binucleated higher Ciliata whose two nuclei evolved into one large metabolic nucleus and one unmodified genetic nucleus.

The adoption of a parasitic habit caused the Opalinidae rapidly to become adapted to this peculiar life, their adaptation becoming complete during a single geologic period—the Triassic. Many species have persisted almost or wholly unmodified from that time. Rapid initial modification, after adapting parasitism, and slow subsequent change are quite generally characteristic of the evolution. Such subsequent evolution as has occurred in the family has been due to factors of evolution within the organism rather than in the environment i.e. not to natural selection. This is definitely shown by the "pattern of occurrence" of the several characters of the family among the branches of the ancestral tree, which is a definitely established tree and not an hypothetical one. Orthogenesis is then more than an hypothesis, it is a fact.

The value of concomitant study of hosts and parasites in problems of geographical distribution and some of their corollaries was briefly illustrated.

(Author's abstract.)

Charles Thom, Recording Secretary.

BIOLOGICAL SOCIETY

742ND MEETING

The 742nd meeting of the Biological Society was held in the new assembly hall of the Cosmos Club January 11, 1930, at 8.10 p. m., with President Wetmore in the chair and 65 persons present. The mintues of the preceding meeting were read and approved.

The President announced the reappointment of Dr. T. S. Palmer as Chairman of the Board of Trustees of Permanent Funds, to serve through

The President read the following resolution adopted by the Council commending the work of C. Davies Sherborn:

Whereas, Charles Davies Sherborn, through his bibliographical researches, has made contributions of such outstanding importance in the field of zoology,

And Whereas, he has by continued and painstaking endeavor placed in the hands of his fellow workers in the "Index Animalium" an instrument of great usefulness,
And Whereas, he has made other notable contributions such as a "Bibliography of the Foraminifera" and an "Index to the Genera and Species of the Foraminifera" and a "Catalogue of British Fossil Vertebrata," and other similar works,
Therefore Be it Resolved, that the Biological Society of Washington extends to Charles Davies Sherborn its appreciation and recognition of the service he has

rendered to his fellow-workers in science.

A. Wetmore stated that three hunters' skins of the giant panda had

recently been received at the National Museum.

F. C. Lincoln reported an unusual migration of waterfowl during the past autumn and winter. Ducks banded in autumn in North Dakota and Louisiana have spread east, in several cases reaching the Atlantic coast.

P. B. Johnson stated that in the newly born hippopotamus the hairs on the upper lip are single in the follicles, but in the adult they are in clusters.

W. H. Rich: Alaska salmon investigations.—The five Alaskan species of salmon all belong to the genus Onchorynchus and are known as the pink, chum, silver, king, and red salmon. All are anadromous and return to spawn to the same stream in which they were hatched and spent the early part of their lives. All die after the first spawning. The young stay in fresh water for varying lengths of time depending on the species and on the locality. Some migrate seaward as soon as they are able to swim, others remain in fresh water for as much as five years. The length of time spent in the ocean is also variable, from one-half to five years. Migrations in the ocean have been studied by means of experiments in which metal tags were attached to adult fish and a reward offered for the return of the tags together with data as to when and where the tags were found. Such experiments have shown that the fish caught at the end of the Alaskan Peninsula had their origin in Bristol Bay.

One of the important lines of investigation has had to do with the study in certain selected streams of the production of adult fish from known breeding populations. Weirs have been constructed across these streams and the number of spawning fish passing up the river is accurately determined. later years the number of fish derived from the spawning of these fish can be determined. These investigations ultimately will produce information that will enable the spawning populations to be regulated so as to maintain the runs at the point of highest productivity. On the basis of knowledge of the spawning escapements as secured by weirs in some streams and by careful observations of the fish on the spawning grounds in other streams it has been possible to prophesy with considerable accuracy the size of the salmon runs for future

seasons. (Author's abstract.)

O. E. Sette: Mackerel investigations (illustrated.)—Biostatistical investigations of the mackerel fishery have been pursued by the Bureau of Fisheries since 1925, the principal object being to determine the causes for fluctuations in the catch. These fluctuations are very severe, the catch ranging from 120,000,000 pounds in some years to as low as 4,000,000 pounds in others.

From an analysis of length measurements of more than 100,000 mackerel from all American fishing localities during five years, it has been possible to determine that the rate of growth is very rapid during the first two years, an average length of 33 cm. being attained at the end of the second season. Thereafter, growth is less pronounced, eight year old mackerel being on the average about 44 cm. long. The outstanding phenomenon in the mackerel fishery is the unequal success of various year broods surviving to commercial size. The 1923 brood furnished the bulk of mackerel in the catch for the years 1925–28. Other broods, particularly those of 1921 and 1927, furnished very few mackerel, while 1922, 1924, 1925, and 1926 accounted for almost none. In 1929, a new brood resulting from the 1928 spawning season entered the commercial catch in such numbers that for the first time since 1925, the 1923 mackerel were overshadowed by another brood.

This fully explains the extraordinary fluctuations. When a large brood enters the fishery, it furnishes good catches for a period of five years; but unless another large brood appears to augment the catch within that period,

the fishery declines to very low levels.

The cause of unequal increments to the commercial fishery from year to year is excessive mortality in early stages, the critical period probably lying somewhere between the hatching of the larvae and the attainment of commercial size. In our present program, particular attention is being given to the observation of oceanographic conditions in relation to the survival of young mackerel in order that the causes of excessive mortality of young stages

may be ascertained. (Author's abstract.)

ELMER HIGGINS: Great Lakes investigations (illustrated).—The fisheries of the Great Lakes depend upon a rich and varied fauna of some 163 species of fish; half of this number are edible. The yield of the commerical fisheries for the past 50 years has been about 100,000,000 pounds annually, of which United States fishermen take 81,000,000 pounds. The yield for the past 7 years compared with the previous 7-year period has declined 16%, and many species are seriously depleted. In Lake Erie, the whitefish has declined 82%,

and the cisco 94% since 1885 and 1890, respectively.

Many biological, limnological, and fisheries investigations of the Great Lakes have been conducted since 1850. Some have led to specific recommendations for regulation of the fishery, but because of divided authority of the eight States and a Canadian province over these waters, no uniform action has been taken. In the summer of 1928, the Bureau of Fisheries organized a coöperative limnological and fisheries investigation of Lake Erie, where fishery problems are most acute. State and private institutions in New York, Ohio, and Ontario cooperated, and the study was continued during 1929. Results indicate that pollution is a negligible factor in limiting the supply of fishes; that the plankton and bottom food supply is abundant; but that thermal conditions, which were carefully studied, may have direct influence upon the availability of fish. This is illustrated by the case of the cisco, which is a cold-water-loving fish, depending upon a food organism likewise limited to cold water. The configuration of the bottom together with variations in the height of the thermocline seem to have concentrated the entire stock of ciscoes in a small area in 1924, when enormous catches were made, so great, in fact, that the fishery has been practically destroyed. The commercial yield fell from 32,200,000 pounds in 1924 to 5,500,000 pounds in 1925, and remained low until the present time.

In addition to such conditions, wasteful methods of fishing appear to be an important factor in overfishing. The Bureau's investigators have therefore undertaken extensive experiments to determine the effect on the fish stock of various sizes of mesh in the nets. Experimental nets alternated with commercial nets have been operated throughout the entire fishing seasons in various parts of the lake in an effort to devise gear that is most efficient from a commercial standpoint as well as least destructive to immature fish. Defi-

nite recommendations for regulations of gear and for a more complete system of fishery statistics useful to the biologists have been offered and have been adopted by most of the States bordering the Great Lakes. (*Author's abstract*).

743D MEETING

The 743d meeting was held in the new assembly hall of the Cosmos Club January 25, 1930, at 8.10 p. m., with President Wetmore in the chair and 80 persons present. New members elected: E. A. Moran, S. F. Stanley.

A. A. DOOLITTLE exhibited two jars which have been hermetically sealed for five years. The jars are not absolutely tight but leak very slightly when placed in water. One was originally filled with air, one with CO₂, and in each a handful of ordinary yard soil with some nasturtium seeds was placed. A fern is now growing in each jar as well as various algae.

The regular programme was as follows:

E. N. Munns: Some forestry observations in Europe (illustrated).—The speaker described silvicultural conditions in Europe and contrasted them with conditions in this country, for the most part to the disadvantage of the latter.

P. N. Martindale, ranger, Yellowstone National Park: Intimate habits of wild animals.—The speaker described the life of rangers in the Yellowstone National Park and gave an account of some of the larger mammals, particularly the bears.

744TH MEETING

The 744th meeting was held in the new assembly hall of the Cosmos Club February 8, 1930, at 8 p. m., with President Wetmore in the chair and 120 persons present. New members elected: Henry O'Malley, J. E. Shillinger.

F. Thone exhibited photographs of the skull of Sinanthropus pekinensis

and mentioned the views of several anthropologists regarding it.

P. B. Johnson reported, with reference to his communication on January 11, that the death of an adult hippopotamus at the Zoological Park had made possible further observations. He finds that all the hairs of each cluster of hairs on the lip and tail of the adult are united at base within the skin.

The regular program was as follows:

H. M. Albright: Some biological problems in National Park administration (illustrated).—The speaker discussed some of the outstanding problems in the administration of National Parks, such as the deer problem in various parks due to overpopulation; the over-familiarity of bears in Yellowstone and Yosemite Parks, with consequent damage to property and also to tourists; the destructiveness of white pelicans to fish in Yellowstone; the predatory animal problem, which is solved by practically exterminating them in the smaller parks and leaving them almost alone in the larger parks; the overpopulation of buffalo in Yellowstone; and the protection of nesting trumpeter swans. He exhibited moving pictures of black and grizzly bears and of woodchucks, elk, and other mammals. In conclusion he introduced A. P. Hare, a former ranger, who gave an amusing account of his experiences with bears and tourists.

745TH MEETING

The 745th meeting was held in the new assembly hall of the Cosmos Club on February 22, 1930, at 8.15 p. m., with President Wetmore in the chair and 50 persons present. New member elected: M. C. James.

T. S. Palmer contrasted the knowledge of biology 200 years ago and now. He also mentioned that quail have been fed by police in five precincts during the recent heavy snow, the grain being paid for by the Audubon Society. The count of the police shows 727 birds. At the time of the heavy storm in 1922 about 1200 were reported.

A. Wetmore reported that he and F. C. Lincoln had found flocks of ducks—Oldsquaw, Goldeneye, and others—at Scotland Beach, Maryland, that day,

in which the birds were evidently mated.

F. C. LINCOLN reported that E. A. McIlhenny, in cooperation with the Biological Survey, had this winter shipped ducks captured and banded in Louisiana to various parts of the country to be released. Returns from these banded birds are expected to throw important light on their migrations.

The regular program was as follows:

A. H. Wiebe: Some observations in increasing pond productivity.—The object of the pond-cultural work at the Fairport (Iowa) station is to raise bass and other game fish to fingerling size for distribution. The general practice up to now has been to distribute the fish as fry. The work at Fairport is done in dirt ponds ranging in size from less than 0.1 to 3.5 acres. The water supply is pumped from the Mississippi River. The ponds are so constructed that they can be drained and all fish recovered. The young fry when 15 to 20 mm. in length are trapped and transferred to nursery ponds. This is done because bass are very cannibalistic. The production of fish is increased not by resorting to artificial feeding, but by increasing the natural food supply. This is done through the use of forage fish and fertilizers. The minnows Notemigonus crysoleucas (golden shiner) and Pimephales promelas (blackhead minnow), because of their slender bodies, their early maturity, and prolonged spawning periods, are particularly well suited for forage. The fertilizers used are sheep manure, soybean meal, shrimp bran, and superphosphate. That fertilizers have a beneficial effect is shown by the increased production of algae, microcrustacea, and fish. (Author's abstract.)

increased production of algae, microcrustacea, and fish. (Author's abstract.) F. A. Warren: Along the trails of Mount Rainier (illustrated).—The speaker, on the basis of several seasons' work, described some of the characteristic plants and animals and illustrated them by lantern slides, as well as

the general features of the mountain.

C. D. Marsh: The poisonous laurel (illustrated).—Mountain laurel (Kalmia latifolia) and sheep laurel (Kalmia angustifolia) are among the most

important poisonous plants of the eastern United States.

Mountain laurel was recognized as poisonous as early as 1743, and sheep laurel in 1749. One of the best descriptions of mountain laurel and its effects was published by Kalm in 1771. The first important contribution of experimental work was by Thomas in 1802. Crawford in 1908 published the only other serious contribution with experimental data. The losses of live-stock have been of sheep and cattle, but it has been shown that goats, monkeys, and probably horses may be poisoned. They may also affect man. The symptoms are the same with both plants and consist mainly of salivation, pronounced nausea, irregular respiration, and weakness, which may result in complete prostration. The toxic and lethal dosage have been studied with both plants, and it has been shown that while the sheep laurel is distinctly more poisonous than the mountain laurel, animals poisoned by the sheep laurel are not as likely to die as those poisoned by the mountain laurel. Both of these plants are more poisonous to sheep and goats than to cattle. Apparently birds are not easily affected by them.

From the literature on the subject, it appears that the flesh of animals feeding upon these laurels may become poisoned. It has also been shown that when bees collect honey from these laurels, the honey becomes poisonous. Experimental work has shown quite clearly that linseed oil is effective in reducing the harmful effects of the plants. (Author's abstract.)

746TH MEETING

The 746th meeting was held March 8, 1930, at 8.15 p.m. in the new assembly hall of the Cosmos Club, with Vice-President Jackson in the chair and 72 persons present. New member elected: F. C. Friesner.

C. W. Stiles announced that the meeting of the International Zoological

Congress will be held at Padua this year on September 4–11.

S. F. BLAKE mentioned the observation of about 100 gulls, apparently Herring Gulls, on the Washington Airport field that morning after a rain the night before.

The regular program was as follows:

H. S. Peters: External parasites of birds (illustrated).—External parasites are commonly found on most wild birds. If we remember that they must all exist at the expense of their host it is reasonable to believe they must have a very harmful and noticeable effect on their host. This opens many interesting fields of study and raises many questions in which the bird bander, especially, should be interested. Banders may find that birds repeating very often at traps or feeding stations are parasitized, weakened and unable to seek their own food. I believe ectoparasites have a definite effect on the behavior of the birds, probably causing them to have a somewhat shorter migration route, shorter life, smaller size and duller plumage; to sing less; and perhaps to have a lower and more variable body temperature than the birds not infested.

All groups of ectoparasites are visible to the unaided eye and may be easily picked from their host with small forceps and placed in small vials of 70% alcohol for killing and preserving until being mounted on microscope slides

for identification.

The biting lice or Mallophaga are most commonly observed and are found on all species of birds. They feed on parts of the feathers and scales of the skin and cause much irritation by their sharp claws. Feather mites are the most abundant parasites but are easily overlooked due to their small size. Ticks are often found on ground-frequenting birds and cause a great loss of vitality by sucking the blood of the host. The stick-tight flea is often found in masses on the head of birds, especially in southern United States. The bird flies (*Hippoboscidae*) are found principally on young birds. The ectoparasites which feed on blood probably have more harmful effect on the birds than the lice. It is hoped that bird banders will observe these parasites and their effect on the host, thus aiding the entomologist in his study of their life history, host relationships, abundance and distribution. (*Author's abstract.*)

PAUL BARTSCH: Collecting in the Caribbean Islands (illustrated).—The speaker gave an account of his explorations in the West Indies last summer in search of land molluscs on a Walter Rathbone Bacon Traveling Scholarship. Nearly all the large and small islands of the West Indies and off the coast of

Venezuela were visited and extensive collections obtained.

747TH MEETING

The 747th meeting was held in the new assembly hall of the Cosmos Club March 22, 1930, at 8.10 p.m., with President Wetmore in the chair and 130 persons present. New member elected: C. V. Morton.

A letter was read from C. T. REGAN thanking the Society on behalf of the Trustees of the British Museum for its resolution expressing appreciation of

the bibliographical work of C. D. Sherborn.

The regular program was as follows:

VERNON BAILEY: Some biological problems of the Grand Canyon region (illustrated).—The speaker spoke of a few of the many biological problems of the Grand Canyon country, with lantern slide illustrations and moving pictures of the Kaibab deer herd, the tufted-eared Abert squirrel, white-tailed Kaibab squirrel, and the porcupines. A colored slide of life zones across a section of the Grand Canyon showed the climatic barrier between the many distinct species of mammals only 13 miles apart on the two sides of the canyon.

Pictures were shown of the Supai Indians living in the bottom of Havisu Canyon in much the primitive style of the ancient cliff-dwellers of the Grand

Canvon and possibly their direct descendents.

The buffalo herd in Houserock Valley, the introduced antelope herd in the Grand Canyon, the mountain sheep along the canyon walls, and the Rocky Mountain mule deer on the Kaibab Plateau were shown in colored lantern slides and their present status discussed. The present system of controlling the overabundance of mule deer by carefully supervised hunting on the edges of their winter range was highly commended and the perpetuation of this splendid deer herd considered assured through the best system of game management ever put into practice in this country. The control of predatory mammals, the mountain lions, bobcats, and coyotes, was shown to be absolutely essential to maintaining the game animals as well as the protection of livestock interests of the region. With our present knowledge of the habits of both the predatory and game animals it is now possible to regulate the abundance of any species of larger mammals as seems most desirable. (Author's abstract.)

E. P. Killip: Over the Peruvian Andes and down the Amazon for plants (illustrated).—An expedition was sent by the Smithsonian Institution to eastern Peru to make general botanical collections and to study especially plants used as fish poisons, the party consisting of A. C. Smith, W. J. Dennis, and the speaker. Brief stops were made in the mountains at Río Blanco, Tarma, Huancayo, and Huanta, but the main work was carried on in the little-known montaña region of eastern and northeastern Peru. This was first reached at Kimpitiriki, on the Apurimac River. After a month in the Chanchamayo Valley, the party proceeded over the Pichis trail and down the Pichis and Ucayali rivers to Iquitos, on the Amazon, in the extreme northeastern corner of the country. Several weeks were spent along the Marañon and Huallaga rivers and at Yurimaguas. The expedition then went down

the Amazon to Pará, making a stop at Manáos.

Approximately 9200 numbers of plants were collected in two complete sets, for the National Museum and the New York Botanical Garden which coöperated in the project. Extra material was obtained for study by

specialists in certain plant groups. (Author's abstract.)

748TH MEETING

The 748th meeting was held in the new assembly hall of the Cosmos Club at 8.10 p. m. on April 5, 1930, with President Wetmore in the chair and 95 persons present.

S. F. Blake mentioned that the grass on the large ant nests along the Maryland route to Great Falls has remained green through the winter, while the grass close by is dry and withered, and asked for an explanation from

entomologists present.

A. Wetmore discussed the limits of the Washington Region as set by different writers by the subject, and favored its extension, from the ornithological point of view, to a circle 40 or even 50 miles in diameter. Discussed by V. Bailey, who also favored its extension from the point of view of mammalogy; by C. H. Merriam, who showed from his own collecting experiences to what an extent the wild life of the region has been pushed back from the city within recent times; and by S. F. Blake, who felt that such an extension would bring in too many plants belonging to diverse associations.

The regular program was as follows:

P. G. Redington: Alaska and some of her interesting inhabitants (illustrated).

749TH MEETING

The 749th regular meeting was held in the new assembly hall of the Cosmos Club April 19, 1930, at 8.10 p. m., with Vice-President Stiles in the chair

and 55 persons present. New member elected: W. L. Brown.

Dr. G. W. Field stated that the discovery of oil in southern Louisiana, close to the large bird reservations on which migratory waterfowl congregate during the winter, has raised new problems in their protection. A bill will be brought up in Congress amending the Oil Pollution Act of 1924 by extending its provisions to the Great Lakes and navigable inland waters (as well as to coastal waters), and putting its enforcement under the officials administering the Migratory Bird Act.

Dr. L. O. Howard introduced Dr. David Miller, Government Entomol-

ogist of New Zealand.

The regular program was as follows:

H. L. Westover: Plant exploration in Turkestan (illustrated).—The speaker gave an account of his travels through Russia and Turkestan in search of alfalfas resistant to the bacterial wilt (Aplanobacter insidiosum), a disease that has been very destructive in the best alfalfa growing districts of the Middle West in recent years. Arrangements for the trip were made previously with the Institute of Applied Botany at Leningrad and this Institute permitted a member of their staff to act as interpreter for the expedition. Mr. Westover was accompanied by W. E. Whitehouse of the office of Foreign Plant Introduction. They entered Russia at Leningrad and after visiting scientific institutions there proceeded to Moscow, Kiev, Kharkov, Saratov, Samara, and thence to Tashkent. The Soviet Government is conducting extensive experiments in agriculture at these points and is spending considerable money in the construction of laboratories and in equipping them. Nearly two months were spent in Turkestan collecting alfalfa seed from all the important seed producing districts between the Chinese Boundary and Caspian Sea. In addition, seeds of pistache, wild plums, wild apricots, legumes, grasses and melons were secured. The melons of Turkestan are noted for their wonderful flavor and great variety.

The conditions among the natives of Turkestan are very primitive. The houses are constructed of mud and usually contain little or no furniture except rugs, which serve as chairs, beds, and covering for the ground. The common plow is a crooked stick with a metal point. The crops such as alfalfa and cereals are harvested with a sickle and are usually thrashed by beating with sticks or tramping with horses. Camels furnish the chief means of transportation to the railroads. (Author's abstract.)

OSWALD SCHREINER: Biological science in the East Indies (illustrated).— The speaker described the organization of agricultural and medical investigations in Java as observed by himself at the recent Pan-Pacific Congress.

750TH MEETING 51ST ANNUAL MEETING

The 750th regular and 51st annual meeting was held May 3, 1930, at 8.00 p.m. in the new assembly hall of the Cosmos Club, with Vice-President Jackson in the chair and 11 persons present. The minutes of the last annual meeting were read and approved. The reports of the Recording Secretary. Corresponding Secretary, and Treasurer were read and ordered placed on file. The election then took place, as follows:

The election then took place, as follows:

President, A. Wetmore; Vice-Presidents, C. E. Chambliss, H. H. T.

Jackson, C. W. Stiles, T. E. Snyder; Recording Secretary, S. F. Blake;

Corresponding Secretary, W. H. White; Treasurer, F. C. Lincoln; Members of

Council, H. C. Fuller, W. R. Maxon, A. A. Doolittle, I. Hoffman, E. P.

Walker.

S. F. Blake, Recording Secretary.

GEOLOGICAL SOCIETY

462ND MEETING (continued from page 243)

J. B. Mertie, Jr.: Mountain building in Alaska.—Reconnaissance geologic surveys in Alaska have progressed to the point where the general character, distribution and sequence of sedimentation and vulcanism are now known. This record affords an effective means for deciphering the history of mountain building, although the mechanics of mountain making, for lack of adequate structural data, are as yet only imperfectly understood.

Orogenically, the highlands of Alaska are classified into five structural provinces:—first, the southern coastal ranges; second, the Alaska Range; third, the highland areas of central Alaska; fourth, the Kuskokwim highland, of southwestern Alaska; and fifth, the Brooks Range, of northern Alaska. Genetically, the mountains of southeastern Alaska are related to the first two groups of highlands.

By provinces, the orogenic history is summarized as follows:—

A. SOUTHERN COASTAL RANGES.

1. Progressive submergence during Lower Jurassic, accompanied by great outpourings of basic lavas.

2. Partial uplift and deformation at end of Lower Jurassic, followed by re-

submergence.

3. Progressive submergence throughout Middle and Upper Jurassic, accompanied by hinge-line deformation along northern coastal margin, by granitic intrusions and by deformation of deeply buried Jurassic sediments.

4. Epeirogenic uplift at end of Jurassic and creation of highland area by

differential eorsion.

5. Partial submergence in late Lower or early Upper Cretaceous, accompanied by differential deformation of adjoining land areas, and possibly by injection of granitic rocks.

6. Epeirogenic uplift in early Eocene, followed by formation of coal meas-

ures

7. Deformation of coal measures in late Oligocene followed by long interval of erosion in Miocene.

8. Regional uplift and mountain building in Pliocene, accompanied by basic lava flows.

B. ALASKA RANGE.

1. Land mass of moderate relief from end of Triassic to some time in Lower Cretaceous.

2. Partial submergence in late Lower or early Upper Cretaceous, accompanied by differential deformation of adjoining land areas. Some granitic rocks possibly injected at this time.

3. Uplift and major mountain building in early Eocene, accompanied by formation of Cantwell formation, and by acidic, intermediate, and basic lava flows. Granitic rocks probably injected at depth.

4. Slow differential uplift in late Eocene, accompanied by deformation of

Cantwell formation and deposition of coal measures.

5. Deformation of coal measures in late Oligocene, followed by long interval of erosion in Miocene.

6. Regional uplift in Pliocene, accompanied by basic lava flows, and followed by differential uplift and formation of Nenana gravels.

7. Further deformation in Quaternary.

C. CENTRAL ALASKA.

1. Land area of moderate relief from end of Triassic to beginning of the Cretaceous.

2. Submergence in Lower Cretaceous, followed by elevation and mountain building in mid-Cretaceous, and injection of granitic rocks.

3. Submergence in Upper Cretaceous, followed by epeirogenic uplift in

Eccene, and formation of coal measures.

4. Late Oligocene deformation and mountain building, accompanied by injection of monzonitic intrusives.

5. Continuous erosion in Miocene and early Pliocene.

6. Epeirogenic uplift in late Pliocene.

D. KUSKOKWIM HIGHLAND.

1. Negative element from Triassic to Tertiary.

2. Regional uplift in Eocene, followed by deposition of coal measures. Mountain making in Aleutian Range.

3. Mountain building in late Oligocene, accompanied by injection of monzonitic intrusives, and a period of cinnabar metallization.

4. Continuous erosion in Miocene and early Pliocene.

5. Epeirogenic uplift in late Pliocene.

E. BROOKS RANGE.

1. Either mountain building at end of Jurassic, or

- 2. Hinge-line deformation during deposition of 10,000 feet of Lower Cretaceous sediments.
- 3. Mid-Cretaceous mountain building, accompanied by injection of granitic rocks.
 - 4. One or two periods of Tertiary uplift and deformation.

5. Quaternary regional uplift. (Author's abstract.) Discussed by Messrs. Capps, Rubey and Mertie.

463RD MEETING.

The 463rd meeting of the Society was held in the Assembly Hall of the Cosmos Club, March 26, 1930, President G. R. Mansfield presiding.

Regular program: N. L. Bowen: Impressions of the Bushveld Complex. Discussed by Messrs. Sampson, Bowen, Lovering, and G. R. Mansfield.

A. C. Bevan: The Front Range northeast of Yellowstone Park. Discussed by Messrs. Sears, Bevan, Rubey, Lovering, Hewett, Resser and Wer-NER.

MARCUS I. GOLDMAN: Types of silicification in the Paleozoic of Virginia. The talk dealt with the results of the laboratory study of a series of silicified specimens collected by Mr. Charles Butts along the contact of the Cambrian with the Ozarkian or Canadian Jonesboro limestone in Virginia. One type was a banded limonitic rock consisting of rather idiomorphic large quartz crystals cutting across the banding.¹ This rock resembles Storz's "rosewood quartzite." Basal sections of these quartz crystals showed no optic figure, and the speaker suggested that this might be due to a concealed fibrous structure in them.

Another type consisted of smaller quartz crystals cutting across the structure of small yellow filamentous and spherular bodies which Dr. David White believes are filaments and spores of some low form of plant, the whole rock having many resemblances to oil shales. Another type, very vesicular, gray, containing much reddish ferruginous material, is believed to be silicified rock underlying the contact. Some of its characters suggest the possibility of its formation from a gel.

A fourth type, which has the appearance of a slightly pinkish quartzite, shows under the microscope a very irregular interlocking mosaic of quartz crystals with undulatory extinction. This is believed to be a silicified cal-

careous rock from directly below the contact.

The character of the quartz in the second and third types was discussed. The crystals show straight, parallel lines of growth making angles with each other suggesting crystal structure, and many of them have a brush-like radiating extinction, especially in their outer parts. The difficulty of explaining the growth lines by formation from a colloid was pointed out.

The second type with plant-like bodies was interpreted as a bog iron deposit formed on a flat, relatively undrained surface between Cambrian and Ozarkian or Canadian; the other types as the result of the accumulation of iron and

silica on or below this old surface. (Author's abstract.)
Discussed by Messrs. Butts, White, Ferguson, Goldman, Foshag, Tunell and Burchard.

C. H. Dane, Secretary

¹ Cf. Oder, Amer. Mineralogist, 14: 382, 1929.

² Storz, Sekundäre authigene Kieselsäure, etc. Borntraeger, 1928, p. 91.

OFFICIAL COMMUNICATIONS THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Evolution.—The mechanism of organic evolution. Charles B. Davenport	
paleontology of Florida. OLIVER P. HAY	
Proceedings	
The Academy	340
The Biological Society	346
The Geological Society	354

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
BUREAU OF CHEMISTRY AND SOILS

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves. Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This Journal, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the ssue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates
are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

SEPTEMBER 19, 1930

No. 15

MATHEMATICS.—The symmetry of the autocatalytic curve. Harry W. Titus, Bureau of Animal Industry. (Communicated by John R. Mohler.)

It is now more than twenty years ago that Robertson started developing his autocatalytic theory of growth. His extensive investigations in this field, stopped only by his very untimely death, have been a direct stimulus to a large number of workers in biology and chemistry. At least in part, because of the acceleration he gave to the study of growth, the amount of work done in this field increased enormously during the last ten or fifteen years. As more and more work was done, it became apparent that the symmetric growth curve was the exception rather than the rule and modifications of the original autocatalytic equation, developed from different points of view^{2,3} were proposed. Along with these proposed modifications some incorrect statements regarding the properties of the modified equations crept into the literature. It is the purpose of this paper to call attention to these statements and to demonstrate, mathematically, that they are incorrect.

A rather general form of the autocatalytic equation⁴ is

$$\ln \frac{x + b}{A - x} = K(A + b) (t - t_1) \dots (1)$$

or
$$\ln \frac{x+b}{A-x} = k(t-t_1)....(1')$$

¹ Received June 28, 1930.

4 The more general form is:

$$\ln \frac{x \pm b}{A - x} = K(A \pm b) (t \pm t_1),$$

² Robertson, T. B. Journ. Gen. Physiol. 8: 463, 1926; 12: 329, 1929.

³ Crozier, W. J. Journ. Gen. Physiol. 10: 53. 1926.

When b = 0, we have

$$\ln \frac{x}{A - x} = KA(t - t_1)....(2)$$

which is the form originally used by Robertson⁵ and later by Brody⁶ and others for describing the phenomenon of growth. More recently equation (1') has been used by Robertson,² Crozier,³ and others for the same purpose.⁷

All possible modifications of the general equation, (1), are symmetric about the point of inflection in the sense that either branch of its curve may be rotated about the point of inflection until it exactly coincides with the other branch. For all positive values of t_1 , the point of inflection occurs to the right of the x-axis (here, the axis of ordinates) and when $t_1 = 0$, it occurs on the x-axis; it occurs above the t-axis (here, the axis of abscissas) when b < A, below when b > A, and at the origin when b = A and $t_1 = 0$. (See Fig. 1.)

Robertson, on several occasions,² has referred to the curve of equation (1') as being asymmetric in type. In the summary of his paper on the growth of normal white mice (1926) he says,

"3. The first and most extensive autocatalytic process is asymmetrical, being defined by an equation of the type:

$$\log \frac{x+B}{A-x} = K(t-t_1).$$

the sign preceding b being always the same in both terms in which b occurs. By the proper selection of the magnitude and sign of b and t_1 , the point of inflection may be made to occur in any one of the four quadrants, or at the origin.

⁵ Robertson, T. B. The chemical bases of growth and senescence. 1923.

⁶ Brody, S. Journ. Gen. Physiol. **3**: 765. 1921; Brody, S., and Ragsdale, A. C. Journ. Gen. Physiol. **3**: 623. 1921.

⁷ That the equations used by Robertson and Crozier are essentially the same, although the methods of developing them are different, is clear from the following:

If the differential form of Crozier's equation,

$$\frac{\mathrm{d}x}{\mathrm{d}t} = (\mathrm{K}_1 + \mathrm{K}_2 \mathrm{x}) (\mathrm{A} - \mathrm{x})$$

be written:

$$\frac{dx}{dt} = K_2 \left(\frac{K_1}{K_2} + x \right) (A - x) = K_2 \left(x + \frac{K_1}{K_2} \right) (A - x),$$

the differential form of Robertson's equation,

$$\frac{\mathrm{dx}}{\mathrm{dt}} = k (x + b) (A - x),$$

may be obtained from it by substituting k for K_2 and b for $\frac{K_1}{K_2}.$

And in a more recent paper, on sequence of growth cycles (1929), he says,

"It (equation (1')) also has the effect of rendering the cycle on either side of the moment of maximum growth velocity, unequal in slope and amplitude."

Snell, 8 in a foot-note to his paper on defects in the theory that growth rate is controlled by an autocatalytic process, says,

"In a later paper (Robertson, 1926) a different equation is used to permit a slightly asymmetrical curve, but it does not remedy this defect, or any of the other defects here discussed."

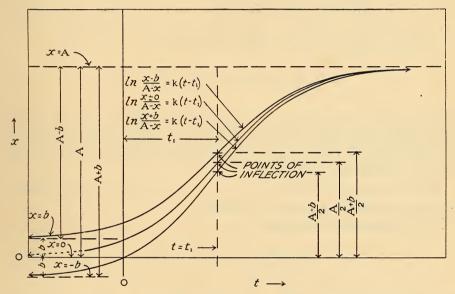


Fig. 1—Graphs of the autocatalytic equation,

$$\ln \frac{x+B}{A-x} = k(t-t_1).$$

N.B. The passing of one of the plotted curves through the origin is merely accidental; by proper selection of the magnitude of b, the curve may be made to cut the axis of ordinates above, or below, the origin.

As a matter of fact, are the two halves of the cycle on either side of the moment of maximum growth velocity unequal in slope and amplitude? Does equation (1'), or (1), define an asymmetric curve? A negative answer must be made.

⁸ SNELL, G. D. Proc. Nat. Acad. Sci. 15: 274. 1929.

Let us consider the differential form of equation (1), i.e.,

$$\frac{\mathrm{dx}}{\mathrm{dt}} = \mathrm{K} (\mathrm{x} + \mathrm{b}) (\mathrm{A} - \mathrm{x})....(3)$$

If we let
$$x = x' - b, (4)$$

then
$$dx = dx'$$
.....(5)

and on substituting (4) and (5) in (3) we get

$$\frac{dx'}{dt} = K(x') [(A + b) - x']....(6)$$

Thus, by a simple linear transformation, we may obtain a differential equation which is precisely of the same type as the differential form of equation (2), that is, it is of the same type as

$$\frac{\mathrm{dx}}{\mathrm{dt}} = \mathrm{K} (\mathrm{x}) (\mathrm{A} - \mathrm{x}) \dots (7)$$

Since the curve of equation (2) is symmetric, it follows that the curve of equation (1) is also symmetric and that the two halves of the cycle on either side of the moment of maximum growth velocity are *not* unequal in slope and amplitude.

That the curve of equation (1), or (1'), is symmetric may be demonstrated, in another manner, as follows:

In the case of the equation,

$$\ln \frac{x + b}{A - x} = k (t - t_1) \dots (1')$$

it may be shown readily that the point of inflection is at $\left[(t_1),\left(\frac{A-b}{2}\right)\right]$. Now, if equal increments of abscissa (t) to the right and to the left of t_1 define values of x which are equidistant from the ordinate $\left(\frac{A-b}{2}\right)$, the curve is symmetric about the point of inflection. Such is the case, for when

$$t = t_1 + n,^9 \dots (8)$$

$$x = \frac{A \epsilon^{nk} - b}{1 + \epsilon^{nk}}, \dots (9)$$

⁹ n being any real number.

and when $t = t_1 - n, \dots (10)$

$$x = \frac{A - b \epsilon^{nk}}{1 + \epsilon^{nk}}, \dots (11)$$

and the distance between the ordinates of the curve at

$$\begin{bmatrix} (t_1 + n), \left(\frac{A \epsilon^{nk} - b}{1 + \epsilon^{nk}} \right) \end{bmatrix} \text{ and at } \begin{bmatrix} (t_1), \left(\frac{A - b}{2} \right) \end{bmatrix} \text{ is}$$

$$\frac{A \epsilon^{nk} - b}{1 + \epsilon^{nk}} - \frac{A - b}{2} \text{ or } \frac{(A + b) (\epsilon^{nk} - 1)}{2 (1 + \epsilon^{nk})} \dots (\alpha)$$

and the distance between the ordinates of the curve at

$$\begin{bmatrix} (t_1), \left(\frac{A-b}{2}\right) \end{bmatrix} \text{ and at } \begin{bmatrix} (t_1-n), \left(\frac{A-b}{1+\epsilon^{nk}}\right) \end{bmatrix} \text{ is}$$

$$\frac{A-b}{2} - \frac{A-b}{1+\epsilon^{nk}} \text{ or } \frac{(A+b)(\epsilon^{nk}-1)}{2(1+\epsilon^{nk})}....(\beta)$$

The quantities (α) and (β) are identical and thus it has been demonstrated that the curve is symmetric, since equal increments, to the right and to the left of t_1 , define values of x which are equidistant from the ordinate $\left(\frac{A-b}{2}\right)$.

By suitable algebraic treatment we may also demonstrate, independently of the above, that the slope of the two branches of the curve is the same. If we substitute the ordinates $\left(\frac{A-b}{2}+m\right)^{10}$ and $\left(\frac{A-b}{2}-m\right)$ in the equation for the slope of the curve defined by equation (1), that is, in

$$\frac{\mathrm{dx}}{\mathrm{dt}} = \frac{\mathrm{k}}{\mathrm{A} + \mathrm{b}} (\mathrm{x} + \mathrm{b}) (\mathrm{A} - \mathrm{x}) \dots (12)$$

we get, in the first case:

$$\frac{dx}{dt} = \frac{k}{A+b} \left(\frac{A-b}{2} + m + b \right) \left(A - \frac{A-b}{2} - m \right)$$
$$= \frac{k}{A+b} \left[\left(\frac{A+b}{2} \right)^2 - m^2 \right], \dots (\gamma)$$

¹⁰ m being any real number.

and in the second case:

$$\frac{\mathrm{dx}}{\mathrm{dt}} = \frac{k}{A+b} \left(\frac{A-b}{2} - m + b \right) \left(A - \frac{A-b}{2} + m \right)$$
$$= \frac{k}{A+b} \left[\left(\frac{A+b}{2} \right)^2 - m^2 \right], \dots (\delta)$$

The expressions (γ) and (δ) are identical and thus it has been shown that the slope of the curve at any two points, which are equidistant from the point of inflection, is the same; and hence the slope of the two branches of the curve is the same.

STIMMARY

Several incorrect statements regarding the curve defined by the autocatalytic equation,

$$\ln \frac{x + b}{A - x} = K (A + b) (t - t_1), \text{ or } \ln \frac{x + b}{A - x} = k (t - t_1)$$

have been made in the literature. These statements are to the effect that:

- (1) the curve described by the above equations is asymmetric, and
- (2) the two halves of the curve have unequal slopes.

It has been demonstrated in this paper that these statements are incorrect.

MICROBIOLOGY.—Myxamoebae in soil and decomposing crop residues. Charles Thom and Kenneth B. Raper, Bureau of Chemistry and Soils.

Amoebae are regularly observed and reported by students of soil organisms. Sandon in his book on Soil Protozoa and Waksman in his "Principles" reviewed the information available to 1927. Sandon supplemented the literature by summarizing the studies made at the Rothamsted Station. He made no reference to the amoeboid phase of the Myxomycetes and the Acrasieae as members of the soil population with characters sufficiently suggestive of protozoa to open the possibility of confusion. Brierley (1928 p. 16) listed five genera of Myxomycetes as occurring in soil with "evidence that they may live vegetatively in this habitat." Waksman in his "Principles", p. 236 refers to the Myxomycetes as including species which are plant para-

¹ Received June 17, 1930.

sites with the comment that they appear able to maintain themselves independently in the soil. Krzemieniewski reported that by proper culture methods many Myxomycetes may be obtained in culture from the soil. Harper, following Krzemieniewski's method, isolated Polysphondylium from soil collected in New York City parks. The extensive cultural studies reported by Olive and others have been primarily concerned with obtaining and identifying the fruiting bodies of this group of organisms. Very little has been reported to indicate the distribution and significance of the amoeboid phase or even the plasmodium phase of these organisms in the soil or in the decaying vegetation of the meadow or the cultivated field. We were surprised, therefore, to encounter these organisms in great numbers in the course of studies begun for entirely other purposes.

In December 1929, samples of decaying grasses and weeds were collected in an experimental field on the Arlington Farm of the United States Department of Agriculture. When brought to the laboratory, selected leaves and stems were cut into convenient lengths and dropped upon the surface of solidified mannite agar in petri dishes to permit certain saprophytic organisms present to develop. The nutrient medium used was free from nitrogen or nearly so, hence considered only as furnishing a moist substratum to favor the further development of organisms already present upon the grass.

Within a week several myxomycete plasmodia developed and moved about upon the agar in these plates. Thousands of amoebae or myxamoebae also spread upon the agar from pieces of decaying grasses and weeds. Masses of bacteria and mold mycelium covered and spread outward from every piece of decaying vegetation. Since we could find no record of observations of Myxomycetes under such conditions several series of such cultures were made to extend our knowledge of the presence and abundance of these forms under winter conditions in Washington and vicinity.

The first of these samples consisted of a few leaves of crab grass collected on February 6th from a roadside. Prior to this, the grass had been covered by snow for several days, and was quite wet when brought to the laboratory. The leaves were cut into convenient lengths and placed upon mannite agar in petri dishes and the dishes were held at room temperature. In the course of a few days, plasmodia were observed in all the plates. Large "amoebae" and small amoeboid cells, possibly myxamoebae, were present in considerable numbers; the latter were particularly numerous. Using a small sterile pipet, a part of one of the plasmodia was transferred on Febru-

ary 12 to a fresh mannite agar plate. To this culture was added from time to time a suspension of dead bacteria belonging to the B. aerogenes group. The plasmodium grew slowly but consistently until March 8th when it was transferred to hav infusion agar medium. By frequent transfers it is still in actively growing condition on this medium after four months. After the snow melted, samples of decaying grass were again collected from the field on February 8th. These samples were plated and incubated as before, and again in the course of a week plasmodia developed in all the plates. Two plates contained particularly well developed grayish-white plasmodia. These were more or less fan shape, measuring 4 cm. across the "fan," with stream of protoplasm extending back for several centimeters along the path, which the main portion of the plasmodium had recently traversed. One of these fruited on February 17th, producing about 150 sporangia which belonged to the genus Didymium. On February 18th a part of the other plasmodium was transferred to hav infusion agar and is still active in culture in May. The portion not transferred fruited two days later as a Didumium.

On February 17 wide mouth bottles of approximately one liter capacity were half filled with wet sand and sterilized. Samples of decaying grass from the field were placed on the sand in a rather compact mat three fourths of an inch in depth. By the end of the first week one of the twelve bottles thus prepared contained a visible plasmodium which climbed up on the side of the bottle. It was grayishwhite in color and measured 1.5-2 centimeters in diameter. During the following week plasmodia were observed in two additional bottles. On February 27th, a few leaves from three of the bottles not containing visible plasmodia were dropped on mannite agar. Plasmodia developed in three-fourths of the plates. (See numbers 9, 12 & 13 in table 2). It was evident that the agar medium was not necessary for the development of plasmodia.

On February 20 (a warm period in 1930) the tobacco fields of the Bureau of Plant Industry and the University of Maryland, situated near Marlboro, Maryland, were visited. Various samples were collected. One mass of decaying annual grasses and the soft soil down to about 10 cm. and totalling perhaps 1 liter was placed in a bag and brought to the laboratory where it was transferred to a covered dish about 25 cm. in diameter and 10 cm. deep without adding any water. In approximately one week a plasmodium moved up from this mass out upon the glass and spread over about half of the inside of the

glass cover. During the following night the fruit bodies of a species of *Didymium* were produced.

In other dishes numerous small plasmodia were produced and spread outward from pieces of grass, ragweed stems and stems of *Erigeron* collected from various tobacco plots, and scattered over mannite agar. In some dishes millions of small myxamoebae were seen and later fruited abundantly as *Dictyostelium*.

In these various plates, microscopic examination regularly showed many encysted as well as active myxamoebae. Microscopic mounts from the dry stems and leaves as brought to the laboratory showed many such cysts which appeared to be similar to those which developed from time to time in the cultures. From these observations it was evident that myxomycetes and allied forms are well represented in the tobacco fields of Marlboro.

In the samples collected and plated thus far, no attempt had been made to separate the standing leaves and culms from those lying on the soil. The question now arose as to whether the myxomycetes were present only in the basal portion of standing grass leaves and in leaves lying on the soil, hence protected against extremes of temperature and desiccation, or if they were also present in leaves standing several inches above the soil. And if present in both, what was their relative abundance in the two? To determine this point a series of samples were collected; the uppermost portion of standing leaves and those lying on the soil were collected and plated separately, the former type being designated by "A" following the sample number, the latter type by "B" following the same sample number. The first of these were collected on February 21st; other samples being taken at later dates. Plasmodia appeared in 70% of all plates prepared from "A" samples and in 67.7% of those prepared from "B" samples. A full account of these platings is given in table 1.

During the same period some additional "composite" samples were collected and plated. Plasmodia appeared in 71% of all plates prepared from these samples. A detailed account is given in table 2.

All the myxomycetes thus far isolated from decaying grass, and cultured as above until fruits were produced, belonged to the genus *Didymium*. Species have not been determined.

Steps were then taken to determine whether or not plasmodia could be obtained from the soil underlying the sod from which the grass samples had been taken. Soil samples from varying levels ranging from the surface to a depth of twelve inches were diluted with 10 cc. of sterile water, and the resulting suspension streaked on mannite agar plates by means of a platinum loop. Four or five streaks, a single drop of the suspension being used for each, were made across a plate and two or three plates prepared for each sample. Twenty-seven

TABLE 1.—Grass Samples—Standing and that Adjacent to Soil Plated Separately

	A. Grass erect		B. Grass on soil						
Sample No.	No. of plates	Plates containing plasmodia	No. of plates	Plates contain- ing plasmodia	Days after inocu- lation	Type of grass	Date of sampling	Remarks	
2	2	0	2	1	12	Rye	Feb. 21	Rye stems. Last sum- mer's growth	
3	4	1	4	2	12	Orchard grass	Feb. 21	Samples 2 to 5 inclu-	
4	4	3	4	3	12	_	Feb. 21	sive taken in very	
5	4	2	4	2	12	_	Feb. 21	warm weather for Feb. Grass very dry	
15	5	5	4	3 .	9	Bluegrass	Feb. 27	Samples 15 & 16 taken	
16	4	4	4	4	9	Orchard grass	Feb. 27	day after rain. Grass moist. Temperature high (Feb.)	
18	4	0	4	1	12	Bluegrass'	Mar. 20	See *19 below	
22^a	2	2	2	2	14	Sedge	Mar. 22	Samples dry	
23	3	3	3	3	14	Velvet grass	Mar. 22	Temperature rather low but not freezing	
24	4	1	4	2	14	Orchard grass	Mar. 22		
25^{5}	3	3	3	3	17	Bluegrass	Mar. 22		
26	5	5	5	3	17	Bluegrass	Apr. 11	Samples 26-29 inclu-	
27	3	3	3	2	17	Velvet grass	Apr. 11	sive. Taken follow-	
28^{b}	5	5	6	5	17	Bluegrass	Apr. 11	ing heavy rains.	
29 19	4 4	2 3	3	0	17 12	Orchard grass	Apr. 11	Temperature 60–70°	
19	4	3	4	4	12	Velvet grass	Mar. 20	Samples 18 & 19 rather dry. Temperature	
	60	42	59	40				40-55°F.	
	= 70%		= 67.7%						

^a Sedge collected from west end of reservoir, sample dry when taken but had been covered with water during much of winter.

samples from five "borings" were collected. The plates were examined after incubation at room temperature from ten days to two weeks. Amoeboids, amoebae or myxamoebae were found to be very numerous in all the samples, even those taken from a depth of twelve inches, but plasmodia developed from only two of the twenty seven samples.

^b Very heavy sod in each case.

One was obtained from a sample of earth collected at a depth of four inches underlying a blue grass sod on March 11th, and resembled closely the plasmodia of *Didymium* which we have in culture. The other was obtained about two weeks later from a sample taken at a depth of three inches underlying another blue grass sod in the same

TABLE 2.—Grass Samples (A. & B. Not Separated)

	A. & B.		Num-				
Sample No.	No. of plates	Plates con- taining Plas- modia	ber days after sam- pling	Date of sampling	Type of Grass	Remarks	
1	6	5	12	Feb. 21	Rye-Compost heap	Rye cut last summer and thrown on compost heap. Samples taken from this heap	
9	4	2	8	Feb. 25	Orchard and Bluegrass	Samples 9 and 10: Grass from Walker Hill placed in bottles	
10	3	0	8	Feb. 25		half filled with sand 2-17-30. Set in greenhouse. Samples from these plated	
M8	6	4	12	Mar. 3	_	Grass collected from experiment station at Marlboro	
12	2	2	9	Feb. 27	Orchard and Bluegrass	Samples 12 to 14 inclusive taken from bottles in greenhouse	
13	2	2	9	Feb. 27		prepared as *9 & 10	
14	4	3	9	Feb. 27	·······································	propulse and me of	
17	4	3	14	Feb. 27	-	Sample taken day after rain- Temperature high for Febru- ary	
20	4	3	12	Mar. 20	Orchard grass	Grass rather dry. Temperature 40-55°F.	
30	4	4	14	Apr. 23	-	Rather dry grass collected from roadside at reservoir, Arling- ton Farm	
31^a	6	4	14	Apr. 23	Sedge	Sedge collected from west end of reservoir. Samples dry	
	45	32				F-1	
٠	= 71%						

^a This sample gave heavy growth of azotobacter in all plates. Nematodes were more numerous than in other samples.

field. This plasmodium was not isolated; but in the original plate it resembled rather closely plasmodia of *Stemonitis*, which had been grown from spores in this laboratory for comparison. This *Stemonitis* plasmodium consisted of very close networks of delicate strands of colorless protoplasm.

Dictyostelium was obtained in similar cultures made from two plots of Leonardtown loam under experimental study in the greenhouse including one plot limed to pH 7.1 and the other with about pH 4.2. Cultures from six other plots in the greenhouse showed abundant amoeboids, but no myxomycete was positively identified.

Among the other experiments already performed, the effect of seasonal changes in temperature have been rather striking. The plasmodia in culture were not much affected by small changes of temperature, but have shown decided dislike for temperatures above 20–22°C. This was particularly evident during the latter part of April and the early part of May, when there was extremely warm weather. The plasmodia growing in the laboratory prior to this became less active and grew very slowly. During the following week this effect was even more pronounced. Plasmodia in most cases broke up into sclerotia and in many cases disintegrated quite completely. Those that were still viable were placed in an incubator with a temperature range of from 15 to 18°C. Within a very short time normal growth and activity were resumed. Subsequent culture experiments have been carried at both incubation temperatures with the forms in culture showing decided preference for the cooler condition.

In another series of studies, dilution cultures at 1 to 50, 1 to 500 and 1 to 5,000 were made to test the presence of protozoa in plots of land containing decomposing rye and vetch. In certain of these cultures, amoeboid organisms were predominant. Mannite plates were streaked from these tubes. Of 15 such cultures, one produced *Dictyostelium* and another produced plasmodia.

These observations are recorded to call attention to the presence of myxomycete amoeboids as part of the soil population. Experiments in culture of these forms and efforts to determine their function as part of such populations are in progress. Meanwhile search of the literature furnished little information on the occurrence of Myxomycetes in the soil, and no direct reference to the isolation of plasmodia from decaying vegetation under winter conditions such as described in this paper. The following references are worthy of note: Miller (6) working in the Johns Hopkins Medical laboratories obtained Stemonitis plasmodia as contaminants in protozoa cultures which were being grown in tap water to which had been added unsterilized hay. He then collected hay from various sources and again plasmodia were obtained. He expresses the opinion that "plasmodia are constantly present on hay in one form or another." Lister (5) in his monograph of the Mycetozoa lists dead leaves and twigs as the most

common substrate for members of the genus *Physarum*. Also of interest here are *P. fulvum* gathered in Colorado at an elevation of 11,000 feet on "living willow, growing in snow," and *P. vernum* which is frequently found in the Swiss Alps growing "on leaves and grass close to the melting snow." Krzemieniewski (4) working in Poland found *Dictyostelium mucoroides* "in almost all soils examined," and species of *Polysphondylium*, though rarely, in uncultivated soils.

In seeking current information several visitors were consulted and the cultures exhibited. Professor George W. Martin of the University of Iowa was shown these cultures but had no record of such observations. Professor Robert F. Griggs of George Washington University reported having often seen a myxomycete fruiting upon the grass in his lawn in summer but that he had made no further study. Professor J. B. S. Norton of the University of Maryland reported similar observations upon the University campus. Professor H. H. Bartlett of the University of Michigan told of plowing an area in the Botanical garden at Ann Arbor and seeing large plasmodia come out upon the surface of the plowed ground and looking "like pancakes scattered over the field." From these reports it is clear that a considerable number of workers have been familiar with the occurrence of these species in cultivated land.

Professor R. A. Harper in his recent paper upon *Polysphondylium* and in conversation about this work attributed the suggestion of his method of isolation to Krzemieniewski and on the basis of his own rediscovery of that species in soil from the parks of New York City, suggested that the amoeboid forms of myxomycetes would probably be found to account for many of the amoebae reported by soil workers.

CONCLUSION

In these experiments with soil from Arlington farm in Virginia and tobacco plots in Marlboro, Md., the myxomycetes have been found to constitute an active component of the micro-population in the decaying vegetation and in the underlying soil.

Myxamoebae and plasmodia were developed in the colder part of the season and have been found to grow better at 15 to 18°C. than at 20 to 22°C. Myxamoebae at least if not the more complex plasmodia were found abundantly upon all parts of the grasses and weeds taken from our experimental plots between December and May 1930.

Members of this group should be considered in surveying the types of microorganisms present in any soil population.

LITERATURE CITED

- 1 Brierley, W. B. The microflora of the soil. Jour. Quekett Microscopical Club 16: 16. 1928.
- 2 Harper, R. A. Morphogenesis in Dictyostelium. Bull. Torrey Bot. Club 53: 229-268. 1926.
- 3 Harper, R. A. Morphogenesis in Polysphondylium. Bull. Torrey Bot. Club. 56: 227-258. 1929.
- 4 Krzemieniewski, Helena S. "Z Mikroflory gleby w Polsce" (Contribution à la microflore du sol en Pologne) Acta. soc. Bot. Poloniae 4: 141-144. 1927.
- 5 Lister, A. & G. A monograph of the Mycetozoa. British Museum, 1911.
- 6 MILLER, C. O. The aseptic cultivation of Mycetozoa. Quart. Journ. Micr. Soc. 41: 43-71. 1898.
- 7 Sandon, H. The composition and distribution of the protozoan forms of the soil. Pp. 237. Edinburgh and London, 1927.
- 8 WAKSMAN, S. A. Principles of soil microbiology. 311-340. 1927.

PALEONTOLOGY.—Discovery of Permo-Carboniferous vertebrates in the Dunkard formation of West Virginia.¹ R. W. Whipple, Marietta College, and E. C. Case, University of Michigan.

On December 27, 1929 Mr. Goff Carder reported to Professor R. W. Whipple the discovery of certain bones at Portland, Jackson County, West Virginia. Professor Whipple visited the locality and determined the horizon to be the Upper Marietta sandstone, which is in the lower portion of the Dunkard. The Marietta sandstones, named by I. C. White² from their typical outcrop in the vicinity of Marietta, Ohio, are easily recognized in this area; and in the interval between the Lower Marietta sandstone and the Upper Marietta sandstone are shaly sandstones, shales and red clay (Creston beds). The bones are from the lower part of the Upper Marietta sandstone 130 feet above the railroad track over Skull Run. The specimen was in a soft clayey cross-bedded sandstone, carrying an abundance of large flakes of white and black mica, made up of small rounded grains of quartz and the whole weathering to a light brown color.

The site was in the center of an old road and the specimen had been partly destroyed by passing wagons. All material that could be recovered was collected and has been studied by Professor E. C. Case. The specimen consists of parts of the spines, centra and ribs of *Edaphosaurus cruciger* Cope. More than half of four spines have been pieced together; there are in addition two nearly complete centra of

¹ Received June 23, 1930.

² West Virginia Geological Survey 2. 1903.

posterior dorsal vertebrae, two nearly complete ribs, and numerous fragments and short pieces of other spines and ribs. So much of the specimen has been recovered that the identification is certain. This discovery confirms the identification of a small fragment previously discovered at Marietta in the Creston beds horizon.³

In a visit by Professors Whipple, Case and Hussey, to the region on May 31, a stop was made at Limestone Hill, on the boundary between Wood and Wirt counties, about thirty miles south of Marietta on the road to Ravenswood, West Virginia. At this locality in the cuts along the new highway are fine exposures of the upper Dunkard rocks with a series of at least four distinct limestones in the upper horizons. The limestone at this locality was identified by I. C. White⁴ as the Nineveh Limestone, which is one of the most important beds in the upper Dunkard, as it can be traced for many miles in the high ridges of hills in the region. It is not a well defined stratum, for it varies from one to five feet in thickness and is often separated into shaly and nodular layers. Ray V. Hennen⁵ designates the three upper beds as the Upper Rockport limestone, Middle Rockport limestone and Lower Rockport limestone from the fine exposures developed near Rockport, Wood county, two and a half miles north; and in his section identifies the lower or fourth bed as the Nineveh limestone. These Rockport limestones are of only local extent, and after further field studies may be identified as phases of the Nineveh limestone.

The upper Rockport is a lens of limestone from one foot to eighteen inches thick. At the upper surface there are a few inches of sandy limestone filled with fragments of bone. Below this, or a phase of it, is a dark mud-shale with numerous fragments. The shale is so fragile that it could not be handled without preparation but there were identified in the field: Pleuracanthus (probably the form described by Stauffer and Schroyer as Diplodus washingtonensis); scales and teeth of fish, probably the Paleoniscus of Stauffer and Schroyer; vertebrae very similar to Lysorophous; vertebrae very similar to Theropleura; a few large teeth of a Pelycosaur like Dimetrodon; a small amphibian femur of the type of Trimerorhachis; and numerous fragments of plates from the head of a similar form.

³ STAUFFER, C. R. and SCHROYER, C. R. The Dunkard series of Ohio. Bulletin 22, Fourth Series, 1920.

⁴ U. S. Geol. Survey Bulletin No. 65: 33, 1891.

⁵ West Virginia Geol. Survey, Report on Wirt, Roane and Calhoun Counties. 46 and 143. 1911.

372

A careful study of the material is planned and may lead to different conclusions, but it seems quite certain that the fauna is very similar to that previously described from near Danville, Illinois, and to that of the Permo-Carboniferous beds of Texas and Oklahoma.

BOTANY.—A new species of Calathea from Panamá. C. V. Morton, National Museum. (Communicated by WILLIAM R. MAXON).

The following species of Calathea was discovered by Dr. A. F. Skutch while engaged in research work at the experiment station of the United Fruit Company at Almirante, Panamá, and is based on ample material presented by him to the U.S. National Museum. The description is also drawn in part from field notes made by Doctor Skutch, who is planning to publish shortly an account of the morphology and method of unrolling of the leaves.

Calathea magnifica Morton & Skutch, sp. nov.

Large herb reaching a height of 5 meters; radical leaves 2-ranked, homotropous; petioles reaching about 290 cm. in length, the lower half sheathing, the upper half terete, 1.3-1.6 cm. thick, the callous body at its upper end 23 cm. long; lamina with the right half always innermost in vernation, gradually increasing in size until the plant matures, oblong, truncate at apex, slightly asymmetric, the largest 114 cm. long by 58 cm. broad, glabrous, the lower surface whitish with a thick layer of wax, this separating in large flakes upon drying: stem 110-150 cm. long, bearing two leaves, the first one with the blade equaling that of the radical leaves, the second reduced; sheath 30-56 cm. long, not or scarcely auriculate, pubescent with short, simple hairs; inflorescence of two groups of spikes, one group from the axil of each of the cauline leaves; peduncles of spikes in the axils of lower leaf 30-60 cm. long, of upper leaf 10-50 cm. long, flattened, often flexuous, pubescent (especially at apex), streaked with pale green and brown; primary spikes 7-9, secondary spikes often arising from the lowermost bract of a primary, subcylindric, 18-30 cm. long, 3.5-5 cm. thick, the bracts 16-20 or more, distichous but somewhat displaced by a spiral twist of the axis, thus forming two spiral series, leathery-chartaceous, broadly obcordate, 5–6 cm. long, 5.5–7 cm. broad, pale green streaked or washed with brown, sparsely pubescent outside, glabrous within; primary bractlets winged on the back, hispid along the wing; flowers in pairs, the two usually not developing simultaneously, 4.6 cm. long; sepals lanceolate, 9-10 mm. long; corolla tube 2.6 cm. long, lobes oblong, obtuse, 20 mm. long, 7 mm. broad, dark Corinthian purple; staminodium white, obovate, 1.5 cm. long, ovary naked, surrounded by a tuft of hairs arising from its base; capsule loculicidal, 1.7 cm. long, pink; seed 7 mm. long; aril lamellose, 5 mm. long.

Type in the U. S. National Herbarium, no. 1,409,622-3, collected at the research station of the United Fruit Company, Almirante, Panamá, April 20, 1929, by A. F. Skutch (no. 12).

¹ Published by permission of the Secretary of the Smithsonian Institution. Received June 15, 1930.

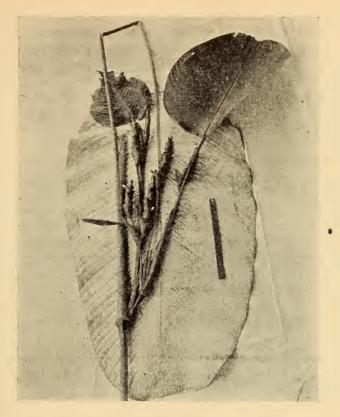


Fig. 1. Calathea magnifica Morton and Skutch. Inflorescence and leaf.



Fig. 2. Same, habitat view.

Dr. Skutch's field notes state that Calathea magnifica is the most abundant and conspicuous Calathea in the lowlands of the province of Bocas del Toro. It forms close stands in marshy places and at the borders of lagoons, and sometimes also in fairly well drained pasture land, but always in open places rather than dense jungles. It was in flower from January to June at least, but at the latter date the spikes were very old. At maturity the pedicel disintegrates, freeing the capsule, which then oozes through the plentiful slime coating the bracts and bractlets until it is exposed at the top, when it is burst by the swelling of the aril. The seeds are sought by birds.

It is surprising that such a large and beautiful species as Calathea magnifica could have remained so long undiscovered. Its closest alliance is with C. lutea (Aubl.) G. F. W. Meyer. This common Central American plant, which is usually smaller, has smaller spikes with fewer, bronze or reddish colored bracts, and yellow corollas. Related also is C. insignis Peters, a species smaller in all parts, having non-ceraceous leaves, glabrous, more widely spreading, closely imbricated bracts, and yellowish or whitish corollas.

In Fig. 1 the scale is indicated by the ruler, which is 30 cm. long.

BOTANY.—Ten new species of Passiflora, mainly from Colombia and Peru.¹ Ellsworth P. Killip, U. S. National Museum.

In the present paper ten new species of *Passiflora* are described, four of which are based upon material collected in the course of botanical exploration in Colombia and Peru recently carried on by the Smithsonian Institution.

Passiflora dolichocarpa Killip, sp. nov.

Stem subquadrangular, hispidulous; stipules semi-ovate, 6 to 7 mm. long, 2 to 3 mm. wide, finely hispidulous, especially at margin; petioles about 2 cm. long, slender, biglandular at or slightly below middle, the glands clavate, about 1.5 mm. long, 1 mm. wide, sessile; leaves hastately 3-lobed, 6 to 10 cm. long, 4.5 to 7 cm. wide (middle lobe lanceolate, acuminate, 3.5 to 4 cm. wide at base, the basal lobes reduced, short-acuminate), sinuate-dentate at margin, cordulate at base, membranous, finely hispidulous on both surfaces; peduncles in pairs, 3.5 to 4 cm. long slender, articulate near apex; bracts semi-ovate, 4 to 5 mm. long, 3 to 4 mm. wide, oblique at base, sessile, irregularly lobed, hispidulous, borne at upper third of peduncle; flowers about 2.5 cm. wide; sepals oblong, 10 to 13 mm. long, 7 to 8 mm. wide, slightly cucullate at apex, hispidulous without, white, longitudinally streaked with red or purple within; petals oblong, 8 to 10 mm. long, 3 to 4 mm. wide, obtuse, white; corona filaments in a single series, narrowly linear, 6 to 7 mm. long, white, banded with red or purple; operculum plicate, about 1.5 mm. high, the margin incurved, minutely denticulate; limen annular; ovary ovoid, tapering at apex, stipitate at base, glabrous; fruit narrowly ovoid-clavate, about 6 cm. long (including stipe 1.5 cm. long), 1.5 cm. in diameter; seeds broadly obovate, 3 to 4 mm. long, reticulate, flattened.

¹ Published by permission of the Secretary of the Smithsonian Institution. Received July 8, 1930.

Type in U. S. National Herbarium, no. 1,315,639, collected at Chicavac, Department Tecpán, Guatemala, altitude 2500 meters, December 25, 1926, by G. Salas (no. 584).

Although obviously related to *P. sicyoides* this species bears conspicuous bracts, shaped much like the stipules, and cleft somewhat as in *P. adenopoda*. The leaves are distinctly hastate, proportionately much narrower than in the case of other species of this relationship. The fruit is unusually long and narrow for the group.

The common name is given as "granadilla."

Passiflora tenella Killip, sp. nov.

Slender herbaceous vine, essentially glabrous throughout; stem subangular, striate; stipules setaceous, 1.5 mm. long; petioles very slender, 1 to 2.5 cm. long, glandless, sparingly pilosulous toward apex; leaves transversely oblong in general outline, 1.5 to 3 cm. long, 4 to 7 cm. wide, shallowly 3-lobed at the truncate apex (lobes obtuse or truncate; rarely the leaves distinctly 3-lobed about a third their length), retuse at base, 3-nerved, not ocellate beneath, bright green above, glaucous beneath, thin-membranous; peduncles solitary, 1-flowered, very slender, 2 to 3 cm. long, articulate just below apex; bracts setaceous, 2 mm. long, soon deciduous; flowers about 1.5 cm. wide, greenish white; sepals narrowly lanceolate, 8 to 9 mm. long, 1.5 to 2 mm. wide at base, acutish, 3-nerved, reticulate-veined, thin-transparent; petals linear, 2 to 3 mm. long, obtuse, thin-transparent; corona filaments filiform, in two series, the outer filaments equaling the sepals, the inner barely 2 mm. long; operculum membranous, about 1 mm. high, very slightly plicate; ovary narrowly ellipsoidal, glabrous; fruit ellipsoidal, about 3 cm. long, 0.8 cm. in diameter, tapering to a stipitate base, acuminate at apex, 6-ribbed; seeds narrowly obovate, about 2.5 mm. long, 1.5 mm. wide, transversely 4- or 5-sulcate, the ridges rugulose.

Type in the herbarium of the Field Museum of Natural History, no. 571,848, collected on plain southeast of Hacienda La Choza, Department Tumbez, Peru, altitude 100 to 200 meters, February 28 to March 3, 1927, by A. Weberbauer (no. 7704). Duplicate in U. S. National Herbarium (no. 1,420,160). Additional specimens examined:

Peru: Lima Botanic Garden, said to have come from forests of eastern Peru, *Pennell* 14801 (Herb. Philadelphia Acad. Nat. Sci.).

This interesting species probably belongs to the subgenus *Plectostemma*, although the small operculum, scarcely plicate, and the angular, capsule-like fruit suggest rather a relationship with *P. tryphostemmatoides* and *P. gracillima*, of Harms' group *Tryphostemmatoides*. The flowers, as well as the fruits, resemble those of *P. gracilis*, a wholly different species without petals and with reticulate seeds and glandular petioles. The leaves are shaped much like those of *P. punctata*, another Peruvian species, but the far more delicate flowers, with filiform corona filaments and a glabrous ovary, clearly separate it.

Passiflora dawei Killip, sp. nov.

Stem triangular, striate, minutely puberulous, at length glabrate; stipules narrowly linear-falcate, 9 to 10 mm. long, 1 mm. wide; petioles 3.5 to 4 cm.

long, glandless; leaves broadly ovate-oblong in general outline, 8 to 10 cm. along midnerye, 10 to 14 cm. along lateral nerves, 8 to 10 cm. wide at middle, 6 to 7 cm. wide between the tips of the lobes, 2-lobed about a third their length (lobes lanceolate, acute, the sinus deeply sinuate, mucronulate at base), rounded or subtruncate at base, 3-nerved, ocellate beneath, subcoriaceous, essentially glabrous, bright green (when dry) on both surfaces; peduncles 5 to 7 cm. long, articulate about 1 cm. below apex; bracts narrowly linear, 5 to 6 mm. long, 0.5 to 1 mm. wide; flowers (not fully developed) 3.5 to 4 cm. wide; sepals oblong-lanceolate, 1.5 to 2 cm. long, about 0.8 cm. wide, obtuse; petals similar to and slightly shorter than the sepals; corona filaments in two series, the outer trigonous, conspicuously dilated at and above middle, dark purple, the inner filiform, half as long, minutely capitellate; operculum closely plicate; limen annular; ovary globose, densely white pilose.

Type in the U.S. National Herbarium, no. 1,422,886, collected in the Department of Cundinamarca, Colombia, in February, 1916, by M. T. Dawe (no. 57).

This species is distinguished from P. chelidonea by proportionately broader leaves, longer peduncles, larger bracts, and by the shape of the outer corona filaments. It might be confused with P. alnifolia, a species common in the Central Cordillera of Colombia, but that has quite differently shaped outer corona filaments, shorter peduncles, and smaller leaves.

Passiflora bucaramangensis Killip, sp. nov.

Slender herbaceous vine, essentially glabrous throughout; stems slightly trigonous, striate, minutely scabrid; stipules narrowly linear-falcate or almost setaceous, 1 to 2 mm. long, reddish purple; petioles slender, 1 to 2.5 cm. long, glandless; leaves transversely oblong, 1 to 3 cm. long, 3 to 7 cm. wide, 3-lobed about a third their length (lobes subequal or the middle lobes slightly the longest, 1 to 2 cm. wide, obtuse or truncate, sometimes emarginate at apex), truncate or cordate at base, 3-nerved (nerves and veins usually prominent beneath), ocellate beneath, subcoriaceous, drying green; peduncles in pairs, about 1.5 cm. long, very slender; bracts setaceous, about 1 mm. long, scattered, persistent; flowers about 2 cm. wide; sepals linear-oblong, about 10 mm. long, 3 mm. wide, obtuse, grass-green, pale at margin; petals oblong, 5 to 6 mm. long, 3 mm. wide, obtuse, white; corona filaments in two series, the outer filaments narrowly linear-clavate, 4 to 5 mm. long, deep purple below, green at the slightly enlarged tip, the inner filaments filiform, 2 to 3 mm. long, grassgreen; operculum closely plicate, denticulate at margin, deep purple; limen annular, green; ovary globose; fruit globose, 8 to 9 mm, in diameter; seeds obcordate, 3 mm. long, 2.5 mm. wide, transversely 5-sulcate, the ridges rugulose.

Type in the U.S. National Herbarium, no. 1,352,481, collected near La Baja, north of Bucaramanga, Department Santander, Colombia, altitude 2,400 meters, January 8, 1927, by E. P. Killip and Albert C. Smith (no. 16787).

Additional specimens examined:

Colombia: Santander: Mesa de los Santos, 1,500 meters, Killip & Smith 15364 (N). California, 2,200 meters, Killip & Smith 17046 (G, N, Y), 18842 (G, N, Y). Tona, 2,000 meters, Killip & Smith 19508 (G, N).

This is distinguished from *P. erythrophylla* by equally 3-lobed leaves, the more slender and longer inner filaments of the corona, and by the relative length of the sepals to the petals.

Passiflora popayanensis Killip, sp. nov.

Stem angular, compressed, tortuous, glabrous; stipules linear-setaceous, about 2 mm. long; petioles up to 1.5 cm. long, minutely pilosulous, glandless; leaves oblong or ovate-oblong, 5 to 7 cm. long, 3 to 3.5 cm. wide, bilobed (lobes lanceolate, 2 to 2.5 cm. long, acuminate, mucronulate, the sinus truncate, often with a small intermediate lobe present), rounded at base, 3-nerved, membranous, glabrous, dark green, usually paler along nerves above, glaucous beneath; peduncles slender, up to 3 cm. long, articulate just below apex; bracts setaceous, 2 to 4 mm. long, borne above middle of peduncle; flowers 3 to 3.5 cm. wide; sepals oblong-lanceolate, 1.2 to 1.5 cm. long, about 0.4 cm. wide, obtuse; petals spatulate, 6 to 7 mm. long, about 3 mm. wide, obtuse, reticulate-veined toward apex, white, the veins darker; corona filaments in two series, filiform, the outer 6 to 7 mm. long, the inner 4 to 5 mm. long; operculum slightly plicate, the margin minutely fimbrillate; nectar ring annular; limen cushion-like, closely surrounding the base of gynophore; gynophore very slender; ovary ovoid, glabrous.

Type in the U. S. National Herbarium, collected on Sotará Volcano, near Popayán, Department El Cauca, Colombia, altitude 2,400 to 2,900 meters, March 3, 1884, by F. C. Lehmann (no. 3731).

This specimen is cited by Masters as P. chelidonea Mast. in a report of Lehmann's Passifloraceae, and is the original of a detailed drawing of P. chelidonea." The thinner, more deeply lobed leaves, glaucous beneath, the longer peduncles, more slender corona filaments, the two series of which are of nearly equal length, and the smaller flowers distinguish P. popayanensis from P. chelidonea. The ovary is glabrous, that of P. chelidonea densely puberulent.

Passiflora lyra Planch. & Linden, sp. nov.

Stem sharply angular, puberulent; stipules setaceous, 5 to 10 mm. long, deciduous; petioles stout, up to 2.5 cm. long, glandless; leaves ovate-lanceolate, 8 to 12 cm. long, 5 to 8 cm. wide, narrowed near the truncate apex, shallowly 2 (or obscurely 3)-lobed (lobes less than 1 cm. long, acute), rounded at base, subcoriaceous, shining and very dark green and finely and sparsely puberulent above, reddish and densely and softly tomentulous beneath, bearing two conspicuous, white, sub-crustaceous glands in the angles of the nerves; flowers white, about 4 cm. wide, on axillary branches up to 10 cm. long which bear much reduced leaves; bracts setaceous, about 5 mm. long; sepals lanceolate, about 1.5 cm. long, 0.5 cm. wide, acutish; petals linear, about 5 mm. long, 2 mm. wide, very slender; corona filaments in two series, the outer filiform, 4 to 5 mm. long, slightly torulose, the inner capillary, 2 mm. long, capitellate; operculum membranous, slightly plicate, erect, irregularly lacerate to middle, about 2 mm. high; limen annular; ovary ovoid, densely brown-pilose.

² Bot. Jahrb. Engler 8: 218. 1887.

³ Harms in Engl. & Prantl Nat. Pflanzenfam. Aufl. 2, 21: 499, f. 230, C, D. 1925.

378

Type in the herbarium of the Muséum d'Histoire Naturelle, Paris, collected at Cumbre de Valencia, State of Carabobo, Venezuela, May, 1846, by Funck and Schlim (no. 552).

The leaves of this species are much like those of typical forms of P. chelidonea in general outline, though much less deeply lobed. The dense indument on the ovary and under surface of the leaves and the position of the flowers on short axillary branches are the most obvious characters by which P. lyra may be distinguished from P. chelidonea.

Passiflora smithii Killip, sp. nov.

Plant glabrous throughout; stem terete; stipules semi-ovate or subreniform, 2.5 to 3.5 cm. long, 1 to 1.5 cm. wide, aristulate at apex, rounded at base, coriaceous; petioles 2.5 to 4 cm. long, 2- to 4-glandular near middle, the glands 0.5 mm. long; leaves 8 to 12 cm. long, 10 to 15 cm. wide, 3-lobed about threequarters their length (lobes oblong or elliptic-oblong, 2.5 to 3 cm. wide, narrowed to an obtuse apex, minutely glandular-serrulate in the rounded sinuses), subtruncate or cordulate at base, 5-nerved, strongly reticulate-veined, coriaceous or subcoriaceous; peduncles 6 to 7 cm. long, slender; bracts narrowly lanceolate, 6 to 8 mm. long, 2 to 3 mm. wide, acuminate, sessile, deciduous, borne at separate points near middle of peduncle; flowers about 5 cm. wide; calyx tube broadly campanulate, about 5 mm. long, 10 mm. wide; sepals oblong, about 2 cm. long, 0.7 cm. wide, obtuse, slightly cucullate, minutely awned dorsally (awn about 1 mm. long); petals linearoblong, about 1 cm. long, 0.4 cm. wide, obtuse; corona filaments in several series, the outermost narrowly liguliform, 0.8 to 1 cm. long, the succeeding 3 or 4 series filiform, about 2 mm. long, minutely capitellate; operculum membranous, about 7 mm. high, closely plicate, lacerate-cleft to below middle; nectar ring annular, obscure; limen about 4 mm. high, closely surrounding base of gynophore, irregularly denticulate; ovary ovoid, glabrous; fruit ovoid, about 6 cm. long, 3 to 3.5 cm. in diameter; seeds oblong, about 6 mm. long, reticulate.

Type in the U. S. National Herbarium, no. 1,350,965, collected on northern slope of Mesa de los Santos, Department Santander, Colombia, altitude 1200 meters, December 11, 1926, by E. P. Killip and Albert C. Smith (no. 15015). Additional specimen examined: Colombia: Department Cundinamarca, Tequendama Falls, 1,000 meters, *Triana* 2947, in part (British Museum).

The tendency among students of *Passiflora* has been to place in the subgenus *Granadilla* all species with large involucral bracts and a complicated coronal structure, subdividing *Granadilla* on the basis of the leaf shape, stipules, and other vegetative characters, thus failing to bring together species that evidently are closely related in flower structure. Harms has suggested a more logical treatment in his recent revision of the family, although he here considers only a part of the described species. *Passiflora kermesina* Link & Otto (*P. raddiana* DC.) he places by itself in a separate series (no. 2) of *Granadilla*, characterized by small bracts and a plicate filamentose operculum.

⁴ Engl. & Prantl Nat. Pflanzenfam. Aufl. 2, **21**: 502–504. 1925.

To this series should be referred P. miersii, P. lehmannii, P. trisulca, P. watsoniana, P. eggersii, and P. smithii. From P. trisulca, with which it appears to be most closely related, the proposed species differs in less deeply lobed leaves which have obtuse apices, and in the shape of the petiolar glands.

Apparently two species are represented by Triana's 2947. The plant at Geneva is P. subpeltata Ort. (P. alba Link & Otto), but the plant at the British Museum is distinct. Triana and Planchon cited no. 2947 as P. stipulata (P. subpeltata, not. P. stipulata Aubl.). Triana's 2946, seen at Paris and in the British Museum is also P. subpeltata.

Passiflora cuzcoensis Killip, sp. nov.

Plant glabrous throughout; stem terete, or the younger portions subangulate; stipules semi-oblong, 2 to 2.5 cm. long, 0.7 to 0.9 cm. wide, acutish at apex, rounded at base, obscurely crenulate; petioles 2 to 3 cm. long, slender, biglandular in upper third, the glands minute, subulate, 0.5 to 0.8 mm. long; leaves suborbicular in general outline, 3-lobed at apex, 5 to 7 cm. along mid-. nerve, 4 to 6 cm. along lateral nerves (lobes rounded, minutely mucronulate the middle lobe 2 to 3 cm. wide), rounded or subtruncate at base, entire, 5 (or obscurely 7)-nerved, membranous; peduncles slender, 3 to 3.5 cm. long; bracts 3, subimbricate, unequal (one larger than the others), cordate, 2.5 to 3 cm. long, 2 to 2.5 cm. wide, obtuse, crenate-serrulate toward apex, persistent; flowers about 5 cm. wide; calyx tube campanulate; sepals lance-oblong, about 2 cm. long, 1 cm. wide, obtuse, awned dorsally just below apex, the awn foliaceous, up to 5 mm. long; petals lance-oblong, about 1.5 cm. long, 0.8 cm. wide, obtuse; corona filaments in two series, the outer radiate, about 2 cm. long, very slender, apparently concolorous, the inner (borne about 2 mm. from the outer), filiform, 1.5 to 2 mm. long; operculum membranous, about 2 mm. high, denticulate, bearing on outside just below margin a row of very slender filaments about 1 mm. long; limen cupuliform, closely surrounding base of gynophore; ovary not seen.

Type in the U.S. National Herbarium, no. 1,442,740, collected in Marcapata Valley, near Chilechile, Province Guispicanchi, Department Cuzco, Peru, February 21, 1929, by A. Weberbauer (no. 7872).

The unusual arrangement of the bracts indicates the relationship of this species to P. tetraden, which it resembles also in the outline of the leaves. The flowers of the two species differ in several details: In P. cuzcoensis the sepals are awned, in P. tetraden they are without awns, apparently an important difference in the subgenus Granadilla to which both belong: the principal or radiate corona filaments are in a single series and concolorous in P. cuzcoensis, in two series and alternately banded with blue and white in P. tetraden; the inner corona consists of short filaments in P. cuzcoensis, of mere tubercles in P. tetraden.

Passiflora spectabilis Killip, sp. nov.

Herbaceous vine, glabrous throughout; stem terete, the younger portions subangular; stipules semi-ovate or semi-oblong, 2 to 6 cm. long, 0.8 to 4 cm. wide, obtuse and mucronulate at apex (mucrone up to 1.5 mm. long), rounded at base, entire or undulate, the midnerve eccentric; petioles 3 to 8 cm. long, bearing two subopposite (or three scattered) sessile ovate glands about 1.5 mm. long, leaves 3-lobed not more than to middle, 6 to 12 cm. along midnerve. 5 to 10 cm. along lateral nerves, 10 to 20 cm. wide (lobes broadly triangular, obtuse or subacute), peltate 5 mm. or more from lower margin (at least the older leaves), 5-nerved, subcoriaceous, glaucescent beneath, at length green; peduncles solitary, 3 to 6 cm. long, articulate at least 5 mm. from apex; bracts ovate, 6 to 7 mm. long, 2 to 3 mm. wide, acute at apex, narrowed at the sessile base, green, borne at point of articulation; flowers 5 to 7 cm. wide; sepals oblong, about 4 cm. long, 1 cm. wide, obtuse, slightly carinate, shortawned (awn 0.5 to 1 mm. long), fleshy, green without, light pink or white within; petals linear, about 2.5 cm. long, 0.4 cm. wide, obtuse, light pink or white; corona filaments filiform, very slender, in four series, those of the two outer about 2.5 cm. long, blue, white at tips, those of the inner 2 to 2.5 mm. long, bifid at apex, white; operculum about 7 mm. high, filamentose nearly to base, the filaments white, blue in upper third; limen tubular, about 5 mm. high, closely surrounding base of gynophore; ovary subglobose; fruit globose. 5 cm. in diameter, purplish when ripe, edible; seeds obovate, about 8 mm. long, 5 mm. wide, coarsely reticulate.

Type in the U. S. National Herbarium, no. 1,356,557, collected at Mishuyacu, about 15 kilometers southwest of Iquitos, Department Loreto, Peru, altitude 100 meters, September 26, 1929, by E. P. Killip and A. C. Smith (no. 29884). Duplicates in the New York Botanical Garden and the Field Museum of Natural History.

Additional specimens examined:

Peru: Junín: Pichis Trail, Eneñas, 1600 meters, Killip & Smith 25764. Loreto: Iquitos, 100 meters, Killip & Smith 27165.

This is related to the Bolivian plant *P. rubrotincta*, both of these species being peltate much farther from the margin than in the case of other representatives of the subgenus *Granadilla*. *Passiflora spectabilis* has proportionately broader leaves than *P. rubrotincta*, smaller bracts which are borne fully 5 mm. below the flower, and very short awns to the sepals.

Locally this is known as pucu-pucu.

Passiflora crassifolia Killip, sp. nov.

Herbaceous tendril-bearing vine; stem subterete, striate, densely villous with spreading grayish hairs; stipules subreniform, 1.5 to 2.5 cm. long, 0.6 to 1 cm. wide, subamplexicaul, aristate (awn about 4 mm. long), reticulateveined, coriaceous, glabrous above, villous on veins beneath and at margin; petioles villosulous, 2 to 6 cm. long, bearing 4 to 6 subsessile glands, dissitate the whole length of the petiole, 0.6 to 0.8 mm. in diameter; leaves lanceolate or ovate-lanceolate, 10 to 18 cm. long, 6 to 12 cm. wide, not lobed or occasionally obsoletely lobed in lower third, obtuse at apex, deeply cordate at base with a narrow sinus, entire or sparingly serrulate toward base, 7-nerved, reticulate-veined (nerves and veins prominent beneath), entire, thick-coriaceous, dark green and glabrous above, paler and appressed-villous on the nerves and veins beneath; peduncles solitary, about 5 cm. long, villous; bracts lanceolate, 1.5 to 2 cm. long, 0.7 to 0.8 cm. wide, sharp-acuminate at apex, cordulate, subsessile, glabrous above, villous on nerves and veins beneath, borne about 5 mm. below base of flower; calyx tube tubular-campanulate, about 5 mm. long, 6 mm. in diameter; sepals oblong, dorsally awned, the awn 2 to 3 mm.

long; corona filaments in three or four series, the outermost about 7 mm. long; operculum membranous, about 5 mm. high, filamentose in upper half; fruit ovoid or ellipsoidal, 4 to 6 cm. long, 2 to 2.5 cm. wide, villosulous; seeds narrowly oblong, 6 to 7 mm. long, 2 to 3 mm. wide, shallowly tridentate at apex, coarsely reticulate.

Type in the U. S. National Herbarium, no. 1,356,480, collected in thickets, La Merced, Department Junín, Peru, altitude 700 meters, May 29, 1929, by E. P. Killip and A. C. Smith (no. 23434).

Additional specimens examined:

Peru: Junín: La Merced, Killip & Smith 23382; Macbride 5371. Along Perené River, near "Hacienda 3," Colonia Perené, altitude 600 meters,

Killip & Smith 25181.

This species is related to P. menispermifolia and P. nephrodes, differing from both in having essentially entire leaves. In addition, the bracts of P. menispermifolia are much narrower and glandular-denticulate, and in P. nephrodes the petiolar glands are much more slender. The specimens examined are all in fruit, with badly withered floral parts, so that an accurate description of the coronal structure is not possible. Apparently the outermost corona filaments are much shorter than in P. menispermifolia or P. nephrodes.

BOTANY.—Four new grasses. A. S. Hitchcock, Bureau of Plant Industry.

Recently Professor L. F. Henderson, Curator of the herbarium of the University of Oregon, Eugene, sent to the Grass Herbarium of the U. S. National Herbarium for identification, a specimen of grass which represents an undescribed species. In a region so well explored as western Oregon, it was surprising to find a novelty among the grasses.

The grasses recently collected in Peru by E. P. Killip and A. C. Smith were submitted to me for identification. Among these specimens there were two undescribed species, as well as several species not included in the grass flora of Peru as described in the "Grasses of Ecuador, Peru, and Bolivia" by Hitchcock (Contr. U. S. Nat. Herb. 24: 291–556, 1927).

The fourth species here proposed is based on a specimen collected in Chile, but submitted by Dr. Ivan M. Johnston of the Gray Herbarium.

Agrostis hendersonii Hitchc., sp. nov.

Plant apparently annual; culms slender, erect, 2-noded, glabrous, about 11 cm. tall; sheaths glabrous; ligule membranaceous, acute, 2 to 3 mm. long; blades flat or loosely involute, glabrous, 1 to 3 cm. long, 1 mm. wide; panicle condensed, about 2.5 cm. long, purplish tinged; spikelets short-pediceled, 5 to

¹ Received July 9, 1930.

6 mm. long; glumes subequal, with a setaceous slightly spreading tip 1 to 2 mm. long; lemma about 3 mm. long, with 2 setaceous teeth about 0.5 mm. long at the summit, the base or callus pubescent; awn from the middle of the back of the lemma, about 1 cm. long, twice-geniculate, the first bend often somewhat obscure; palea obsolete.

Planta annua (?); culmi erecti, 10 cm. alti, ligula 2-3 mm. longa; panicula condensa, 2.5 cm. longa, purpurascens; glumae subaequales, 5-6 mm. longae, aristatae; lemma 3 mm. longum, 2-aristatum, aristis 0.5 mm. longis, e dorso medio aristam emittens, arista 2-geniculata, 1 cm. longa, callo pubescente; palea nulla.

Type in the U.S. National Herbarium, no. 1,445,585, collected on wet ground, Sams Valley, a few miles from Gold Hill, Jackson County, Oregon, May 4, 1930, by L. F. Henderson (no. 12387).

The specimen at hand has the aspect of a depauperate plant of Agrostis microphylla Steud., but differs in the longer awn and in the two setaceous teeth of the lemma. Only two plants were found by Professor Henderson and these may be depauperate specimens. The duplicate type is in the herbarium of the University of Oregon, Eugene.

Calamagrostis stipitata Hitche., sp. nov.

Plant perennial, stramineous, rather soft; culms densely cespitose, erect, glabrous, 5 to 10 cm. tall; sheaths glabrous, scarious-margined, the uppermost inflated, 3 to 5 mm. wide as folded; ligule membranaceous, acute, 5 to 8 mm. long; blades erect, glabrous, involute, filiform, not more than 0.5 mm. thick, pungently pointed, mostly exceeding the culms; panicles condensed, 1 to 3 cm. long, tinged with purple or bronze, mostly partly included in the sheath, the axis and branchlets minutely hispid; spikelets 3.5 mm. long; glumes equal, acute, glabrous, scabrous on the keel, the tip somewhat erose; floret stipitate, the rachilla internede about 0.5 mm. long; lemma 2 mm. long, the callus hairs copious, as long as the lemma, the apex with 4 rather stout teeth, the awn borne below the middle, straight or a little bent, slightly exceeding the glumes; palea a little shorter than the lemma; prolongation of the rachilla about 0.5 mm. long, the rachilla hairs copious like the callus hairs.

Planta perennis, straminea; culmi dense caespitosi, erecti, 5-10 cm. alti; ligula membranacea, acuta, 5-8 mm. longa; laminae erectae, graciles, involutae, glabrae, quam culmi paullo longiores; panicula condensa, 1-3 cm. longa; spiculae 3.5 mm. longae; glumae acutae; floscula stipitata; lemma 2 mm. longum, aristatum, arista recta glumas paullum superante, apice 4-dentata, callo dense piloso, pilis 2 mm. longis; palea quam lemma paullo brevior; processus rhachillae 0.5 mm. longus, pilis 2 mm. longis.

Type in the U.S. National Herbarium, no. 1,445,584, collected in gravel along a streamlet, Mina Desputada (Los Condes), Prov. Santiago, Chile, alt. 4000 to 4100 meters, January, 1930, by G. Looser (no. 1114).

Also collected in the Cordilleras of Colchaqua, Chile, January, 1930, by Padre Anastasio Pirion (no. 117).

Stipa smithii Hitchc., sp. nov.

Plant perennial; culms closely cespitose, erect, glabrous, usually 3-noded, about 60 cm. tall; sheaths glabrous; ligule a truncate membrane about 0.5 mm. long: blades erect, rather loosely involute, glabrous on the outer surface, rather rigid, acuminate to a fine hard point, 10 to 15 cm. long; panicle erect, narrow but scarcely spikelike, interrupted below, 10 to 18 cm. long, the branches appressed, the lower as much as 4 cm. long, the main axis glabrous, the branches and pedicels pubescent; spikelets strongly tinged with purple; glumes equal, about 6 mm. long, 3-nerved, lanceolate, acuminate, sometimes sparingly pubescent near base; lemma 3 mm. long, including the acute callus about 0.5 mm. long, oblong, brownish, loosely pilose with white appressed hairs, the summit whitish, the margins of the lemma extended into minute lobes, the overlapping one indurate and forming a minute blunt tooth at the summit of the lemma; awn early-deciduous, twice-geniculate, sometimes obscurely so, scabrous, about 14 mm. long, the first segment twisted, about 5 mm. long, the second segment like the first, 2 mm. long, the third segment straight, about 7 mm. long.

Planta perennis; culmi caespitosi, erecti; laminae laxe involutae, glabrae, erectae, rigidae, 10–15 cm. longae; panicula erecta, angusta, 10–18 cm. longa, ramis appressis; spiculae purpurascentes; glumae acuminatae, 6 mm. longae, 3-nervae, basi paullum pubescentes; lemma oblongum, pubescens, 3 mm. longum, apice minute dentato; arista 2-geniculata, scabra, inferne torta, circ. 14 mm. longa.

Type in U. S. National Herbarium, no. 1,357,804, collected on open hill-side, Río Blanco, Dept. Lima, Peru, alt. 3000 to 3500 meters, April, 1929, by E. P. Killip and A. C. Smith (no. 30669).

Panicum killipii Hitche., sp. nov.

Plant perennial: culms erect, sparingly branching, glabrous, solitary or few. in a tuft, 100 to 150 cm. tall; sheaths glabrous, sometimes tuberculate-hispid on the margins; ligule a membrane about 1 mm. long, the upper surface of the blade just above densely hispid; blades flat, narrowly lanceolate, acuminate, the upper rounded or somewhat cordate, the lower narrowed into a petiole-like folded base, glabrous beneath, the upper surface often sparsely beset along the nerves with tuberculate hairs or with tubercles only, minutely roughened along the margin especially toward the apex, 20 to 35 cm. long, 2 to 3 cm. wide, the uppermost smaller; panicle erect, ovate-pyramidal in outline, 15 to 25 cm. long, the axis glabrous on the lower part, scabrous above, the branches ascending or the lower spreading, solitary or 2 or 3 together, the lower as much as 12 cm. long, 1 to 3 cm. distant, the upper successively shorter and more crowded, sometimes a few long hairs in the axils, the spikelets short-pediceled, rather crowded and more or less secund on the primary branches, the lower branches sometimes again branching; spikelets purplish, glabrous, oval-oblong, obtuse, about 2 mm. long, single or in pairs on flat slightly scabrous pedicels, mostly shorter than the spikelets; first glume narrow, acute or acuminate, nerveless, from minute to nearly half as long as the spikelet; second glume and sterile lemma subequal, 5-nerved, the glume sometimes with a few delicate hairs at the summit; sterile floret staminate, with large anthers, the hyaline palea as long as the lemma; fruit as long as the spikelet, plano-convex, slightly apiculate, pale, smooth and shining.

Planta perennis; culmi erecti, glabri, 100–150 cm. alti; laminae planae, anguste lanceolatae, 20–35 cm. longae, 2–3 cm. latae, acuminatae, superiores cordatae vel rotundatae, inferiores basi longe attenuatae, panicula pyramidalis,

15–25 cm. longa, ramis ascendentibus, inferioribus 7–12 cm. longis; spiculae glabrae, ovato-oblongae, obtusae, 2 mm. longae, subsecundae, breviter pedicellatae; gluma prima, acuta, 0.5–1 mm. longa; gluma secunda et lemma sterile subaequales. 5-nervia; flos sterilis masculus, palea magna; lemma fertile paullum apiculatum.

Type in the U. S. National Herbarium, no. 1,357,803, collected in thickets, Aina, between Huanta and Río Apurimac, Dept. Ayacucho, Peru, alt. 750 to 1000 meters, May, 1929, by E. P. Killip and A. C. Smith (no. 22804). Also in the same locality, Killip & Smith 22522, 22803; Ccarrapa, same region, Killip & Smith 22491.

This plant is not closely allied to any known species.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

418TH MEETING

The 418th regular meeting of the Entomological Society of Washington was held at 8 p.m. Thursday, March 6, 1930, in Room 43 of the new building of the U. S. National Museum. President J. E. Graf presided; there were present 37 members and 24 visitors. C. Graham and F. F. Murdock were elected to membership.

The first communication on the regular program was presented by Mr. O. E. Gahm, of the Bureau of Entomology, and was entitled "Insect Pests and Mites Related to the Mushroom Industry."

History, Development and Present Status of the Industry in the U.S.

"The mushroom industry is comparatively young and is perhaps one of the most centralized of its kind in this country, as nearly 80% of all the mushrooms grown in the U. S. are raised in the southern halves of Chester and Delaware Counties, Pa., representing a radius of not more than 25 miles. The remaining 20% of our commercial production is scattered throughout several states, the principal ones being New York, Ohio, Michigan, Illinois, Missouri, Minnesota, Colorado, Washington, Oregon, and California.

The growth of the industry is rather unique in that commercial production began as a sideline with two greenhouse men at Kennett Square about 40 years ago. Since that time the industry has developed into a business representing a capital investment of over \$10,000,000 for growing houses and equipment, the annual production of mushrooms in Pennsylvania being about 15,000,000 pounds and having a total value of over \$5,000,000.

The Industry in New York State—Adaptation of Ice Houses

While the bulk of the crop is grown in specially constructed houses, there have been a few adaptations whereby certain buildings and caves are now being used for the culture of mushrooms. One of the most noted of these adaptations is found in New York State where the largest mushroom plant in the world exists today. This plant consists of several abandoned ice houses along the Hudson River, from Kingston to Albany, which have been converted into mushroom houses and comprise a total of about 1,500,000 sq. ft. of bed

space for the growing of mushrooms. In reconditioning these houses, the floors were cemented and a false ceiling 8 feet from the floor was made by fastening a network of twine string to strong twine supports or ropes suspended from the rafters, and then covering the twine network with 3 to 5 ply of building paper. From 4 to 5 carloads of building paper are used each season in making these false ceilings. Knock-down type construction beds were made of California spruce, which are 4 tiers high. Large removable doorways were made in the side of the houses which permit the trucks to haul the manure directly into and out of the houses. This company has a standing order with the manure dealers in New York City for over 10,000 tons of horse manure each year. All this manure is brought up the Hudson River on barges and unloaded with cranes into motor trucks which haul it directly into the ice houses where it is composted. Most of the labor involved in composting and turning of the manure is done by special machinery. The spent compost is loaded into trucks, dumped on barges and shipped South.

Six of these large ice houses are equipped for use in the summer. Large, well insulated rooms were constructed in the center of the ice house proper, in which 6,000 to 10,000 tons of ice are stored in the winter and used in summer for cooling. When the temperature rises above the optimum for mushroom culture, slide doors in the ice chamber are opened and the cool air is forced

out into the plant by means of electric fans.

The growers in the ice houses estimated their production for the summer of

1929 to be around 145,000 three-pound baskets of mushrooms.

There are also some large limestone caves in New York State where mushrooms are grown the year round, but climatic conditions are not as favorable for successful culture of mushrooms in the caves as in the reconditioned ice houses.

Industry in the Northwest

The industry in the Northwest is centered around the twin cities, Minneapolis and St. Paul, where between 300,000 and 400,000 pounds of mushrooms are grown annually in the sandstone caves or mines along the banks of the Mississippi River, which have been mined out for the extremely high grade sand used for manufacture of glass. Some of these mines are enormous in size, being from 300 to 400 feet long, 30 feet high and 30 feet wide. The temperature remains fairly constant the year round and affords a favorable place for the culture of mushrooms. There are, however, some hazardous factors which enter into the culture in these sandstone caves, which will be mentioned later.

The industry has gradually spread westward and at the present time there are large mushroom plants at San Francisco, Whittier and Redwood City, California, and at Denver, Colorado. Plants are in the process of construction at Seattle, Washington, and at Portland, Oregon. The annual production of mushrooms on the West Coast is approximately 1,000,000 pounds.

Insect Pests and Mites Associated with Mushroom Culture

It seems as though the insect pests and mites have kept pace with the growth of the industry, and as the industry became more centralized, the flies flew from one house to another and in many instances carried the mite hypopi with them. The chief insect pests found in the commercial mushroom houses are the Sciarid, Phorid and Cecid flies, springtails and sowbugs. The injurious mites include the so-called mushroom mite *Tyroglyphus lintneri*,

Rhizoglyphus phylloxerae and Linopodes antennaepes. The Sciarid larvae do considerable injury by destroying the mycelium in the beds and also by feeding on the small mushrooms which they completely devour in many instances. They are also productive of commercial damage to the larger sporophores which are rendered unfit for the market when the larvae tunnel up into the stem and cap. The Phorid larvae are often quite numerous in the compost but do not cause the damage which the Sciarid larvae are capable of producing. The writer has not yet found any of the Phorid larvae up in the stem or cap of the mushroom. The larvae of the Cecid fly also produce injury by burrowing into the cap as well as the damage which they cause by destroying the mycelium in the beds. The flies being vectors of disease are also serious pests of the mushroom industry in this connection.

Springtails cause very little damage to mushrooms in the East, but are however one of the most serious pests which the growers in the sandstone caves of the Northwest have to contend with. While the species found in the sandstone caves has never been described in the United States, I doubt very much whether it would cause commercial damage in the modern constructed houses in the East due to unfavorable climatic conditions for their

reproduction.

Mites have become one of the major pests of cultivated mushrooms and are capable of producing considerable injury to the crop. The one most commonly found is the so-called mushroom mite Tyroglyphus lintneri. Rhizoglyphus phylloxerae which resembles Tyroglyphus lintneri is also quite prev-These mites are very destructive to the mycelium and also render many of the sporophores unfit for market by eating into the stem and cap. Many of the plants in Pennsylvania were infested with this mite this season, and one plant in Ohio comprising 91,000 sq. ft. of bed space was heavily infested and approximately \$10,000 worth of damage produced.

Another mite, Linopodes antennaepes, a new pest of mushrooms in this country, apparently made its appearance in one of the commercial houses in Pennsylvania last March and was found during the summer of 1929 in mushroom houses at Ashtabula, Ohio, Naperville, Illinois, and in one of the

sandstone caves at St. Paul, Minnesota.

The yield was reduced about 40% in the plant at Ashtabula, Ohio, which consisted of 375,000 sq. ft. of bed space. Control of this mite was received by passing steam over the surface of the manure after the last turning and before it was taken into the houses.

Control Measures

There exists in the preparation of the compost for mushroom culture a natural means of insect and mite control, which if properly utilized would aid materially in reducing heavy insect and mite infestations. The compost usually undergoes a secondary fermentation process after it is put into the house during which period the temperature in the compost in the top bed rises to the point where all insect and mite life present in the manure is either killed or driven to the surface of the bed, where fumigants can be used effectively. The temperature of the compost in the bottom beds seldom rises above 110 to 115°F, and does not go this high in most cases if beds are built on the ground. The temperature in the bottom beds being low, the insects are neither killed nor driven to the surface where fumigants can be used effectively, and hence these beds serve as breeding grounds or sources of pollution for the whole house.

Preliminary tests with electric fans to break up the dead air space and circulate the air have every indication of being both practical and profitable for this purpose. Three 16-inch oscillating electric fans placed in a single mushroom house, 50 ft. long, with the face of the fan pointed upward at an angle of 45° will circulate the air very well. By this means we have been able to get the air temperature in the bottom of the houses the same as it was in the top of the houses; and where the bottom beds are raised off the ground to get the temperature of the compost within 2° of the compost temperature in the top beds. In using fans, they should not be started until the temperature of the compost in the top beds has reached 125 to 130°F. The fans not only equalize the temperatures, thereby either killing the insects in the manure or driving them to the surface where fumigants can be used effectively; but also serve as a means whereby the house can be left closed for a longer period of time without danger of burning the manure in the top beds.

Precautionary Measures

Due to the fact that some of the mushroom pests are almost invariably present in the compost when it enters the mushroom house, it is necessary to take certain precautions while the compost is going through its secondary decomposition process to prevent heavy infestations of flies and mites. Calcium cyanide has been recommended and used when the compost was at its peak heat for the control of insect pests and mites in the compost. scattered in the aisles at the rate of one pound per 1,000 cu. ft. of air space in the mushroom house. Results of aspiration experiments conducted in the mushroom house under practical conditions show that the gas is liberated very quickly, the maximum concentration being received at the time of the first aspiration, which was made 15 minutes after the calcium cyanide had been scattered in the aisles. Starch papers dipped in picric acid were inserted in the compost to determine the depth to which the hydrocyanic acid gas penetrated. These tests showed that the gas did not penetrate into the compost more than one inch; hence the necessity of driving the insects and mites to the surface. Due to the fact that hydrocyanic acid gas does not seem to be as effective on mite hypopi as sulfur dioxide several experiments were conducted in the mushroom houses in Pennsylvania during the fall of 1929 whereby sulfur was burned in the houses at the rate of 1 to 3 pounds per 1,000 cu. ft. of air space when the compost was at peak heat. pH determinations of the compost were made before and after the sulfur was burned. Results of several determinations showed that the pH of the compost on the surface changed from about 7.5 to about 6.5, or roughly one point, while the pH of the compost from the center of the bed remained unchanged showing that the sulfur fumes did not penetrate far into the compost. A greenish mold developed on the surface of the compost after the house had been cooled down, but apparently dried up before the beds were cased and did no harm. Yield tests from several of the houses in which sulfur was burned showed normal crops. While there is a slight fire hazard in using sulfur for fumigation at this time, it is much cheaper and apparently a better miticide than hydrocyanic acid gas.

Results of preliminary tests with ethylene oxide indicate that it is very effective against mites, but further experiments as to its effect on the mush-room and mycelium will have to be made before it can be tried on a commercial scale in the mushroom houses. It is a very penetrating gas, having killed mites which were buried in compost at a depth of 3 inches when used at the

rate of 1 pound per 1,000 cu. ft. of air space. Due to the extreme sensitivity of the mushroom and of the mycelium, very few fumigants can be used while a crop is on the beds. Pyrethrum powder is the most extensively used insecticide for control of flies during the cropping period. A 100% active pyrethrum dust was used until the fall of 1929. It was too heavy and did not remain in suspension long enough for most effective results. A 60–40 pyrethrum diatomaceous earth combination is now being used in considerable quantity and has proven more effective than the 100% active pyrethrum dust. The new dust not only remains in suspension longer thereby becoming more effective than the heavier dust but is also about 25¢ per pound cheaper than the 100% material. Nicotine smudges as well as a special pyrethrum smudge do not seem to be toxic enough to afford effective results.

All spent compost as well as left over compost should be disposed of as quickly as possible and the doors and ventilators of the mushroom house screened with 30-mesh copper wire cloth, to prevent reinfestation once a house has gone through the heat and has been fumigated. Cheesecloth can be used to screen the doors and ventilators but copper wire cloth is more dura-

ble and perhaps the cheapest in the long run. (Author's abstract.)

A number of slides were shown. This paper was discussed by McIndoo, Graf, Bishopp, Howard Balduf, and Bridwell.

(To be continued.)

SCIENTIFIC NOTES AND NEWS

Mrs. Agnes Chase, of the Grass Herbarium, has returned from 7 months in Brazil. On this, her second visit to Brazil, Mrs. Chase collected grasses in the states of Rio de Janeiro, Espirito Santo, Minas Geraes, Goyaz, Sao Paulo, and Matto Grosso, going west to the boundary of Bolivia and south to near the boundary of Paraguay. In the two visits Mrs. Chase has made the largest collection of grasses ever obtained in Brazil, including many extensions of range and additions to the known flora of the country.

- Dr. A. S. Hitchcock sailed for Europe August 1, to attend the International Botanical Congress at Cambridge, England. Dr. Hitchcock attends the Congress as delegate from the U. S. Department of Agriculture, the Botanical Society of America and the Botanical Society of Washington.
- R. C. Wells has been appointed chief chemist in charge of the Division of Chemistry and Physics, Geologic Branch, U. S. Geological Survey, and George Steiger, former chief, will return to studies in chemical and spectroscopic analysis.

EUGENE CALLAGHAN, PERRY A. DAVISON, EDWIN B. ECKEL, CHARLES L. GAZIN, E. N. GODDARD, CHARLES B. HUNT, BERNARD N. MOORE, WATSON H. MONROE, CHARLES F. PARK, JR., WILLIAM S. PIKE, JR., GEORGE F. TAYLOR, and AARON G. WATERS have been appointed junior geologists; and LLOYD G. HENBEST, J. HARLAN JOHNSON, MAXWELL M. KNECHTEL, ALBERT H. KOSCHMANN, ROBERT E. LANDON, CHARLES B. READ, PHILIP J. SHENON, RALPH B. STEWART, and J. STEELE WILLIAMS, assistant geologists in the Geologic Branch, U. S. Geological Survey. RALPH W. RICHARDS has been reinstated as Geologist.

OFFICIAL COMMUNICATIONS THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

	age
Mathematics.—The symmetry of the autocatalytic curve. HARRY W. TITUS	357
Hicrobiology.—Myxamoebae in soil and decomposing crop residues. Charles Thom and Kenneth B. Raper	362
Paleontology.—Discovery of Permo-Carboniferous vertebrates in the Dunkard formation of West Virginia. R. W. Whipple and E. C. Case	3 7 0
Botany.—A new species of Calathea from Panama. C. V. Morton	37 2
Botany.—Ten new species of Passiflora, mainly from Colombia and Peru. ELLSWORTH P. KILLIP	
Botany.—Four new grasses. A. S. Hitchcock.	381
Proceedings	
The Entomological Society	384
SCIENTIFIC NOTES AND NEWS	388

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries





OF THE

WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD

EDGAR T. WHERRY
UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves. Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the ssue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints*—Eifty reprints without covers will be furnished gratis. Covers

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

OCTOBER 4, 1930

No. 16

GEOLOGY.—Pleistocene seashores.¹ C. Wythe Cooke, U. S. Geological Survey.

The Pleistocene terraces of the Atlantic seaboard have excited the interest of many geologists. The name Columbia was applied to some of them by McGee in 1887. Darton described them in the Washington Folio. Shattuck, who was the first to study them in detail, published on the Maryland terraces in 1901. B. L. Johnson and Stephenson worked out the series in North Carolina; Matson, in Florida; Cooke, in Georgia; and Wentworth, whose results are still unpublished, in Virginia. All of these students reached the conclusion that some or all of the terraces are due wholly or in part to invasions of the sea or tidal waters upon the land. Shattuck proved that the terraces in Maryland were not produced by simple intermittent emergence from the sea but by alternating emergence and submergence, which he ascribed to oscillations of the land.

If the invasions and retreats of the sea are really due to oscillations of the land, the terraces ought to be warped or tilted, for it seems very unlikely that two thousand miles of sea coast should have been rigidly upheaved and depressed not once, but several times, without warping or tilting.

My work in 1924 on the physical geography of Georgia convinced me that the terraces there are not warped, but maintain their horizontality within the State of Georgia. In that investigation I applied a method, frequently neglected, of defining marine terraces by reference to the abandoned shore lines which bound them. The method of

¹ Received May 26, 1930. Read before the Geological Society of Washington May 14, 1930. Published by permission of the Director of the U.S. Geological Survey. The subject matter of the first part of this paper is discussed more fully and with references in a manuscript entitled *Correlation of coastal terraces*, to be published in the Journal of Geology.

correlating terraces by means of the altitude of the terrace itself is unreliable, for altitudes of points on a terrace vary considerably, like soundings in the sea; but the abandoned shore line is a definite plane of reference, like modern sea level. Slopes due to warping of a terrace cannot with certainty be distinguished from the original slopes of the old sea bottom; but sloping shore lines usually indicate warping. It is obvious, however, that considerable discrimination is necessary in deciding what part of an abandoned beach represents the former stand of mean sea level, for tidal range, strength of winds and waves, and many other factors affect the profiles of beaches.

I have recently traced on topographic maps the shore lines of the coastal terraces both north and south of Georgia but have detected no evidence of warping. The shore lines maintain their horizontality from Florida at least as far north as New Jersey, and appear to continue unchanged in altitude, but doubtless veneered with glacial deposits, up the Hudson and Connecticut valleys. The few maps available along the Gulf coast show terraces at the same altitudes as far as Texas. As the terraces appear to be unwarped for a distance of 2000 miles, I infer that the horizontal shore lines of the Pleistocene terraces record high stages of the sea on a stable land and not upheavals of the continent.

If the sea once stood high on the Atlantic coast of North America. it must have stood equally high on every coast, and traces of its marks, where not obliterated, should stand at the same altitudes on every stable land. The shore lines of the Pleistocene terraces stand approximately 25, 65, 95, 160, 215, and 265 feet above sea level. Although I have not attempted an exhaustive survey of the literature, evidence that terraces stand at approximately these same altitudes in many countries is accumulating. Daly has shown that the 25-foot level is world wide. Depéret assigns terraces on all three coasts of France to horizontal shore lines at very nearly the same altitudes as ours, and Dubois has ventured to correlate the French terraces with the American on the basis of their altitudes. The correspondence with South Africa is remarkably close, for Krige reports well-developed marine terraces 20 and 60 feet above sea level, a beach about 100 feet, a 170foot shelf at Cape of Good Hope, another at 200 feet, and another about 250 feet above sea level. Four of these levels in South Africa differ by only 5 feet from the altitudes that I have assigned to shore lines in the United States, one is ten feet higher, and two are 15 feet lower than mine. These differences fall well within the range of possible error of the method of work. The 10 and 15-foot differences are between shore lines in America and shelves in South Africa. The correspondence of the actual shore lines may be closer, for P. A. Wagner reports marine gravel 210 feet above sea level at the mouth of the Buffels River.²

What made the sea fall and rise at least six times, as recorded by the shore lines of the terraces? Glacial control of sea level seems to be the most effective cause of this periodic shifting of the strand during the Pleistocene. When the great ice caps accumulated on the land during each glacial stage, there was less water in the sea than when the ice caps were melted and the water restored to the sea during each interglacial stage. It has been estimated that if the ice caps on Greenland and on Antarctica were melted, the sea would be raised 200 feet above its present level. This estimated height falls short by less than 25 per cent of the actual rise of the sea needed to submerge the land to the 265-foot shore line. It is quite possible that crustal movements as well as glaciation caused changes in sea level during the Pleistocene. If the change due to crustal movements was downward, we need not resort to the hypothesis of unequal deglaciation to explain the steplike arrangement of the terraces. But in any event the changes of sea level due to glaciation alone are of too great magnitude to be ignored.

Geologists recognize five times of conspicuous Pleistocene glaciation in North America. These are called the Nebraskan, Kansan, Illinoian, Iowan, and Wisconsin glacial stages. The Wisconsin glacial stage was interrupted by at least one temporary retreat of the ice. These six glacial stages (counting the Wisconsin as two) alternate with six warmer periods, namely, the preglacial stage, and the Aftonian, the Yarmouth, the Sangamon, and the Peorian interglacial stages, and an inter-Wisconsin interglacial substage.

Let us assume that glacial control was the dominant cause of changes of sea level. Then each interglacial stage, being a time of high sea water, should have a corresponding high shore line, but the deposits that accumulated in the sea during each glacial stage should now be submerged. Let us further assume that these terraces stand in regular sequence as to age, the highest being the oldest, and the lowest the youngest. Then it may be possible to assign each of the six Pleistocene terraces to a definite stage of the glacial chronology. The 265-foot shore line, corresponding to the typical Brandywine terrace, falls into the pre-glacial stage; the 215-foot Coharie level into the Aftonian;

² Trans. Geol. Soc. South Africa 31: 11. 1928.

the 160-foot Sunderland into the Yarmouth; the 95-foot Wicomico into the Sangamon; the 65-foot Chowan into the Peorian; and the 25-foot Pamlico into the inter-Wisconsin.

The discovery of any more Pleistocene shore lines or the recognition of any more stages in the glacial chronology would throw this tentative correlation of the Pleistocene marine terraces with the interglacial stages out of step, and the correlation would need readjustment. That there may be more shore lines than the six already mentioned is not improbable; Wentworth, in manuscript, reports one in Virginia about 15 feet above sea level; in the District of Columbia there are at least 2 levels higher than 265 feet, and the lower of the two seems to be wide spread. But there may also be more interglacial stages than are now formally recognized, for the Wisconsin glacial deposits record 4 separate advances of the ice which were interrupted by retreats of greater or less magnitude. As a tie point between the two shifting scales is the discovery by Leverett that a gravel train derived from the Illinoian drift can be traced down the Susquehanna River to the head of Chesapeake Bay, where it ends in the marine Wicomico formation. If the Wicomico is Sangamon, as postulated here, it is the oldest marine formation now above sea level in which debris from the Illinois drift could possibly occur.

Although the coastal terraces show no conspicuous signs of warping, there is abundant evidence that the Atlantic seaboard has been deformed in the not-far-distant past. The streams have been unequally drowned. Every stream has been drowned to some extent, but those north of Cape Hatteras have been drowned deeper than those farther south. Examination of hydrographic charts brings out the fact that Chesapeake Bay and its tributaries have not been drowned as deeply as the submarine course of Hudson River. Further evidence of rather late deformation of the eastern part of the United States is given by the attitude of Pliocene deposits. Shaw found considerable warping of Pliocene terraces in Mississippi; Florida has been tilted to the west since the deposition of the Pliocene Citronelle formation; Campbell reports that the Pliocene (?) Bryn Mawr gravel has been deformed. The ending of the period of crustal instability which deformed Pliocene deposits but which did not deform Pleistocene terraces in the same region is a convenient time at which to date the close of the Pliocene and the beginning of the Pleistocene.

Let us now apply these principles of correlation to our local conditions and attempt to interpret the geologic history of the District of Columbia.

During Pliocene time a large alluvial fan or delta accumulated on the Coastal Plain and lower parts of the Piedmont where the Potomac emerged from the higher land. Later, the margin of the continent was uplifted to such an extent that the seashore lay along or below the edge of the continental shelf. This uplift of the land may have taken place by stages sufficiently distinct to cut terraces in the Pliocene delta of the Potomac. During this high stand of the continental margin, the valleys now occupied by Chesapeake Bay, Delaware Bay, and the submarine valley of the Hudson were eroded. We may picture the Potomac River of late Pliocene time as very similar to the present river from its headwaters to Little Falls. At Little Falls it probably dropped as much as 60 feet. From Georgetown to its junction with the Susquehanna it was a normal Coastal Plain river—deep, fairly rapid but with no falls—flowing in a broad valley between gravel-capped uplands.

Then came a time of widespread crustal instability. The continental margin between Cape Cod and Cape Hatteras was depressed, the greatest depression being near the submarine channel of the Hudson. When this movement ceased the Pleistocene epoch had begun.

Since the beginning of the Pleistocene the land has remained stationary but the sea has fallen and risen upon it. The opening of the Pleistocene finds the sea at a height of 265 feet above its present level. Nearly all the Coastal Plain in this vicinity was submerged except an island covered with Pliocene gravel which rose 40 feet above the water southeast of Washington. Tides extended up the Potomac almost to Harpers Ferry. The Brandywine terrace was formed at this time. The flat-topped ridge southeast of Baileys Crossroads is a remnant of the Brandywine terrace.

Then came the Nebraskan glaciation; the tidal waters receded and the Potomac reoccupied its Pliocene channel.

After the Nebraskan ice had melted the Aftonian sea stood 215 feet above modern sea level. Tide probably extended up the Potomac to Point of Rocks. At Georgetown the river broadened and emptied into a bay about 7 miles wide with a prolongation extending northeastward towards Laurel. The Coharie terrace was formed at this time. Mt. Pleasant and Meridian Hill Park are on the Coharie terrace.

The waters receded during the Kansan glacial stage but readvanced during Yarmouth time to the 160-foot level. Tide reached above the dam at Great Falls. All of Washington below Florida Avenue was again under water, but the northeastern prolongation of Potomac

Bay was considerably smaller than its earlier stage. The Sunderland terrace was formed at this time. The shore line of the Sunderland terrace follows the bluff north of Florida Avenue between Eleventh Street and Connecticut Avenue.

During the Illinoian glacial stage the seas were again depleted and tidal waters drained away down the Pliocene course of the Potomac. When the ice had melted during the Sangamon interglacial stage, tides rose only about 95 feet above present sea level and extended up the Potomac only to the foot of Great Falls. Down-town Washington was again under water and Potomac Bay was not greatly altered. The terrace corresponding to the 95-foot stage is the Wicomico. Capitol Hill is an outlier of the Wicomico, and Dupont Circle, Scott Circle, Thomas Circle, and Iowa Circle are on the same terrace.

After the low water of the Iowan glacial stage, the water rose in Peorian time to an altitude of only 65 feet. Tides extended to the head of Stubblefield Falls and up the Eastern Branch to Berwyn. Capitol Hill made an island in Potomac Bay. The Chowan terrace was formed at this time. F and G streets, Lafayette Square, and Union Station Plaza are on the Chowan terrace.

Sea level fell in early Wisconsin time, but during the inter-Wisconsin retreat of the ice it rose again to an altitude of about 25 feet. At this time the Pamlico terrace was formed. Tides were stopped by Little Falls. Pennsylvania Avenue between Peace Monument and Fifteenth Street was flooded, and most of Southwest Washington except an island at the Department of Agriculture site was under water.

Late Wisconsin glaciation again lowered sea level, but at the beginning of the Recent epoch the water attained its present stage. Tides now extend to Little Falls and up the Eastern Branch to Bladensburg.

SUMMARY

The important conclusions of this paper are as follows:

The shore lines of the six Pleistocene terraces are horizontal as far as they have been traced. Horizontal terraces at the same altitudes have been noted in France and in South Africa. The shore lines are therefore interpreted as high-water marks made by a fluctuating sea upon stationary continents rather than as marks of a stationary sea made upon oscillating continents.

Glacial control of sea level is regarded as the dominant cause of the fluctuations of sea level during the Pleistocene epoch. Sea level was high during interglacial stages and low during glacial stages. The

shore lines of the terraces therefore represent the high-water marks of the preglacial and interglacial stages.

The warping of the continent which brought about the unequal drowning of the Atlantic coast deformed Pliocene deposits but did not deform Pleistocene shore lines. It is therefore regarded as the closing episode of Pliocene time.

BIOLOGY.—The interrelation of Foraminifera and Algae. JOSEPH A. Cushman, Sharon, Massachusetts.

The relationship of the Foraminifera and Algae has already been noted.² It has been well known for some time, too, that there is an association of Algae with Corals. In tropical, warm, shallow waters, such as give the right conditions for the development of coral reefs. there are found several groups of larger Foraminifera. For the most part these are limited to such conditions, and are known only from the tropics, most of them from the Indo-Pacific. These include particularly the families Camerinidae, Peneropliidae, and Alveolinellidae. Just what the relationship is between the two forms of the Foraminifera and the Algae is not yet clear. It may be due to food relations, or to the development of oxygen by the Algae. That the relationship is a very definite one is shown by the fact that distribution of these larger Foraminifera is limited to a depth of about 30 fathoms. This depth is approximately that to which Algae are limited by the amount of sunlight that penetrates the sea-water. It is probable that when the relationships between Algae and Corals are fully known the same factors will apply to the Algae and the Foraminifera.

In the fossil series larger Foraminifera of the families already mentioned and those belonging to the extinct group of the Orbitoids are very prominent from the later Cretaceous, and representatives of the earlier groups except the Orbitoids are still living under the conditions already noted. A map of the distribution of the Orbitoids, for example, in the Eocene will show that they are very largely limited to areas which at that time from the occurrence of Corals and other forms are known to have been warm shallow areas. During this period great masses of limestone many thousands of feet thick were developed across the tropical regions of the world in large part built

¹ Received June 23, 1930.

² Cushman, Shallow water Foraminifera of the Tortugas Region, Publication Carnegie Institution, Washington, 311: 10.1922; Observation on living specimens of Iridia diaphana, a species of Foraminifera, Proc. U. S. Nat. Mus. 57: 154, 1920.

up of such Foraminifera. These same areas parallel very closely the distribution of Tertiary oil fields, and it is at least suggestive that there may be a relationship between the two.

This relationship of the Algae and the Foraminifera might well furnish an interesting problem for research, either from an economic or purely scientific point of view. So far as observations have been made, both green and brown Algae can assume this relationship with the Foraminifera, usually unicellular forms showing this relationship. These often give a definite color to the living Foraminifera which is not seen at all in the dried material.

BOTANY.—A new cannon-ball tree from Panama.¹ By C. V. Morton, National Museum. (Communicated by William R. Maxon).

Included among the plants of a recent collection made by Dr. A. F. Skutch in the vicinity of Almirante, Panama, and generously presented by him to the U.S. National Museum is a specimen of cannon-ball tree (Couroupita), which critical study shows to represent a new species, as suspected by Doctor Skutch in the field. It is described herewith, the specific name being in honor of Mr. Victor M. Cutter, President of the United Fruit Company, in recognition of generous support of many projects relating to tropical American botany.

Couroupita cutteri Morton & Skutch, sp. nov.

Very tall tree with widely spreading branches; branchlets glabrous, conspicuously marked with leaf scars; leaves clustered at the ends of the branchlets, alternate, nonpunctate, deciduous at flowering time; petiole short, about 10–12 mm. long, pubescent; lamina oblanceolate, 13–21 cm. long, very obtuse at apex, cuneate at base, minutely denticulate, glabrous, except in the axils of the veins beneath; secondary veins 16–18, conspicuously raised beneath; inflorescence paniculate, arising from the trunk and main branches, up to 50 cm. long; calyx of 6 sepals, 6 mm. long, 7.5 mm. broad, broadly rounded at apex, fleshy, thinner at margin, ciliolate; petals oblong, very fleshy, 4–4.5 cm. long, 3–3.5 cm. broad, greenish white outside, cream color within, ciliolate; androphore cream color, basal ring 17–18 mm. in diameter, the ring and the inner surface of the hood completely covered with fertile stamens; filaments of the basal ring clavate, 1 mm. long, those of the hood more elongate (about 3.5 mm.); anther cells divaricate at base; ovary 6-celled, fruit not seen.

Type in the U. S. National Herbarium, no. 1,409,624, collected in a pasture near base line, 15 miles from Almirante, Panama, in May, 1929, by A. F. Skutch (no. 19). Alcoholic specimens of the flowers are also preserved.

¹ Published by permission of the Secretary of the Smithsonian Institution. Received June 16, 1930.



Fig. 1. Couroupita cutteri, sp. nov.

The cannon-ball trees are apparently very rare in Central America. The present species and the recently described C. parviflora Standl. bring the known number up to five, all represented by very few collections. Of these C. cutteri is the largest-flowered and probably also the tallest. It is most closely related to C. darienensis Pittier, which has short racemes arising from the smaller branches, instead of panicles arising from the trunk. C. darienensis has, moreover, pinkish rather than cream colored flowers, which also are rather smaller.

The illustration is from a photograph of the tree from which the specimens were later taken. When photographed (March 8, 1929) it was not in flower.

BOTANY.—Some new species of Pythium.¹ Charles Drechsler, U. S. Department of Agriculture.

Although the fungi to be described herein are all referable to Pythium in the broader sense in which that genus has generally been understood, they include members of groups rather diverse in their more intimately distinctive morphological tendencies. Puthium dissotocum in its small degree of outward sporangial differentiation, approximates more closely than any of the others the condition described by Pringsheim (9) for P. monospermum Pringsh., which with the subsequent transfer of his P. entophytum to Lagenidium, remains as the obvious type of the genus. It therefore also comes closer than any of the others in conforming to the requirements for Schröter's (10) definition of his genus Nematosporangium which stipulates filamentous sporangia not wider than the mycelial hyphae. That in the choice of the generic name the one introduced in its present meaning by Pringsheim (9) was adopted, is to be attributed, however, less to the production by the fungus of slightly swollen dactyloid elements evidently essentially sporangial in nature, than to the unsoundness of Schröter's dispositions historically. For whatever may have been the propriety of Pringsheim's followers in bringing forms differing considerably from P. monospermum into the same fold, and whatever the utility of Fischer's (5) subdivision of the enlarged genus into three subgenera, there can be little doubt that Schröter's elevation to generic rank of the one of these subgenera to which had been assigned the very species that had originally formed the basis of the genus Pythium, was flagrantly in contravention of nomenclatorial stability. Nor apparently have the ill-advised dispositions of Schröter been sanctioned by use, as most authors of the past four decades have continued to

¹ Received July 15, 1930.

include species having other than subspherical sporangia among the members of the older genus.

In Pythium periilum and P. myriotylum are represented departures from the outwardly completely undifferentiated filamentous form of sporangium demanded by Schröter's definition of Nematosporangium wider than in P. dissotocum, as in these two fungi swollen lobulate elements occur more freely and constitute a larger proportion of the volume of the parts concerned in asexual reproduction. In P. periplocum the sporangia consist very largely of moriform aggregations of lobulate elements in comparison with which the undifferentiated mycelial parts are often altogether insignificant in volume. Assignment of a fungus having a sporangium consisting of distended elements in intricate arrangement to a genus of which the chief distinctive feature is by definition a filamentous sporangium not wider than the mycelial hyphae would seem rather obviously out of question.

The sporangia of $Pythium\ paroecandrum\ and$ of $P.\ salpingophorum$ are of typically subspherical form, those of the former species resembling in general the sporangia of $P.\ debaryanum$ Hesse, while those of the latter are noteworthy mainly because of the conspicuous distal widening of their individual evacuation tubes. The sporangia of $P.\ acanthicum\ and\ P.\ oligandrum\ likewise$ are often simply subspherical, but frequently, again, a filamentous part of varying length is included, or more especially in $P.\ oligandrum$, several subspherical elements communicate by connecting portions of filament, so that structures more or less transitional between subspherical and filamentous sporangia and between subspherical and lobulate sporangia, respectively, are brought about.

The sexual apparatus of *Pythium dissotocum* invites comparison with that of *P. debaryanum* inasmuch as it exhibits monoclinous antheridia both in proximate and in more distant mycelial relationship to the oogonium, while the regularly proximate origin of the monoclinous antheridia of *P. paroecandrum* provides a parallelism with *P. ultimum* Trow. In *P. periilum* the antheridia and the branching filaments supporting them are wrapped extensively and intimately about the oogonium in a manner suggestive of various species of Aphanomyces. Envelopment of the oogonium is effected also in *P. myriotylum*, though usually less extensively than in *P. periilum*, and never quite as intimately. However, the oogonia of *P. periilum*, owing here, to be sure, more to the rangy lobate antheridia spreading over the female organ as closely as the spiny configuration permits, than to the rather moder-

ately developed antheridial branches creeping closely between the spines.

The frequently somewhat lobate shape of the antheridium, the longitudinal application of the male organ to the oogonium, and the creeping of the antheridial stalk between the spiny protuberances of the female organ, prevalent in P. oligandrum, are indicative of a somewhat close relationship to P. periplocum, which, it may be admitted, the frequent parthenogenesis and the simpler construction of sporangium distinctive of the former species do little to sustain. A certain degree of relationship to P. periplocum is evidenced also by P. acanthicum in the production of a frequently lobate antheridium and its application lengthwise to the spiny oogonium. Accordingly, P. periplocum, P. oligandrum and P. acanthicum might perhaps well be regarded as members of a group articulating with P. artotrogus de Bary. It must be mentioned, however, that the very usual origin of the antheridial branch in P. acanthicum from the hypha bearing the oogonium and at a variable but mostly small distance from the female organ, provides a similarity with the arrangement of the sex organs in P. debaryanum and its allies, P. mamillatum Meurs and P. spinosum Sawada, which especially in the case of the latter two forms, would seem to be further sustained by the presence of numerous protuberances on the oogonium. However in P. acanthicum as in P. periplocum and P. oligandrum, the more delicate hyphae are much more extensively developed relative to the stouter hyphae than in members of the debaryanum series, and the oogonial protuberances usually taper noticeably from base toward apex instead of maintaining approximately the same diameter.

The sexual stage of *Pythium salpingophorum* is noteworthy chiefly because of the frequency of parthenogenetic development manifested by it. In regard to such development as well as to the frequent moniliform arrangement of its oogonia and the usual complete filling of the latter structures by their individual oospores, the species shows a striking resemblance to *P. papillatum* Mathews (7).

Although the fungus now to be described under the binomial *Pythium anandrum* was cited in an earlier note (3) as apparently having an intercalary antheridium in the frequently contorted distal portion of the oogonial stalk, it is now evident that the oogonial stalk serves no direct sexual function, and that the development of the oospore is consistently parthenogenetic. The spiny oogonial protuberances of this fungus are longer and more acutely pointed than those of any congeneric form hitherto described. In some instances an individual spine has been observed to have developed into a process measuring

30 to 40μ in length and widening midway to the tip into an expansion provided with secondary spiny protuberances and bearing internally a secondary oospore approximately 10 to 11μ in diameter. The combination of a sexual stage so unusual with a sporangium resembling that of a proliferous species of Phytophthora in all details except in that the zoospores are fashioned entirely in accordance with the asexual development characteristic of Pythium, makes P. anandrum one of the most anomalous members of the genus.

Pythium mastophorum and P. polymastum, in spite of the absence of any indication of a proliferous sporangial habit, represent species apparently most directly related to P. megalacanthum De Bary. In both fungi the mycelium is conspicuous for its haphazard disposition, and the sporangia are unusually tardy of development. The large oogonial protuberances that have suggested the specific terms submitted are perhaps even more distinctive because of the thickness of wall they exhibit and because of the mammiform shape they frequently assume than because of their extraordinary size.

Pythium helicoides, P. oedochilum, P. polytylum and P. palingenes are representatives of the group of species to which reference was made earlier in a brief abstract (4). The terminally borne, subspherical, proliferous sporangium with mostly apical evacuation tube which is characteristic of each of these representatives, corresponds well to that described and figured by various authors for Pythium proliferum De Bary. However in De Bary's account (1) of the sexual apparatus of the latter species, the antheridia were set forth in text and in figures as essentially similar to those of his P. debaryanum (i.e., P. ultimum) in shape as well as in relationship to mycelium and oogonium. In the four species under consideration the antheridium is a terminal, long, curved cylindrical structure applied lengthwise very tightly to the oogonium, and producing an evacuation tube from a navel rather than from an apical position. And the oospore is distinguished not only by an unusually thick wall, but also by an organization of contents different from that of the oospores of the generality of forms assigned to Pythium, a half dozen to a score of reserve globules and a few to a dozen of refringent bodies being distributed with some uniformity through a densely granular matrix. Protrusion of the oogonium where in contact with antheridia, involvement of hyphal elements supporting the oogonium by those supporting an antheridium, occurrence of granular residues between ripe oospore and oospore wall, and pronounced yellow coloration of oogonium and oospore, are among the

402

additional features displayed in varying measure by one or another of the species.

In the literature only Dissmann's (2) figures of the elongated antheridium of his Pythium proliferum shows unmistakable evidence of affinity with the group of proliferous forms under consideration. Examination of the fungus investigated by Kanouse (6) under the name Pythiomorpha gonapodioides Petersen reveals it as similarly a member of the same series, although her publication, except for its description of the clasping antheridium, gives the impression of having been based on a proliferous species of Phytophthora. It is to be noted that the illustrated description of the sexual stage given by Minden (8) for his Puthiomorpha gonapodioides sets forth a clavate or ellipsoidal antheridium making apical contact with the base of the oogonium—a relationship unlike that found in members of the helicoides series as well as unlike that mentioned by Kanouse. Indeed Minden's account of the sexual apparatus of Pythiomorpha gonapodioides rather supports the conclusion to be drawn from his statement of mycelial characters and his description of sporangial development, that under the binomial mentioned, he, like Petersen before him, dealt with a proliferous species of Phytophthora.

Of the species herein described, three at least are definitely known to be of economic importance as parasites of cultivated plants. Pythium periplocum is responsible for some very small loss in destroying watermelon fruits. P. acanthicum is often energetically destructive of watermelon fruits, causing on the whole several times as much damage to this particular product than all other species of Pythium combined. P. myriotylum though apparently not closely related to P. butleri Subr. exhibits the same sort of aerial parasitism, and like the latter species is to be reckoned among the most destructive members of the genus. During periods of high humidity it similarly puts forth a profuse growth of aerial mycelium that through the production of an extraordinary number of appressoria, fastens upon and penetrates into any host structures it may chance to encounter. The fungus would seem however to have a more limited range than P. butleri, in the United States being encountered frequently only in the more southern latitudes.

Pythium dissotocum sp. nov.

Intramatrical mycelium somewhat lustrous, capable of approximately 18 mm. radial extension in 24 hours at 24° C., the relatively straight axial hyphae mostly 3.5 to 6μ , more rarely up to 7μ in diameter, the branching elements of more irregular course, mostly 2 to 4μ in diameter; under aquatic

conditions extramatrical mycelium meager, the hyphae sometimes as narrow as 1.5μ . Appressoria borne terminally on more delicate intramatrical branches in moderate number, often curved clavate, the distal part about 7μ in diameter. Aerial mycelium usually absent though sometimes very spar-

ingly present.

Sporangia usually consisting entirely of undifferentiated mycelial filaments, but at times including somewhat swollen dactyloid lateral elements, simple or sparingly branched, 5 to 8μ in diameter. Evacuation tube sometimes more than 1 mm. in length, 1.5 to 4μ in diameter, widening at the refringent tip to a diameter of 2.5 to 9μ . Zoospores usually 10 to 75 in a vesicle, but sometimes in excess of 100, after rounding up usually 8 to 9μ in diameter, germinating usually by a single germ tube 1.5 to 2μ in diameter, or diplanetic through production of an evacuation tube 1 to 1.5μ in diameter, and up to 12μ in

length.

Ogonia terminal, intercalary or laterally intercalary, provided with a smooth sturdy wall approximately 0.8μ in thickness, subspherical, measuring 12 to 32μ , usually 17 to 25μ (average 20.7μ) in diameter, the delimiting septum or septa frequently inserted somewhat beyond the spherical contour, so as to include at either or both ends a cylindrical part up to 8μ in length. Antheridia usually crook-necked, mostly 5 to 8μ in diameter near apex, measuring individually 6 to 16μ along curved axis from apex to basal septum, the apical end often somewhat flattened and thus making broad contact with oogonium about a short fertilization tube approximately 1.4μ in diameter; varying in number usually from 1 to 3, 4 or 5 rarely present; when plural, each usually autonomous in origin; often sessile on the oogonial filament immediately adjacent to oogonium, or borne terminally on branches arising from a neighboring filament or from the oogonial filament often in immediate proximity to oogonium or at a variable distance from it. Oospore smooth, colorless or slightly yellowish, usually very largely though not completely filling oogonium, 11 to 27μ , mostly 15 to 21μ (average 17.6μ) in diameter, with a wall 1.0 to 2.2μ , mostly 1.3 to 1.8μ (average 1.5μ) in thickness, a reserve globule 5 to 17μ , mostly 7 to 10μ (average 8.4μ) in diameter, and a refringent body oblate ellipsoidal or subspherical in shape, in latter case mostly 3.5 to 5μ in diameter.

Type culture isolated from diseased rootlets of Saccharum officinarum L.

collected near Thibodaux, La., April, 1927.

Pythium periilum sp. nov.

Intramatrical mycelium often of lustrous, cumulous appearance, capable of approximately 18 mm. radial extension in 24 hours at 24°C., the relatively straight axial hyphae mostly 3.5 to 5μ , rarely up to 6μ in diameter, the branching elements of more irregular course mostly 2 to 3.5μ in diameter; extramatrical mycelium under aquatic conditions meager, the hyphae sometimes as narrow as 1.5μ . Appressoria knob-like, borne terminally on finer intramatrical branches in moderate number or more abundantly, often 7μ in width and 7 to 10μ in length. Aerial mycelium absent, or on richer substrata present in small quantity as a shallow felty layer that collapses with age.

Sporangium consisting sometimes entirely of undifferentiated mycelial elements, but generally composed in part of sparingly distributed inflated dactyloid elements usually 6 to 8μ , rarely 8 to 12μ in diameter, and sometimes constituted in larger part of such inflated elements, which then are often concentrated in closely arranged branching systems though not in intricate complexes. Evacuation tube often 0.1 to 0.5 mm. in length, mostly

about 3μ in diameter, but in the distal part widening to a diameter of 5 to 6μ . Zoospores up to 75 in a vesicle, after rounding up usually 8 to 9μ in diameter,

germinating usually by a single germ tube 1.5 to 2μ in diameter.

Oogonium terminal or more often intercalary, provided with a smooth wall approximately 0.5 \mu in thickness, subspherical, measuring usually 16 to 22μ (average 18.8μ) in diameter, the delimiting septum or septa frequently inserted somewhat beyond the spherical contour, so as to include at either or both poles a cylindrical part up to 4μ in length. Antheridia crook-necked. mostly 4 to 5μ in diameter in median or distal part, measuring individually 7 to 14u along curved axis from apex to basal septum, the bluntly rounded apical end making narrow contact with oogonium about a very short fertilization tube approximately 1μ in diameter, the proximal part usually tapering somewhat more gradually toward delimiting septum to diameter of supporting filament; varying in number usually from 2 to 5, borne terminally or less frequently laterally, all on branching prolongations of a single hypha originating sometimes from the oogonial hypha at some distance, rarely less than 50μ , from the oogonium, or more frequently from a neighboring filament: the branching prolongations bearing the antheridia together usually with several similar vegetative prolongations being wrapped rather extensively and rather closely about the oogonium, and very frequently though not always as closely, about the adjacent portions of the oogonial filament. Oospore colorless or somewhat yellowish, smooth, completely or nearly completely filling the oogonium, 14 to 20μ (average 17.3μ) in diameter, with a wall 1.1 to 1.8μ (average 1.5μ) in thickness, a reserve globule usually 7 to 11μ (average 8.9µ) in diameter, and a refringent body oblate ellipsoidal or subspherical in shape, in latter case measuring on the average 4.2 u in diameter.

Isolated from diseased rootlets of Saccharum officinarum L. collected near

Thibodaux, La., April, 1927.

Pythium myriotylum sp. nov.

Intramatrical mycelium somewhat diffuse in appearance, capable of approximately 34 mm. radial extension in 24 hours at 24° C., the younger actively growing hyphae 2.5 to 4μ , mostly 3 to 4μ in diameter, the older axial hyphae often up to 7μ in diameter, and occasionally attaining a diameter of 8.5μ previous to degeneration; provided with numerous appressoria in the form of swollen clavate or knob-like terminations 7 to 11μ in diameter at the adhering apex. Under aquatic conditions extramatrical mycelium copious, often with numerous appressoria. Aerial mycelium under humid conditions very copious, adhering to solid bodies through the production of very numerous appressoria usually in large densely branching clusters or brush-like groups, each cluster or group including frequently 10 to 75 or more appressoria.

Sporangia terminal or intercalary, consisting sometimes of portions of outwardly undifferentiated filaments, delimited by septa or more massive plugs, the portions measuring 0.1 to 0.3 mm. in length and 3 to 7μ in diameter; but more often including a number of swollen lobulate or digitate elements attached laterally in open arrangement, or sometimes consisting for the most part of swollen elements which then are usually present in denser branching arrangements; the swollen elements highly variable in size, measuring 10 to 175μ in length and 7 to 17μ in diameter, though mostly not exceeding 50μ in length and 12μ in diameter. Evacuation tube often a prolongation of undifferentiated sporangial filament, but frequently arising as a special structure from swollen element or laterally from filamentous part; measuring 10 to 100μ or more in length and 2 to 3.5μ in diameter at base, widening usually

only slightly to a diameter of 4 to 6μ below somewhat expanded refringent apex; often failing to function effectively, then becoming set off in whole or in part by septum or plug, followed by production of another tube. Zoospores formed 3 to 40 in a vesicle, longitudinally grooved, broadly reniform, biciliate, 9 to 16μ , mostly 10 to 12μ (average 11μ) in diameter, germinating

usually by a single germ tube, 2.5 to 3μ in diameter.

Oogonia terminal or intercalary, smooth, provided with a wall 0.5 to 1μ , mostly 0.7 to 0.8μ in thickness, subspherical, 15 to 44μ in diameter, when most abundantly and normally developed 15 to 33μ , mostly 23 to 30μ (average 26.5μ) in diameter. Antheridia up to 10, usually 3 to 6 to an oogonium; terminally expanded, clavate, often crook-necked or arched, the proximal end of the individual male organ frequently in contact with oogonium, the middle part upcurved, the broadened rounded apex rather narrowly applied and bearing the usually short (1 to 3μ long), narrow (1 to 1.5μ wide) fertilization tube; measuring 4 to 8μ in diameter and 8 to 30μ in length, but more normally mostly 4.5 to 7μ in diameter and 8 to 16μ in length, borne terminally or somewhat laterally on branches often loosely or more intimately enveloping the oogonium, and supplied from 1 to 3 parent hyphae not demonstrably connected with the oogonial filament or connected with the latter at a distance usually in excess of 100μ from the oogonium. Oospore colorless or yellowish; subspherical, 12 to 37μ in diameter with a wall up to 2μ in thickness and a reserve globule up to 18μ in diameter, but when most abundantly and normally developed, 12 to 26μ , mostly 18 to 24μ (average 20.8μ) in diameter, provided with a wall 1.3 to 1.9μ (average 1.6μ) in thickness, and containing a reserve globule 6 to 12μ (average 9.8μ) in diameter, and a refringent body, subspherical or sometimes strongly flattened, measuring when subspherical mostly 3.5 to 5μ in diameter.

Causing a decay of fruits of *Cucumis sativus* L. in South Carolina, of fruits of *Citrullus vulgaris* Schrad. in Florida and Georgia, of fruits of *Solanum melongena* L. in Florida; and isolated from discolored rootlets of *Lycopersicum*

esculentum Mill. in South Carolina.

Pythium periplocum sp. nov.

Intramatrical mycelium somewhat lustrous, capable of approximately 25 mm. radial extension in 24 hours at 24°C., consisting while in active growth of filaments 1.2 to 4.8μ , mostly 1.8 to 4.2μ in diameter, later including somewhat larger hyphae with thicker walls, measuring up to 8.5 or 9μ in diameter; the more delicate ramifications very irregular in course, often present as luxuriantly and densely branching systems. Under aquatic conditions extramatrical development rather meager. Aerial mycelium usually scanty,

though on rich substrata present in some quantity.

Zoosporangia appearing promptly and in moderate abundance; mostly intercalary though often terminal or lateral; consisting usually very largely of branching digitate or lobulate elements, measuring 10 to 30μ in length and 8 to 20μ , mostly 10 to 15μ , in diameter,—these elements frequently assembled in numbers up to 20 or 25 in an intricate moriform arrangement together with 1 or several contiguous filamentous parts usually not exceeding 75μ in combined length; larger moriform complexes composed of more than 30 or 40 swollen elements, frequently becoming evacuated through 2 or 3 tubes, constituting compound or plural sporangia. Evacuation tube 50 to 500μ in length, arising from inflated element or less frequently from undifferentiated filamentous part, measuring 2 to 4.5μ in diameter at the base, widening usually to a diameter of 3 to 8μ below the refringent apex; after discharge the tip

sometimes reflexed. Zoospores formed usually up to 125 in a vesicle, longitudinally grooved, broadly reniform, biciliate, briskly active, measuring 8 to

 11μ , mostly 9 to 10μ in diameter after rounding up.

Oogonia terminal or intercalary; subspherical, measuring 13 to 32μ , mostly $22 \text{ to } 28\mu \text{ (average } 24.6\mu)$ in diameter, not including the spiny protuberances of which 25 to 65 are usually visible in upper and equatorial aspects and which measure 2 to 4μ (average 2.8μ) in length and 1.4 to 3μ (average 1.8μ) at the base from which they taper somewhat toward the rounded apex; provided with a wall approximately 0 6 \mu in thickness that becomes attentuated to approximately 0.3\mu in the protuberances. Antheridia usually 1 to 4 in number, usually supplied from 1 or from 2 hyphae not closely connected with the oogonial hypha; sometimes consisting of a simple clavate part, but more regularly longer measuring 15 to 30u or more in length, markedly lobed, the several lobes mostly 5 to 10μ in length and 5 to 8μ in diameter, disposed either in series or in branching arrangement, but in any case each making contact ventrally with the oogonium, the rangy male organs together frequently with distal portions of the branching hyphal elements supporting them thus rather intricately and extensively wrapped about the oogonium,—each antheridium giving rise usually to only a single, narrow, rather short, inconspicuous fertilization tube. Ospores smooth, colorless or yellowish, not filling oogonium completely; subspherical, measuring 11.5 to 27μ mostly 18 to 24μ (average 21.2μ) in diameter; provided with a wall 0.7 to 1.9μ (average 1.4μ) in thickness, and containing a reserve globule 6.2 to 13.6μ (average 10.7μ) in diameter and a refringent body, subspherical or somewhat flattened, measuring when subspherical usually 4 to 5μ in diameter.

Causing occasional instances of blossom-end decay of fruits of *Citrullus vulgaris* L., manifested outwardly by a dark brown or bluish brown discolora-

tion, in Virginia and Maryland.

Pythium paroecandrum sp. nov.

Intramatrical mycelium somewhat lustrous, of radiating aspect, capable of approximately 15 mm. radial extension in 24 hours at 24°C., composed of hyphae 2.7 to 9μ in diameter, the relatively straight axial ones well supplied with sturdy branches, which may bear appressoria in moderate or more considerable number as curved clavate terminations 8 to 11μ in diameter, often developing into systems of connected sickle-shaped structures. Aerial mycelium often absent or present only in moderate or in meager quantity; under aquatic conditions, extramatrical growth rather scanty.

Sporangia formed promptly, mostly intercalary though occasionally lateral or terminal, subspherical or often prolate ellipsoidal 12 to 30μ in transverse diameter. Evacuation tube arising indiscriminately from any part, generally 3 to 30μ in length, and 2 to 5μ in diameter at the base, frequently widening toward the apex and thus attaining a diameter of 2.5 to 7μ below refringent tip. Zoospores usually 3 to 25 in a vesicle, biciliate, reniform,

measuring 9 to 11μ in diameter after rounding up.

Oogonia usually intercalary, smooth; subspherical, though often prolonged at either end or both ends; measuring 11 to 28μ , mostly 18 to 25μ (average 21.4μ) in transverse diameter; with a wall 0.4 to 0.9μ , mostly 0.6 to 0.7μ thick, not readily collapsing after maturity. Antheridia 1 to 5 to an oogonium, of monoclinous or diclinous origin: When of monoclinous origin sometimes consisting of an outwardly undifferentiated segment of hypha adjacent to the oogonium, mostly 7 to 15μ in length and 4 to 7μ in diameter; sometimes of a somewhat swollen adjacent segment; sometimes of an adjacent segment

together with a bulbous lateral outgrowth from which the fertilization tube is produced; sometimes of a sessile pouch-like or crook-necked structure, measuring mostly 7 to 15μ in length and 6 to 8μ in diameter, arising proximate to the oogonium; sometimes of an inflated and often crook-necked terminal structure borne on a branch arising in proximate relation to the oogonium, together often with a proximal or distal cylindrical part; sometimes of an intercalary portion of an antheridial process arising in such proximate relationship, and including generally a cylindrical part in addition to an inflated part; a sessile antheridium or antheridial branch or antheridial process occasionally arising from a functional adjacent antheridium; an antheridial process occasionally composed of two antheridia in series; and when two or more oogonia are formed adjacent to one another on the same hypha, the sessile antheridium or antheridial stalk or antheridial process supplying one oogonium often coming to have origin from the juxtaposed (and presumably younger) oogonium. Antheridia of diclinous origin mostly terminal expanded structures, often crook-necked, resembling branch antheridia of monoclinous origin, measuring mostly 6 to 8μ in diameter at the distal expanded part, and 10 to 20μ in length; rarely consisting of an intercalary portion of hypha bearing a broad protuberant part. Contact of antheridium with oogonial wall other than at delimiting septum usually moderately narrow, the oogonial membrane often lipped about the fertilization tube, which latter measures mostly 1 to 4μ in length and 1.2 to 3μ in diameter. Oospores colorless or vellowish, smooth, subspherical, 10 to 22μ , mostly 16 to 21μ (average 18.3μ) in diameter, provided with a wall 0.6 to 1.6μ , mostly 1.1 to 1.5μ (average 1.3μ) in thickness, containing a reserve globule 6 to 14 μ , mostly 10 to 13 (average 11.5μ) in diameter, and a refringent body, subspherical, with a diameter of 3.5 to 4.5μ , or often more or less flattened.

Isolated from discolored root of Allium vineale L. collected near McLean,

Va., May, 1925.

Pythium salpingophorum sp. nov.

Intramatrical mycelium somewhat lustrous, of pronounced radial appearance, capable of approximately 22 mm. radial extension in 24 hours at 24 °C., composed of hyphae 1.5 to 7μ , mostly 2 to 5.5μ in diameter, bearing appressoria in moderate number as clavate terminations mostly 7 to 8.5μ at the adhering apex, often developing into systems of connected sickle-shaped elements. Under aquatic conditions extramatrical mycelium meager or of

moderate quantity. Aerial mycelium usually absent.

Sporangia formed promptly and in great numbers; sometimes terminal but mostly intercalary often only a short distance from the tip of the supporting filament, the short distal element of the latter, often 5 to 15μ in length, thus frequently borne as an apical appendage; subspherical, 17 to 33μ , mostly 21 to 29μ (average about 24μ) in diameter; occasionally though not regularly proliferous, the secondary sporangium being borne within the primary one. Evacuation tube arising from any part of sporangium but especially frequently in proximate relation to one or the other of the delimiting septa; generally 3 to 45μ in length and 1.5 to 3μ in diameter at base, but widening often up to a diameter of 11μ toward the apex, the membrane of the frequently pestle-like apical enlargement often flaring backward after discharge. Zoospores formed usually 15 to 40 in a vesicle; longitudinally grooved, broadly reniform, biciliate; often very sluggish in movement and soon coming to rest; after rounding up, measuring usually 7.5 to 9.2μ (average 8.5μ) in diameter.

Oogonia borne on hyphae usually 2 to 3μ , rarely up to 4μ in diameter:

terminal or intercalary, often laterally or tangentially intercalary; subspherical, measuring 11 to 22μ , mostly 13 to 19μ (average 15.8μ) in transverse diameter, delimited by septa or irregular plugs inserted sometimes at a distance from juncture of subspherical part with cylindrical filament and thus often including a portion of latter at one or two ends up to 15μ , usually 2 to 5μ , in length; often occurring adjacent to one another in series of 2 to 5 individuals, then sometimes without separating partitions; developing parthenogenetically in most (approximately 3 out of 4) instances, in other instances supplied with 1 or more rarely 2 antheridia. Antheridia arising sometimes from a filament not closely related to the oogonial hypha, then often lateral, sessile and straight; but more often arising from the oogonial hypha proximate to the oogonium, then usually strongly crook-necked; in either case measuring mostly 10 to 20μ in length and 3.5 to 6μ in diameter, individually usually producing a short, narrow fertilization tube, though sometimes without delimiting septum, without fertilization tube, non-functional. Oospore colorless or yellowish, subspherical, usually filling completely the spherical part of oogonium and fusing indistinguishably with the portion of oogonial wall in contact with it, measuring 10 to 19μ , mostly 12 to 18μ (average 14.6μ) in diameter, provided with a wall mostly 0.8 to 1.5μ (average 1.2μ) in thickness, a reserve globule 4.5 to 10μ (average 6.3μ) in diameter and a refringent body subspherical or somewhat flattened which when subspherical measures mostly 3 to 4μ in diameter.

Isolated from decaying roots of Pisum sativum L. collected near Eden,

N. Y., June, 1924.

Pythium acanthicum sp. nov.

Intramatrical mycelium lustrous, often of cumulous appearance, though frequently highly diaphanous and therefore inconspicuous, capable of approximately 14 mm. radial extension in 24 hours at 24 °C., composed of hyphae 1.3 to 5.6μ in diameter, mostly 2 to 4.5μ while in actively growing condition, the more delicate of the filamentous elements of irregular course and abundantly developed. Extramatrical mycelium under aquatic conditions meager. Aerial mycelium usually absent, sometimes occurring in very small quantity.

Sporangia produced fairly promptly; sometimes terminal but more often intercalary in position; sometimes subspherical, 12 to 43μ in diameter, but as frequently consisting individually of a subspherical part together with a contiguous portion of filament that may be relatively short or up to 75μ or more in length, in latter case often including one or more branches; or consisting of 2 or more subspherical or irregularly swollen parts communicating by a filamentous part or parts. Evacuation tube arising from subspherical parts or from filamentous part, but especially frequently from near the junction of the two; measuring 10 to nearly 200μ (mostly 20 to 60μ) in length, 2.5 to 4μ in diameter at the base, often widening somewhat toward the apex, the open termination after evacuation mostly 4 to 6μ in diameter, rarely as much as 9μ ; often marked by numerous irregularities in course. Zoospores produced 5 to 50, usually 15 to 30 in a vesicle, biciliate, longitudinally grooved, broadly reniform, decidedly active, after rounding up measuring usually 8 to 9.5μ in diameter.

Organium sometimes terminal especially on shorter branches, but much more frequently intercalary, often laterally or tangentially intercalary; provided with a wall usually 0.4 to 0.6μ in thickness; subspherical, 13 to 30μ , mostly 19 to 28μ (average 23.7μ) in diameter, not including the spiny protuberances of which 20 to 55 are usually visible in upper and equatorial

aspects; the protuberances with a wall approximately 0.3μ thick, measuring 1.5 to 5μ (average 2.7μ) in length and 1 to 3μ (average 1.9μ) in diameter at the base from which they usually taper rather slightly toward the bluntly Antheridium, except in occasional cases when 2 male organs are present, occurring singly; borne terminally on a branch occasionally arising from a hypha other than the oogonial hypha and without close mycelial connection with the latter, but much more frequently arising from the oogonial hypha at variable distances usually not exceeding 25µ and mostly not exceeding 10 or 15μ from the septum delimiting the oogonium, the stalk then frequently of somewhat irregular course, measuring mostly 0.5 to 3μ in diameter and 6 to 33μ in length; inflated clavate, straight or crook-necked, measuring mostly 8 to 17μ in length and 5 to 9μ in diameter; the longer ones often with 1 or 2 transverse constrictions and therefore somewhat lobate; sometimes applied rather broadly by the apex, but more often, especially the longer ones applied frequently together with a short distal portion of the supporting stalk lengthwise to the oogonium. Oospore smooth, colorless or often yellowish; usually occupying the oogonial cavity almost completely, though without adhering to oogonial wall; subspherical, measuring 12 to 27μ , mostly 17 to 26μ (average 21.7μ) in diameter; provided with a wall 1.3 to 2μ (average 1.6μ) in thickness; often remaining for extended period with 6 to 12 reserve globules, but in more fully matured condition revealing a single reserve globule, 5.5 to 12μ (average 9μ) in diameter, and a single refringent body, subspherical or flattened, when subspherical measuring 3.5 to 5μ in diameter; germinating by the production of several germ tubes, or often without extended resting period developing as a sporangium by discharge of contents through an evacuation tube.

Causing a blossom-end rot of the fruit of *Citrullus vulgaris* L. manifested outwardly by a dark brown or bluish brown discoloration, in Florida, Georgia, Missouri, Indiana, and with greater destructiveness in Maryland and Virginia.

Pythium oligandrum sp. nov.

Intramatrical mycelium somewhat lustrous, sometimes of somewhat cumulous appearance, capable of approximately 27 mm. radial extension in 24 hours at 24 °C.; composed of hyphae 1.5 to 6.8μ in diameter, the more delicate elements ramifying freely and developing extensively though not usually occurring in excessively compact branching systems. Under aquatic conditions extramatrical development rather profuse. Aerial mycelium usually present

in some quantity, on richer substrata in moderate abundance.

Sporangia formed promptly and abundantly; terminal or more often intercalary; mostly subspherical, 25 to 45μ in diameter, but often consisting of a subspherical element together with a variable length usually up to 50 or 75μ , of filament modified little if at all, or consisting of 2 to 5 subspherical elements sometimes fused into a somewhat irregular structure, and sometimes connected by undifferentiated filamentous portions either in a series or in branching arrangement. Evacuation tube arising from any part of sporangium but especially frequently from near juncture of subspherical part with filamentous part, usually up to 35μ or more in length, mostly 2 to 4μ in diameter at base, generally widening to a diameter of 3.5 to 6.5μ toward the expanded apex. Zoospores formed mostly 20 to 50 in a vesicle, longitudinally grooved, broadly reniform, biciliate, moderately active, measuring usually 9 to 10μ (average 9.4μ) after rounding up.

Oogonia terminal or intercalary, often intercalary close to tip of the supporting filament, and often laterally or tangentially intercalary; provided

with a wall approximately 0.5 to 0.7μ in thickness; subspherical, measuring 17 to 35μ , mostly 22 to 31μ (average 26.4μ) in diameter, not including the spiny protuberances of which from 15 to 125, mostly 35 to 75, are visible in upper and equatorial aspects,—the spiny protuberances mostly 3 to 7μ (average 3.9μ) in length and 1.5 to 3.5μ (average 2.2μ) in diameter at base. tapering usually markedly toward the rather sharply pointed apex, sometimes somewhat irregular and jagged in profile, with membrane usually approximately 0.3 \(\mu \) in thickness; in most (approximately 4 out of 5) cases developing parthenogenetically, in other cases supplied with 1 or less often 2 antheridia. Antheridium borne terminally on branch arising usually from a hypha other than the one bearing oogonium, the branch in distal portion for length of 5 to 25μ usually closely applied to oogonium; measuring 12 to 25μ (usually approximately 18μ) in length and 5.5 to 8μ in diameter in the more inflated distal part; when relatively short usually clavate and somewhat crooknecked, when longer often divided into 2 or 3 lobes by transverse constrictions; in any case applied lengthwise closely to the oogonium, the short fertilization tube produced from near the apex. Oospore colorless or yellowish; subspherical, 15 to 30μ , mostly 19 to 27μ (average 23.1μ) in diameter; provided with a wall 0.9 to 2.2μ (average 1.5μ) in thickness and containing a reserve globule 6 to 14.5\mu (average 9.6\mu) in diameter; refringent body often not clearly in evidence, when visible often subspherical, 3 to 4.5μ in diameter. Isolated from discolored rootlet of Pisum sativum L. collected near Eden,

Pythium anandrum sp. nov.

N. Y., June, 1924.

Intramatrical mycelium of radiating aspect, only slightly lustrous, capable of approximately 22 mm. radial extension in 24 hours at 24°C., composed of relatively straight axial hyphae mostly 5 to 8.3μ in diameter, bearing shorter, more irregularly disposed ramifying branches usually 3.5 to 5μ in diameter. Extramatrical mycelium under aquatic conditions rather meager, delicate, the hyphae often as narrow as 2μ . Aerial mycelium absent or when present, scanty and loosely arachnoid.

Sporangia borne terminally on simple or sparingly branched filaments which measure, except in the frequently expanding distal portion, 2 to 3μ in diameter and often up to 2 or 3 mm. in length, or later through continuation of growth by the supporting filament from immediately below the delimiting septum, sometimes occupying a lateral position; elongated,prolate ellipsoidal, measuring 18 to 40μ (average 25.3μ) in diameter by 32 to 85μ (average 50.4μ) in length exclusive of the usually sessile papilla of dehiscence mostly 6 to 8μ in basal diameter and 3 to 5μ in length; occasionally proliferous, mostly by the sporangiophore growing through the empty sporangium to produce another sporangium farther on. Vesicle usually sessile on the sporangium, developing 8 to 30 zoospores; the latter biciliate, reniform, somewhat sluggish in movement, measuring mostly 12 to 14μ (average 13μ) in diameter on rounding up.

Oogonia borne terminally on branches often somewhat irregular or contorted and frequently widening toward the rather broad, usually convexly protruding delimiting septum; subspherical 12 to 33μ , mostly 23 to 32μ (average 28.3μ) in diameter exclusive of the conically spiny protuberances, of which 35 to 65 are usually visible in upper and equatorial aspects, and which on firm substrata measure mostly 2 to 4μ (average 2.8μ) in basal diameter and 3 to 11μ (average 7.1μ) in length, though under aquatic conditions often not exceeding 1μ in basal diameter and 2μ in length; provided with a

wall of moderate thickness, this thickness usually between 0.5 and 0.8μ becoming reduced somewhat in the spiny protuberances; constantly parthenogenetic, developing in the absence of any recognizable antheridia. Oospore colorless or yellowish, largely filling oogonium, smooth, subspherical, 11 to 28μ , mostly 21 to 27μ (average 24.4μ) in diameter, provided with a wall 0.8 to 2.1μ , mostly 1.2 to 1.8μ (average 1.6μ) in thickness, the reserve globule measuring 7 to 16μ , mostly 10 to 14μ (average 12.8μ) in diameter, and the refringent body when subspherical measuring mostly 4 to 5μ in diameter, though frequently somewhat flattened.

Isolated from softened underground bud of Rheum rhaponticum L. col-

lected near Brentwood, Md., June 13, 1924.

Pythium mastophorum sp. nov.

Intramatrical mycelium without pronounced luster or radiating aspect, capable of approximately 20 mm. radial extension in 24 hours at 24°C., consisting of hyphae 2 to 7.8μ in diameter, often somewhat contorted and typically disposed in haphazard, irregular course, bearing in moderate number appressoria mostly knob-shaped, 8 to 12μ in diameter, or less often sickleshaped. Extramatrical growth under aquatic conditions sparse. Aerial

mycelium absent or scantily developed.

Sporangia not known to be proliferous, subspherical, usually 17 to 38μ (average 29.3μ) in diameter, somewhat darkly opaque, terminal or intercalary, in latter case often near tip of supporting hypha. Evacuation tube arising indiscriminately from any portion of sporangium, mostly 15 to 125μ in length and 2.5 to 8μ in diameter, often more or less contorted, sometimes bearing 1 or several short diverticulations, the apical portion below refringent tip widening little, if at all; frequently ineffective for discharge and then often 0.2 or 0.3 mm. in length. Zoospores formed 3 to 14 or sometimes more in a vesicle, biciliate, broadly reniform, usually somewhat sluggish in movement,

after rounding up measuring 12 to 14μ in diameter. Oogonium when primary in origin borne usually terminally on a branch commonly 5 to 25μ long, subspherical, 24 to 48μ , mostly 30 to 41μ (average 35μ) in diameter exclusive of the spiny protuberances that number usually 25 to 75 in upper and equatorial aspects; the spiny protuberance conical or often mammiform, measuring on firm substrata 2 to 8μ (average 5.2μ) in length and 2 to 6μ (average 4.3μ) in diameter at the base, where its wall is often approximately 1μ in thickness to become usually noticeably attenuated toward the frequently papillate apex at which the lumen yet often becomes very narrow; under aquatic conditions protuberances more minute, often not exceeding 2μ in length and 1μ in diameter. Antheridium usually single; borne usually terminally or more rarely in intercalary position on a hypha without close connection with the oogonial branch; variously shaped, often somewhat lobate, 7 to 15μ (usually approximately 12μ) in diameter and 16 to 28μ (usually approximately 20μ) in length; making broad apical contact with the organium about the origin of a fertilization tube generally measuring 1.5 to 4μ in diameter and 1.5 to 3μ in length; the antheridium and the distal part of its supporting hypha often though not always closely engaging the oogonial stalk and the basal portion of the oogonium, the engagement sometimes made more intimate through the presence of diverticulations. Oospore colorless or somewhat yellowish; smooth, subspherical, when primary in origin measuring 20 to 44μ , mostly 24 to 36μ (average 28.9μ) in diameter, provided with a wall 1.4 to 2.3μ (average 1.8μ) in thickness, containing a reserve globule 12 to 18μ (average 15.5μ) in diameter, and a refringent body subspherical or oblate ellipsoidal in shape, measuring when subspherical usually 4 to 6μ in diameter, germinating by the production of a germ tube, or under aquatic conditions, often developing as a sporangium with the dis-

charge of contents through an evacuation tube.

Primary oogonium under some conditions frequently producing instead of an oospore, an endogenous secondary oogonium which is often similarly though usually more sparingly provided with protuberances, but is of inferior size, the smaller ones often little more than 20μ in diameter, and produces a proportionately smaller oospore, the diameter of the latter sometimes little exceeding 15μ , or occasionally gives rise to an endogenous tertiary oogonium within which the small oospore is produced.

Isolated from discolored root of Bellis perennis L. collected in Washington,

D. C., June, 1927.

Pythium polymastum sp. nov.

Intramatrical mycelium of diffuse appearance, capable of approximately 19 mm. radial extension in 24 hours at 24°C., consisting of hyphae 2.5 to 9.5μ in diameter, haphazard in disposition and branching habit, usually devoid of recognizable appressoria. Under aquatic conditions extramatrical mycelium sparse or nearly moderate in quantity. Aerial mycelium absent,

or if present, rather scanty and floccose.

Sporangia not known to be proliferous; somewhat darkly opaque; borne on extramatrical hyphae, sometimes formed terminally, though then later often coming to have a lateral position through continuation of growth of the supporting filament, or somewhat more often originating in intercalary position frequently a short distance from tip of supporting hypha, the distal element of latter then present as an apical appendage; usually subspherical, often noticeably oblate measuring 20 to 36μ (average approximately 30μ) in diameter, but sometimes of rather irregular shape through presence of 1 or more dome-shaped protuberances, or even composed of 2 or 3 subspherical parts fused into a lobate structure. Evacuation tube arising indiscriminately from any portion of sporangium, measuring mostly 14 to 55μ (average approximately 30μ) in length and 4.5 to 7.5 μ in diameter. Zoospores formed 2 to 12 or sometimes more in a vesicle, longitudinally grooved, biciliate, broadly bean-shaped, usually somewhat sluggish in movement, often 18μ in length and 13μ in diameter, after rounding up measuring usually 14 to 17μ in diameter.

Oogonia usually borne terminally on branches infrequently more than 100μ , usually less than 50μ and often less than 10μ long, though sometimes lateral and sessile on the parent filament; subspherical, measuring 29 to 67μ , mostly 29 to 58μ (average 45.6μ) in diameter, exclusive of the spiny protuberances of which usually from 10 to 125 (average approximately 55) are visible in upper and equatorial aspects; the spiny protuberance conical or often characteristically mammiform, measuring 1 to 10μ (average 5.5μ) in length and 2.5 to 6.5μ (average 4.5μ) in diameter at the base, where its wall is 0.8 to 1.4μ in thickness to become usually noticeably attenuated toward the frequently narrowed papillate apex at which the lumen yet often becomes very narrow. Antheridia 1 to 4 in number; usually terminal on branches without close mycelial connection with the oogonium, or sometimes intercalary, then mostly intercalary a short distance from tip of supporting hypha, or sometimes lateral and sessile on the parent filament; variously shaped, broadly saccate

or cylindrical or barrel-shaped, often with diverticulate or cupulate protuberances, or sometimes markedly lobate; measuring mostly 20 to 43μ (average approximately 27μ) in length and 12 to 21μ (average approximately 15μ) in diameter; making broad apical contact with the oogonium about the origin of a fertilization tube sometimes approximately 4μ long and 2.5 to 3.5μ in diameter; 1 antheridium and the distal part of its supporting stalk sometimes closely engaging the oogonial stalk and the basal part of the oogonium. Oospore nearly colorless or somewhat yellowish, smooth, subspherical, mostly 25 to 42μ (average 35.3μ) in diameter, provided with a wall 1.2 to 2.2μ (average 1.6μ) in thickness, containing a reserve globule 16 to 28μ (average 21.3μ) in diameter, and a refringent body, subspherical or strongly flattened, when subspherical measuring usually 4.5 to 5.5μ in diameter.

Isolated from Lactuca sativa L. in Connecticut, April, 1921.

Pythium helicoides sp. nov.

Intramatrical mycelium diffuse in appearance, capable of approximately 29 mm. radial extension in 24 hours at 24°C., consisting of axial hyphae measuring in actively vegetative condition 4 to 8μ in diameter, later sometimes attaining a diameter of 9.5μ , and of branching elements mostly 2 to 4μ in diameter usually very extensively developed and bearing a moderately abundant supply of appressoria as clavate or knob-like terminations measuring 6 to 8μ toward the adhering apex. Under aquatic conditions intramatrical mycelium of moderately copious development, the most delicate elements sometimes only 1.5μ in diameter. Aerial mycelium usually well and often profusely developed, under conditions not too humid persisting without

collapsing.

Sporangia regularly formed terminally, generally on long extramatrical hyphae and on branches borne mostly on the distal portions of such hyphae often in racemose or cymoid arrangement; individually later often coming into a lateral position through continued elongation of the supporting filament from immediately below the delimiting septum; subspherical or more often obovoid; measuring mostly 9 to 40μ (average approximately 28μ) in transverse diameter and 17 to 45\mu (average approximately 31\mu) in length, not including an apical papillary protuberance, approximately 6μ in basal diameter and 4μ in length, often present during prolonged resting periods; regularly discharging through an evacuation tube mostly 3 to 40μ long and 3 to 9.5 \mu in diameter arising from the apex, or sometimes especially following frustration of an apical tube, from an equatorial or a basal position; very often once and sometimes twice proliferous, the secondary or tertiary sporangium being formed usually within the empty envelope of its predecessor, though sometimes borne externally on a prolongation of the sporangiophore passing out through the evacuation tube. Zoospores formed usually 2 to 40 in a vesicle, longitudinally grooved, bean-shaped, biciliate, after rounding up measuring 10 to 15μ (average 12.3μ) in diameter; occasionally giving rise to a secondary swimming spore through the production of an evacuation tube measuring approximately 2.8μ in diameter and 8μ or more in length.

Oogonium borne terminally sometimes on longer branch and sometimes on branch less than 5μ in length, but especially often through further shortening of such branches, borne laterally as a structure sessile on the parent filament; subspherical, often broadly protruding toward the antheridium; measuring mostly 26 to 40μ (average approximately 33μ) in diameter; pro-

vided with a sturdy wall approximately 0.7μ in thickness; and often retaining at maturity considerable granular residues outside of the oospore. Antheridia 1 to 4 in number; when plural, sometimes each of origin independent of the other or others, and sometimes 2, rarely more, supplied by the same branching filamentous element; in any case borne terminally on branches not closely connected with oogonial hypha, one of the branches, or its parent filament or a short vegetative branch from the parent filament or two of such elements collectively regularly winding about the oogonial hypha or the parent filament of the latter in 2 to 4 close helical turns, and occasionally, in addition, a filament closely connected with a second antheridium similarly involving a hyphal element having close mycelial relationship to oogonium; elongated, curved, cylindrical; measuring 20 to 42μ in length and 6 to 9μ in diameter; very intimately applied lengthwise to oogonium for entire length; producing a fertilization tube from navel position measuring usually 3 to 7μ in length and 2 to 3μ in diameter, occasionally widening to a diameter of 5μ . Oospore nearly colorless or more often decidedly yellowish; subspherical, measuring mostly 21 to 32μ (average approximately 27.5μ) in diameter; provided with a wall mostly 2.5 to 3.2μ in thickness, and containing at maturity 6 to 20 reserve globules, mostly 4 to 6μ in diameter, and 2 to 4 refringent bodies, approximately 3μ in diameter.

Isolated from decaying roots of Phaseolus vulgaris L. collected near Pom-

pano, Fla., March and April, 1926.

Pythium oedochilum sp. nov.

Intramatrical mycelium diffuse in appearance, capable of approximately 20 mm. radial extension in 24 hours at 24°C., consisting of hyphae 1.8 to 6.5μ in diameter, bearing appressoria rather sparingly or often in moderate abundance as swollen clavate terminations usually curved and measuring 5 to 7μ at the adhering apex. Under aquatic conditions extramatrical mycelium of meager or sometimes of nearly moderate development. Aerial mycelium sparse, or moderately profuse, though even in latter case somewhat arach-

noid; under conditions not too humid persisting without collapsing.

Sporangia regularly formed terminally on long, slender, extramatrical hyphae that measure 2 to 4.5μ , mostly about 3μ , in diameter, or terminally on branches from the distal portion of such hyphae, in either case individually later often coming to a lateral position through continued growth of the supporting hypha; in exceptional instances intercalary; subspherical, obovoid or more often ovoid, measuring mostly 17 to 42μ (average approximately 30μ) in transverse diameter and 25 to 48μ (average approximately 35μ) in length not including a papillary apical protuberance 6 to 8μ in basal diameter and in length, often present during resting periods; becoming discharged individually by means of an evacuation tube mostly 3 to 32μ (average approximately 16μ) and 3.5 to 8μ (average approximately 6μ) in diameter, arising usually from the apex but sometimes especially after functional frustration of apical tube from an equatorial or a basal position; sometimes proliferous though not abundantly so, most often once, somewhat rarely twice, usually by continuation of growth of the supporting hypha through the orifice of the evacuated membrane, and formation of another sporangium externally. Zoospores formed usually 10 to 35 in a vesicle, longitudinally grooved, bean-shaped, biciliate, after rounding up measuring 11 to 15μ in diameter.

Organium occasionally intercalary, but usually borne terminally on longer branch or less frequently terminally on branch less than 5μ in length, and

sometimes attached laterally to the parent filament as a sessile structure; subspherical, often with prominent protrusion directed toward antheridium and pierced centrally by the evacuation tube to yield a thick-lipped profile; measuring 19 to 39μ , mostly 27 to 36μ (average 31.5μ) in diameter; provided with a sturdy wall 0.4 to 1.1μ (often 0.7μ) in thickness; sometimes retaining at maturity rather meager granular residues outside of the oospore. Antheridia 1 to 4, mostly 1 or 2, in number; borne terminally usually on branches not often exceeding 50μ in length and generally arising from a filament not closely connected with the oogonial filament, yet occasionally arising from the oogonial hypha though at distances usually more than 40μ from the oogonium, or sometimes sessile and borne laterally on the parent filament,-in any case involvement of a filamentous part supporting the oogonium by a filamentous part supporting an antheridium associated with that oogonium, of decidedly rare occurrence; curved, elongated cylindrical, often somewhat wavy in contour, measuring 13 to 30μ in length and 4.5 to 8μ in diameter; applied intimately to the oogonium lengthwise along its entire length; producing a fertilization tube usually 2 to 4μ in length and 1.2 to 2.5μ in diameter from a somethat forward navel position. Oospore usually distinctly yellowish; subspherical, measuring 16 to 34μ , mostly 23 to 32μ (average 28.1μ) in diameter; provided with a wall 1.8 to 3.6μ , mostly 2.1 to 3.2μ (average 2.5μ) in thickness, and containing 5 to 20 reserve globules, mostly 4 to 6.5 \mu in diameter, and refringent bodies 2.5 to 3.5 in diameter, numbering usually 3 to 4 at early maturity and 10 to 20 at later maturity.

Isolated from decaying roots of Dahlia sp. in Washington, D. C., August,

1926.

Pythium polytylum sp. nov.

Intramatrical mycelium diffuse in appearance, capable of approximately 25 mm. radial extension in 24 hours at 24°C., consisting of hyphae measuring 1.9 to 7.5μ in actively vegetative condition, later sometimes attaining a diameter of 8μ ; the more delicate elements abundantly developed and bearing abundant appressoria as curved, swollen, clavate terminations, 6 to 8μ in diameter at the adhering apex. Under aquatic conditions extramatrical mycelium of moderately abundant development. Aerial mycelium usually produced in moderate quantity or sometimes more copiously, and often per-

sisting long without collapsing.

Sporangium appearing somewhat tardily; sometimes intercalary, especially laterally intercalary but usually formed terminally on long, slender extramatrical filament little given to branching, though later often coming to occupy a lateral position through continuation of growth of the supporting filament from immediately below the delimiting septum; subspherical, in case of larger examples often 28 to 33μ in diameter not including the papillary protuberance of variable size sometimes present during resting periods; regularly discharging through an evacuation tube measuring mostly 8 to 20μ in length and 7 to 9μ in diameter and arising often from apex but sometimes from other positions, especially after functional frustration of apical tube; proliferous development infrequent and often absent. Zoospores formed usually 10 to 35 in a vesicle, longitudinally grooved, bean-shaped, biciliate, after rounding up measuring mostly 9.5 to 11.5μ in diameter.

Oogonium sometimes terminal on branch generally less than 50μ , rather often less than 5μ in length, sometimes lateral and sessile on parent filament; subspherical, though frequently protruding broadly toward antheridia;

measuring 26 to 40μ , mostly 29 to 37μ (average 32.6μ) in diameter; provided with a wall 0.5 to 1μ (average 0.7μ) in thickness. Antheridia 1 to 4, mostly 1 or 2 in number; sometimes lateral and sessile, but usually borne terminally on branches rarely more than 80μ. mostly less than 50μ and sometimes less than 5μ (average approximately 25μ) in length, the branches arising mostly from hyphae not closely connected with oogonial filament, though sometimes arising from parent filament oogonial branch or its mycelial connections, the length of hypha intervening between the septa delimiting oogonium and antheridium usually exceeding 60μ ,—in any case the filamentous elements supplying the sex organs only infrequently exhibiting helicoid involvement; curved, elongated cylindrical, often somewhat wavy in profile; measuring usually 15 to 40μ (average approximately 30μ) in length, and 5 to 7.5μ (average approximately 6μ) in diameter; intimately applied lengthwise to the oogonium, and except sometimes for a short proximal portion, applied throughout its length; producing from a navel position a fertilization tube often 3 to 4μ in length and 2μ in diameter. Oospore usually distinctly yellowish. subspherical, 23 to 35μ , mostly 25 to 33μ (average 28.8μ) in diameter, provided with a wall 2.1 to 3.4μ (average 2.6μ) in thickness, and containing 6 to 20 reserve globules, mostly 4 to 6μ in diameter, and 4 to 8 or more refringent bodies mostly 2.5 to 3.2μ in diameter.

Isolated from decaying root of Prunella vulgaris L. collected near Dela-

plane, Va., August, 1926.

Pythium palingenes sp. nov.

Intramatrical mycelium diffuse in appearance, capable of approximately 26 mm. radial extension in 24 hours at 24°C., consisting of hyphae 2 to 7μ in diameter, bearing appressoria in moderate abundance as distended, clavate or knob-like terminations mostly 5.5 to 7.5μ in diameter toward adhering apex. Under aquatic conditions extramatrical mycelium of meager, sometimes of nearly moderate development. Aerial mycelium sometimes scanty, but more often of moderate or copious development; under conditions not

too humid persisting long without collapsing.

Sporangia formed promptly and in large number; regularly formed terminally on long simple extramatrical filaments mostly 2 to 4μ in diameter and mostly devoid of branches in the distal part, but often continuing growth from immediately below one sporangium to produce another farther on, the older one then coming to occupy a lateral position; subspherical or often somewhat ovoid, individually measuring mostly 24 to 42μ (average approximately 33μ) in length and 18 to 36μ (average approximately 29μ) in transverse diameter, the former dimension not including a sessile apical papilla often present during resting periods and measuring often approximately 6μ in basal diameter and 4μ in length; individually discharging often by means of the sessile apical papilla, but more frequently through an evacuation tube measuring exclusive of refringent tip usually 2 to 35μ (average 8μ) in length and 5.5 to 10μ (average 6.6μ) in diameter,—the tube arising usually from the apex, but occasionally, especially after failure of apical tube, from other positions; abundantly proliferous, both by formation of sessile or nearly sessile secondary and often tertiary sporangia within primary ones, and by growth of the supporting filaments through the orifices of the empty sporangial envelopes to produce sporangia externally,—the latter type of development frequently repeated 2 or 3 times, usually in conjunction with the former at any or all of the serial sporangia. Zoospores produced 6 to 30 in a vesicle; longitudinally grooved, bean-shaped, biciliate, after rounding up measuring 11 to 17μ (average 14μ) in diameter; individually germinating vegetatively by a germ tube usually 2 to 3μ in diameter, or often giving rise without interposition of a vegetative phase to a secondary zoospore,—the repetitional development taking place either by direct discharge of contents through an evacuation tube 3 to 6μ in diameter and 5 to 15μ in length, or by the production terminally of an elongated miniature sporangium often 16 to 32μ in length and 7 to 13μ in transverse diameter on a germ sporangiophore mostly 2μ in diameter and 40 to 285μ in length. Conidia often borne in large numbers on aerial hyphae on dry substrata, generally similar to sporangia formed under aquatic conditions, though usually somewhat smaller, often intercalary as well as terminal, and usually germinating by the production of one or more germ

tubes rather than giving rise to zoospores.

Oogonia sometimes borne terminally on branches up to 75μ or more in length, more often on short stalks less than 5μ in length, or frequently sessile on the parent filament, or intercalary, especially laterally or tangentially intercalary; nearly colorless or sometimes decidedly yellowish; subspherical, though often protruding toward antheridia; measuring 19 to 41µ, mostly 28 to 40μ (average 34μ) in diameter; provided individually with a wall 0.4 to 1μ , mostly approximately 0.6μ in thickness. Antheridia 1 to 4 (average 2) in number, sometimes borne laterally on hyphae as sessile structures, but more often borne terminally on branches sometimes less than 5μ , and usually not more than 50μ in length,—these supporting branches usually not closely connected with the oogonial filament though sometimes, like often also certain vegetative branches, wrapped about the latter in 2 or 3 close helical turns; curved cylindrical, often wavy or more markedly irregular in contour; measuring mostly 20 to 28μ in length and 6 to 8μ in diameter; intimately applied lengthwise to the oogonium, sometimes for entire length and sometimes only along anterior portion; producing individually an evacuation tube measuring often 2 to 4μ in length and 2μ in diameter, from a navel or often more forward position. Oospore usually yellowish; subspherical, measuring 18 to 37μ , mostly 26 to 36μ (average 31.3μ) in diameter; provided with a wall 1.5 to 3.5μ (average 2.6μ) in thickness, and containing 5 to 30 reserve globules 3 to 6μ in diameter, and 2 to 5 refringent bodies mostly 2.5 to 4μ in diameter.

Isolated from roots of Ambrosia trifida L. collected near Delaplane, Va.,

August, 1926.

LITERATURE CITED

- 1. Bary, A. de. Untersuchungen über die Peronosporeen und Saprolegnieen und die Grundlagen eines natürlichen Systems der Pilze. Abhand. Senckenb. Naturf. Gesell. 12: 225-370. 1881.
- 2. Dissmann, E. Vergleichende Studien zur Biologie und Systematik zweier Pythium-Arten. Archiv für Protistenkunde 60: 142-192. 1927.
- 3. Drechsler, C. The cottony leak of cucumbers caused by Pythium aphanidermatum. Jour. Agr. Research 30: 1035-1042. 1925.
- 4. Drechsler, C. A peculiar type of Pythium. (Abstract.) Phytopathology 17: 55. 1927.
- 5. Fischer, A. Phycomyceten. In: Rabenhorst, L. Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. Aufl. 2, Bd. 1, Abt. 4. 505 p. 1892.
- Kanouse, B. B. Physiology and morphology of Pythiomorpha gonapodioides. Bot. Gaz. 79: 196-206. 1925.

- 7. Mathews, V. D. Nowakowskiella and a new species of Pythium. Jour. Elisha Mitchell Sci. Soc. 43: 229-232. 1928.
- 8. Minden, M. von. Beiträge zur Biologie und Systematik einheimischer submerser Phyconyceten. Mykologische Untersuchungen und Berichte von Dr. Richard Falck 1: 146-225. 1916.
- 9. Pringsheim, N. Beiträge zur Morphologie und Systematik der Algen. II. Die Saprolegnieen. Jahrb. Wissensch. Bot. 1: 284-306. 1858.
- 10. Schröter, J. Saprolegniineae. In: Engler, A., and Prantl, K. Die Naturlichen Pflanzenfamilien. Lfg. 93, Teil. 1, Abt. 1: 93-105. 1893.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

Dr. Frank Wigglesworth Clarke, on the nomination of the Geologica Society of Washington, has been elected an Honorary Member of the Academy. This action has been taken in recognition of his contributions to geochemistry, particularly the chemistry of the silicates. He has also done notable work in the development of methods of analysis, in the computation of atomic weights and in the philosophical discussion of the evolution and disintegration of matter. He has for many years been intimately connected with scientific activities in Washington and has served the Academy as member and officer since its foundation.

Dr. William Henry Holmes, in recognition of his distinguished contributions to geology and ethnology, his high place in the scientific life of Washington, and his long service as member and officer, has been elected an Honorary Member of the Academy.

The following have recently been elected to membership in the Academy:

William Dunford Appel, Chief, Textile Section, Bureau of Standards.

Dr. Arthur Charles Bevan, State Geologist of Virginia.

Dr. Burt H. Carroll, Photographic Chemist, Bureau of Standards.

Dr. Fred O. Coe, Medical Specialist.

Carle Hamilton Dane, Associate Geologist, Geological Survey.

Dr. Herbert Friedmann, Curator, Division of Birds, National Museum.

Dr. James H. Hibben, Physical Chemist, Geophysical Laboratory.

Henry Freeborn Johnston, Physicist, Department of Terrestrial Magnetism, Carnegie Institution.

Louis Jordan, Chief of Chemical-Metallurgical Section, Bureau of Standards. Arthur Remington Kellogg, Assistant Curator, Division of Mammals, National Museum.

James H. Kempton, Botanist in Biophysical Laboratory, Bureau of Plant Industry.

Herbert W. Krieger, Curator, Division of Ethnology, National Museum.

Dr. William M. Mann, Director, National Zoological Park. Dr. Wendell C. Mansfield, Associate Geologist, Geological Survey.

Dr. Archibald Turner McPherson, Associate Chemist, Bureau of Standards.

Dr. Charles Moon, Physicist, Bureau of Standards.

William J. Rooney, Physicist, Department of Terrestrial Magnetism, Car-

negie Institution.

Howard S. Rappleye, Associate Mathematician, Coast and Geodetic Survey. Dr. Frank H. H. Roberts, Jr., Archeologist, Bureau of American Ethnology. Rufus Harvey Sargent, Topographic Engineer, Geological Survey.

Waldo La Salle Schmitt, Curator, Division of Marine Invertebrates, National

Museum.

Dr. Edgar Reynolds Smith, Chemist, Bureau of Standards.

John Albert Stevenson, Senior Mycologist, Bureau of Plant Industry.

Dr. Harold F. Stimson, Physicist, Bureau of Standards.

William H. Swanger, Chief of Mechanical Metallurgy Section, Bureau of Standards.

David G. Thompson, Geologist, U. S. Geological Survey. Joseph S. Wade, Entomologist, Bureau of Entomology.

Dr. George Ray Wait, Physicist, Department of Terrestrial Magnetism, Carnegie Institution.

Dr. Henry Theodore Wensel, Senior Physicist, Bureau of Standards.

RESOLUTION ON THE DEATH OF FRIDTJOF NANSEN

Whereas, The members of the Washington Academy of Sciences have learned, with profound regret, of the death on May 13, 1930, of their honored

and beloved fellow member, FRIDTJOF NANSEN, therefore be it

Resolved, That the Academy hereby records its sorrow over this grievous loss to itself and to all the world of a scientist who contributed abundantly to our knowledge, a statesman of high and steadfast purpose and a humanitarian who labored for the good of nations and of peoples—a man of highest character, unmindful of hardships, fearless in danger, deaf to plaudits and blind to pomp and circumstance, and be it further

Resolved, That a copy of this resolution be sent to Dr. Nansen's immediate

family.

The following members of the Academy were elected to membership in the National Academy of Sciences in April, 1930: Dr. Eugene T. Allen, Geophysical Laboratory; Dr. William W. Coblentz, Bureau of Standards; Dr. Vernon Kellogg, National Research Council; and Dr. Samuel C. Lind, University of Minnesota.

The corresponding list for the American Philosophical Society is: Dr. Norman L. Bowen, Geophysical Laboratory, Dr. Harvey W. Cushing, Harvard Medical School, and Dr. Alexander Wetmore, Smithsonian Institution.

SCIENTIFIC NOTES AND NEWS

Dr. Edgar T. Wherry, one of the Editors of this journal, has resigned from the position of Principal Chemist in charge, Crop Chemistry Laboratory, Bureau of Chemistry and Soils, to become Associate Professor of Plant Ecology in the Department of Botany of the University of Pennsylvania, Philadelphia, Pa.

Wendell P. Woodring, for the past few years on the staff of the California Institute of Technology, resumed full time service with the U. S. Geological Survey on July 1, 1930.

STANLY CATHCART, formerly connected with the Geological Survey, was reinstated as geologist in the Conservation Branch but has recently joined the Pennsylvania Geological Survey staff.

RICHARD C. CADY and STANLEY W. LOHMAN have been appointed junior geologists; and Victor T. Stringfield and Charles V. Theis, assistant geologists, in the Water Resources Branch.

W. D. Johnson and F. G. Wells have been transferred from the Water Resources Branch to the Geologic branch and assigned to field work.

Obituary

Professor William Suddards Franklin, a member of the Academy, was killed in an automobile accident on June 6th, 1930. He was born at Geary City, Kansas, in 1863, and was educated at the University of Kansas. In 1901 he received the degree of Sc.D. from Cornell University. He taught physics and electrical engineering successively at Kansas, Iowa, Lehigh, Massachusetts Institute of Technology, and Rollins College.

Dr. Jesse Walter Fewkes, for ten years chief of the Bureau of American Ethnology, a member of the Academy, died on May 31, 1930. He was born at Newton, Massachusetts, in 1850, and studied at Harvard and Leipzig Universities, and at various zoological stations. While engaged in work on marine zoology in California in 1887 he became interested in the American Indians, and in subsequent years devoted his attention to their ethnology and archeology. He was appointed ethnologist in the Bureau of American Ethnology in 1895, and Chief of the Bureau in 1918.

Dr. Harvey Washington Wiley, Chief Chemist of the Department of Agriculture from 1883 to 1912, died on June 30, 1930. He was born at Kent, Indiana, in 1844, and educated at Hanover College, the Indiana Medical School, and Harvard University. He early realized the need of legislation to protect the public against adulteration and misbranding of foods and drugs, and succeeded in bringing about the enactment of the Federal Food and Drugs Act in 1906. To the end of his life he continued his efforts to keep our foods and drugs pure, and to furnish sound advice on diet and health matters.

OFFICIAL COMMUNICATIONS THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Geology.—Pleistocene seashores. С. Wттне Сооке	389
Biology.—The interrelation of Foraminifera and Algae. Joseph A. Cushman	395
Botany.—A new cannon-ball tree from Panama. C. V. Morton	396
Botany.—Some new species of Pythium. Charles Drechsler	398
Proceedings	
THE ACADEMY	418
Scientific Notes and News.	419
OBITUARY: W. S. Franklin, J. W. Fewkes, H. W. Wiley	420

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries

JOURNAL

OF THE



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD

EDGAR T. WHERRY
UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

MT. ROYAL AND GUILFORD AVES. BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided tor in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: Inis Journal, the ometal organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates
are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

OCTOBER 19, 1930

No. 17

GEOLOGY.—Paleozoic formations in the Gold Hill quadrangle, Utah.¹
Thomas B. Nolan, U. S. Geological Survey. (Communicated by R. C. Wells.)

Within the Gold Hill Quadrangle in western Utah, there is exposed a section of Paleozoic rocks that is comparable in thickness and in the time intervals represented to that at Eureka, Nevada.² The situation of the quadrangle (just east of the Nevada-Utah line and at the 40th parallel) about midway between the classic Nevada section and the well-known sections in the Wasatch³ and in the Tintic district⁴ makes this stratigraphic column of particular interest. In the present paper the Paleozoic formations that have been distinguished in the quadrangle are named and very briefly described, in advance of a more extended discussion which is to be published by the Geological Survey.⁵ Table 1 summarizes the section.

CAMBRIAN SYSTEM

Prospect Mountain quartzite.—The oldest formation exposed is a massively bedded quartzite that is identified with the Prospect

¹ Published by permission of the Director, U. S. Geological Survey. Received July 3, 1930.

² Arnold Hague. Geology of the Eureka district, Nevada. U. S. Geol. Survey Monograph 20. 1892.

³ F. F. Hintze. A contribution to the geology of the Wasatch Mountains, Utah. Annals New York Acad. Sci. 23: 85-143. 1913. F. C. Calkins. In Ore deposits of Utah. U. S. Geol Survey Prof. Paper 111: 233-239. 1920.

⁴ G. F. Loughlin. Geology and ore deposits of Tintic mining district, Utah. U. S. Geol. Survey Prof. Paper 107. 1919.

⁵ Geology and ore deposits of the Gold Hill quadrangle, Utah. U. S. Geol. Survey. (Report in preparation.)

Mountain quartzite of the Eureka district.⁶ There are several thin shale beds in the upper part of the formation and lenticular conglomerates are rather abundant. Near the base of the formation as exposed in the quadrangle, there are several horizons of dark micaceous shale and some thin beds of dark quartzite that are interbedded with the normal quartzite. These shale horizons are well exposed along Basin Creek on the east front of the Deep Creek Mountains, 7 miles south of the southern boundary of the quadrangle.

The formation at this locality was estimated to be about 4,750 feet thick, divided as follows: (1) at top, quartzite, 2500 feet; (2) shale, 300 feet; (3) quartzite, 500 feet; (4) shale, 600 feet; (5) quartzite, 200 feet; (6) shale, 100 feet; (7) quartzite, 500 feet; (8) shale, 50 feet. No fossils were found in the formation, but, since it underlies conformably a Lower Cambrian formation, it is thought to be of the same age.

Cabin shale.—This formation, named from exposures in Cabin Gulch, south of North Pass Canyon, is composed dominantly of a dark green or khaki colored shale, which is only locally calcareous. Sandy laminae are abundant near the top of the formation, which grades, rather abruptly into the overlying Busby quartzite. The average of two fairly satisfactory measurements gave a thickness of 510 feet. A single fragmentary trilobite, found by Dr. Edwin Kirk, Jr., was submitted by Dr. C. E. Resser who reports that "the thoracic segment from Sheep Canyon, because of the sharp angle on its anterior side, seems pretty definitely to belong to a Mesonacid which would make it Lower Cambrian in the present usage of that term in the West."

Busby quartzite.—The basal 50 to 75 feet of the formation here named Busby quartzite is made of coarse-grained quartzite which contains in places tiny rock fragments in addition to quartz. Thin beds of dark quartzite and green sandy shale in varying proportions compose the remainder of the formation, the shales becoming increasingly abundant upwards. Mud cracks and fucoid markings are present in many of these beds. The top of the formation has been arbitrarily placed at the base of the lowest limestone bed, although quartzites and shales similar to those in the Busby are present above this line. The average of two closely accordant measurements indicates that the thickness of the formation is not far from 440 feet. No fossils have been identified from the formation but the gradational character of the contact with the overlying Abercrombie formation of

⁶ Arnold Hague. Abstract of the report on the geology of the Eureke district, Nevada. U. S. Geol. Survey Third Ann. Rept. 254. 1882.

Middle Cambrian age make it appear that the Busby quartzite is also of this age. The formation name is taken from Busby Canyon, on the northeast slope of Dutch Mountain, in which this formation is exposed.

Abercrombie formation.—The most characteristic type of lithology in the formation here named Abercrombie formation is a blue-gray dense limestone whose thin bedding is caused by thin bands or partings of

TABLE 1.—PALEOZOIC FORMATIONS IN THE GOLD HILL QUADRANGLE, UTAH

System	Series	Formation	Thickness in feet
	Permian	Gerster formation	600
	Permian and Pennsyl-		
	vanian	Oquirrh formation	8000±
	Pennsylvanian (Potts-		
Carboniferous		7	****
		.Manning Canyon formation.	500±
	Mississippian (upper)	Ochre Mountain limestone Woodman formation	4500±
	Mississippian (lower)	Madison limestone	1500± 0-400
	(Mississippian (lower)	wadison imestone	0-400
	(Guilmette formation	900-1200
Devonian	Middle	Simonson dolomite	1000
		Sevy dolomite	450
Silurian		.Laketown dolomite	1000±
0.1	Upper	.Fish Haven dolomite	250
Ordovician	Lower	.Fish Haven dolomite	0-1000±
	(11	Hicks formation	600-1200
	Upper	Hicks formation Lamb dolomite	1050
		(Trippe limestone	. 725
O h) 74: 111	Young Peak dolomite	0-600
Cambrian	$\left\{ \mathrm{Middle} \right\}$	Abercrombie formation	2700
		Busby quartzite	450
	T	Cabin shale	510
	Lower	(Prospect Mountain quartzite.	$3000 – 4750 \pm$

shale, which may be yellow, buff, pink or light gray. The limestone bands are from one-quarter to one-half inch thick. The shaly material is present only locally along many of the bedding planes and similar splotches of shale are found less commonly within the limestone and not parallel to the bedding. With increase or decrease in the amount of shale, the rock grades into lenticular shale beds or into relatively massively bedded limestones. Where best exposed the formation is

approximately 2700 feet thick. Almost all of the shale beds are fossiliferous. Dr. C. E. Resser of the National Museum divided the collections made into two groups. One of these, from the lower portion of the formation, contained Bathyuriscus productus, Zacanthoides sp, Obolus sp, Linguella sp, and Hyolithes sp. He writes: "This seems to be the lowest horizon secured. The fauna corresponds with the Chisholm and Ophir." From the other group, Elrathia sp, Paterina cf. utahensis, Micromitra sp, Obolus sp, and Fucoids were recognized. This group he considers as Middle Cambrian, somewhere in the lower part. Abercrombie Peak on the ridge south of Dry Canyon is underlain by the formation.

Young Peak dolomite.—At the southern end of the quadrangle the formation here designated as Young Peak dolomite consists of 600 feet of massive dark gray to black crystalline dolomite spangled with short white rods of dolomite. Hand specimens of the rock are identical with those from the Bluebird dolomite at Tintic.⁷ As the formation is followed to the north, however, the dolomite interfingers with shaly limestones similar to those in the Abercrombie formation. Less than 5 miles to the north only a few feet of dolomite can be found, and the stratigraphic interval of the formation is occupied by portions of the Abercrombie formation. The upper contact of the formation is remarkably persistent in view of the characteristic lenticular habit of most of the Cambrian formations. This horizon, which marks the base of the overlying Trippe limestone, consists of a dark gray dolomite containing abundant nodules of dark gray chert which may reach several feet in diameter. It is overlain by a cream colored, finely laminated dolomite. These beds extend beyond the last reminants characteristic of the Young Peak dolomite. No determinable fossils were found in the dolomite, but it is undoubtedly of Middle Cambrian age. The dolomite is well exposed on Young Peak on the south side of Dry Canyon.

Trippe limestone.—This formation, named from exposures in Trippe Gulch on the south side of North Pass Canyon, is composed in large part of thin-bedded shale-mottled limestones similar to those that are so abundant in the Abercrombie formation. It contains in addition a few dark dolomite layers, beds of more massive limestone, and several horizons of finely laminated white dolomite and limestone. Most of the beds appear to be lenticular, since sections of the formation

⁷ G. F. Loughlin. Geology and ore deposits of Tintic mining district, Utah. U. S. Geol. Survey Prof. Paper 107: 28. 1919.

at different points fail to show similar sequences and thicknesses. The average of three measurements of the Trippe limestone is 725 feet. No fossils were found in any of these beds but the fact that much of it is lithologically similar to the Abercrombie formation makes it seem probable that it too is of Middle Cambrian age.

Lamb dolomite.—The lower third of the formation, here named Lamb dolomite is made up largely of thick-bedded onlitic and pisolitic dolomites, some of which are cross-bedded. Above this lies thick-bedded medium gray dolomite that is mottled by patches of dolomite containing white rods and resembles closely parts of the Young Peak dolomite. In the upper 150 feet thinner bedded dolomites with sandy partings become increasingly abundant and these grade upwards into a sandstone weathering reddish-brown that was chosen to mark the upper limit of the formation. This sandstone lenses out to the north but a similar lens starts at about the same locality a short distance higher stratigraphically. The Lamb dolomite is 1050 feet thick. Although no fossils were collected from it, its age is thought to be Upper Cambrian, since it is similar lithologically to the overlying Hicks dolomite, which is definitely of this age. The formation is exposed in Lamb Gulch, on the north side of Dry Canyon.

Hicks formation.—The greater part of the beds here named Hicks formation consist of dolomites similar to those in the Lamb dolomite, but the formation also contains lenticular beds of sandstone, fossiliferous limestone, and, in one place, shale. Two collections of fossils from one of the limestones were reported by Doctor Resser to contain Pseudagnostus sp., Dunderbergia sp., Obolus sp., and Acrotreta sp. He reports that these represent a lower Upper Cambrian horizon. The thickness of the formation varies from 1200 feet to less than 600 feet, the more southern sections being the thinner. This decrease in thickness is found within a strike distance of $3\frac{1}{2}$ miles and is thought to indicate an erosional unconformity between the Hicks formation and the overlying Chokecherry dolomite, of Lower Ordovician age. The same is taken from Hicks Gulch in North Pass Canyon, in which the formation is well exposed.

ORDOVICIAN SYSTEM

Chokecherry dolomite.—This formation is characterized by the presence of considerable silica, found both as nodules and bands of chert, usually dark gray to black in color, and as sandy laminae between thin beds of dolomite. The lower beds are, as a rule, rather massively

bedded chert-bearing dark-mottled dolomite, locally onlitic and crossbedded, and containing thin lenses of dolomite conglomerate. beds are supplanted higher in the formation by thinner-bedded dolomite with sandy laminae, or, locally, by bands of dark chert. A single collection of fossils from near the top of the formation contained only Scaevogyra (?) sp. Dr. Edwin Kirk, Jr., who identified it, reports: "The few gastropods in this lot do not permit exact age determination, and as yet we know of no other horizon with which it may be correlated. It may safely be considered as early Lower Ordovician, however." The formation is exposed only in the southern third of the quadrangle where its thickness ranges from 850 feet to more than 1,000 feet. In the northern part of the area it is entirely absent,—the overlying Fish Haven dolomite resting directly upon Upper Cambrian beds. There must, therefore, be a pronounced unconformity above the formation. The formation takes its name from the exposures in Chokecherry Canyon just south of the southern boundary of the quadrangle.

Fish Haven dolomite.—This formation contains the same fauna, of Upper Ordovician age, as the typical Fish Haven dolomite of northeastern Utah,8 and has therefore been given the same name. It is composed of medium to thick-bedded dolomite, usually dark gray in color, and with but little chert. In general the mottling and other textures found so abundantly in the formations above and below are lacking. In the northern part of the area, the basal bed is full of small silicified brachiopods (Rhynchotrema argenturbica) and is very readily recognized. The formation preserves a remarkably constant thickness of about 250 feet throughout the quadrangle, although its contact with the overlying Silurian Laketown dolomite is wavy in detail. The following species were recognized by Doctor Kirk in the fossil collections from the formation: Halysites gracilis, Streptelasma trilobatum, Streptelasma sp., Columnaria sp., Calapoecia cf. anticostiensis, Rhyncotrema capax, Rhyncotrema argenturbica, Dinorthes subquadrata, Zygospira recurvirostris.

SILURIAN SYSTEM

Laketown dolomite.—The lower half of the formation is dark gray and rather massively bedded. Many beds are mottled or laminatedy and intraformational conglomerates are numerous. This zone is locally very fossiliferous, one bed about 100 feet above the base being

⁸ G. B. Richardson. The Paleozoic section in northern Utah. Am. Jour. Sci. (4) 36: 409-410, 1913.

full of the pentameroid brachipod Virgiana sp. Above the dark dolomite is 350 to 400 feet of medium-gray, massively bedded dolomite. This horizon is almost lacking in fossils and has none of the textural features so abundant in the lower beds. It is succeeded by 150 to 200 feet of dark gray to black dolomite containing large numbers of silicified fossils, particularly corals. At the top is locally found a medium to light gray coarsely crystalline dolomite, which is sparingly fossiliferous. The upper contact of the formation is an unconformity, the overlying Sevy dolomite containing scattered boulders of the Laketown dolomite in its basal beds, and in several places, occupying depressions in the older rock. The only complete section of the formation measured 970 feet, but its thickness is obviously variable, since different horizons have been found at the contact with the overlying Devonian formation. Edwin Kirk, Jr., has examined a number of fossil collections from the beds herein identified as the Laketown dolomite, and reports that "This formation may be considered of Niagaran age. It correlates in part with the Fuselman limestone of Texas and New Mexico, the Laketown dolomite of northern Utah, and probably the upper portion of the Lone Mountain limestone of the Eureka district, Nev."

DEVONIAN SYSTEM

Sevy dolomite.—The Sevy dolomite, well exposed in Sevy Canyon on the western side of the Deep Creek Range, is remarkably homogeneous in its character throughout the area of outcrop. The typical rock is a well bedded, light mouse-gray dolomite in layers 6 to 12 inches thick, which weathers to a very light gray color. It is extremely dense and shows, on breaking, a conchoidal fracture. Most of the beds show a faint lamination parallel to the bedding. The formation contains a few beds of darker dolomite near the top and locally beds containing tiny nodules of light-colored chert. The basal bed of the formation is conglomeratic, as noted above. The only fossils found in the Sevy dolomite, which is about 450 feet thick, were a few crinoid stems and some poorly preserved gastropods, neither of which, according to Edwin Kirk, Jr., were in any way diagnostic. The formation is, however, gradational into the overlying Middle Devonian Simonson dolomite, and is presumably of the same age.

Simonson dolomite.—The characteristic rock of this formation is a dark to medium gray dolomite in which the individual grains are sufficiently large to be distinguished by the unaided eye. Individual beds are from 1 to 2 feet thick. The most striking feature of these

dolomites is the general presence of a fine lamination which is commonly extremely irregular in detail. Two non-persistent dolomite conglomerates are found within the formation and a third, which persists throughout the outcrop of the formation has been chosen to mark the upper boundary. The fossil evidence available, however, indicates that the time break represented is unimportant. The average of two measurements of the thickness of the formation is very close to 1,000 feet. Three lots of fossils collected were examined by Doctor Kirk, and were considered by him to prove the Middle Devonian age of the formation. He recognized the following species:—Favosites (digitate form); Bellerophon sp; Stringocephalus burtoni; Martinia cf. meristoides; Atrypa reticularis.

The formation takes its name from the exposures in Simonson Canyon on the western side of the Deep Creek Range.

Guilmette formation.—This formation, named from exposures in Guilmette Gulch, is composed chiefly of dolomite but contains also a number of thick limestone beds and several lenticular sandstones. The dolomite that is most characteristic is a fine-grained rock, dark to medium gray on fresh fracture and weathering to lighter shades of gray and containing numerous vugs almost completely filled with white coarsely crystalline dolomite. Less abundant but far more striking are dark dolomites filled with fragments of tubular corals. Most of these contain a coral of small diameter (Cladopora sp.) but a number are filled with a larger branching variety (Striatopara sp.). The limestone beds differ from those lower in the section, being massively bedded, dense rocks that are light brownish gray on fresh fracture but weather to shades of bluish gray. The sandstone beds form a comparatively small part of the formation, but the brownish color they assume on weathering makes them conspicuous. Three measurements of thickness ranged from 1200 feet down to 890 feet, indicating that there is an unconformity between the Devonian and Carboniferous formations in this part of Utah. Several lots of fossils were submitted to Edwin Kirk, Jr., for identification. He identified: Favosites (digitate form); Syringopora sp.; Stringocephalu. burtoni; Atrypa reticularis; Martinia meristoides; Platyschisma (?) cf mccoyi; Cyclonema (?) sp.; and Pycinodesma sp. He writes: "The formation probably correlates with the Nevada limestone of the Eureka district in part. The horizon by virtue of the Stringocephalus may accurately be placed as high as Middle Devonian."

CARBONIFEROUS SYSTEM

Rocks of this age are by far the most widespread of the Paleozoic sedimentary rocks in the quadrangle. They have been divided into six formations, three of Mississippian, one of Mississippian (?) and Pennsylvanian age, one of Pennsylvanian and Permian age, and one of Permian age. Three facies of the Carboniferous have been distinguished. These have been brought into more or less close contact with each other by two large thrust faults; originally they were probably a number of miles apart. One of the three facies is represented by rather limited outcrops of only one formation,—the Woodman,—which overlies unconformably the older Paleozoic rocks. This may be called the eastern facies. It underlies the lower of the two thrusts and was the most easterly of the three facies. The second facies,—termed the central facies in this paper,—lies between the two thrusts. Three formations, the Ochre Mountain limestone, and the Manning Canyon and Oquirrh formations, are present in this facies. The third and last facies is the western facies, which contains representatives of all six formations. It lies above the upper thrust. The lithologic differences between the Manning Canyon and Oquirrh formations in this facies and in the central facies are striking.

Madison limestone.—This limestone on fresh fracture is a dull dark gray but weathers to a distinctly lighter gray color. The beds are moderately thin, ranging from three inches to a foot in thickness, the bedding being marked in many places by a concentration of pink or, less commonly, yellowish clay. Small amounts of similarly colored clay are also found within individual beds in some places, and the weathered surfaces of such beds have a faint pinkish mottling. At the top of the formation there are about 10 to 15 feet of more thickly bedded limestone, which contains numerous nodules of dark chert. Above this, apparently conformable, are sandstones of the Woodman formation. This formation was found only in the western facies, in which its lower limit was a thrust fault. The maximum thickness seen was about 400 feet. Several lots of fossils were collected and submitted to G. H. Girty of the Geological Survey. He reports that "there can be little doubt of the geologic age as lower Carboniferous and the correlation as with the Madison limestone."

Woodman formation.—This formation, which underlies Woodman Peak on the south end of Dutch Mountain, consists of a lower division of diminantly calcareous sandstone and an upper one of sandy limestone. The sandstone division is roughly 200 feet thick and is gen-

erally poorly exposed. The beds are purplish or reddish brown, fine grained and contain a variable though small proportion of calcite as the cement. Thin lenses of limestone and shale are interbedded with the sandstone. The greater part of the upper division is made up of sandy limestone, which is dark gray to almost black on fresh fracture but which weathers to shades of light brown to pinkish. Nodules of dark gray to black chert are abundant and many be as large as a foot in diameter. Interbedded with the limestones and gradational into them are calcareous sandstones. A few beds of relatively pure limestone may also be found. No complete sections of this formation were found in any of the three facies, but it is probable that there is no great difference in thickness or lithology between the three. The thickest continuous section found measured 1,000 feet but the top was not exposed. The total thickness probably does not exceed 1500 feet. however. A large number of fossil collections were made from the formation and Doctor Girty, who examined them, writes that they indicate an upper Mississippian age.

Ochre Mountain limestone.—This formation takes its name from the fact that it is well exposed on Ochre Mt. It is composed almost entirely of massively bedded limestones, which are usually brownish gray on fresh fracture and weather to a light bluish gray color. Most of them are fine-grained, but there are local coarser beds. Individual beds may be as much as 10 feet in thickness and almost all are more than a foot thick. The basal few hundred feet of the formation includes beds that contain large amounts of chert, some beds being considerably more than half chert. The chert is generally light gray in color but weathers to a characteristic tan. About 1700 feet above the base of the western facies lies a thin and poorly exposed horizon of black shale interbedded with sandstone which is here named the Herat shale member from exposures near the Herat claims. No lithologic distinction could be made between the central and western facies of this formation. The thickness of the Ochre Mountain limestone was not accurately determined but it appears to be about 4500 feet. It is locally abundantly fossiliferous, and Doctor Girty reports that the fossil collections made prove that the formation, like the underlying Woodman formation, is of upper Mississippian age.

Manning Canyon formation.—Both the central and western facies of the beds here identified with the Manning Canyon shale of the Oquirrh Mountains are composed almost entirely of dark quartzites and sandy shales, and black shales. The first two are relatively more abundant in the central facies, and the latter in the western facies. Limestone beds are found only locally. The exposed thickness of the formation is very variable, ranging from only a few feet to more than 1,000 feet, but this variation appears in part at least due to the fact that the weak shales have been the locus of considerable low-angle faulting. A number of fossils collected from the interbedded limestones are considered by Doctor Girty to indicate a Pottsville or lower Pennsylvanian age. In the Oquirrh Range, to the east Gilluly found high upper Mississippian fossils near the base of big Manning Canyon shales, and it is possible that if better exposures were present at Gold Hill, a similar fauna might also be found. The writer was not able to distinguish unconformable relations between them, however, but this may have been because of the widespread alteration and crushing at this horizon.

Oquirrh formation.—The eastern and western facies of the rocks here identified with the Oquirrh formation of the Oquirrh Mountains—are strikingly different. The central facies is made up of a number of different kinds of rocks. Each rock type is repeated over and over again throughout the section, and individual beds are generally lenticular, two features which render it impossible to subdivide the formation.

The facies is prevailingly sandy. Sandstones form about half of the section, and sandy limestones and sandy shales a large part of the remainder. Interbedded with these are numerous beds of limestone and dolomite and a few horizons of conglomerate. The western facies shows very little resemblance to the central. At the base is a moderate thickness of light-colored sandstone, above which is nearly 3,000 feet of massively bedded limestones, similar lithologically to those that make up the Ochre Mountain limestone. The remainder of the formation is composed of interbedded sandstones and dolomite with only minor amounts of limestone. The total thickness of the eastern facies is unknown as the top is nowhere exposed. At least 5300 feet of beds are shown at one locality, however. The western facies is considerably interrupted by faulting but a total thickness of about 8,000 feet must be present. The formation is abundantly fossiliferous. The lower few hundred feet of both facies contains a Pottsville fauna similar to that in the underlying Manning Canyon formation. The remainder of the Central facies and the bulk of the western facies is reported by Doctor Girty to belong to the higher Pennsylvanian. A few fossils collected from the upper part of the western facies proved to be of Permian age.

Gerster formation.—The Gerster formation, named for exposures in Gerster Gulch in the northwestern corner of the quadrangle, is made

up largely of thin bedded sandy and shaly limestones, which are brownish gray on fresh surfaces, and which weather to yellowish brown or pink. The beds are from 2 inches to a foot in thickness and generally have a concentration of sandy or shaly material along the bedding planes. Locally thin beds of sandstone may be found and in most exposures moderately thick beds of cherty limestone are also present. The formation is sharply set off from the underlying Oquirrh formation by its lithology and abundant fossil content. The thickness of the formation is approximately 600 feet in the one locality where the overlying Trissic is found. Doctor Girty reports that the fauna is that of the *Spiriferina pulchra* zone of the Permian.

PALEONTOLOGY.—Contributions to the paleontology of Peru, IV: "Orthophragmina" (Discocyclina) meroensis W. Berry, n.sp.¹ Willard Berry, Ohio State University. (Communicated by John B. Reeside, Jr.)

In a gritty greenish-brown calcareous sandstone at Calita Mero, Department of Piura, Peru, I have found a new species of "Orthophragmina," which is here named "O." meroensis. This species, is associated with O. stewarti W. Berry, originally described from the Saman conglomerate at Calita Sal, in the same Department and about seventy miles south of Calita Mero. The Saman conglomerate is, so far as I know, the only formation in the Peruvian Tertiaries containing members of the genus "Orthophragmina" and I think I am safe, therefore, in saving that it is this formation which is exposed near Calita Mero. The matrix is similar to that at Calita Sal except that it contains few pebbles and many of the grains are subangular. The material was apparently laid down in shallow water, though the size of the particles and almost complete absence of pebbles suggest that the deposits at Calita Mero must have been farther from shore than at Calita Sal, or the land mass from which they were derived had been eroded so that less heavy and bulky material was being carried into the ocean at that point. In general the genus "Orthophragmina" lived in shallow, tropical waters which were fairly free from coarser clastic material, and the matrix of the fossils from Calita Mero is in agreement with this fact. From Calita Sal I have described also solitary corals. It would seem that in this general region during Saman conglomerate times little detrital material other than much angular quartz was being deposited.

¹ Received April 1, 1930. Work carried out under a grant from the National Research Council.

The new orbitoid may be described as follows:

"Orthophragmina" (Discocyclina) meroensis W. Berry, n. sp.

Fig. 1

Test large, very thin, slightly undulating, flanged, pronounced umbo; diameter 7.5 mm.; thickness 1.84 mm.; ratio of diameter to thickness about 4:1; fairly large central boss 3 mm. in diameter with a flange about 2.25 mm. in diameter. Surface covered with small polygonal papillae 116.9 microns in diameter at the surface. The surface diameter of the lateral chambers is 97.5 microns.

In equatorial section the nucleoconch is composed of two chambers, the initial chamber is 83 microns in diameter and is half surrounded by the second chamber; diameter of the entire nucleoconch is 501 microns; the walls of the nucleoconch are thin, being only about 16.7 microns thick. The equatorial chambers are typically orthophragminic in shape and are 50 microns in radial diameter and 23.4 microns in tangential diameter near the center; 83.5 microns in radial diameter and 33.4 microns in tangential diameter at the edge of the boss, and 100 microns in radial diameter and 33.4 microns in tangential diameter at the periphery, with walls 15.6 microns thick; these chambers are arranged mostly in circles altho some of the circles are not entire but shrink in radial diameter until they merge into the chamber walls.

In vertical section (Fig. 1) the wall between the equatorial chambers and the lateral chambers is 15.6 microns thick. Vertical diameter of the equatorial chambers at the center of the test 35.1 microns and at the edge of the boss 58.5 microns; the weakness of the flange prevents any measurements at the periphery. Vertical diameter of the lateral chambers 58.5 microns near the central part of the test; thickness of the horizontal walls 7.8 microns. There are 30 lateral chambers on the side of the equatorial chambers near the center of the test.

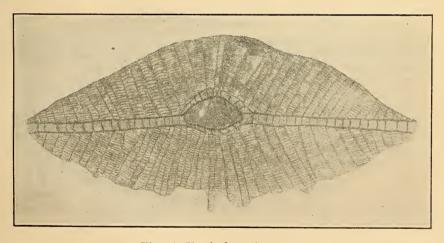


Fig. 1. Vertical section \times 23

Occurrence—Calita Mero, Department of Piura, Peru, associated with "Orthophragmina" (Asterodiscocyclina) stewarti W. Berry.

This species is somewhat like O. pratti Michelin but differs in having a much bigger umbo and in having equal-size papillae. It also resembles O. varians Kaufmann except that the boss in "O." meroensis is more pronounced.

The types are deposited in the Geological Museum of the Ohio State University, Cat. No. 17114.

ORNITHOLOGY.—The geographic variations of Neocichla gutturalis (Bocage). Herbert Friedmann, National Museum.

Neocichla gutturalis (Bocage) has always been considered as an indivisible species comprising a monotypic genus. There is some uncertainty as to its correct systematic affinities. Sclater (Syst. Avium Aethiop., pt. 2, 1930, p. 359) puts it in the Timaliidae, but it may prove to be more closely allied to the starlings. The species ranges from southern Angola east through Northern Rhodesia and the Katanga to central Tanganyika Territory.

While examining two specimens of this species in the Loveridge Tanganyikan collection I took the opportunity to compare them with two birds from Angola (Boulton coll.) in the American Museum of Natural History, and found them to differ so markedly that there seemed no reason for considering them as anything but distinct subspecies. Inasmuch as the species was described from Huilla, Angola, the eastern birds are the ones that require a name. They may be known as

Neocichla gutturalis angustus subsp. nov.

Type: Museum of Comparative Zoology no. 134447, adult female, collected at Muhulala, Kilimatindi, Tanganyika Territory, March 3, 1922, by

Arthur Loveridge.

Subspecific characters: Similar to the typical race but differing at first glance by the very much narrower white tips on the rectrices. In two Angolan birds the white tips of the outermost rectrices measure 12–15 mm. in width (measured along the shaft), while in five Tanganyikan specimens they measure from .5 to 5.0 mm. The nominate race is conspicuously a bird with white tips to the tail feathers; angustus is often practically devoid of tips or at most has them in the form of narrow bands.

Measurements of type: wing 109.0; tail 87.0; culmen from base 22.5; tarsus

28.0 mm.

Remarks: I have seen no material from the Katanga or from Northern Rhodesia and cannot say to which form the birds of those regions belong. I have seen angustus from the following localities (all in Tanganyika Territory); Muhulala, Kilimatindi; Kakoma; Kawewe's, 35 miles south of Tabora; and Manyani.

¹ Published by permission of the Secretary of the Smithsonian Institution. Received August 1, 1930.

A young male topotype of angustus, in the plumage described by Büttikofer (Notes Leyden Museum, x, note 22, 1888, p. 229, pl. 9, fig. 1) as kelleni, differs from that figure in being pale buffy gray instead of bright tawny on the rump and lower back, and on the edges of the feathers of the upper back. Schalow (Journ. f. Ornith., 1883, pp. 357-358) describes a juvenal bird from Kakoma which approximates that of kelleni, and agrees with the present male except that he writes that the head is dark brown whereas it is black in the present example, and likewise the neck is black and white, not brown and white as in his description.

I am much obliged to the American Museum of Natural History for the loan of two Angolan and three Tanganyikan birds with which to compare the two Loveridge specimens.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

464TH MEETING

The 464th meeting was held at the Cosmos Club April 9, 1930, President

G. R. Mansfield presiding.

Informal communication: C. P. Ross showed lantern slides of very rapid wave erosion in a Tertiary conglomerate on the shores of Gatun Lake, Canal Zone. A recession of 30 feet in 16 years has been measured. The rapidity of erosion is attributed to the susceptibility of the bentonitic matrix of the rock

to attack by water.

Program: M. R. Campbell: The problem of the scientific classification of coal.—Although coal is the standard fuel of the world, there is no generally accepted scheme of classification, either for the world as a whole or for any of the component countries. Large manufacturing organizations in the United States buy their coal generally on specifications which are based on the composition of the coal expressed in volatile matter, fixed carbon, ash or sulphur; but such a scheme is impossible of application by a small consumer, and consequently he is at the mercy of the dealer from whom he buys, who in turn is at the mercy of the jobber or the producer who mines the coal.

In order to obviate some of the difficulties specified above, a committee of the American Standards Association was organized to study the question and, if possible, propose a classification that would be generally accepted. This committee has been at work for nearly three years, devoting its time mainly to clearing the ground for real work by discarding many of the schemes already

proposed as inadequate or inappropriate.

The basis for a classification has been the bone of contention and this was not cleared up until the last meeting, when it was definitely decided to base the accepted scheme of classification on the changes that vegetal matter undergoes as a result of rock metamorphism, starting with peat and ending with graphitic anthracite. The number of stages to be recognized, their names, and the criteria for their differentiation are yet to be determined. (Author's abstract.) Discussed by Lane.

R. W. Goranson: Some problems in isostasy. (Abstract to be published

in a later number of this JOURNAL.) Discussed by LOVERING.

A. C. Lane: Geotherms. (Abstract to be published in a later number of this Journal. Discussed by Hewett, Gilluly, G. R. Mansfield, Spencer, RUBEY.

465TH MEETING

The 465th meeting was held at the Cosmos Club April 30, 1930, President

G. R. Mansfield presiding.

Informal communications: W. D. Johnston described some stalactites collected from the roof of the inspection chamber of the Wilson Dam. Muscle Shoals, Alabama. The water was completely let into the dam to a level of 90 feet above the roof of the chamber on January 1, 1925. Five years later stalactites 15 inches in length were collected. Discussed by Matthes,

Program: R. T. Chamberlin: Isostasy from a geological viewpoint. (Abstract to be published in a later number of this Journal.) Discussed by KEITH, BOWIE, LANE, G. R. MANSFIELD, SPENCER, A. C. LAWSON, HEWETT, LOVERING.

466TH MEETING

The 466th meeting was held at the Cosmos Club May 14, 1930, President

G. R. Mansfield presiding.

Program: C. P. Ross: Classification of the ore deposits of south-central Idaho.—The ore deposits of the region may be divided into two classes, of Mesozoic and Tertiary age respectively, each class divisible into four groups, each group in turn divisible into one or more sub-groups. Most of the lodes of Mesozoic age of major past and present economic importance are in shear zones and are characterized by galena and other sulphides in a sideritic' gangue. They have in the past yielded moderately rich ore from shoots of good size, but attempts to follow the lodes to any considerable depth have generally been unavailing. Hopes for the future, in these lodes, lie largely in solving the problems of finding new ore shoots at greater depth and of the metallurgical treatment of the more complex ore left by the early operators. In addition, there are other deposits in shear zones characterized by jamesonite, chalcopyrite, auriferous pyrite, or other sulphides, some of which have been profitably worked on a small scale. Mesozoic irregular replacements in calcareous rocks have locally proved profitable, though individual shoots are generally small. Contact metamorphic deposits and pegmatitic veins of the same age appear to be of small economic interest.

The Tertiary lodes have been and are likely to continue to be valuable mainly for precious metals, free and in selenide, although a few good mines of copper and other base metals have been and will be developed. In the past the precious metal lodes have yielded rich ore, which, with a few notable exceptions, was in rather small bodies. Such ore is becoming increasingly hard to find, and the hope for the future lies in the development of the large, low-grade bodies of gold ore which it is impractical to mine under present conditions, partly because in many the fine state of subdivision of the precious metals, even where free, and the fact that part of the values are locked up in exceedingly fine grains of selenide, present difficult metallurgical problems. Unlike the Mesozoic deposits, some of the Tertiary contact metamorphic lodes contain commercially valuable copper, lead and zinc ore. (Author's abstract.) Discussed by Ferguson, Lovering, Spencer, Hewett, G. R. Mansfield.

F. C. Schrader: Antimony deposits.—Antimony deposits are many and widely distributed in the world. The primary and chief ore mineral is stibnite, the sulphide of antimony. It alters to various whitish or yellowish

oxides, such as cervantite.

Stibnite deposits occur in various kinds of both sedimentary and igneous rocks of various ages, chiefly in limestone, shale, sandstone, and granitic rocks. They occur chiefly in quartz veins, but also as replacements and impregnations, especially along contacts and bedding planes, as in Arkansas, Bolivia, and China. They are always epigenetic or later than the rocks that inclose them, and therefore never occur as an original constituent of igneous rocks.

In a series of peripheral zones about a parent rock, antimony deposits, according to Emmons, occur in the outer zone, and with reference to depth, in

the surface zone, depending on the physical and chemical conditions.

Most of the more important deposits in the United States, according to Hess, occur in and around the Great Basin in Nevada and neighboring States in a region containing largely comparatively young (Cretaceous-Tertiary) granitic intrusive and extrusive rocks in which erosion has not been sufficient to remove to great depths the rocks covering and surrounding these intrusives.

Antimony deposits are simple in character and not extensive. The average width of the lodes or veins worked is about a foot. They are pockety and usually narrow and become low grade or barren in depth, usually at depths of

about 150 feet.

Commonly associated with the deposits is a small amount of other sulphides, such as pyrite and realgar, and many deposits are valuable for their

gold content.

Origin.—Most stibnite deposits of commercial value for their antimony content seem to have been formed near the surface, and at not necessarily high temperatures. They were formed by ascending hot solutions, as at Sulphur Spring, Calif., and Steamboat Springs, Nev., where Becker proved that the mercury and antimony being deposited are contained in the waters as double alkaline sulphides. Stibnite and kermesite are also being deposited at the West Gore mine, Nova Scotia, and in places stibnite is being replaced by pyrite, arsenopyrite, and galena.

China.—The world's chief reserve of antimony is in China, which country in recent years has supplied 90 per cent of the world's output and is appar-

ently able to supply the world's demand for a long time to come.

The antimony deposits in China occur mainly in the southeast provinces south of the Yangtse River in a broad northeast-southwest belt 1200 miles long. They parallel the belt, mountain ranges, valleys and rock structures of the region, which feature is regarded as favorable for their continuity. They nearly all occur in well defined veins in Paleozoic sedimentary rocks,

and range in age from late Paleozoic to early Miocene.

Of the seven or more productive fields in Hunan, which is the leading province, the richest is the Hsi-K'wang Shan (Shikungshan) field which is estimated to have supplied in recent years about 90 per cent of the world's output. It is $3\frac{1}{2}$ miles long by 2 miles wide. In it the deposits occur in a quartzitic sandstone of Silurian age. They occur in 4 principal groups or ranges of hills of which the richest is the Hsi-K'wang Shan,—'tin mine,' or antimony,—hill. It is $1\frac{1}{2}$ miles long by $\frac{1}{2}$ mile wide and consists mainly of a hogback ridge in which the sandstone has been upfaulted and greatly deformed with dip about 30° SE.

The ore, which is relatively pure stibnite ore, occurs as seams, pockets, bunches, lenses and veins irregularly distributed in the sandstone, the richer ore shoots tending to occur beneath domal or anticlinal structures. The deposits have been worked to the depth of 300 feet on the incline. They constitute the largest known antimony deposit and the largest producer in

the world. The antimony content of the sandstone taken as a whole in the ridge, is estimated by Tegengren to be about 6%, and the total visible reserves of the ridge to have been about 1,500,000 tons of metallic antimony, of which only about 100,000 tons or 200,000 tons of 55% ore had been mined by 1915.

The deposits seem to have been formed by ascending thermal solutions derived from some deep-seated intrusive rock not yet found in the present field. Of the three other groups or ranges of deposits in this field, that of the Kiang Ch'ung range is estimated to be nearly as rich as the one just described.

America.—In the Americas, nearly all the antimony deposits occur on or near the Pacific slope in a relatively narrow belt extending from Bolivia 8,000 miles northwestward through South and Central America, Mexico, United States, Canada and Alaska to the Arctic Coast at Cape Prince of Wales. They are associated with the various mountain ranges en route and relatively young granitic rocks. Occurring in this belt and ranking next in importance to the antimony deposits of China are those of Bolivia and Mexico, both of which countries, however, can produce only in time of high prices.

Mexico.—In Mexico, which has produced 20,000 tons of metallic antimony, the deposits occur principally in a belt 14 miles long lying in and between Characas and Catorce in the States of San Luis Potosí and Queretaro. They are chiefly stibnite ores but include also oxides. They are largely associated with porphyry and limestone. At Zimapan, Hidalgo, according to Lindgren and Whitehead, a large deposit of jamesonite occurs in Cretaceous limestone, and is genetically connected with intrusive monzonite and diorite

porphyry.

Bolivia.—In Bolivia, which has produced antimony ore, mostly of high grade, containing 43,000 tons of metallic antimony, the deposits, mainly stibnite ore, occur chiefly in a belt 150 miles wide extending from Lake Titicaca 450 miles southward to Tupiza and Atocha, and from the Chilean boundary eastward to Potosí. They occur mainly in the departments of Potosí, Tarija and La Paz. According to Voge they occur generally in black Paleozoic shale in vertical quartz veins ranging up to 3 feet wide, but according to Miller and Singewald, they became barren at shallow depths, and some of the stibnite is auriferous and is associated with galena. The deposits, however, seem to contain a large reserve of medium or low-grade ore. Although they occur in the same region as the tin ores which frequently contain antimony minerals, the antimony veins are distinct from the tin-ore veins. Pilz regards the deposits as a differentiation product of a granite magma that according to temperature and pressure relations first formed tin and gold ore lodes, then copper, zinc-lead, and antimony-ore lodes. (Author's abstract.)

C. WYTHE COOKE: Correlation of coastal terraces.—This paper has been printed under the title Pleistocene seashores. (This Journal, 20: 389-395.

(930.)

Discussed by G. R. Mansfield, D. White, Ferguson, Lovering, Mendenhall, Spencer, Rubey.

JAMES GILLULY, C. H. DANE, Secretaries.

ENTOMOLOGICAL SOCIETY

418TH MEETING (continued)

Remarks were made on invitation by a nonresident member, Mr. A. O.

LARSON, of the Bureau of Entomology, now located in California.

Mr. Larson said that early in the bean weevil investigation it was found that bean weevil infestations were local in their nature—that one farmer would have weevily beans at harvest time while another not far distant would have

weevil free beans of the same variety. It was found that an infestation in the field could usually be traced to a source of infestation—beans in which weevils had been allowed to breed during the summer. Quite often this source of infestation was the beans contained in bean straw stacks. Bean straw stacks held over for feed or bedding for livestock could carry weevil infestations for

several years.

He also said that in sections where a concerted effort had been made to remove all sources of weevil infestation in the spring there had been a decided decrease in the amount of weevil infestation in the growing crops. He said that in the large bean growing section adjacent to Modesto, Calif., there had been a very decided decrease in the amount of bean weevil damage due to the adoption of the recommendations of the Bureau of Entomology. The weevils he discussed were the common bean weevil and the Southern cowpea weevil. (Author's abstract.)

Brief remarks also were made on invitation by Mr. F. J. Spruijt of the Bureau of Entomology, formerly located in the Pacific Northwest, but now visiting Washington from his new location on Long Island, New York. He referred very briefly to some of his recent experiences in former research work, but stated that he had barely commenced study of his present problem, and therefore was not prepared to go into it as yet with any detail. He expressed his satisfaction at opportunity of visiting Washington and examining the available literature pertaining to his work, and his pleasure at meeting the other scientific workers here.

Mr. S. A. Rohwer, on the request of the Chairman, discussed briefly some of the more recent developments pertaining to the pink bollworm work in

Arizona and the Mediterranean fruit fly work in Florida.

Prior to discussing the work on the Mediterranean fruit fly, Mr. Rohwer reviewed briefly the situation regarding the pink bollworm, stating that since the last meeting of the Society guarantees satisfactory to the Secretary of Agriculture had been received from some 21 associations or corporations. These contracts provided that the guarantors would pay to the Federal Government sums which in the aggregate would equal one-half of the estimated actual and necessary losses sustained by farmers in connection with the enforced nonproduction of cotton in the noncotton zones which had been established in the State of Arizona for the crop of 1930. The contracts further provided that the guarantors would reimburse the Federal Government in event the State, through its legislature, did not, prior to December 1, 1932, appropriate and pay one-half of the actual and necessary losses. The urgent need of commencing the cleanup work at the earliest practicable date prompted the Secretary to agree to release the funds for cleanup on receipt of telegraphic advice from the guarantors that they would sign a contract acceptable to the legal advisors of the Secretary. By February 24 twenty-one guarantors had advised the Secretary that they would sign such a contract, and funds appropriated for cleanup were released on that date. The cleanup work started on the 25th and more than twelve thousand laborers are now employed in cleaning fields. In addition to this a large number of mowers and rakes are used in cutting the cotton prior to the more detailed cleanup work which is done by hand. After all the crop remnants have been removed from the fields and placed in piles they are burned.

In speaking of the Mediterranean fruit fly, Mr. Rohwer stated that a subcommittee of the House committee on appropriations, by authority conferred in a resolution passed by the House on February 10, were at the present time holding hearings in Florida to investigate the situation concerning the fruit fly and arrive at a determination as to the funds which might be appropriated for work on this pest. It will be remembered that on December

9, 1929, the President submitted an estimate requesting \$15,381,000 for additional funds to carry on the eradication and other work connected with the fruit fly. Pending final consideration of the estimate, Congress by joint resolution made available \$1,290,000 to carry on the work. The House Committee in reporting this estimate stated that it was not intended that any of this fund should be used for those features of the work connected with eradication. The work which had been done since January first dealt largely with inspection to determine the presence of the fly, to enforce the quarantine and to certify and supervise the movement of products under conditions imposed by the quarantine. For the work which is now being conducted it is estimated that the funds available will last until approximately the middle of April.

Mr. Rohwer also stated that information had been received from Dr. Baker that on February 28th all living stages of the Mediterranean fruit fly in the experimental laboratory at Orlando had been destroyed. In the early phases of the work it had been necessary to maintain a stock of living material in order to get adult flies to determine what fruits and vegetables they would attack and also for the development of an insecticide for spraying purposes least injurious to the crops. The idea of having living material even for research purposes in an area where eradication was being carried on was accepted only because of the necessity of having information concerning the habits of the fly under Florida conditions and from the beginning it was the intention to use these adult flies only as long as necessary to secure information pertinent to the eradication work and later on to transfer investigations to Hawaii. The time limit set for these experiments had been March 1, and they have now been discontinued.

Mr. Řohwer further said that on the afternoon of March 4, larvae of the fruit fly were found in two sour oranges in a grove in the town of Orlando. Practically all of the fruit from this grove had already been marketed. Immediately following the discovery of the infestation, cleanup work was under-

taken and other precautions to eliminate it.

In response to a question from Dr. Poos, Mr. Rohwer spoke briefly of the cleanup and removal of alternate hosts which had been carried on during the summer. At this time he emphasized that it would appear from statements included in various papers and periodicals that many of the people in the North had a very erroneous idea of the eradication work, believing that large areas of land were laid waste in connection with the campaign. He emphasized that nothing could be farther from actual facts. The work that had been done by the Department had made it possible for the growers to market their crops without material loss. With the exception of one small area in which infestation had been found on November 16, no fruit had been destroyed. In order to move their fruit to points interstate, the growers were required to keep the drops and culled fruits picked up and meet other sanitary requirements both in the groves and packing houses. In complying with these requirements the orchards were usually free from fallen fruit and to the casual observer would appear to be in unusually favorable condition. In this connection the Administration had received a large number of comments as to the favorable appearance of the groves in Florida. Furthermore the casual visitor would not notice any difference concerning crops. The requirements of the quarantine may have in individual instances imposed hardships and required the grower to change plans as to the type of vegetables or other annuals that he would plant, but such facts would not be apparent to those not thoroughly familiar with the situation. The speaker suggested that those who had knowledge of methods and facts concerning eradication coöperate and as occasion permitted correct the erroneous ideas which seem to be more or less prevalent. (Author's abstract.) J. S. Wade, Recording Secretary.

OFFICIAL COMMUNICATIONS

1

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

Philosophical Society

The address by W. J. Humphreys, The Philosophical Society of Washington through a thousand meetings, which appeared in the issue of this Journal for July 19, 1930, has been published in pamphlet form by the Philosophical Society. Copies, bound in stiff covers, may be obtained for forty cents each, postpaid, from the Treasurer, Capt. N. H. Heck, U. S. Coast and Geodetic Survey, Washington, D. C.

ANNOUNCEMENTS OF MEETINGS

Tuesday, October 21 Wednesday, October 22

Saturday, October 25 Wednesday, October 29 Saturday, November 1 Tuesday, November 4 Wednesday, November 5 The Anthropological Society
The Geological Society

The Medical Society
The Philosophical Society
The Medical Society
The Biological Society

The Botanical Society
The Engineering Society
The Medical Society

The programs of the meetings of the affiliated Societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

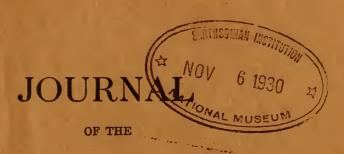
Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

	rage
Geology.—Paleozoic formations in the Gold Hill quadrangle, Utah. THOMAS B.	
Nolan	421
Paleontology.—Contributions to the paleontology of Peru, IV: "Orthophragmina"	
(Discocyclina) meroensis W. Berry, n. sp. Willard Berry	432
Ornithology.—The geographic variations of Neocichla gutturalis (Bocage). HER-	
BERT FRIEDMANN	434
Proceedings	
The Geological Society	435
The Entomological Society	

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries.



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN
PHILOSOPHICAL SOCIETY

E. A. GOLDMAN
BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt, Royal and Guilford Aves, Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of poetage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following pages with the following pages. ance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices: First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

NOVEMBER 4, 1930

No. 18

GEOLOGY.—Abstracts of papers on isostasy and related topics given before the Geological Society of Washington during the spring of 1930.

I. Some problems of mountain structure and mountain history.

Chester R. Longwell

Attempts to establish some of the principles of tectonics call for critical examination of the concepts, old and new, which have gained a prominent place in this field. I propose to consider briefly three questions: (1) Is diastrophism periodic? (2) Do folding and thrusting result directly in mountain uplift? (3) What is the rôle of isostasy in relation to mountain making?

(1) Many geologists believe firmly that diastrophism is periodic and several modern textbooks offer this doctrine to the student without reservation or qualification. At best, the doctrine involves a loose definition of the word periodicity, which to the mathematician and physicist denotes a relationship that can be expressed by a rigid formula or represented by a regular curve. Events that seem to recur approximately with each geologic period can hardly meet the requirements of this definition, since the geologic periods probably differ greatly in length. Moreover the intensity of diastrophism appears to be distributed irregularly. A composite curve prepared by Holmes² has the required regularity, but the time period assumed is highly speculative, and to this is added the uncertainty as to the exact position in the geologic scale of many diastrophic events. Stille, after a com-

¹ Abstract of Some problems of mountain structure and mountain history, Am. Jour. Sci., 19: 419-434, 1930.

² Holmes, A., The Age of the Earth, p. 49. Ernest Benn, Ltd., London, 1927.

prehensive tectonic study,³ describes diastrophism as periodic; but he groups all post-Cambrian disturbances into three "orogenies," in each of which the separate events are disposed with some irregularity about a culminating point. This conclusion is expressed in graphic form by Lotze,⁴ who attempts to represent the relative intensities of deformation. If anything approximating a periodic relationship of diastrophic events ever is established, probably it will be between a few widely-spaced high points, and not between events in successive geologic periods. At present, the most we can say is that diastrophism has been recurrent, and that a few episodes, widely-spaced, seem to have been of unusual severity. Periodicity may be entertained as a promising hypothesis, but the common assumption that this relationship is established is wholly unwarranted.

(2) Are genuine mountains made by folding and thrusting? Berry expresses the belief that the present Appalachians are the only considerable mountains that ever existed on their site.⁵ Probably his reasoning is by analogy, since elsewhere in the same paper he points out that the present height of the Rockies, Andes, and other mountain units has been produced by vertical uplift much later than the folding. We should keep in mind, however, that the Appalachian folding is much older than the Rocky Mountain deformation, and that the Tertiary arching in the Appalachians occurred after a vast quantity of rock had been removed by erosion. Possibly this arching is merely the latest and weakest of several vertical uplifts that succeeded the Appalachian folding; and considerable initial elevation may have resulted from the folding directly.

For deductive study, consider the section in central Pennsylvania, where the folds are relatively simple. The Nittany Arch and other great folds, if reconstructed in any reasonable form, would rise nearly five miles above the truncated limbs. Assume that the land was at sea level when the folding began, and that isostatic equilibrium was maintained throughout the deformation. This would require that anticlines like the Nittany Arch rise to mountain heights, unless erosion proceeded as fast as uplift. But if the competent formations had been cut through at an early stage of the folding, then with further

 $^{^{3}}$ Stille, H., ${\it Grundfragen \ der \ vergleichenden \ Tektonik}.$ Gebrüder Borntraeger, Berlin, 1924.

⁴ LOTZE, F., Die Joly'sche Radioactivitätshypothese zur Erklärung der Gebirgesbildungen. Nachrichten der Gesellschaft der Wissenschaften zu Göttingen, Math.-Phys. Klasse, p. 102, 1927.

⁵ Berry, E. W., Shall we return to cataclysmal geology? Am. Jour. Sci., 17: 1-12. 1929.

compression it seems that these stiff units would have been pushed over the eroded crests to form erosion thrusts. In central Pennsylvania, however, no such thrusts were formed. This argument favors the idea of considerable initial uplift, and is strengthened by the point that folding would concentrate rock of low density at the top of the zone, requiring a rise of the surface to maintain equilibrium.

The limited sedimentary evidence that has been preserved indicates high topography along the Appalachian axis in Triassic time. In the Rocky Mountain region the character and structure of early Tertiary sediments constitute strong evidence of high topography while folding and thrusting were in progress.

One of the most hopeful methods of attacking the problem consists in comparison of the older folded zones with those in which similar structure has been formed in late geologic and recent time. The Timor-Ceram island arc, in the East Indies, represents a large anticline which is being crowded against the Sahul shelf.⁶ This fold is almost uneroded, and obviously its vertical growth has progressed with horizontal movement. The Alps may be taken to represent a later stage in the development of similar mountains. Apparently in the early stages the Alps were similar to the Timor and neighboring arcs. In the Miocene, after the greatest piling up of the thrust sheets, the present Alpine area was a range of considerable height, shedding coarse debris into the Molasse synclinal trough. The last pulse of compressive deformation, in the later Tertiary, was followed by general vertical uplift which completed the mountain growth.

Taken together, the evidence from the East Indies, the Alps, the Rockies, and the Appalachians suggests that folding and thrusting are attended by considerable direct uplift, but only a fractional part of that indicated by the crustal shortening, because approximate isostatic balance is maintained. Later there is strong vertical movement, carrying the mountain region to far greater height. Other pulses of uplift rejuvenate the wasting mountains, even after almost complete planation. In the Appalachians the latest vertical movement was by regional arching; in the Sierra Nevada area it was by tilting uplift of a great fault block. The existence of Cretaceous and early Tertiary highlands on the site of late Jurassic folding in the Sierra Nevada area is attested by vast quantities of sediments furnished by this belt during those periods.

⁶ Brouwer, H. A., The geology of the Netherlands East Indies, Chap. 3. The Macmillan Co., New York.

(3) The relation of isostasy to mountain making has already been referred to in some of its aspects. Bowie and others have performed valuable service in persistent emphasis of the isostatic principle, but have failed to consider much of the geologic evidence bearing on the subject. Bowie represents the crust as too weak to bear even moderate vertical stresses, and incapable of transmitting horizontal thrust. The geologist sees overwhelming evidence of repeated deformation by horizontal movement, and bases his estimate of crustal strength chiefly on this geologic evidence. Some of the geodetic data also, interpreted from the geologic viewpoint, appear to support the conclusion of great crustal strength. One example is sufficient for illustration.

The work of Hayford and Bowie reduced the gravity anomalies in the United States to a small average value. However, isolated stations, and even some groups of stations covering large areas, still. show anomalies of considerable size. Bowie has pointed out that many of these outstanding anomalies appear to be related to the local geology; positive values being explained by rocks of high density, and negative values by light rocks, near the station. We are familiar with David White's study of this question. He found that all of the stations in the "Appalachian Valley" show pronounced negative anomalies, whereas most of the stations on the crystalline rocks just to the east show positive values. This distribution is striking, and the suggestion of control by the Appalachian structure is obvious. White concluded that part of the explanation for the negative group lies in the great depth of folded sediments; but since these formations are highly indurated and only slightly deficient in density, there must be another important factor also. He suggested that the crystalline basement under the sediments is also abnormally light as compared with the rocks in the Piedmont, because it has not been subject to erosion since the beginning of the Paleozoic, and therefore the denser rocks are still at great depth in the valley belt. This explanation assumes perfect isostasy, and seeks only a special local cause for the anomalies. The conclusion is heartily indorsed by Bowie.

Let us compare this case with another. In his study entitled "The strength of the earth's crust," Barrell attempted to show that great modern deltas are loads borne by the crust. A few years later Bowie studied the same problem, with the advantage of several gravity values recently determined on the Mississippi delta. There are eight

⁷ Gravity observations from the standpoint of the local geology: Bull. Geol. Soc. Amer. **35**: 207-278. 1924.

of the stations of which four show positive and the other four negative anomalies. Taking the group as a unit, the gravity anomaly is essentially zero; precisely, it is negative by only 0.007 dyne. Bowie closes his discussion of the group as follows: "We are evidently justified in concluding that the block of the isostatic shell directly under the Delta of the Mississippi is very nearly in isostatic equilibrium and that the delta material has been compensated for by a movement of material from the base of the block."

The geologist, approaching the subject fresh from the discussion of local geology and its influence on gravity, naturally looks for some evaluation of this factor for the delta stations; but the subject is not even mentioned in Bowie's discussion. If there is any one area in which the influence of the underlying rock on gravity values should be carefully considered, surely that area is the Mississippi delta. On any reasonable premises, the depth of abnormally light sediments must be large. It is estimated that the thickness of the post-Paleozoic section in the Gulf region is of the order of 15,000 feet; it may be much thicker under the delta, depending on the amount of subsidence that has accompanied delta building.

Let us start with the assumption that the delta is in equilibrium. Taking the thickness of the sedimentary section as 15,000 feet and the deficiency in density as 0.4, and using the method of computation given by Bowie, the average negative anomaly ought to be at least 0.060 dyne. Since this negative anomaly does not exist, the measured gravity is abnormally large, and therefore the delta area is overloaded. According to the table of ratios proposed by Barrell, this anomaly corresponds to a thickness of 3,000 feet of rock. This estimate could be reduced considerably and still allow the conclusion that the crust is very strong even under vertical bending stresses.

This reconsideration of the delta anomalies suggests further examination of abnormal groups elsewhere. We do not feel justified in starting, as did White, with an assumption of perfect isostasy. Returning to the Appalachian trough, it seems more probable that a considerable part of the negative values indicates lack of adjustment in this area. As a result of the latest uplifts erosion has attacked the belts of weak sediments, and a large quantity of rock has been re-

⁸ W. Bowie, Isostatic investigations and data for gravity stations in the United States established since 1915: U. S. Coast and Geodetic Survey Special Pub. No. 99, 1924, pp. 49-50. Also in Isostasy, pp. 89-91.

⁹ Loc. cit., p. 37.

¹⁰ Barrell, J., The strength of the earth's crust: Jour. Geol., 22: 309. 1914.

removed. The stations in the valley belt are located in these areas of maximum erosion. The physiography of the region indicates that uplift has occurred in a succession of pulses, with intervals of quiet between. It is highly improbable, therefore, that perfect adjustment has been maintained; and the large negative anomalies are in accord with this view.

Both the geologic and the geodetic evidence, then, lead us squarely back to the conclusion of Barrell that the crust is strong enough to bear loads of considerable size. This is the only ground on which all of the facts taken together will harmonize.

II. ISOSTASY: WHAT GRAVITY MEASUREMENTS REVEAL. G. R. Putnam

The results of gravity measurements afford abundant evidence that the crust of the earth is in some sort of equilibrium, but the interpretation of these results presents some difficulties because of the elaborate mathematics involved. A large part of the available data has been derived on an assumption of complete local isostasy, with the assertion that any error resulting from this assumption is negligible. This has been a source of perplexity to geologists. It has now been proved that gravity results derived on an assumption of complete local isostasy may be materially in error, as is rather clearly shown by the results in extremely mountainous or uneven regions. An assumption of a moderate degree of regional isostasy makes the gravity results more consistent within themselves, and also makes them more harmonious with reasonable geological theories and evidence.

The theory of isostasy holds true whether equilibrium exists between large surface blocks, as is probably the fact, or between very small areas. Thus far the only gravity reduction method which eliminates the excessive residuals for very high summits is a method based on an assumption that blocks of about 100 miles radius are in approximate equilibrium. This indicates that features of moderate extent, such as single mountains, are not separately compensated, but are supported, in part at least, by the strength of the earth's crust.

Regional isostasy is a conception of the earth's crust wholly different from that of perfect, or nearly complete local isostasy. It is in harmony with the known strength of the crustal materials, and with reasonable density distributions, with which local isostasy can not be fitted in. It permits the application of ideas of crustal action under loading and unloading, bending or breaking of the crust, difficult to conceive of with local isostasy.

The gravity results clearly prove the existence of a state of equilibrium in the earth's crust, and strongly indicate that this isostasy falls within limits which are not unreasonable from the geologist's point of view.

III. Some problems in isostasy. R. W. Goranson

In view of the many recent rather eulogistic discussions on the subject of isostasy I shall limit myself to a few questions that still await clarification. Isostasy can be made an important tool of geophysics—viz., as a criterion of crustal equilibrium in the continuous process of deposition and erosion with its consequent shifting of loads, but to do this our gravity anomalies must be reliable.

Now we have considerable evidence to show that the upper part of the crust tends to approach equilibrium discontinuously by faulting—e.g., the uplift resulting from the unloading of the Pleistocene ice caps is taking place by step-faulting, subsidence in the Hawaiian and Fijian Islands is accompanied by faulting; furthermore, discontinuity of subsidence is indicated by deposition cycles of geosynclines, which is just what we would be led to expect in a material of finite strength.

Hence, if we knew the deviation of a region from equilibrium—i.e., could evaluate the stresses and knew the strength of the crust—we might be able to supply answers, in some cases at least, to two outstanding questions: Are earthquakes apt to occur or continue in a certain region? If so, what will be their periodicity and intensity? Earthquake periodicities resulting from statistical studies do not answer these questions but, on the other hand, may be likened to the firing pin of a semi-diesel engine which although kept continually hot yet will not fire the charge until it attains a certain pressure.

The first question to arise is: How reliable are the gravity anomalies? If we assume the measured values to be good—i.e., within 0.003 dynes per cm², this question can be phrased as—What is the possible error in the computed value of gravity? It lies in the corrections for compensation and topography.

It is necessary, in calculating the amount of compensation, to assume a standard column as a comparison. In order to do this intelligently one must examine the data on variation of density with depth and again on how this varies with latitude and longitude.

Let us merely recapitulate what is generally conceded to be the situation, since time does not permit us to examine critically the reasons for these conclusions.

First, seismological data tell us that lateral heterogeneity seems to be limited to a depth of 60 km or less. Seismology has also given us a general picture of widespread lateral heterogeneities, as for instance between oceanic and continental columns. We know that a continental column to an average depth of 30 ± 10 km is of a "granitic" type and below this to a depth of 45 ± 10 km, of a "basaltic" type of rock. These depths vary with locality and seemingly bear a relation to topographic elevation. Under the Pacific, on the other hand, the upper granitic shell is apparently non-existent. Lying below 45 ± 10 km in both regions is a "peridotitic shell" in which density is apparently a function of depth only.

TABLE I

THOUS I		
Anomalies for different types of compensa	tion	
Station elevation 787.5 m. av. for circle 170 km	n. radius	
\mathbf{g} (observed)	980.404 980.618	
Elev. correction	243 + .087	(to 170 km)
Column correction and distant zones	+.019	
	980.481	
Isostatic correction. = .077		
Compensation		Anomaly
A. Pratt-Hayford (113.7 km)		-0.020
B. At 26 km depth		-0.004
C. At 50 km depth		-0.016
D. Divided, 26 and 50 km depth		-0.009
Max. diff		0.016
Av. deviation		±0.006

At some depth we shall, presumably, reach plastic material and thus a depth at which inequalities of load have all been ironed out. Between this plastic material and the surface isostatic movements will take place largely by faulting and thus seismology should give us a clue to the depth of this plastic layer. The clue is that earthquake foci seem to be definitely centered in a region lying between the surface and 35 km depth. But even if faulting did extend much farther, the compensating deficiency of mass will lie at about 20 ± 10 km and

NOV. 4, 1930 GORANSON: ISOSTASY 449

 45 ± 10 km depths. If compensation extends below 50 km depth the center of gravity of the compensating deficiency will lie at about 35 ± 10 km depth. If compensation is complete above 50 km then the center of gravity of the compensating deficiency is at about 30 ± 10 km depth.

The above table indicates discrepancies which may be introduced by choosing different depths of compensation.

This station was so chosen that the Pratt-Hayford reduction would give the same anomaly whether we assumed local or regional compensation. As one can see, the differences are not large. Ordinarily, however, if compensation is regional any calculated value of gravity based on local compensation may be in error by as much as \pm 0.02 dynes per cm².

The next table indicates errors that might be introduced by not correcting for deviations of density distribution from the standard column.

TABLE II

TABLE II	
Apparent anomalies introduced	
·	dynes/cm²
Diabase sill 20 km diameter at 1 km depth (density difference	
from standard +0.3)	
5 km thick	+0.040
2 " "	+0.018
1 " "	+0.010
0.5 " "	+0.005
0.25 " "	+0.003
Diabase sill 40 km diameter at 5 km depth 5 km thick	+0.032
Sedimentary layer at surface 20 km diameter (density difference from standard -0.3)	
2 km thick	-0.021
1 ((((-0.021 -0.012
0.5 " "	-0.012 -0.005
0.0	-0.005

The next table indicates the gravity anomalies that would be obtained by introducing some of the heterogeneities listed in Table II into the column used in Table I.

Thus an isostatically balanced column may have a plus or minus anomaly of as much as 0.030 dynes per cm². Similarly an uncompensated column 350 meters elevation may have a zero gravity anomaly giving us *pseudo-isostasy*.

TABLE III

Gravity anomalies					
	Normal	E.	F.	G.	
Α.	-0.020	+0.008	-0.002	-0.041	
В.	-0.004	+0.028	+0.014	-0.025	
C.	-0.016	+0.016	+0.002	-0.037	
D.	-0.009	+0.023	+0.009	-0.030	

A. B. C. D are as given in Table I.

E-diabase laccolith 20 km rad., 5 km thick at 5 km depth.

F-diabase sill 20 km rad., 2 km thick at 1 km depth.

G-Deficient density due to light sediments.

Corrections for variations of density from the standard column chosen will have to be made by methods similar to those used by oil geologists in plotting subterranean strata. The depth and method of compensation must be obtained by a statistical method. However, we see that until we can correct for heterogeneity of columns such an analysis must still remain somewhat doubtful.

Thus we see that two stations in which columnar heterogeneities of density have not been corrected for could have a gravity anomaly difference of as much as 0.07 dynes/cm² and yet both be isostatically compensated; hence columnar heterogeneities of density must be corrected for before gravity anomaly discrepancies existing in the second decimal place can be depended upon.

IV. GEOTHERMS. A.C.Lane

In Nature, May 9, 1878, Vol. 18, p. 42, there was published a report of a lecture by Sir George Airy, revised by him. In this he summed up the conclusions of over 50 years. One paragraph closes with this sentence: "The form of the earth is not such as would be taken by a solid structure but such as would be taken by a fluid mass with solids floating upon it." This is a theory of isostasy. The next paragraph begins "In the second part of his address Sir George Airy referred to what is known about the temperatures." Again in 1851, Osmond Fisher published his book "Physics of the Earth's Crust" and after Chapters 14 and 15 on the "revelations of the plumb line" and

of the pendulum, he goes on to the "revelations of the thermometer." This paper on temperature followed that of Goranson on isostasy. Thus history repeats itself.

The sources of the earth's heat are (1) environmental, or (2) inherent.

(1) The environmental is mainly from the sun. In that we can not neglect the atmosphere. The temperature drops from 5 to 6°F. per thousand feet over Washington. If we had less atmosphere, as in Mars, there would be a climate more like that of the high mountains of the earth. On the other hand, if we had more atmosphere, we should have a warmer climate at its base. If the sun, or the earth itself, was so much hotter that the present ocean of say, 2000 fathoms depth, was evaporated, the pressure at the base would be 400 times more than at present. The bottom of that atmosphere might have water at the critical temperature 374°C, since the pressure would be above the critical pressure 217.5 atmospheres. There is, therefore, one important error in Lord Kelvin's calculations of the age of the earth in that he assumes the temperature of the earth to have suddenly dropped from a constant temperature of 7000°F, to 0°F. Suppose it had been at 374°C. for a long time, how far down would the wave of change of heat have penetrated in a given time? What is the effect of a a wave of change of temperature going down from the surface?

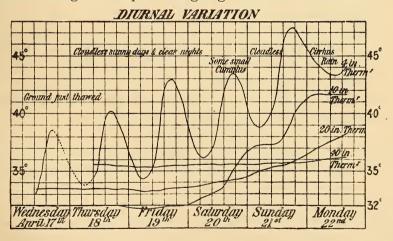


Fig. 1. Callendar's observations of soil temperatures at Montreal, *Trans. Roy. Soc. Can.*, 1895, p. 15, showing the observations for six days with four thermometers at various depths.

To illustrate this, it is well to begin with the daily wave of temperature. One of the most thorough studies has been made by Callendar and McCloud at Montreal. (Fig. 1.) Numerous other studies are avail-

able (by Tamura in Japan, by myself in Michigan, by Spence, Angstrom, etc.). At Montreal the daily heat wave on the 4 inch thermometer which was hottest about 6 o'clock in the afternoon, shows about 2 o'clock in the morning, Sunday, on the 10-inch thermometer and is barely visible at greater depths. Now the mathematical treatment of all these heat problems shows that in heat problems or any diffusion where the rate of change in time is proportional to the acceleration of change in space (which seems natural, since you would expect no change in time if as much was lost in one direction as was gained in another) the temperature depends upon a function of X (distance) divided by $a\sqrt{t}$, where t is the time, so that if a daily heat wave is reduced to 1/10 or its heat wave in 2 feet, the yearly heat wave will be reduced by the same amount and will similarly be retarded in $(\sqrt{365} = 19)$ × 2 ft. or 38 ft., so that a well whose water is from some 38 ft. below may well be coldest in summer. If there is a heat wave which has occurred during the last 10,000 years and previous to that there was ice for a long time, the effect of that heat wave should (other things being equal) be felt 100 times 38, 3800 ft. down. It is thus desirable to test carefully, as Van Orstrand is doing, the temperatures of wells, especially under some of the ancient lakes. For instance, if Lake Lahontan was cold water 4900 years ago, the effect of the warming of the soil since might be confined to the first $70 \times 38 = 2560$ ft. Thus, if 25,000,000 years ago, as Kelvin suggested, the earth was so hot that the ocean was up in the air, and surface temperature was 374°C., and if since that time the surface heat has gradually sunk to say 24°C., only 38 miles down the temperatures would still be adjusted to 374°. This would account for something like 1/3 of the present gradient.

As the deep wells are now getting numerous, the present record being 9629 ft., we may well ask if we see any signs of these waves of heat. We do, for generally speaking, it is true that the gradient in the lower part of a well if continued would point to a lower temperature at surface than at present. We must remember that the amplitude of the heat wave decreases very rapidly so that refined tests such as Van Orstrand is making are needed to get all the possible information. The general tendency of temperature curves to flatten going down is illustrated in Figure 2 from Van Orstrand and is widely characteristic.

We must not forget, however, that there is another factor to consider—namely, the diffusivity. A blanket is a poor conductor so there may be a great difference of temperature on two sides. The better the conductor, the harder it is to keep up a difference of temperature and the more heat must flow through. In diffusion of heat, however,

NOV. 4, 1930 LANE: GEOTHERMS 453

another factor comes in, in the capacity of the material to absorb heat itself. The amount it can send on is only the surplus after it has itself absorbed some. So that the diffusivity is the conductivity divided by its heat capacity per unit volume. On the whole, near the surface the strata are porous and less compacted. We should expect them to be poorer conductors and that the rate of increase of temperature would be relatively high. As a matter of fact, however, as Van Orstrand says, it is usually the other way. This increases the probability that a warming up of the world's climate has taken place during the last few thousand years which has produced a flatter gradient for the first 3000 ft. or 1000 meters.

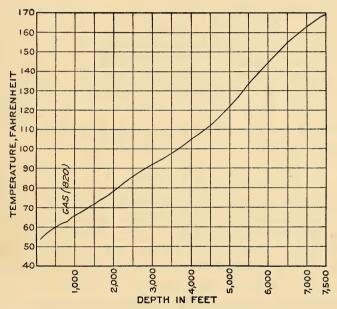


Fig. 2. Temperatures of the Ligonier deep well, Fairmont, W Va., showing the penetration of heat since the last ice age down to about 3500 feet. (After C. E. VAN ORSTRAND.)

Omitting various chemical factors considered by Bischoff in his prize essay, such as oxidation, hydration, and the generation of oil from carbides or by bacterial action, we will consider the effect of radioactive disintegration. Granite is the most radioactive of ordinary rocks, although the range is enormous—three times as much in some granites as in others. The average given by Holmes is 1.3 millionths of a calorie per second per c. c. If the outflow of earth heat is from a gradient of 30°C. per kilometer and the conductivity is .008, the

outflow would be 2.4 millionths of a calorie per second, equivalent to that generated by a column of 18 kilometers of granite. If there is more than that generated, it could not escape by a peaceful steady flow but by occasional spasmodic outbursts like the steam from a tea kettle as suggested by Joly. This would fit in very well with the theories of Schaller and Hess and Kirsch of long time and repeated activity in the formation of pegmatites. We have also the radio-activity of the underlying basalt to account for, but this is only 5/13 to 36/130 of that of the granite. We can see from this the importance of knowledge of what the flow of heat really is and the importance of studies of differing conductivities and diffusivities in the rocks. I have not mentioned the effect of cutting down the surface faster than the geotherms can keep pace with it, which means that over domes and arches the geotherms are crowded.

Nor have I mentioned the effect of forcing up material from below, as in salt domes and in batholiths, nor the effect of circulation of radioactive water up a fault leaking into a stratum and affecting the temperatures. The report by K. C. Heald to the American Petroleum Institute in Chicago, December 5, 1929, suggests research of scientific as well as of practical value along these lines.

V. ISOSTASY FROM THE GEOLOGICAL POINT OF VIEW. R. T. Chamberlin

The geologic facts which have to be taken into account are as follows: (1) Folding into mountain ranges occurs, in general, where weak and light sediments have previously accumulated to exceptional thickness. (2) Low-angle overthrusts with horizontal displacement up to 20 miles, or even more, are a characteristic and dominant structure of the more strongly folded mountain systems. (3) The folding. faulting, schistosity, etc., involve much crustal shortening—200 miles for the Appalachian belt (Keith), 125-185 miles for the Alps (Heim), etc. (4) The horizontal squeezing of broad belts of the earth's surface into deformed strips of half their former width forces material either upward, or downward, or both. (5) Resistance is presumably easiest upward. In the surface portion which we see there has been more upward folding than downward. Taking the Briceville, Tennessee, folio as typical of the western flank of the Appalachians, the border thrust fault sharply separates the intricately deformed Appalachian Mountain belt from the flat-lying Pennsylvanian strata of the Cumberland Plateau to the west. The horizontal strata of the Cumberland Plateau (or top of the sedimentary column there) provide a datum plane above which to figure the relative movement.

deformed mountain region has been folded and faulted upward with respect to this. More recently, since passing through a near-baselevel stage, both the deformed mountain belt and the undeformed plateau belt have been uplifted bodily. (6) There may, in addition, have been some downward movement of material in the deeper reaches of deformed belts far below the surface. Heim has urged this strongly for the Alps.

The key note of isostasy is a working toward equilibrium. It is not a process which upsets equilibrium, but one which restores equilibrium. The light and heavy columns of the isostatic conception tend to become more and more equal in specific gravity, and consequently height, as time goes on. In short, the system by itself, runs down. Relief on the globe, following the purely isostatic view, should have been greatest in the Archeozoic, less in the Proterozoic, still less in the Paleozoic, and least at the present time. Yet today is a time of exceptional relief in the history of the globe. Not denying the validity of the principle of isostasy, it seems clear that it can not be the dominating principle.

Isostatic forces are incompetent to explain the observed crustal shortening. The observed folding and thrust faulting are not primarily the result of isostatic adjustment, though forces tending toward adjustment must be in the total equation of forces.

Operating on a purely isostatic basis a mountain block cut down to baselevel should rise (isostatically) to $\frac{9}{11}$ of its original height (Bowie, Lawson). With the progress of erosion, the mountain column should keep rising, theoretically, and a tremendous amount of erosion would be required to get it finally down to a condition of comparative stability (baselevel). Estimating the average height of the reconstructed Appalachian folds of the Tyrone-Harrisburg section at about 16,000 feet above the Kittatinny peneplain, I calculate that this mountain belt would have to be cut down about 81,000 feet, on a $\frac{9}{11}$ basis, to bring it to baselevel. Yet it has only been cut down about 16,000 feet.

Lawson and others have emphasized the fact that the initiation of a geosyncline must be due to some other cause than loading alone. A plain on which sediments are deposited can be depressed, by loading alone, less than two thirds as much as the thickness of the sediments. The fore-deeps paralleling mountain ranges and chains of islands are striking topographic depressions below the adjacent oceanic floors. They are ready to receive sediment, but not much sediment has yet reached them. In general they show a deficiency of mass.

Following the removal of the Pleistocene ice-sheets, the areas most deeply buried have risen with respect to sea-level. The rise seems to have been greatest where the ice was thickest. This appears to be the best geologic evidence for the importance of the isostatic principle. Explained in part by elastic yield, it appears to require also transfer of material at considerable depth.

Tests to decide between four different types of isostatic compensation have shown that, so far as satisfying the equations is concerned, it makes little difference how the compensation is distributed, or accomplished, so long as its effect is centered at about 35 miles below the surface. The methods are not discriminative, and it is clear that the geodetic evidence does not indicate how the compensation takes place.

What we know of the rocks of the lithosphere indicates great heterogeneity. Myriads of intrusions of different specific gravity cut the earth shell. The present isostatic picture is geometric, not geologic.

The geologic picture of the yielding of the lithosphere is partly by solid rock movement under differential stress and partly by liquid flow of magmas. Each is a means of accommodation to stress, but their behavior is different, and the possibilities are various. Isostatic equilibrium, thus established, would be by complex, heterogeneous compensation. I believe that compensation takes place in some places and at some times in one way; at other places and at other times in other ways; and that a definite depth of compensation is not a physical entity. No uniform depth, nor any single type of compensation, seems consistent with the complex, variable factors involved. We are familiar with the simple concept for the use of mathematics, but we need a complex, composite one for the actual earth, whose many variables transcend the powers of mathematics.

David White has brought out the fact that the gravity anomalies, if one takes the average of a sufficiently large number of determinations for a geologic province, bear a general relation to the density of the rocks in the outermost mile or two of the area. On the other hand, the present anomaly charts of the United States and Canada show an absolute disregard for the topography, the geologic structure, and the kinds of rock of the areas considered. The surprising discrepancy between these two methods of study seems to indicate that the positive or negative sign of the anomaly for any given station has no necessary relation to the regional geology. It may be determined by local peculiarities of density. But for a large number of stations, the preponderance of either positive or negative anomalies does show relationship to the regional geology.

Over large portions of the interior of North America there is little topographic relief to compensate. Compensation is not very significant there, and alternative hypotheses may work equally well. Isostasy is indeterminate from data obtained at low stations. Can we be certain, then, that peneplains are in a state of isostatic adjustment, or is that largely an inference from the fact that mountainous tracts show considerable compensation? In any case, the real test would seem to lie in the limited regions of high relief.

Young mountains, like the Alps, show a marked deficiency of density, and at the same time a moderate excess of mass. An analysis of the mountain-building processes shows why this should be so. (1) The horizontal squeezing of belts of thick, light sediments into strips of less than half their former width greatly thickens the cover of light sedimentary rocks in the mountain belt. As these light rocks close to the surface are nearest the geodetic station, they exert, on the principle of the inverse square of the distance, a preponderating influence on the gravity determinations. (2) Large batholithic intrusions characteristically appear in the cores of folded ranges in a late stage of the deformation. If magmatic differentiation takes place to any great extent, the lighter differentiates will be in the upper portion of the igneous mass. Even though the total weight of the column may be unaffected by this process, these lighter rocks close to the surface will cause the geodetic instruments to give lower gravity values than would otherwise be the case. This will make the excess of mass appear less, though actually it may not be. (3) The squeezing up of mountain folds and the rise of fault slices imposes an added burden upon the supporting lithosphere beneath. Added weight presses downward on the isostatic principle. Hence the lower portion of the deformed wedge mass may be forced downward, while the upper part protrudes upward as mountains. Heim, Kossmat, Born, Lawson, and others believe in a downward movement of the deeper portion of the deformed mass. The denser rock material in the lower portion of the deformed mass may be both depressed more deeply beneath the surface, and also perhaps forced out from the deformed belt beneath the immediately adjoining tracts. If the latter be so, it affords a possible picture of the nature of the accommodation between the lower portion of a deformed mountain wedge-block and the main mass of the lithosphere beneath. At the same time that the denser, deepseated rocks are depressed and forced outward below, lighter surficial rocks are crowded into the mountain column above. The result is that the mountain mass becomes a lesser burden to be supported than

would otherwise be the case. No division of the lithosphere into a crustal and sub-crustal portion enters into the concept. It is all solid lithosphere, except for local occurrences of magmas. (4) During an orogenic revolution, erosion is actively at work, steadily reducing the excess mass of the rising mountain chains.

If this analysis of the operating geologic processes be valid, we see how geosynclinal strata may be folded and faulted into mountain ranges, exhibiting the familiar observed phenomena, and yet at the same time satisfying the gravity determinations. We see a harmonization of geologic facts and geodetic determinations, so far as deformed mountain ranges are concerned. But all of these processes together, for a considerable time at least, fail to prevent the development of some excess mass in the mountainous belt. The excess mass is supported by the strength of the earth.

If folded mountain chains were formed by the forces tending toward isostatic equilibrium, departures from adjustment should be greatest immediately before the mountains were built. Making the mountains should restore equilibrium, and the adjustment should be most nearly achieved, and most perfect, just as the forces have been spent in completing the mountains. Just the reverse, however, appears to be the case. Recently folded mountains are particularly out of adjustment. Hence we are forced to conclude that mountain folding is primarily in dependent of isostasy and in direct opposition to it. The mountains are formed in spite of isostasy. Isostatic forces, however, are all in the whole equation of forces, and play their appropriate part, but that part is secondary and subordinate. They are not the fundamental active forces which do things; their function is to restore balance. Isostasy works in opposition to mountain folding; it works in opposition to erosion. When things are doing, or done, it tends to restore equilibrium. Limited thus, to its proper sphere, it is an important principle and should be used as such.

PALEOBOTANY.—A new Pterophyllum from the Shinarump conglomerate in Utah.¹ Edward W. Berry, Johns Hopkins University.

The remains of terrestrial plants are so infrequent and so poorly preserved in the continental Triassic of the southwest that the discovery of material sufficiently complete to be identified with certainty deserves to be recorded. It was collected by Mr. Arthur A. Baker during the field season of 1928 and may be described as follows:

¹ Published by permission of the Director, U. S. Geological Survey. Received August 1, 1930.

Pterophyllum bakeri Berry, n. sp.

Fronds oblong in youth, somewhat obovate in outline at maturity, of variable size, preserved for lengths of 20 centimeters and varying in maximum width from 2.5 to 9 centimeters. Rachis stout. Pinnules inserted at the sides, closely spaced, subopposite to alternate, united by the whole base, which is neither narrowed nor decurrent, linear in form, with truncated tips rounded at the corners. The pinnules are for the most part nearly straight and symmetrical, but they may curve upward slightly in their distal halves; their angle of divergence from the rachis varies with their position on the frond, the median ones in the most complete specimen collected are at angles approaching 90°, but they become more ascending toward the apex and terminate in an odd-pinnate pinnule. There doubtless was considerable variation from frond to frond with respect to the attitude of the pinnules, since in some specimens they appear uniformly ascending at angles of about 70°. They appear to have been rigid and coriaceous. The veins appear simple and parallel but are not especially clear, and some may bifurcate near their origin, although the undiminished width of the pinnule renders this unlikely. The veins are thin and from 14 to 21 per pinnule.

One fragment shows short, less truncate proximal pinnules less than a centimeter in length, and 6 centimeters higher up they are 3 centimeters long. The following measurements will give an adequate idea of the proportions of the pinnules: Distal, 2.5×0.5 centimeters; median maximal, 1×4.5 centimeters; proximal, 3.5×10 millimeters. It appears to me that all of the

specimens collected at this outcrop belong to a single species.

The species is considered new and is named for the collector, Arthur A. Baker. It comes from the top of the Shinarump conglomerate near the southwest corner of sec. 26, T. 41 S., R. 12 E., on the east side of Nokai Creek, Utah.

The material is abundant but somewhat fragmentary and is in the form of impressions with the frond substance entirely oxidized away. It shows considerable variation in size, length, and attitude of the pinnules but is believed to represent a single species. Two specimens showing the extremes of size are figured, and I have reconstructed an entire frond from the various parts illustrated by the various fragmentary specimens.

The various so-called genera of cycadophytes based upon frond characters are not especially precise, nor are authors agreed regarding their limits. *Pterophyllum*, to which the present species is referred, is most likely to be confused with *Zamites* or *Nilssonia*. In *Zamites* the pinnules are not truncate tipped, and they are contracted at the base which is attached to the upper surface of the rachis. In *Nilssonia* the pinnules are short and truncate, but the frond may be entire or split up into segments of unequal width, and the lamina of the two sides meets in the center of the upper side of the rachis to which they are attached. In *Pterophyllum* the pinnules are of uniform width, are usually elongate, and are attached to the sides of the rachis.

No described American species of Pterophyllum are especially close

to the present species, although it is possible that some very incomplete pinnules from the Jelm formation ("Popo Agie beds") of Fremont County, Wyoming, which I have recorded as *Pterophyllum?* sp.² might represent it. These show neither habit of attachment or tips and have somewhat fewer veins per pinnule and might equally well represent *Zamites* or *Pterophyllum*.

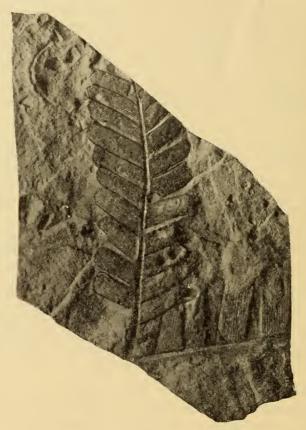


Fig. 1. Pterophyllum bakeri, natural size

Newberry described a *Pterophyllum* from the Triassic of Los Bronces, Sonora, Mexico, under the two names of *fragile*³ and *delicatulum*,

² Berry, Edward W., Jour. Geology, **32**: 494, fig. 3, 1924.

³ In Macomb's Explor. Exped., p. 144, pl. 6, figs. 6, 6a, 1876.



Fig. 2. Pterophyllum bakeri, reduced 1/8

which is somewhat similar to the present species. It is said to be of a delicate texture whereas the present form is coriaceous, the rachis is also more slender, although the two specimens which Newberry figures differ considerably in this and other respects, and his Figure 6a is more similar to the Utah form. The material is fragmentary and poorly preserved, and it is impossible to arrive at any satisfactory conclusions concerning it.

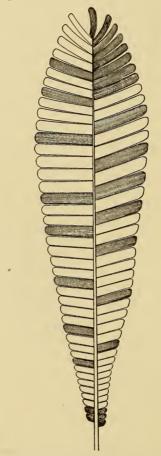


Fig. 3. Reconstruction of Pterophyllum bakeri

The genus is abundantly represented in the Triassic of Europe and other parts of the world, and several European species, such as *P. meriani* Brongniart, *P. longifolium* Brongniart, *P. jaegeri* Brongniart, and *P. brevipenne* Kurr, are abundant and have been discussed by numerous students during the last 100 years.

The first of these is probably a young frond of one of the others, as Schimper long ago suggested, and the others show a great amount of variation. *P. jaegeri* is distinctly different from the Utah form, but certain Swiss specimens referred to *P. longifolium*, e.g. one figured by Heer,⁴ are exceedingly like the Utah species. The chief differences are the more oblong frond outline, the slightly narrower and more openly spaced pinnules, the fewer veins per pinnule, and the longer proximal pinnules of the Swiss specimen. I consider the American form specifically distinct, but the resemblance is great. *P. longifolium* is a Keuper species.

The genus appears in considerable abundance in the later Paleozoic, becoming cosmopolitan and reaching its zenith in the Rhaetic, continuing abundant through the Jurassic and dying out in the mid-Cretaceous.

SCIENTIFIC NOTES AND NEWS

W. J. Humphreys of the U. S. Weather Bureau has received the following letter from Sir Joseph Larmor, relative to the account of the *Philosophical Society of Washington through a Thousand Meetings* which appeared in this Journal for July 19, 1930: "I have been more than delighted to receive the handsome set of portraits of the heroes of the Washington Academy [Philosophical Society], to not a few of whom I can apply the Tennysonian phrase 'the great Ulysses whom I knew.' The only things approaching it in interest that I possess are a Vienna set of 30 years ago in honour of Victor von Lang and the Berlin account of the German Physical Society in *Wissenschaften*. I was interested to see if I could identify you, also by the predominantly Anglo-Saxon type, if I may so guess, of those days."

L. W. Currier has been appointed Assistant Geologist in the United States Geological Survey and has been assigned to work in the Metalliferous Section.

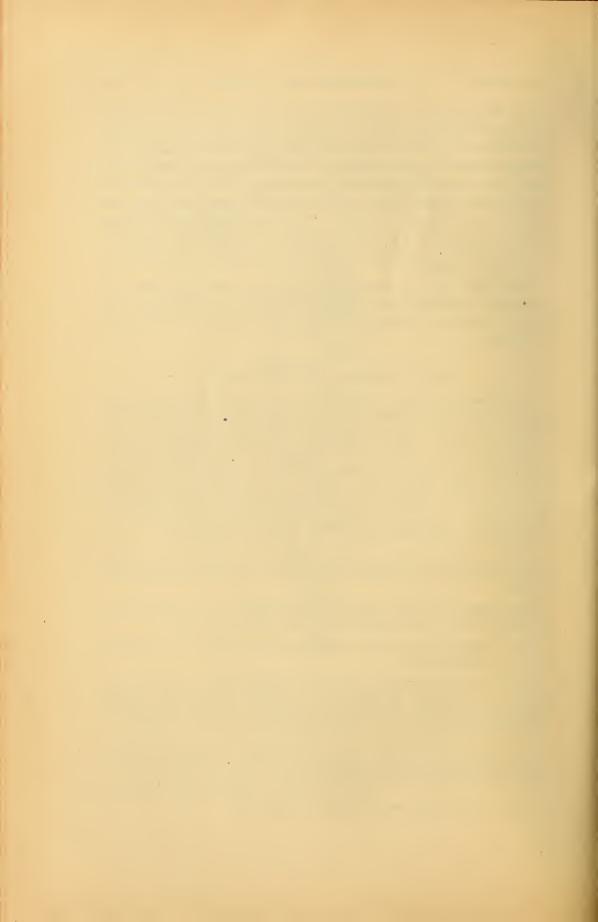
Josiah Bridge has been appointed Paleontologist in the United States Geological Survey, with headquarters at the National Museum.

LEE T. RICHARDSON has been appointed Junior Chemist in the United States Geological Survey.

Frank M. Weida, Assistant Professor of mathematics at Lehigh University, has been appointed Associate Professor of mathematics at The George Washington University. Dr. Weida is a specialist in mathematical statistics, actuarial theory, and practical mathematical analysis.

RAYMOND JOHN SEEGER has been appointed Assistant Professor of physics at The George Washington University.

⁴ HEER, OSWALD, Flora Fossilis Helvetiae, pl. 33, fig. 1, 1876.



OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

Philosophical Society

The address by W. J. Humphreys, The Philosophical Society of Washington through a thousand meetings, which appeared in the issue of this JOURNAL for July 19, 1930, has been published in pamphlet form by the Philosophical Society. Copies, bound in stiff covers, may be obtained for forty cents each, postpaid, from the Treasurer, Capt. N. H. Heck, U. S. Coast and Geodetic Survey, Washington, D. C.

ANNOUNCEMENTS OF MEETINGS

Friday, November 4 Saturday, November 5 Tuesday, November 8 Wednesday, November 9

Thursday, November 10 Friday, November 11 Saturday, November 12 Tuesday, November 15

Wednesday, November 16

Thursday, November 17 Friday, November 18 Saturday, November 19 The Geographic Society
The Philosophical Society
The Electrical Engineers

The Geological Society
The Medical Society
The Chemical Society
The Geographic Society

The Biological Society
The Anthropological Society
The Historical Society

The Washington Engineers

The Medical Society
The ACADEMY

The Geographic Society
The Philosophical Society
The Helminthological Society

The programs of the meetings of the affiliated Societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards.

Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

	Page
Geology.—Abstracts of papers on isostasy and related topics given before the Geological Society of Washington during the spring of 1930:	
I. Some problems of mountain structure and mountain history. CHESTER R. LONGWELL	441
II. Isostasy: What gravity measurements reveal. G. R. PUTNAM	446
III. Some problems in isostasy. R. W. GORANSON	447
IV. Geotherms. A. C. Lane	450
V. Isostasy from the geological point of view. R. T. CHAMBERLIN	454
Paleobotany.—A new Pterophyllum from the Shinarump conglomerate in Utah.	
Edward W. Berry.	458
SCIENTIFIC NOTES AND NEWS	463

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries.



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY
UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE
U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves. Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors: they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of the second seco ance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150 .	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices. First 100, \$4.00; additional 100,

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

NOVEMBER 19, 1930

No. 19

BOTANY.—Mosses collected in Brazil and Argentina by J. N. Rose in 1915. R. S. Williams, New York Botanical Garden. (Communicated by William R. Maxon)

The mosses reported upon in the present paper are part of a large botanical collection made in Brazil and Argentina in 1915, upon an expedition conducted by Dr. J. N. Rose under the auspices of the Carnegie Institution of Washington and the New York Botanical Garden, the principal object of the exploration having been to collect cacti. Dr. Rose was accompanied by Paul G. Russell, detailed by the U. S. National Museum as assistant. The mosses listed are in the U. S. National Herbarium and the herbarium of the New York Botanical Garden.

SPHAGNUM MAGELLANICUM Brid.

Vicinity of Itatiaya, Brazil, July 26–30 (20486). This species, largely under the name of S. medium, is known from Alaska southward, also from Europe, Asia, and Africa.

Sphagnum subsecundum Nees

Locality and date of preceding (20508). Largely known as S. platyphyllum, and of about as wide distribution as the preceding. (I am indebted to Dr. A. LeRoy Andrews for the determination of these Sphagnums.)

DITRICHUM RUFESCENS Hampe

Locality and date of preceding (20544). Not before credited to Brazil, I believe, but found on the west coast southward to Chile.

CERATODON STENOCARPUS Br. & Sch.

Locality and date of preceding (20527, 20544). Common in tropical regions of the Old World also.

¹ Received September 3, 1930.

Aongstroemia vaginata (Hook.) C. M.

Locality and date of preceding (20449a). No. 60 of E. Ule's mosses of Brazil, called $A.\ julaceo-divaricata$ C. M., does not seem to be distinct from this species.

DICRANELLA EXIGUA (Schwaegr.) Mitt.

Itacurussa, State of Rio de Janeiro, Brazil, July 24 (20423, 20426).

DICRANELLA GUILLEMINIANA (Mont.) Hampe Vicinity of Itatiaya, Brazil, July 26–30 (20576).

DICRANELLA HILARIANA (Mont.) Mitt.

Vicinity of Bahia, Brazil, May 29 (19689). Monte Serrat, vicinity of Itatiaya, Brazil, July 26–30 (20443, 20446). Near Milo Pecanna, State of Rio de Janeiro, Brazil, Aug. 9 (20734); very poor specimens but probably belonging here. This species occurs commonly from the southern United States to southern Brazil and has been described under a great variety of names.

DICRANELLA PABSTIANA (C. M.) Mitt.

On Corcovado, Rio de Janeiro, Brazil, July 12; marked "h."

DICRANELLA SUBSULCATA Hampe

Vicinity of Itatiaya, Brazil, July 26–30 (20578; 20450, immature but probably belonging here). Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20629).

CAMPYLOPODIUM PUSILLUM (Schpr.) Williams

Vicinity of Itatiaya, Brazil, July 26–30 (20545a). Ule's no. 102 from this region, called *C. itatiaiense*, does not seem to me distinct.

HOLOMITRIUM ARBOREUM Mitt.

Vicinity of Toca de Onca, Brazil, June 27–29 (20122). Vicinity of Itatiaya, Brazil, July 26–30 (20548).

Holomitrium Crispulum Mart.

Forests of Jabaquara, Brazil, Aug. 15 (20860, 20864).

HOLOMITRIUM OLFERSIANUM Hsch.

Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22–24 (20391).

CAMPYLOPUS ARCTOCARPUS (Hsch.) Mitt.

Vicinity of Itatiaya, Brazil, July 26-30 (20509).

Campylopus detonsus (Hampe) Par.

Vicinity of Bahia, Brazil, May 30 (19696). Sterile.

Campylopus introflexus (Hedw.) Mitt.

Vicinity of Itatiaya, Brazil, July 26-30 (20474).

CAMPYLOPUS PENICILLATUS (Hsch.) Jaeg.

Locality and date of preceding (20434).

Campylopus subarctocarpus (Hampe) Jaeg.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20811). On Papagaya, Rio de Janeiro, Brazil, Aug. 1 (20698b).

CAMPYLOPUS SP.?

Near Santos, Brazil, Sept. 20 (21111). Sterile.

CAMPYLOPUS SP.

Vicinity of Itatiaya, Brazil, July 26-30 (20548a). Sterile.

PILOPOGON SUBJULACEUS Hampe

Vicinity of Itatiaya, Brazil, July 26-30 (20545, 20477a).

LEUCOBRYUM ALBICANS (Schwaegr.) Lindb.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20858).

OCTOBLEPHARUM ALBIDUM (L.) Hedw.

Vicinity of Bahia, Brazil, May 26 (19633, 19642). Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22–24 (20388).

FISSIDENS OBTUSATUS Hampe

Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22-24 (20389).

FISSIDENS PSEUDOBRYOIDES Schlph.

Vicinity of Bahia, Brazil, May 30 (19704) and June 3 (20139a). Sao Miguel, State of Bahia, Brazil, June 26 (20055). This determination as F. pseudobryoides appears to be correct, but on further study it would seem that the species is not sufficiently distinct from the older F. Kegelianus.

CALYMPERES RICHARDI C. M.

Vicinity of Bahia, Brazil, May 26 (19632).

HYMENOSTOMUM MICACEUM (Schlecht.) Hampe

Vicinity of Bom Finn, Bahia, Brazil, June 8, 9 (19830). Vicinity of Cabo Frio, Rio de Janeiro, Brazil, Aug. 8 (20730). This species is distinguished by having the costa quite papillose on the upper surface from near the apex about two-thirds of the way down, the back of the leaf and costa being smooth or slightly papillose, and the upper surface of leaf mostly mamillose. Known only from Brazil until collected at Frederiksted, St. Croix, West Indies, by Rose, Fitch and Russell, in Feb. 1913, no. 4448.

TIMMIELLA UMBROSA (C. M.) Broth.

Near Cassaffousth, Córdoba, Argentina, Sept. 9 (21068).

DIDYMODON SCHIMPERI (Mont.) Broth.

Portrerillos, Mendoza, Argentina, Sept. 2 (20998). Apparently not known previously outside of Chile.

Tortella caespitosa (Schwaegr.) Limpr.

Vicinity of Toca de Onca, Bahia, Brazil, June 27–29 (20118). Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22–24 (20386, 20387, 20392). Monte Serrat, vicinity of Itatiaya, Brazil, July 26–30 (20444). Near Iguaba Grande, Rio de Janeiro, Brazil, Aug. 7–9 (20715). Petropolis, Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20829). Near Cassaffousth, Córdoba, Argentina, Sept. 9 (21066). On Corcovado, Rio de Janeiro, Brazil, July 19, marked "a."

HYOPHILA MICROCARPA (Besch.) Broth.

Salgada, State of Bahia, Brazil, June 1 (19712). Queimadas, Bahia, Brazil, June 9–17 (19861, 19882). Vicinity of Machado Portello, Bahia, Brazil, June 19–23 (19934, 19997).

HYOPHILA TORTULA (Schwaegr.) Hampe

State of Bahia, Brazil, May 31 (19707). Alagoinhas, State of Bahia, Brazil, June 12 (19883).

BARBULA UNCINICOMA C. M.

Near Cassaffousth, Córdoba, Argentina, Sept. 9 (21067).

Desmatodon stomatodontus (Card.) Williams

Vicinity of Bahia, Brazil, May 25 (19620), mixed with Tortula agraria Sw. Same locality, June 15 (19892).

TORTULA AGRARIA SW.

Vicinity of Bahia, Brazil, May 25 (19620a).

Tortula perrufula (C. M.) Williams, comb. nov.

Barbula perrufula C. M. Hedwigia 36: 103. 1897. This seems to belong rather to Tortula, inasmuch as there is no stereid band on the upper side of the costa. It has leaf margins of a double thickness of cells, 32 twisted teeth from a rather high basal membrane, and an annulus of 2 or 3 rows of cells.

GLYPHOMITRIUM BALANSAE (Besch.) Broth.

Near Cassaffousth, Córdoba, Argentina, Sept. 9 (21064). Here must be referred G. brevifolium C. M., which apparently is not distinct in any way from G. Balansae.

Zygodon subdenticulatus Hampe

Vicinity of Itatiaya, Brazil, July 26–30 (20512). Not previously credited to Brazil.

MACROMITRIUM FRAGILE Mitt.

On orchids in market, Bahia, Brazil, May 26 (19643).

Macromitrium mucronifolium (Hook. & Grev.) Schwaegr.

Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22–24 (20380). Near Santos, Brazil, Sept. 20 (21115).

SCHLOTHEIMIA NITIDA Schwaegr.

Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20632).

SCHLOTHEIMIA RUGIFOLIA (Hook.) Brid.

Vicinity of Toca de Onca, Bahia, Brazil, June 27–29 (20122a). North of Caldeirao, State of Bahia, Brazil, June 30 (20134).

TETRAPLODON ITATIAIAE C. M.

Vicinity of Itatiaya, Brazil, July 26-30 (20475).

Funaria apiahyensis (C. M.) Broth.

Vicinity of Itatiaya, Brazil, July 26-30 (20558, mixed with Psilopilum Ulei).

FUNARIA CALVESCENS Schwaegr.

Vicinity of Itatiaya, Brazil, July 26-30 (20451, 20466, 20467, 20468, 20595).

Funaria hygrometrica (L.) Sibth.

Vicinity of Buenos Aires, Argentina, Aug. 28 (20960).

Funaria serricola (C. M.) Broth.

Vicinity of Itatiaya, Brazil, July 26–30 (20465). Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20626).

MIELICHHOFERIA MANCA (C. M.) Broth.

Vicinity of Itatiaya, Brazil, July 26-30 (20539, 20546).

BRYUM ARGENTEUM L.

Aramary, State of Bahia, Brazil, May 31 (19708). Sao Miguel, State of Bahia, Brazil, June 26 (20054). Vicinity of Toca de Onca, Bahia, Brazil, June 27–29 (20121). Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22–24 (20355). Vicinity of Itatiaya, Brazil, July 26–30 (20547, mixed with a sterile Campylopus).

BRYUM CRUGERI Hampe; C. M.

Vicinity of Toca de Onca, Bahia, Brazil, June 27–29 (20119). Near Santos, Brazil, Sept. 20 (21112). Apparently not before reported for Brazil.

BRYUM DENSIFOLIUM Brid.

Near Santos, Brazil, Sept. 20 (21113). Vicinity of Toca de Onca, Bahia, Brazil, June 27–29 (20120). Alta Boa Vista, vicinity of Rio de Janeiro, Brazil, July 18 (20306).

BRYUM GARDNERI Mitt.

Near Santos, Brazil, Sept. 20 (21114).

RHODOBRYUM GRANDIFOLIUM (Tayl.) Par.

Vicinity of Itatiaya, Brazil, July 26-30 (20575).

MNIUM LIGULATUM C. M.

Vicinity of Itatiaya, Brazil, July 26-30 (20577). Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20776, 20806).

RHIZOGONIUM SPINIFORME (L.) Bruch

On Papagaya, Rio de Janeiro, Brazil, Aug. 1 (20647). Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20810, 20822).

PHILONOTIS CURVATA (Hampe) Jaeg.

Nazareth, vicinity of Bahia, Brazil, June 30 (20139).

PHILONOTIS UNCINATA (Schwaegr.) Brid.

Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20637).

OLIGOTRICHUM RIEDELIANUM (Mont.) Mitt.

Vicinity of Itatiaya, Brazil, July 26-30 (20449, 20556a).

PSILOPILUM ULEI Broth.

Vicinity of Itatiaya, Brazil, July 26-30 (20465a, 20555, 20558a).

POLYTRICHADELPHUS UMBROSUS Mitt.

On Corcovado, Rio de Janeiro, Brazil, July 11, marked "f."

POGONATUM ABBREVIATUM Mitt.

Monte Serrat, vicinity of Itatiaya, Brazil, July 26-30 (20447).

POGONATUM GARDNERI (C. M.) Mitt.

Vicinity of Itatiaya, Brazil, July 26–30 (20556).

POLYTRICHUM ANGUSTIFOLIUM Mitt.

Vicinity of Rio de Janeiro, Brazil, July 26-30 (20436).

POLYTRICHUM ANTILLARUM Rich.

Vicinity of Rio de Janeiro, Brazil, July 26–30 (20436a). Vicinity of Itatiaya, Brazil, July 26–30 (20448, 20452, 20530, and "k"). Petropolis, Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20827).

ERPODIUM CORONATUM (Hook. f. & Wils.) Mitt.

Vicinity of Machado Portello, Bahia, Brazil, June 19-23 (19996).

ERPODIUM GLAZIOVII Hampe

On Corcovado, Rio de Janeiro, Brazil, Aug. 17 (20875).

RHACOCARPUS HUMBOLDTII (Hook.) Lindb.

Vicinity of Itatiaya, Brazil, July 26-30 (20508a, 20521).

ORTHOSTICHOPSIS TENUIS (C. M.) Broth.

On Corcovado, Rio de Janeiro, Brazil, July 11, marked "j."

SQUAMIDIUM NITIDUM (Sull.) Broth.

North of Caldeirao, State of Bahia, Brazil, June 30 (20133a).

LINDIGIA CAPILLACEA (Hornsch.) Hampe

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20781b). No. 70 of E. Ule's Brazilian mosses, issued as L. paupera C. M., apparently an unpublished name, evidently belongs here.

LINDIGIA TRICHOMITRIA C. M.

Collected with the last preceding (20781a).

• PHYLLOGONIUM IMMERSUM Mitt.

On Papagaya, Rio de Janeiro, Brazil, Aug. 5 (20648).

NECKERA ARGENTINICA Lor.

Tucumán, vicinity of Buenos Aires, Argentina, Aug. 29 (without number).

Porotrichum Korthalsianum (Dz. & Mb.) Mitt.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20821). Previously collected only in Venezuela and Surinam.

POROTHAMNIUM STRIATUM (Mitt.) Fleisch.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20772).

STEREOPHYLLUM LEUCOSTEGUM (Brid.) Mitt.

Rio Branco, State of Bahia, Brazil, June 12 (19877).

Fabronia Lorentzii C. M.

Vicinity of Córdoba, Argentina, Sept. 8 (21039).

FABRONIA POLYCARPA Hook.

Bahia, Brazil, May 28 (19660). Vinicity of Bom Finn, Bahia, Brazil, June 8, 9 (19829, 19831). On Corcovado, Rio de Janeiro, Brazil, Aug. 17 (20875, 20876).

Helicodontium tenuirostre Schwaegr.

Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20631).

Hookeriopsis Beyrichiana (Hampe) Broth.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20808a).

Hookeriopsis Glaziovii (Hampe) Jaeg.

Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20633).

LEPIDOPILUM SUBULATUM Mitt.

Organ Mountains, Rio de Janiero, Brazil, Aug. 12 (20781).

Hypopterygium monoicum Hampe

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20775).

HELICOPHYLLUM TORQUATUM (Hook.) Brid.

Itumirim, State of Bahia, Brazil, June 5 (19815).

HAPLOCLADIUM RIOGRANDENSE C. M.

Jardim Botanico, Rio de Janeiro, Brazil, Aug. 10 (20745).

THUIDIUM DELICATULUM (L.) Mitt.

Vicinity of Itatiaya, Brazil, July 26-30 (20472a, 20557). T. brasiliense Mitt. is near this species, but has larger leaf cells and larger, higher papillae.

THUIDIUM PSEUDORECOGNITUM (Hampe) Broth.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 20 $(20\tilde{7}72a)$. This species appears to come nearest to T. Antillarum, from which it is distinguished by the cells of the branch leaves having several papillae to each cell-surface instead of only one. The inner perichaetial leaves are long-ciliate. Small, often scarcely elongate cells extend almost to the leaf-base in both stem and branch leaves, and in the branch leaves the costa is very prominent and rough on the back.

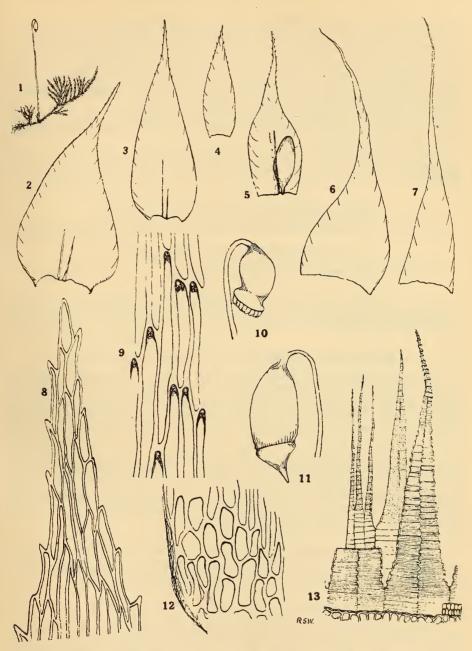
Amblystegium varium (Hedw.) Lindb.

La Plata, Argentina, Sept. 14 (21106). E. Ule's no. 73, A. pulchellum C. M., apparently an unpublished name, seems to belong here.

Microthamnium Russellii R. S. Williams, sp. nov.

Figs. 1–13

Dioicous, of flowers, about midway on the branches, rather narrowly ovate-acute, a little over 1 mm. high, the inner perigonial leaves with ovate base rather gradually narrowed to a lanceolate, serrulate point, enclosing 5-6 antheridia about .33 mm. long and a few slender paraphyses; plants growing in pale yellowish-brown mats with more or less trailing and branching stems mostly 3 or 4 cm. long, bearing scattered clusters of radicles and rather short, mostly .5-1 cm. long, often divided branches hardly complanate and tapering to apex; leaves not complanate, those of the upper stem shortly bicostate, about 1.5 mm. long, from a broadly ovate base gradually tapering to a very acute point, the borders more or less recurved and serrulate to near base; leaves of lower stem mostly shorter and broader than above and ecostate and entire; branch-leaves narrower and smaller than upper stem leaves, serrulate and bicostate except the much smaller apical leaves, these ecostate; cells of the branch-leaves mostly distinctly papillose on back at upper end, the median about 5μ wide by $35-50\mu$ long, the alar cells sometimes forming a rather distinct group of wider, shorter cells; seta 2-2.5 cm. long; inner perichaetial leaves longer than stem-leaves, ecostate, from an ovate or lanceolate base gradually narrowed to a very slender, entire or nearly entire point; cap-



Microthamnium Russellii: 1. Plant about natural size. 2. Middle stem-leaf ×35. 3. Middle branch-leaf ×35. 4. Terminal branch-leaf ×35. 5. Perigonial leaf, antheridium and paraphyses ×35. 6 and 7. Inner perichaetial leaves ×35. 8. Apex of branch leaf ×210. 9. Median cells of leaf ×210. 10. Dried deoperculate capsule ×14. 11. Moistened capsule ×14. 12. Group of alar cells from upper stem leaf ×210. 13. Part of peristome and annulus ×150.

sule nodding or pendant, oblong or often unsymmetrical, about 2 mm. long with the acutely pointed lid, when dry contracted below the rim; annulus of two rows of cells; peristome-teeth finely cross-striate about three fourths up, the slender apex papillose; segments a little shorter than teeth, from high basal membrane, finely papillose, slightly or not split along median line, with 2 or 3 slender, papillose cilia a little shorter than the segments; calyptra smooth; spores minutely roughened, $10-12\mu$ in diameter.

Type locality: Vicinity of Itatiaya, Brazil, collected by J. N. Rose and P. G. Russell, July 26–30, 1915, No. 20469 (type in herbarium of the New

York Botanical Garden).

Plants much like \dot{M} . reptans but perichaetial leaves more entire, with shorter hair-point, capsules rather larger and not so narrowed at the base and dioicous.

Isopterygium brachyneuron (C. M.) · Mitt.

Ilha Grande, Distrito Federal, Rio de Janeiro, Brazil, July 22-24 (20382).

ISOPTERYGIUM TENERUM (Sw.) Mitt.

Locality and date of the last preceding (20384).

TRICHOSTELEUM PAPILLOSISSIMUM (Hampe) Broth.

Itacurussa, State of Rio de Janeiro, Brazil, July 24 (20425). Determined from description only.

Trichosteleum Schlimii (C. M.) Williams, comb. nov.

Hypnum Schlimii C. M. Bot. Zeit. 6: 781. 1848. This species has been placed under both Sematophyllum and Rhaphidostegium and doubtless specimens that have been called Schlimii belong under those genera; Müller, however, in his description cites only one number, 356, collected by Funck & Schlim in Venezuela. The specimens under this number show the back of the leaf often with more or less numerous, single papillae over the center of the cells, which are very long and narrow (about 4μ wide by $50-60\mu$ long) with the exception of the inflated alar group. This type specimen has perichaetial leaves with long, slender, recurved points, serrulate with often widely spreading, almost recurved teeth; the stem leaves are ecostate; the capsule is nodding, mostly not quite symmetrical, on a smooth pedicel about 1 cm. long. Organ Mountains, Brazil, Aug. 12 (20812).

Sematophyllum cyparissoides (Hornsch.) Williams, comb. nov.

Hypnum cyparissoides Hornsch. in Mart. Fl. Bras 12: 88. 1840. This species has the peristome teeth not furrowed along the median line.

SEMATOPHYLLUM GALIPENSE (C. M.) Mitt.

Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20625). On Papagaya, Rio de Janeiro, Aug. 1 (20650). Jardim Botanico, Rio de Janeiro, Aug. 11 (20836). On Corcovado, Rio de Janeiro, Aug. 19, marked "c." Garden of Museo Paulista, São Paulo, Brazil, Aug. 14, 15 (20842). Near Santos, Brazil, Sept. 20 (21110).

SEMATOPHYLLUM MAILUSIAE C. M.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20780).

Sematophyllum subpinnatum (Brid.) E. G. Britt.

Tijuca, vicinity of Rio de Janeiro, Brazil, Aug. 1 (20630 in part). Near Iguaba Grande, Rio de Janeiro, Aug. 7–9 (20749). Petropolis, Organ Mountains, Rio de Janeiro, Aug. 12 (20826, 20831). Jardim Botanico, Rio de Janeiro, Aug. 11 (20835). Garden of Museo Paulista, Sao Paulo, Brazil, Aug. 14, 15 (20869). Near Santos, Brazil, Sept. 20 (20899).

RHYNCHOSTEGIUM BESKEANUM (C. M.) Jaeg.

Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20777). Petropolis, Organ Mountains, Rio de Janeiro, Aug. 12 (20828).

RHYNCHOSTEGIUM SELLOWII (Hornsch.) Jaeg. On Corcovado, Rio de Janeiro, Brazil, July 14, marked "d."

RHYNCHOSTEGIUM SUBROTUNDUM (Hampe) Jaeg. Organ Mountains, Rio de Janeiro, Brazil, Aug. 12 (20778).

ANTHROPOLOGY.—The antiquity of man as shown at Frederick, Oklahoma: A criticism.¹ O. F. Evans, University of Oklahoma. (Communicated by A. Hrdlička)

The Holloman gravel pit at Frederick, Okla., has yielded fossils and artifacts which are thought by some persons to indicate a great antiquity for man in America. In the light of my rather extensive experience in that region, I wish to point out what I believe to be some serious mistakes which have been made in the interpretation of the evidence.

The deposits rest on Red Beds which are probably of Permian age. The lower four or five feet consists of consolidated cross-bedded sand, clean pebbles, and boulders up to five or six inches in diameter. The coarse material is found in the lower part and except for being consolidated is the same as that found in the bottom of most streams in the region at the present time. These streams have the coarser material at the bottom of the sand and boulder beds, not only because the streams come nearer and nearer to grade as the material in the bottom is deposited but also because rapid changes in velocity, resulting from the numerous floods, keep the loose material of the stream beds agitated and hence the larger materials work toward the bottom as in a miner's pan.

¹ Received September 25, 1930.

This cross-bedded sandstone and conglomerate represents the early normal period of the old stream's history. In the Frederick pit it is more tightly cemented than the material higher up because it lies at about the top of the ground-water level and has been subjected to more wetting and drying by the rising and falling of the ground-water table than has the material of the upper layers.

Above this old river bottom is a middle layer, ten to twelve feet thick, of water-deposited material, consisting of sand, gravel and small boulders. The materials are in great variety. Some can be recognized as having come from the Wichita mountains a few miles to the north, but much has the same source as other numerous gravel and sand deposits in that part of southwestern Oklahoma, west of the Wichita, whose source was somewhere to the west toward the Rocky mountains.

It contains in particular the same varieties of igneous rocks and schists that are found in other deposits all along the present North Fork of the Red River at elevations of about 70 to 80 feet above the present stream bed. These other deposits also contain numerous animal remains similar to those of the Holloman pit, such as tusks, thigh bones, etc., which on casual examination appear to be what are generally referred to as of Pleistocene age. Gravel deposits containing such animal remains, but of course varying as to the nature of the rock materials, are found lying 60 to 100 feet above the present stream beds along nearly all the streams in the whole of western Oklahoma.

This would seem to be fairly good evidence of a post-Pleistocene uplift over this region. All we can say at present as to the time of this uplift is that it occurred long enough ago so that the streams have since had time to cut down to their present level. Unfortunately there is so little known by geologists about the actual rate of erosion for any particular area that to try to fix the length of a period of time in years on any such basis is no better than a guess. Neither do we know the rate of the uplift nor how long it continued. Like most such uplifts it was probably gradual and any streams that may have been aggrading or in equilibrium, were slowly changed to degrading streams.

Above this layer of water-deposited sands and gravels is an upper layer of several feet of material that appears to be partly water- and partly wind-deposited, taking on more and more of the character of wind-deposited material higher up. The middle part of this layer contains some aggregates of calcareous material whose origin so far has not been satisfactorily explained.

The ridge on which the gravel pit is located extends to the northwest to about where Otter creek appears to have once joined the North Fork of Red River, and contains at several places stream gravels similar to those of the Holloman pit. A study of the region suggests very strongly to anyone familiar with the work of streams of Oklahoma and the southwest that the present lower course of the North Fork of the Red, a few miles west of Frederick, is in the course of a stream that committed piracy on the stream that laid down the gravels of the Holloman pit. If this is the case, the Holloman pit is in the bed of what was formerly the North Fork of the Red. We have no way of knowing how long ago this act of piracy was completed and any attempt to determine it from rate of erosion would be idle speculation, since we do not know how large a valley the more westerly stream had eroded before the piracy was committed, nor do we know anything about the rate of erosion in this particular area either before or after the piracy.

The coarse, water-deposited material of the middle layer above the old stream bed means a quickening of the stream velocity and this might easily have occurred at the time of the post-Pleistocene uplift which would have also been a favorable time for the committing of the piracy by the rapid cutting headward of the more westerly stream.

The lower part of the upper beds were apparently deposited in that period of the stream's history when the river had not completely left its old channel and was still depositing during periods of high water. The uppermost part is wind-deposited material dropped there after the channel no longer contained a running stream.

Arrowheads, metates and bones of Pleistocene animals, at least some of which have been identified by Hay as of Aftonian age, have been found in the middle layer and a few arrowheadlike artifacts have been found in the lower beds. So far no articulated skeletons have been found. The nearly complete carapace of a glyptodon was found and is now in the University of Oklahoma museum, but no part of its skeleton was found. This fact indicates some disturbance of the animal remains since they were first buried. A few of the Pleistocene bones show much wear as though they had been transported a considerable distance, but most of them show but little wear.

Metates are considered by anthropologists to have appeared rather late in the history of the human race, and the arrowheads found in the pit are also of a late type. In fact some of them look the same as those now frequently picked up on the surface in this region.

The presence of the bones of Pleistocene animals mixed with metates and arrowheads is apparently considered by Cook, Figgins and some others as prima facie evidence of the existence of man on the earth at the same time as the animals which furnished the bones. It seems to be a case of trying to apply to land deposits a line of reasoning which is excellent for marine deposits, but which does not apply at all in the case of stream deposits. With rocks of marine origin we are quite justified in assuming that the animal remains found in them are of the same age as the sediments and that bones and shells once deposited with sediments on the bottom of the ocean were not disturbed before consolidation. The general rule for marine deposits may be said to be continued stability after deposition.

However any geologist after a little thought on the subject will be convinced that, in general, stream deposits are unstable. Any stream deposit is subject to disturbance at any time as long as a stream continues to flow in the valley of the deposit.

This being the case the line of reasoning regarding the Holloman gravel pit and the remains found in it is evident.

- 1. It is a stream deposit.
- 2. As a stream deposit it was subject to disturbance at any time up to the time the stream left the valley.
- 3. There is no reliable evidence as to the time the stream which deposited the gravels left its valley, since calculations based on rate of erosion have no value.
- 4. The coarser material of the middle layer shows an increase of velocity must have occurred. This might have been at the time of the post-Pleistocene uplift, but not necessarily.
- 5. Since no articulated skeletons have been found in the pit it is probable that the skeletons have been disturbed since the original deposition. This disturbance may easily have been post-Pleistocene.
- 6. If there has been a disturbance, the finding of metates and arrowheads mixed with Pleistocene bones does not mean that the metates and arrowheads are of Pleistocene age. On the contrary the metates and arrowheads are just as good evidence of the age of the pit as are the bones.
- 7. Since anthropologists have good reason to believe that the kind of arrowheads and the metates found here are of rather recent age, we are not justified in saying that the deposit indicates great antiquity of man in the region.

The geological history of the pit may have been about as follows. Piracy was committed by the stream to the west soon after the post-Pleistocene uplift, thus causing the old stream to leave the bed in which the gravel pit is found. The surrounding region had been considerably eroded before this occurred. Soon after the uplift and at about the time the piracy occurred, when the waters of the old stream were at flood stage and flowing rapidly, a gravel deposit, a little farther up the stream than the present one, was undercut and redeposited. This contained the bones now found in the Holloman pit, while the arrow heads and metates were on the surface where they had been left a comparatively short time before, and all went into the river and were redeposited together in what is now the Holloman gravel pit.

BIBLIOGRAPHY OF FREDERICK GRAVEL PIT

HAROLD J. COOK, New Trails of Early Man in America, Scientific Amer-

can, 1927: 114.

J. D. Figgins, The Antiquity of Man in America, Natural History, 27: 229,

1927.

HAROLD J. COOK, New Geological and Paleontological Evidence Bearing

on the Antiquity of Mankind in America. Natural History, 27: 240, 1927.

J. D. Figgins, Early Man in America. Science News Letter, 12: 215, 1927.

Leslie Spier, A Note on Reputed Ancient Artifacts from Frederick, Oklahoma. Science, 68: 184, 1928.

OLIVER P. HAY, On the Antiquity of Relics of Man at Frederick, Okla-

homa. Science, 67: 442, 1928.

HAROLD J. COOK, Further Evidence Concerning Man's Antiquity at Frederick, Oklahoma. Science, 67: 371, 1928.

Leslie Spier, Concerning Man's Antiquity at Frederick, Oklahoma.

Science News Letter, 67: 160-161, 1928.

CHAS. N. GOULD, On the Recent Finding of Another Flint Arrowhead in the Pleistocene Deposit at Frederick, Oklahoma. This Jour., 19: 66-68, 1929.

SCIENTIFIC NOTES AND NEWS

An aquarium section in the new reptile house at the National Zoological Park has been endowed by Maj. Leigh Zerbee, U. S. A., in memory of his wife, Frances Brinckle Zerbee. Mrs. Zerbee was a great lover of aquaria, and the memorial is for the purpose of encouraging interest in home aquaria. The income of the endowment is to be used to keep stocked with interesting specimens this section of the new reptile house.

Paul W. Oman has been appointed by the Bureau of Entomology as a specialist in the order Homoptera, which includes principally the insects commonly known as leaf-hoppers. Mr. Oman, who studied these insects under Professor P. B. Lawson at the University of Kansas, will take charge of the collection of Homoptera at the National Museum.

Dr. B. Prashad of the Zoological Survey of India at Calcutta recently examined the types of mollusks in the Lea Collection at the National Museum.

JOHN OLIVER LA GORCE was the guest of honor at a dinner given November 5 at the Willard Hotel by the trustees of the National Geographic Society in celebration of the twenty-fifth anniversary of his association with the organization.

G. A. COOPER has been appointed Assistant Curator in the Division of Stratigraphic Paleontology of the National Museum. For several years past, Dr. Cooper has been studying Paleozoic brachiopods at Yale University.

Obituary

Frank James Katz, a member of the Academy, died on August 21, 1930. He was born at New York City January 27, 1883, received the degree of bachelor of arts from the University of Wisconsin in 1905, and held a fellowship in the department of geology at the University of Chicago in 1906–07. He was on the staff of the U. S. Geological Survey from 1907 until 1925, when he became Chief Engineer of the Division of Mineral Resources and Statistics of the U. S. Bureau of Mines.

GEORGE McLane Wood, editor of the United States Geological Survey from 1908 to 1925, died in Washington October 26, in his 81st year. His service of nearly 40 years in the Geological Survey, as editorial clerk, assistant editor, and editor, left an enduring monument in the wide reputation for clear, terse expression attained by the published reports of that organization and exerted a far-reaching influence on scientific writing everywhere through his Suggestions to authors. This pamphlet, prepared primarily for use in the Geological Survey, proved to contain so much wise counsel of general application that it rapidly became a "best seller" among Government publications. It was first published in 1909 and was revised and enlarged twice. The third edition, issued in 1916, has been reprinted seven times—the latest printing of 1,000 copies in July, 1930—and sent to all parts of the world on request from writers of many classes, teachers of English in universities and colleges, research organizations, and business executives. After his retirement from the Government service Mr. Wood continued to do editorial work, and the demand for his assistance was so great that he worked longer hours than ever. At the time of his death he was editorial reader for the Bulletin of the Geological Society of America and the Arkansas Geological Survey. He wrote most of the articles on the geology of North and South America for the new Encyclopoedia Britannica. He died practically "in harness," having been ill only three days.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

Philosophical Society

The address by W. J. Humphreys, The Philosophical Society of Washington through a thousand meetings, which appeared in the issue of this JOURNAL for July 19, 1930, has been published in pamphlet form by the Philosophical Society. Copies, bound in stiff covers, may be obtained for forty cents each, postpaid, from the Treasurer, Capt. N. H. Heck, U. S. Coast and Geodetic Survey, Washington, D. C.

Announcements of Meetings

Wednesday, November 19
Thursday, November 20
Friday, November 21
Saturday, November 22
Wednesday, November 26
Friday, November 28
Saturday, November 29
The Engineering Society
The Academy
The Geographic Society
The Geological Society
The Medical Society
The Geographic Society
The Geographic Society
The Biological Society
The Biological Society

Saturday, November 29
Tuesday, December 2
Wednesday, December 3
The Biological Society
The Botanical Society
The Engineering Society
The Medical Society
The Entomological Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: Henry G. Avers, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Botany.—Mosses collected in Brazil and Argentina by J. N. Rose in 1915. R. S. WILLIAMS	
Anthropology.—The antiquity of man as shown at Frederick, Oklahoma: a criticism. O. F. Evans	
Scientific Notes and News	479
OBITUARY: F. J. KATZ, G. M. WOOD	480

This JOURNAL is indexed in the International Index to Periodicals to be found in public libraries.

Vol. 20



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE BOTANICAL SOCIETY HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

MT. ROYAL AND GUILFORD AVES.
BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors: they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered

serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices. First 100, \$4.00; additional 100, \$1.00.

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The Journal does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

^{*}Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

DECEMBER 4, 1930

No. 20

MATHEMATICAL PHYSICS.—Appell's equations.¹ R. J. Seeger, The George Washington University. (Communicated by Edgar W. Woolard.)

Appell's equations² describe the motion of a dynamic system. Their use involves two advantages of theoretical importance: The mathematical one of applicability to both holonomic and nonholonomic systems (such as do or do not have integrable relations connecting the coördinate-velocities); the physical one of immediate expressibility in terms of accelerations (cf. the methods of Lagrange and of Hamilton which start with coördinates and velocites). However, the significance of the latter seems to be wholly superficial upon closer examination of the usual derivation of the equations.³ For the basis is Lagrange's formulation of D'Alembert's principle—virtually a reduction of the dynamical problem to a statical one. Although this is a virtue in the light of practicability, it is logically vicious. Gibbs⁴ has remedied this defect of the standard equations of motion by the postulation of a formula involving "geometric" accelerations instead of the ordinary "geometric" displacements. (It is to be remembered that all such variations are mathematical inventions—not physical ones.) Moreover, he has shown his expression to be a more complete and a more accurate description of the laws of motion than the previous one. The question arises as to whether Appell's equations can be derived on such a basis. We shall now consider this point. And, incidentally, the relativistic form of the equations on the Special Theory will be given.

¹ Received September 20, 1930.

² P. Appell. Sur une forme général des équations de la dynamique. (Memorial des sciences mathematiques). Paris, 1925.

³ J. S. Ames and F. D. Murnaghan. Theoretical mechanics, page 329. 1929.

⁴ J. W. Gibbs. On the fundamental formulae of dynamics. Am. Jour. Math. 1879: 49.

Suppose we have a dynamic system composed of m particles and possessing n degrees of freedom. Also, in addition to the r distinct generalized coördinates there are s superfluous ones. All these are bound together by k relations of the following form:

$$\sum_{\alpha=1}^{r} a_{\alpha\beta} dq_{\alpha} + \sum_{\alpha=r+1}^{r+s} p_{\alpha\beta} + b_{\beta} dt = 0 \quad \beta = 1 \dots k$$
 (1)

where $a_{\alpha\beta}$ and b_{β} are functions of the coördinates q_{α} and the time t and where $p_{\alpha\beta}$ represent linear, differential functions of the same. Hence, n = r + s - k. This equation indicates the type of the system: holonomic if s can be made equal to k, non-holonomic if s must be less than k, (unsolvable for s > k)

First we set up Gibbs' equation in relativistic form for the Cartesian coördinates of the particles:

$$\sum_{i=1}^{m} \sum_{j=1}^{3} \left[X_{ij} - \frac{d}{dt} (M_{ij} \dot{x}_{ij}) \right] \delta \ddot{x}_{ij} = 0$$
 (2)

where the symbols have their usual meanings. In order to transform this expression into one involving the generalized coördinates only, we make use of certain relations (that must be given) of the following type:

$$x_{ij} = x_{ij} (q_1 \ldots q_{r+s}, t)$$

Hence,

$$\delta \overset{\circ}{x}_{ij} = \sum_{\alpha=1}^{r+s} \frac{\partial \overset{\circ}{x}_{ij}}{\partial q_{\alpha}} \delta q_{\alpha} + \sum_{\alpha=1}^{r+s} \frac{\partial \overset{\circ}{x}_{ij}}{\partial \dot{q}_{\alpha}} \delta \dot{q}_{\alpha} + \sum_{\alpha=1}^{r+s} \frac{\partial \overset{\circ}{x}_{ij}}{\partial \ddot{q}_{\alpha}} \delta \ddot{q}_{\alpha} + \frac{\partial \overset{\circ}{x}_{ij}}{\partial t} \delta t$$

But the validity of equation (2) is conditioned by the vanishing of both δq_{α} and $\delta \dot{q}_{\alpha}$ at a given instant. Thus we obtain

$$\delta \ddot{x}_{ij} = \sum_{\alpha=1}^{r+s} \frac{\partial}{\partial \ddot{q}_{\alpha}} \ddot{x}_{ij} \delta \ddot{q}_{\alpha}$$
 (3)

not all the δq_{α} are independent. Therefore we must consider the modification in (3) due to equations (1). The independence of the latter and their linearity enable us to solve for k of the coördinate-differentials, which can then be expressed linearly in terms of the remaining ones. Denoting the coördinates by Q_{α} after such a procedure, we have

$$dQ_{\beta} = \sum_{\gamma=1}^{n} A_{\beta\gamma} dQ_{k+\gamma} + B_{\beta} dt \quad \beta = 1 \dots k$$

Subjecting the variations to the same conditions as above, we obtain

$$\delta \dot{\mathbf{Q}}_{\beta} = \sum_{\gamma=1}^{n} \mathbf{A}_{\beta\gamma} \ \delta \ddot{\mathbf{Q}}_{k+\gamma} \quad \beta = 1 \dots k$$

We now substitute these $\delta \ddot{Q}_{\beta}$ in (3). Hence,

$$\delta \ddot{x}_{ij} = \sum_{\gamma=1}^{n} C_{ij\gamma} \delta \ddot{Q}_{k+\gamma}$$
 (4)

and equation (2) becomes

$$\sum_{i=1}^{m} \sum_{j=1}^{3} \left\{ \left[X_{ij} - \frac{d}{dt} \left(M_{ij} \dot{x}_{ij} \right) \right] \sum_{\gamma=1}^{n} C_{ij\gamma} \delta \ddot{Q}_{k+\gamma} \right\} = 0$$
 (5)

or

$$\sum_{\gamma=1}^{n} \left\{ \sum_{i=1}^{m} \sum_{j=1}^{3} \left(\left[X_{ij} - \frac{d}{dt} \left(\mathbf{M}_{ij} \ \dot{x}_{ij} \right) \right] \mathbf{C}_{ij\gamma} \right) \right\} \delta \ddot{\mathbf{Q}}_{k+\gamma} = 0$$

But the $\delta \ddot{\mathbf{Q}}_{k+\gamma}$ are arbitrary. Therefore

$$\sum_{i=1}^{m} \sum_{j=1}^{3} \left(\left[X_{ij} - \frac{d}{dt} \left(M_{ij} \dot{x}_{ij} \right) \right] C_{ij\gamma} \right) = 0 \quad \gamma = 1 \dots n \quad (6)$$

These are the equations of motion.

As a matter of secondary interest, we shall now express these relations in a more compact—but less convenient—form. For

$$\sum_{i=1}^{m} \sum_{j=1}^{3} \left[\frac{d}{dt} \left(\mathbf{M}_{ij} \ \dot{x}_{ij} \right) \ \mathbf{C}_{ij\gamma} \right] = \sum_{i=1}^{m} \sum_{j=1}^{3} \frac{\mathbf{M}_{io}}{\left[1 \ - \left(\frac{\dot{x}_{ij}}{c} \right)^{2} \right]^{3/2}} \mathbf{C}_{ij\gamma} \ \ddot{x}_{i_{j}}$$

where M_{io} is the rest-mass and c is the velocity of light.

But \dot{x}_{ij} can be written

$$\dot{x}_{ij} = \sum_{\gamma=1}^{n} C_{ij\gamma} \dot{Q}_{k+\gamma} + C_{ij}$$
 (7)

where C_{ij} represents the terms due to the explicit dependence on the time.

484 JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES VOL. 20, NO. 20

Likewise

$$\ddot{x}_{ij} = \sum_{\gamma=1}^{n} \dot{C}_{ij\gamma} Q_{k+\gamma} + \sum_{\gamma=1}^{n} C_{ij\gamma} \ddot{Q}_{k+\gamma} + \dot{C}_{ij}$$
 (8)

From (7) we conclude that $\frac{\mathbf{M}_{io}}{\left[1-\left(\frac{\dot{x}_{ij}}{c}\right)^{2}\right]^{3/2}}$ is not a function of $\ddot{\mathbf{Q}}_{k+\gamma}$.

And from (8) we note that $C_{ij\gamma}$ can be regarded as $\frac{\partial \ddot{x}_{ij}}{\partial \ddot{Q}_{k+\gamma}}$ (the derivative being purely formal). Let

$$\Gamma_{\gamma} \equiv \sum_{i=1}^{m} \sum_{j=1}^{3} X_{ij} C_{ij\gamma}$$

and

$$\Lambda \equiv \sum_{i=1}^{m} \sum_{j=1}^{3} \frac{1}{2} \frac{M_{io} \ddot{x}_{ij}^{2}}{\left[1 - \left(\frac{\dot{x}_{ij}}{c}\right)^{2}\right]^{3/2}}$$

Then

$$\Gamma_{\gamma} = \frac{\partial \Lambda}{\partial \ddot{\mathbf{Q}}_{k+\gamma}} \qquad \gamma = 1 \dots n$$
 (9)

These equations can be identified with those of Appell for the non-relativistic case by a consideration of coördinate-velocities small with respect to the velocity of light. For, our Λ then reduces to his "energy of the accelerations."

BOTANY.—The genus Trichanthera. EMERY C. LEONARD, U. S. National Museum. (Communicated by E. P. Killip.)

Until recently the genus *Trichanthera* of the Acanthaceae family was known from a single species, *T. gigantea*. It was fully described and finely illustrated by Humboldt and Bonpland as early as 1809² but was placed by them in the genus *Ruellia*. Their uncertainty as to the correctness of this course of action is shown by their remarks—"La plante que je viens d'écrire se trouve bien placée parmi les Acanthes;

¹ Published by permission of the Secretary of the Smithsonian Institution. Received September 3, 1930.

² Pl. Aequin 2: 68. 1807.

mais il n'est pas facil de la rapporter à un des genères connus de cet ordre, ou d'en établir un nouveau qui offre des charactères bien tranchés. Dans cette incertitude, j'ai préferé la rapporter au genère Ruellia, plutôt que d'en établir un nouveau. Je donne à cette nouvelle plant le nom de Ruellia gigantea, parce que c'est un arbre très élevé."

The name *Trichanthera* was introduced ten years later when Kunth redescribed³ this well-marked species and added the following observation, "Certe distincti generis ob stamina exserta, antheras pilosas et capsulae loculos dispermos. Fortasse Trichanthera nominandum."

In the present paper two species and one variety are described. These consist of attractive large-leaved shrubs or trees with silky reddish flowers crowded in terminal racemes or corymbs.

KEY TO THE SPECIES

1. Trichanthera gigantea (Humb. & Bonpl.) Nees in DC. Prodr. 11: 218. 1847.

Ruellia gigantea Humb. & Bonpl. Pl. Aequin. 2: 68. pl. 102. 1807.

Trixanthera angularis Raf. Fl. Tellur. 146. 1838.

Shrub or tree up to 5 meters high (sometimes bushy and bearing adventitious roots); top round; twigs quadrate, the angles rounded, the tips minutely brown-tomentose; lenticels prominent, round, about 1 mm. in diameter; petioles 1 to 5 cm. long, channeled, glabrous or minutely pubescent; leaf blades ovate to oblong, the largest seen 26 cm. long and 14 cm. broad, acuminate at apex, narrowed at base, entire or undulate, glabrous except the veins and midrib, these prominent and more or less pubescent; inflorescence a terminal campact, secund panicle 5 to 15 cm. long and 4 to 5 cm. broad, brown-tomentose; bracts triangular, 3 mm. long; calyx 10 to 12 mm. long, brown-tomentose, the lobes erect, oblong, 7 to 10 mm. long, 5 mm. broad, rounded at apex; corolla 3 to 4 cm. long, red and glabrous proximally, yellowish and silky tomentose distally, red and glabrous within, the tube 1 to 1.5 cm. long, 6 mm. broad, sometimes slightly swollen or curved, the throat campanulate, the limb 2 to 3 cm. broad, the lobes oblong to oblong-ovate, 10 mm. long, 3 to 5 mm. broad; stamens exserted, the filaments 3 to 3.5 mm. long, pilose below, glabrous above, the anthers 6 mm. long, 3 mm. broad, bluntly apiculate at apex, bearded along the sutures, the hairs white and about 2 mm. long; ovary tomentose, 8-ovuled; style 4 to 5 cm. long, glabrous; stigma 2-lobed, one lobe vestigial, the other subulate, 2 mm. long; capsule oblong, 1.5 to 2 cm. long, 0.5 cm. broad, obtuse at apex, silky pubescent with closely appressed hairs, retinacula 3 mm. long, curved, truncate and erose at tip; mature seeds 1 to 4 in each capsule, lenticular, glabrous, 3 to 4 mm. in diameter.

Type locality: "In sylvis fluvii magdalenae prope Badillas," Colombia.

Specimens examined:

³ H. B. K. Nov. Gen. & Sp. 2: 243. 1817.



Fig. 1.—Trichanthera gigantea. In cultivation at Bucaramanga, Colombia. (Killip and Smith 15452.)

Costa Rica: Moist forest of Tilarán, Province of Guanacaste, alt. 500 to 650 meters, *Standley and Valerio* 46569 (N).⁴ Dry forests of Nicoya, *Tonduz* in 1900 (N).

 4 N = U. S. National Museum; Y = Herbarium of the New York Botanical Garden; G = Gray Herbarium.

Panama: Vicinity of Gatuncillo, Canal Zone, *Piper* 5606 (N). Along the Sambú River, southern Darien, above tide limit, *Pittier* 5541 (N, Y). Forests around Pinogana, southern Darien, *Pittier* 6544 (N, G). Wet forest, Río Tapia, Province of Panamá, *Standley* 26149 (N), 30662 (N). Juan Diaz, Province of Panamá *Standley* 30542 (N). Narraganti, *Williams* 1007 (N, Y).

Colombia: Lehmann 3040 (N). Antioquia: vicinity of Medellín, Toro 78 (Y). Fredonia, Archer 523 (N). Bolívar: Open forest, Sahagun, alt. 150 to 200 meters, Pennell 4101 (N, G, Y), San Martín de Loba, Lands of Loba, Curran 54 (N). Tolima: Ibagué, Holton in 1853 (Y). Santander: In yard, Bucaramanga, alt. 1000 meters, Killip and Smith 15452 (N). Dry hillside, Río Suratá valley, between El Jaboncillo and Suratá, alt. 1,500 to 1,800 meters, Killip and Smith 16426 (N). Norte de Santander: Roadside thicket, Culagá Valley, near Tapatá, alt. 1,500 to 2,100 meters, Killip and Smith 20504 (N, Y); Western side of Culagá Valley, alt. 1,480 to 1,550 meters, Killip and Smith 20534 (N, G, Y). In open along trail between Chinácota and La Esmeralda, alt. 1,000 to 1,300 meters, Killip and Smith 20891 (N). Cundinamarca: El Colegio, Ariste-Joseph 1061 (N); Between La Mesa and Magdalena, Bogotá, alt. 600 to 1,400 meters, Triana in 1851–57 (N, Y). El Valle: Thicket, "La Manuelita," Palmira, alt. 1,090 to 1,110 meters, Pennell and Killip 6193 (Y).

Venezuela: Between Valera and Monte Carmelo, Trujillo, alt. 535 to 1,830 meters, *Bellard* in 1923 (N). Near Río Cito, *Mell* in 1923 (Y). In

hedge, Paso de Guanare, Portuguesa, Pittier 3951 (N, Y).

Ecuador: Provincia Manabi, Eggers 14823 (N).

Peru: Near Tarapoto, Dept. of San Martín, Spruce 3951 (G).

As in the case of many attractive plants this species bears several common names. In Costa Rica and Panama it is known as "palo de agua;" in Venezuela, "naranjillo;" in Colombia, "aro-blanco" and "rompebarringa."

TRICHANTHERA GIGANTEA GUIANENSIS Gleason, Bull. Torrey Club 54: 617. 1927.

Inflorescence 3 to 8 cm. long, 2 to 3 cm. broad; corolla 3 to 4 cm. long, yellow and scenlet; filements piles throughout

low and scarlet; filaments pilose throughout.

British Guiana: Anabisi River, Northwest District, De La Cruz 1348 (N, Y). Canaan, Demerara River, Jenman 5356 (Y). Barina River, Jenman 7037 (Y).

Surinam: Paramaribo, Reyne in 1922 (N).

Brazil: Pará: Breves, Killip and Smith 30230 (N, Y).

Reyne found this tree planted as a windbreak in Surinam, where it is called "watra-hoedoe." It differs from the typical form in much smaller inflorescence and in the filaments being pilose throughout.

2. Trichanthera corymbosa Leonard, sp. nov.

Tree up to 3 m. high; twigs quadrangular, brownish tomentose, becoming gray and glabrous with age, the angles rounded, the nodes somewhat swollen, the lenticels prominent, round, about 0.5 mm. in diameter; petioles 1 to 5 cm. long, brown-tomentose; leaf blades ovate, 10 to 22 cm. long, 5 to 15 cm. broad, acuminate, blunt at tip, rounded at base or abruptly narrowed and slightly decurrent on the petiole, somewhat oblique, firm, shallowly crenate, the upper surface bearing numerous cystoliths and a few scattered hairs, the

lower surface tomentose, the veins (about 10 pairs) and midrib prominent and strongly tomentose; inflorescence corymbose, 10 to 20 cm. broad, the branches subquadrate and minutely brown-tomentose, the lenticels prominent; bracts small, leaflike, deciduous, those subtending the flowers triangular, 2 to 3 mm. long, 1 to 2 mm. broad; pedicel 2 to 5 mm. long, velvety browntomentose; calyx irregular (anterior lobe appreciably longer then the others), 1.5 to 2.5 cm. long, velvety brown-tomentose, the lobes oblong, 10 to 20 mm. long, 3 to 5 mm. broad, obtuse or acute, 5-nerved, the middle nerve more pronounced than the 4 lateral ones; corolla 3 cm. long, the tube 5 to 6 mm. broad, glabrous, the throat and lobes whitish or brown and densely tomentose without, purple and sparingly pubescent within, the limb 2.5 cm. broad, the lobes erect or spreading, ovate, 12 mm. long, 8 to 10 mm. broad, obtuse; stamens 4, in pairs, which are inserted on the upper portion of the corolla tube, exserted, the filaments 15 mm. long, united at base, the united portion 5 to 6 mm. long and pilose, the free portions glabrous; anthers 7 mm. long, 2 mm. broad, the lobes 2 to 3 mm. long, obtuse, sparingly pilose along the sutures; ovary densely yellowish tomentose, 8-ovuled; style 3 to 4 cm. long, pilosulous below, glabrous above, stigma 2-parted, one lobe rudimentary, the other subulate, about 4 mm. long, usually curved at tip; capsule oblong, 1.5 to 2 cm. long, 5 to 7 mm. broad, acute or obtuse at apex, densely tomentose with brownish, more or less spreading hairs; mature seed not seen but probably glabrous and lenticular.

Type in the U. S. National Herbarium, no. 1,355,268, collected in the Culagá Valley, near Tapatá, Dept. Norte de Santander, Colombia, altitude 1500 to 2100 meters, March 4, 1927, by E. P. Killip and Albert C. Smith (no. 20140). Also deposited in the Gray Herbarium and herbarium of the

New York Botanical Garden.

Additional specimens examined:

Venezuela: Vicinity of Tovar, Mérida, along the Río Macoties, alt. 900 meters, *Pittier* 12828 (N, Y).

This species is very distinct and easily recognized by the cordate leaf blades which are densely brown-tomentose on the lower surface, the unequal calyx lobes with narrow, pointed tips, and the loosely-flowered corymbose inflorescence.

ENTOMOLOGY.—New Coccinellidae from the West Indies.¹ EDWARD A. CHAPIN, Bureau of Entomology, United States Department of Agriculture. (Communicated by Harold Morrison.)

The material described below has been received from several sources but by far the most important part has come for study and description from Mr. S. C. Bruner, of the Estacion Experimental Agronómica de Cuba, at Santiago de las Vegas. In studying Mr. Bruner's Scymnillodes it was found necessary to work over all specimens of that genus from the West Indies. Unfortunately, there is at hand no material

¹ Received September 17, 1930.

from Jamaica, from which island there have been described three species. This has prevented a monographic treatment of the genus.

Geodimmockius, new genus²

Head prognathous; front slightly convex; epistoma not covering and not conspicuously raised above labrum; labrum transverse; antenna long, reaching to base of pronotum, inserted near eye at side of front, base free, ten-segmented, first segment the largest, somewhat bent, second as broad as first and little more than half as long, third about half as broad and slightly longer than second, fourth similar to third but slightly shorter, fifth, sixth and seventh of equal length, each slightly shorter than fourth, sixth and seventh noticeably wider than fifth, eighth to tenth forming a fusiform club, ninth and tenth of equal length; mandible with apex undivided, subapical tooth large and prominent, ventral submedian tooth obsolete, dorsal submedian tooth reduced to a small knob, median notch on inner edge large, deep, quadrate; inner margin of mandible above notch cut away; maxilla with threesegmented palpus, apical segment very large, hatchet-shaped, second segment not prolonged at inner apical angle, galea and lacinia each with a cluster of long setae at tips; labium poorly chitinized, quadrate, with a few long setae on external surface, internal surface closely studded with short spines, apical segment of palpus conical, slightly attenuate near tip which is squarely truncate, mentum trapezoidal, broadest in front, bearing eight long setae, submentum very short and transverse. Pronotum moderately convex, transverse, lateral margins broadly explanate, not excavate below for reception of antennae, prosternum moderate, not concealing trophi, tumid, median paired carinae absent. Mesosternum with the median, anterior, crescent-shaped portion deeply sunk and bounded behind by a prominent arcuate carina, intercoxal portion trapezoidal, mesepisternum feebly chitinized and not well defined as to limits, mesepimeron roughly triangular, its inner point reaching and partially bounding coxal cavity. Metasternum broad, anterior lateral portions separated from posterior portion by a prominent transverse carina which is broken at median line, metepisternum not chitinized, metepimeron long and narrow, not excavate for reception of part of leg II. Elytron with epipleura horizontal, lateral margin strongly explanate, epipleura not excavate for reception of legs. Wing venation reduced, only costal, cubitus and fourth median veins visible. Legs essentially similar, femora not notably expanded, tibiae slender, parallel-sided, without grooves for reception of tarsi, without apical spurs but with the usual row of apical setae, tarsi four-segmented, third segment small and inconspicuous, claw with prominent basal tooth. Abdomen with sternites III-VIII visible, metacoxal arcs short and incomplete.

Genotype.—Geodimmockius explanatus, new species

This genus is closely allied in structure, though not in appearance, to the following West Indian genera: *Psorolyma* Sicard, *Bura* Mulsant, *Botynella* Weise, all of which the writer has been able to dissect and study. This well defined group shares the following characters: four-segmented tarsi, tarsal claws toothed at base, tibial spurs absent, mandible with subapical tooth

² To George Dimmock (1852–1930) for his extensive investigations in entomology and especially for his *Algunas Coccinellidae de Cuba*, Primer Informe Annual de la Estacion Central Agronómica de Cuba, pp. 287–392, June 1, 1906.

large and remote from apex and with median quadrate notch, antennae tensegmented with three-segmented fusiform club, metacoxal arcs incomplete.

The following key, based on external characters only, will serve to separate the species of these genera which are known to me.

- 2. Length 2.8 mm., bronze with metallic luster, epipleurae descending externally, lateral margin of pronotum not explanate. Bura cuprea Muls. Length 1.7 mm., head, thorax and humeri black, elytra light castaneous, epipleurae horizontal, lateral margins of pronotum explanate Geodimmockius explanatus, new species.

Geodimmockius explanatus, new species

Nearly circular, strongly convex, lateral margins of pronotum and elytra with broad, transparent, testaceous, explanate margins; head, last three segments of antenna, pronotum, humeri and under surface of body black, elytra (except humeri) castaneous, basal segments of antenna, trophi and legs testaceous. Head finely sparsely punctured, eyes convex and prominent, labrum nearly quadrate; pronotum convex, more coarsely and much more densely punctured than head, twice as broad as long (by measurement), elytra with punctation similar to that of pronotum, greatest width at basal third where their combined width is one and one-half times that of pronotum; under parts finely alutaceous, very finely and sparsely punctured; legs moderately long, not received in cavities beneath body. Length: 1.7 mm., width: 1.5 mm., altitude: 0.85 mm.

Type and paratypes.—Cat. No. 43129, U. S. N. M.

Type a male, paratypes two females, all from S. Nicolas, Oriente Prov., Cuba, July 20–27, 1927, S. C. Bruner, collector, taken on *Coffea arabica*, E. E. A. de Cuba, No. 9338. One paratype, female, same data, in collection of S. C. Bruner. One paratype, female, same data, in collection of the British Museum.

Scymnillodes bruneri, new species

Oval, convex, shining, brassy with rose-red reflections, under parts black. Head with reflexed epistoma, front sparsely and moderately coarsely punctured, sparsely hairy. Antennae brownish, palpi and mandibles black. Pronotum about twice as broad as long (length-width ratio = 20:39), marginal bead very fine, sides rather broadly and strongly reflexed. Punctation extremely fine, hardly visible under magnification of 64×. Elytra punctured like pronotum, lateral margin beaded and slightly reflexed, basal and sutural margins not beaded. Epipleurae with very slight excavations for legs, broad before middle, disappearing shortly behind middle. Prosternum and mesosternum with a few very coarse punctures, metasternum sparsely and rather

finely punctured. First visible abdominal sternite very sparsely punctured outside of the strongly raised metacoxal area, areas enclosed by arcs strongly alutaceous and more finely and densely punctured. Second to fourth sternites alutaceous laterally, shining medianly, each with one complete transverse row of rather coarse punctures and with other punctures near lateral margins. Legs and tarsi black. Length: 1.5 mm., width: 1 mm., altitude: 0.7 mm.

Type.—Cat. No. 43130, U. S. N. M., from Santiago de las Vegas, Cuba, April 1, 1930, S. C. Bruner, collector. Paratype, same place, April 8, 1930, S. C. Bruner, collector, in collection of S. C. Bruner.

Easily separated from the other species of the genus by the black legs and almost invisible punctation of the pronotum and elytra.

Scymnillodes iris, new species

Oval, convex, shining, head bluish green, pronotum brassy-green, elytra rosy purple margined with brassy green, all parts with strong metallic reflections, under parts black. Head with reflexed epistoma, front moderately densely set with deep and distinct punctures, sparsely but rather conspicuously clothed with white hairs. Antennae not noticeably paler than palpi or mandibles. Pronotum twice as wide as long, marginal bead strong, side margins narrowly but sharply reflexed. Punctation of pronotum finer and slightly denser than that of head, pubescence not evident. Elytra with punctures of two sizes; however, the difference in the sizes is not so well marked as in S. splendidus. The density of punctation is about the same on pronotum and elytra. Marginal bead fine, noticeable both on lateral and sutural margins, basal margin not beaded. Epipleurae without defined excavations for reception of legs, broad anteriorly, rapidly disappearing behind. Prosternum very coarsely punctured, meso- and metasternum less coarsely and rather sparsely punctured. First abdominal sternite sparsely but coarsely punctured, other sternites as in S. splendidus. Legs and tarsi black. Length: 1.5 mm., width: 1.1 mm., altitude: 0.7 mm.

Type.—Cat. No. 43131, U. S. N. M. from Havana, Cuba, W. M. Mann, collector.

Scymnillodes splendidus, new species

Broadly oval, strongly convex, shining, greenish-blue to purplish blue, luster strongly metallic, under parts black. Head strongly and moderately densely punctured, very inconspicuously hairy, epistoma strongly margined. Antennae brownish, palpi and mandibles black. Pronotum more than twice as broad as long (length-width ratio = 14:30), marginal bead complete, punctures of uniform size, rather coarse and not densely placed. Scutellum small, triangular, impunctate. Elytra with mixed punctures of large and small punctures, the large punctures and also the punctures of the pronotum umbilicate. Lateral marginal bead very strong, basal and sutural margins not beaded. Epipleurae broad basally, excavate for reception of middle and hind legs but not sharply so, narrowing rapidly behind middle and disappearing in the latitude of the second visible abdominal segment. Prosternum and mesosternum very coarsely and closely punctured, metasternum less coarsely and quite sparsely punctured, especially in the median area. First visible abdominal sternite very sparsely punctured outside of the strongly raised metacoxal arcs, areas enclosed by arcs strongly alutaceous and more finely

and densely punctured. Second to fourth sternites alutaceous laterally, shining medianly, each with one complete transverse row of rather coarse punctures and with other punctures near lateral margins. Fifth sternite broadly rounded behind, slightly tumid in female, flat in male, evenly and rather coarsely punctured. Legs black, tarsi slightly paler. Length: 1.6–1.8 mm., width: 1.3–1.4 mm., altitude: 0.90–0.96 mm.

Types and paratypes.—Cat. No. 43132, U.S. N. M.

Types and two paratypes from Baragua, 8.3.27, on citrus, L. C. Scaramuzza, collector, T. P. R. F. No. 3237; eight paratypes from Guantanamo, 1918, W. M. Mann; one paratype from Cayamas, 8.6., E. A. Schwarz; one paratype from Central Jaronu, Aug. 10, C. F. Stahl, T. P. R. F. No. 2246; six paratypes from Paso Estancia, May 2, 1916, preying on Lepidosaphes sp.; six paratypes from Santiago de las Vegas, April 3, 1930, S. C. Bruner, E. E. A. de Cuba No. 9325; two paratypes from same place, Feb. 18, 1930, P. A. Berry, on Aleurocanthus woglumi Ashby; three paratypes from same place, July 14, 1930, S. C. Bruner; one paratype from near Santiago de Cuba, Oct. 4, 1928, Silvestri and Bruner; six paratypes from Camaguey, July 19, 1923, J. Acuña; four paratypes from Isle of Pines, on grapefruit, intercepted at Cincinnati, Ohio, U. S. A. by R. S. McKay. Paratypes in the collection of S. C. Bruner: one from Santiago de las Vegas, Feb. 18, 1930, P. A. Berry; one from same place, April 8, 1930, S. C. Bruner; one from Paso Estancia, May 2, 1916; one from Guantanamo, 1918, W. M. Mann; one from Camaguey, July 19, 1923, J. Acuña. Paratypes in collection of the British Museum: one from Santiago de las Vegas, Feb. 18, 1930, P. A. Berry; one from Paso Estancia, May 2, 1916.

The Santiago de las Vegas, Santiago de Cuba, and Isle of Pines specimens differ from the others in that the elytra are sharply bicolored, the lateral margins being deep blue while the discal areas are greenish. In a few the suture is also blue. I have been unable to find the slightest structural difference between specimens of these forms.

Scymnillodes caseyi, new name

1924. Delphastus violaceus Casey, Memoirs Coleoptera, 11: 170, nec Scymnillodes cyanescens? var. violaceus Sicard, 1922.

This species was based on one of a series of specimens taken at Cayamas, Cuba, by the late E. A. Schwarz. Judging from the eight specimens in the Museum collection, Casey's type was not fully colored at the time of its capture and for this reason only the posterior femora are dark. In what appear to be fully colored specimens all femora are nearly black, the pale yellowish tibiae in striking contrast with them. In addition to the Schwarz specimens from Cayamas there are in the collection one specimen from Cayamas collected by George Dimmock, one from Simpatia, Cuba, by W. M. Mann, two from Cabada, Cuba, by W. M. Mann, and two from Maricao, Porto Rico, July 2, 1917, by Harold Morrison (his number A-289).

The Dimmock specimen noted above was recorded in his "Algunas Coccinellidae de Cuba" as Bura sp.

Scymnillodes gilvifrons, new species

Oval, convex, shining, head metallic greenish, pronotum and elytra metallic violaceous, front of head and anterior angles of pronotum densely set with golden pubescence, under parts black, appendages yellowish to reddish testaceous. Head with epistoma hardly reflexed, punctation moderately dense and coarse but somewhat obscured by the pubescence. Mandibles castaneous, darker than labrum, antennae or palpi. Pronotum twice as wide as long, marginal bead strong at sides and across base, complete but fine across front margin, side margins narrowly but sharply reflexed. Punctation less dense but equally coarse to that of head, pubescence restricted to anterior angles. Elytra coarsely, sparsely and irregularly punctured, fine punctures absent. Marginal bead fine, present only on lateral margins. Epipleurae without defined excavations for legs, rather narrow from base to end of first abdominal sternite, rapidly disappearing behind. Prosternum with a few very coarse punctures covering most of the surface, meso- and metasternum more sparsely punctured, the latter punctured only at sides and along median line. Abdominal sternites strongly alutaceous at sides, sparsely and rather finely punctured. Legs and tarsi reddish testaceous. Length: 1.5 mm., width: 1.1 mm., altitude: 0.8 mm.

Type and three paratypes.—Cat. No. 43133, U. S. N. M., from Maricao, Porto Rico, July 2, 1917, H. Morrison, collector, original number A-289.

Easily recognized by the brilliant yellow pubescence on head and pronotum.

Scymnillodes subtropicus Casey

1924. Delphastus subtropicus Casey, Memoirs Coleoptera, 11: 170.

Five specimens of this species from Key West, Florida, and one from Biscayne, Florida, are in the Museum collection. The Biscayne specimen is rather more violaceous in color than the Key West series but in structure and punctation there appear to be no differences. A true *Scymnillodes* and the only species of this genus to be reported from the mainland of the Americas.

Scymnillodes atrox, new species

Oval, convex, shining, black, head with a greenish metallic luster, pronotum with bluish metallic luster, appendages reddish testaceous. Head with epistoma slightly reflexed, front rather sparsely and finely punctured, sparsely pubescent with pale whitish hairs. Pronotum very slightly more than twice as broad as long (length-width ratio = 19:40), marginal bead fine, side margins very narrowly reflexed. Punctation of pronotum same as that of head, pubescence not evident. Elytra rather less densely punctured than pronotum, punctures of a uniform size which is slightly larger than those of pronotum. Marginal bead fine, noticeable both on lateral and sutural margins. Epipleurae not foveolate, moderate in width, rapidly disappearing behind level of first abdominal sternite. Prosternum coarsely but obsoletely punctured, mesosternum rather densely set with large ill-defined punctures, metasternum very sparsely and rather finely punctured. Abdominal sternites alutaceous laterally, sparsely and finely punctured, the second to fourth with the usual single transverse row of punctures. Legs and tarsi reddish testaceous. Length: 1.4 mm., width: 1.0 mm., altitude: 0.7 mm.

Type.—Cat. No. 43134, U. S. N. M., from Camp Herrin, La Prise, Haiti, July 26, 1925, W. A. Hoffman, collector.

The various species of *Scymnillodes* known to me may be separated one from another by the following table. It is impossible to place the Sicard species with any degree of certainty as the original descriptions are rather incomplete as regards the structural characters. Color and size alone are not sufficient to define species in this genus.

1	I am block
1.	Legs black
_	Legs, at least in part, pale4
2.	Elytra impunctate
	Elytra conspicuously punctured3
3.	Elytral punctures nearly uniform in size; length 1.5 mm.
	S. iris, new species
	Elytral punctures of two conspicuously different sizes; length, 1.6-1.8
	mmS. splendidus, new species
4	Apices of femora, tibiae and tarsi paler (usually very distinctly so) than
т.	
	remainder of femora; second abdominal sternite with two irregular
	transverse rows of punctures
	Legs entirely uniformly pale; second sternite with a single regular trans-
	verse row of punctures5
5.	Anterior angles of pronotum and front of head thickly set with golden
	pubescenceS. gilvifrons, new species
	Anterior angles very sparsely pubescent6
6.	Above bluish-black, beneath pale, intercoxal process of first abdominal very
٠.	sparsely and irregularly puncturedS. subtropicus Casey
	Above deep black, beneath deep brownish black, intercoxal process rather
	sparsely but quite regularly puncturedS. atrox, new species

Diomus bruneri, new species

Form elongate, sides parallel; varying in coloration from piceous-black with head, trophi and antennae, anterior and side margins of pronotum, and two large spots on each elytron and legs pale to entirely pale except for the first two abdominal sternites which are castaneous. Head sparsely and finely but distinctly punctured, sparsely pubescent. Pronotum much broader than long (length-width ratio = 28:48), lateral margins gently and evenly curved, anterior angles directed downward, anterior margin rather strongly convex so that the head is almost entirely concealed from above by the pronotum, lateral and basal margins finely beaded, surface sparsely and very finely punctured, sparsely set with decumbent pubescence. Elytra more strongly punctured than pronotum, pubescence similar to that of pronotum, lateral marginal bead very fine, epipleura narrow at base and disappearing at a point anterior to insertion of posterior coxae, piceous black bimaculate with stramineous in fully colored specimens. The anterior spot is large and roughly quadrate, occupying all of the anterior three-fifths of the elytron except the narrow basal, lateral and sutural margins. The posterior spot is irregular in shape and is usually connected with the anterior spot by a small isthmus of pale color at the sutural third of the width of the elytron. In its anterior half the spot fails to reach either suture or lateral margins, in its posterior half it suddenly widens to include all of the tip of the elytron. In pale specimens the dark color is completely absent. The prosternum between coxae is flat, apparently devoid of punctures, and is bordered by the usual carinae. The remaining under parts are finely and rather sparsely punctured and sparsely pubescent.

The abdomen becomes somewhat paler toward the apex. The fifth visible sternite is broadly emarginate in the male, normal in the female. Length: 1.7–2.0 mm., width: 0.96–1.1 mm., altitude: 0.72–0.80 mm.

Type and paratypes.—Cat, No. 43168 U.S. N. M.

Type and thirteen paratypes from Cayamas, various dates from December to June, E. A. Schwarz; two paratypes from Est. Cent. Agr. de Cuba, June 2, 1916; one paratype from Havana, C. F. Baker; four paratypes from Baraqua, July to October, L. C. Scaramuzza, T. P. R. F. No. 3222; one paratype from Santiago de las Vegas, July 14, 1930, S. C. Bruner; one paratype from Hoyo Colorado, Havana, D. W. Jones and S. C. Bruner, E. E. A. de Cuba, No. 9347; one paratype from Sierra Rangel, August 28, 1929, J. Acuña and S. C. Bruner; one paratype from Nagua, Oriente Prov., July 7, 1922, S. C. Bruner and C. H. Ballou.

In the collection of S. C. Bruner—two paratypes from Cayamas, E. A. Schwarz, and one paratype from Hoyo Colorado, Havana, E. E. A. de Cuba, No. 9347. In the collection of the British Museum—two paratypes from

Cayamas, E. A. Schwarz.

Superficially resembles *Diomus quadritaeniatus* Lec. from Florida but is larger, much more finely punctured and with the pronotum less broad proportionately.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

419TH MEETING

The 419th regular meeting of the Entomological Society of Washington was held at 8 p.m., Thursday, April 3, 1930, in the U. S. National Museum. F. C. Bishopp presided. Remarks were made by Doctor Morrison, the chairman of the program committee, Prof. E. N. Cory and Doctor, Howard regarding a proposed meeting of our Society on the grounds of the University of Maryland at College Park, Maryland, the first Thursday afternoon and evening June 5 next, at which it was proposed to have opportunity for insect collecting, and an informal basket supper, followed by an open air meeting. On vote of the Society, this program was accepted with pleasure and thanks were extended to Professor Cory and his colleagues for the invitation.

Program: J. M. Aldrich gave some informal reminiscences of early years in Dipterology, with special emphasis on his own personal acquaintance with the personnel of its growth and development in this country. He apologized for dealing with the subject in such a personal way as he had no desire to appear egotistical or to appear to put himself unduly forward in the matter, but he considered that such a presentation from the standpoint of an individual could be made a much more vivid and colorful narrative. Doctor Aldrich stated that he was born at Rochester, Olmsted Co., in Minnesota in 1866, where he spent his childhood. Parenthetically he added that at that time Rochester was an obscure village but is known now all over the world because of the famous medical and surgical institution there. In 1881, at the age of 15, his people moved to eastern South Dakota, near the Minnesota

state border. He had a very brief high school career in 1884 and 1885 and later attended the State Agricultural College at Brookings, South Dakota, where he worked his own way through school. It was a new school in a new country, and began on a very small scale. However most of the student body were working their way and eager to learn, while the faculty was composed of friendly and helpful people; the speaker received in three years of this kind of atmosphere an intellectual impetus which is not always imparted in the largest universities. He did not however receive any important body of facts to carry away. His progress through the institution was accelerated by the desire of the President to have a graduating class in 1888, as a result of which he received his degree in three years. Entomology first came within his ken in the last term of college, when a course was given by Prof. I. H. Orcutt, a medical doctor who had been put on the faculty and given a large field in The worthy doctor had never studied entomology himself, but he was wise enough to turn the students loose with the insects, and the speaker made a considerable collection and enjoyed the course immensely, but without the least thought that he might continue the subject, still less find his life work in it.

After graduating, still at sea in regard to his next move, he, like a number of the other students, decided to canvass for a book to get a little ready money. Three days of this was enough to convince the speaker that he was not made for a book agent, and he went back to his father's farm to assist in the harvest. A few days later, while shocking up wheat, the idea crossed his mind that Professor Orcutt, who had become entomologist of the newly-established Agricultural Experiment Station in addition to his teaching duties, really needed an assistant, and that an opening here might lead to an attractive field of activity. So he wrote to Doctor Orcutt, who consulted the President and wrote back that young Aldrich should study entomology through the winter, and in the spring they would see what could be done. With this much encouragement the young man taught a term of school to get a little money, and in late fall made his way to the University of Minnesota to take up entomology again. This university then had about 500 students, ranking well in size among the western institutions. President Cyrus Northrup, after the manner of the time, interviewed all the new students personally; he said they had no courses in entomology, but out at the Experiment Station at St. Anthony Park they had a very able entomologist, Otto Lugger, who would perhaps give a student private instruction during the winter. So Aldrich went out to St. Anthony Park armed with a letter from the President, and was readily accepted as a student by Lugger. Arrangements were made to eat at the new School of Agriculture nearby, and sleeping accommodations were found in a cold room used by laborers in summer. Lugger originally was a German coleopterist and had a fine collection well mounted; he had been employed by Riley in Missouri, and after some years had been in the Division of Entomology staff in Washington for a short time before coming to Minnesota a year or two before 1888. The winter's work leaned rather heavily on Leconte and Horn's "Classification of the Coleoptera of North America," but the student could not fail to absorb some of the enthusiasm of the teacher, who was a born naturalist. In the spring, after considerable delay, the young aspirant was given a three months' engagement at the Agricultural College at Brookings, at \$40 a month. In the fall he was put on the staff with an annual appointment at \$500, with the understanding that he would devote his winters to study.

Where to go to study entomology in the fall of 1889 was one of the first questions that arose, and was decided in favor of the Michigan Agricultural College; there was very little choice at that time, especially as the young student had not heard of Cornell University except in very vague terms. In November he started for Lansing, Mich., and spent the winter with a group of ten young men who, under Prof. A. J. Cook, were doing what was then believed to be advanced work in entomology. Among the group were A.B. Cordley and F. J. Niswander, assistants to Professor Cook; Chas. B. Cook, nephew of the professor; Victor Lowe, later at the Geneva Experiment Station; H. E. Weed, Gager C. Davis, and C. F. Baker, who was still an undergraduate. Professor Cook was described by the speaker as an excellent teacher and a keen and practical man of affairs, with tremendous energy. He advised young Aldrich to select a single order as a specialty, and to proceed at once to get together a library and collection; he also suggested the Diptera as a large order in which there were but two workers (Williston and Coquillett) at the time in the country. The advice was accepted, and the library and collection duly begun, in the spring of 1890. Aldrich became a subscriber of Entomological News before the second number of Volume 1 was issued. Williston sent him his separates, as did Coquillet and Osten Sacken, and he

began buying at an alarming rate out of his small salary.

Returning to South Dakota for the year's work, he collected as many Diptera as possible, and arranged in the fall with Professor Hagen to spend the following winter at the Museum of Comparative Zoology at Harvard in a study of the Loew-Osten Sacken collection of Diptera, then the only one of any importance in the United States. In November he started east with this object in view, first stopping at Ames, Iowa, to become acquainted with Osborn and Gillette. He accompanied both of the entomologists to Champaign, Illinois, to attend a meeting of the recently organized Association of Economic Entomologists. Professor Osborn shared his sleeping-car berth en route with the impecunious student, a characteristic act of kindness never forgotten. At Champaign he met Riley, Howard, John B. Smith and others, and found that Professor Cook had already secured his election to the Association. Arriving at Harvard University, he was informed by the registrar, Frank Bolles, that Professor Hagen had suffered a stroke of paralysis and his department had been closed, making it impossible for anyone to study the This was a severe blow, as it was hard to arrange any other plan for the winter without far exceeding the available funds of the student. In explaining his situation to the sympathetic registrar, he happened to allude to his graduation from the South Dakota Agricultural College; this had a remarkable effect, for Harvard University at that time was very ambitious to develop a strong graduate department, and any sort of a degree meant a great deal in a student. So Mr. Bolles began to plan to secure from Alexander Agassiz some concession which would permit Aldrich to remain. Following the directions of Bolles, he went to Agassiz's door expecting to see the eminent Director, but was kept waiting outside while a secretary went in and explained his broken plans. After a time she came back and opened the door sufficiently to say that Mr. Agassiz could do nothing about the matter. Mr. Bolles later interviewed Agassiz himself with no results, and a letter of explanation from Aldrich to Agassiz, suggested by Bolles, brought only a printed postal card denying the request.

Forced to abandon his winter's plans, he started for Washington to see the collections there, but on the way stopped at Brown University to see Professor

Packard, who was most friendly and hospitable, and took the young entomologist home to dinner, after which they spent the evening in the library, and Packard showed materials for future publications which he was preparing. It was the first glimpse into the field of real science, and made a profound

impression on the westerner.

Arriving in Washington early one morning in late November, Aldrich waited for the opening of business and pawned his watch for \$5, after which he ate breakfast and shortly made his way to the Division of Entomology. Doctor Howard took him in charge, suggested a place to stay and arranged about his work in the National Museum, where the collection of insects was under the direction of Martin Linell. The main part of the collection of Diptera was in the Syrphidae, where Williston's Syrphidae were deposited. With these and such other material as has been accumulated, Aldrich spent three profitable weeks. A meeting of the Entomological Society occurred in this period, which he attended on the invitation of Doctor Howard. It was in a private house, and the small room was soon so full of tobacco smoke that at the conclusion the visitor was obliged to seek fresh air, without sharing in the social hour which was then an outstanding feature. His money exhausted, Aldrich returned home and spent the remainder of the winter classifying his flies with the help of the library he had accumulated.

The following winter was spent at home, as his collections and library had then assumed enough importance to justify all the time he could spend upon

them.

In the summer of 1892 he had his first real collecting trip, a small appropriation having been secured for a trip to the Black Hills lasting some three or four weeks. In the Hills he joined a party from the University of Nebraska, under the management of Professor Bruner. Among the members were Rydberg, White, A. F. Woods, and other students, as well as the Bruner

family and several women and children.

Conditions in the college had become disturbed, owing to factional strife. Professor Orcutt had become involved as an opponent of the President. In November several removals from the faculty took place, and among those to go where Orcutt and Aldrich. It did not take a young dipterist of those days long to decide that the proper course lay in joining Williston in the University of Kansas; so about New Year's he arrived at Lawrence, where Williston received him with open arms and he spent the rest of the year adding a little other work to his main study of the Diptera. It was in the last of June, after the close of the college year, that he was appointed Professor of Biology in the University of Idaho, and he concluded his reminiscences at this point.

Summarizing his educational experiences, he noted that his four teachers, Orcutt, Lugger, Cook and Williston, formed a sort of ascending series, but each contributed an important element. He began his professorship in the new University of Idaho with pathetically inadequate preparation (never having seen an Amoeba, for instance). Fortunately the instruction for some years was elementary, and by diligent application he attained a fair degree of self-education;—"And after all," he concluded, "I do not know of any other

kind of education." (Author's abstract).

This paper was discussed by Doctor Howard.

W. V. Balduf: Preliminary remarks on the habits and taxonomy of the chalcid genus Decatoma Spin. This will be amplified and published later. Discussed by Doctor Howard.

E. A. Chapin: Remarks on exotic Scarabaeidae imported into the United States. Doctor Chapin gave a short discussion of a few of the Scarabaeidae which have been imported into the United States at various times. The species mentioned were Onthophagus nuchicornis L., Aphodius rufipes L., Geotrupes stercorosus Scriba, Hybosorus illigeri Reiche, Autoserica castanea Arr., Serica similis Lewis, Plectris sp. near pexa Germ., Anomala dubia Scopoli, Anomala rufocuprea Mots., Anomala orientalis Waterh., Popillia japonica Newm., and Oxycetonia jucunda Fald. Of these, all but two have been previously reported. Plectris sp. near pexa Germ. was taken at or near Charleston, S. C., July 1922. That year it appeared to be quite numerous. However, nothing has been seen of it since, according to Miss Laura Bragg of the Charleston Museum. Anomala rufocuprea Mots. is a Japanese species twice taken in this country. One specimen comes from Kent, Washington where it was collected by H. E. Burke, July 10, 1905. The other was taken in a greenhouse at the Demoto Nursery, Melrose, Calif., May 17, 1915 by E. O. Essig. In regard to the names of two of our imported pests, the speaker pointed out that no possible case for the retention of Aserica Lewis in place of Autoserica Brenske can be made which will not conflict with the International Code of Nomenclature. The case is fully covered in Opinion 14. at issue in the case of Anomala orientalis Waterh, is not one of nomenclature so much as one of zoology. The species was described in *Phyllopertha* where it obviously does not belong. Reitter's genus *Exomala* was proposed to care for this one species. It seems hardly necessary however, and its transfer to Anomala was made as early as 1887.

This paper was discussed by Rohwer, Morrison, Bishop, and Howard. Miss Colcord exhibited a copy of a mimeographed contribution just issued entitled "Check list of the publications on entomology issued by the United States Department of Agriculture through 1927, with subject index," by Mabel Colcord, Ina L. Hawes, and Angelina J. Carabelli, U. S. Dept. of Agriculture Library Bibliographical contribution No. 20, January, 1930.

420TH MEETING

The 420th regular meeting of the Entomological Society of Washington was held at 8 p.m. Monday, April 28, 1930, in the Assembly Hall of the Cos-

os Club. The President, Mr. J. E. Graf, presided. Brief preliminary remarks were made by the President, introducing the speaker of the evening. He stated that the Society was called together on short notice at other than its regular meeting time, in order to give the personnel opportunity and pleasure of meeting and listening to an address by a distinguished visitor, Professor Carl von Frisch, Director of the Zoological Institute, University of Munich, Germany, who had been on a lecture tour throughout this country since March 11, and who would depart for New York the following day where he would lecture on Wednesday and Thursday at Columbia University and would sail for Europe on Friday.

Professor von Frisch thereupon addressed the Society on the subject of The senses and language of the honeybee. In this he first reviewed briefly the results of some experimental work performed by various workers from Sir John Lubbock to himself on the ability of bees to distinguish differences of color, and showed some of the mechanical equipment and methods used in his own work along that line. The first experiments were with blue, and later with purple, orange, green, and other colors. Later efforts were made to detect ability of bees to distinguish variations in closely related shades, especially in blossoms of plants, and on cardboards with and without sugar

baits. Attention also was given to experiments on underlying reasons why certain species of bees appear always to feed on the same species of flowers, and possible relation thereto of senses of taste and smell, and the ability to distinguish sweet, sour or bitter substances. Methods used to segregate by number, or otherwise to mark the individual bees for observation purposes, were shown. Moving pictures also were shown of various forms of dancing by bees and the possible significance was discussed. A considerable number of slides and motion picture reels were shown during the address.

This communication was discussed by McIndoo and Busck.

J. S. Wade, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

Dr. Carleton R. Ball, until recently principal agronomist in charge, Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and now engaged in agricultural writing, was elected national president of Gamma Sigma Delta, honor society of agriculture, at its recent annual meeting in St. Louis. He had been its vice-president for the past two years.

Prof. Lawrence M. Gould of the University of Michigan, geologist of the Byrd Antarctic Expedition, delivered an illustrated lecture before the National Geographic Society November 14 on the subject With Byrd to the bottom of the World. On the afternoon of November 15 he spoke informally about the geology of Antarctica to a group of geologists at the Geological Survey.

Mr. Melbourne Ward, of the Australian Museum, is spending a few weeks examining crustacea at the National Museum. On November 15 he gave an illustrated lecture before the Biological Society on *The natural history of the barrier reef of Australia*.

OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

Philosophical Society

The address by W. J. Humphreys, The Philosophical Society of Washington through a thousand meetings, which appeared in the issue of this JOURNAL for July 19, 1930, has been published in pamphlet form by the Philosophical Society. Copies, bound in stiff covers, may be obtained for forty cents each, postpaid, from the Treasurer, Capt. N. H. Heck, U. S. Coast and Geodetic Survey, Washington, D. C.

Announcements of Meetings

Thursday, December 4
Friday, December 5
Saturday, December 6
Tuesday, December 9
Wednesday, December 10

Thursday, December 11 Friday, December 12 Saturday, December 13 Tuesday, December 16

Wednesday, December 17

Thursday, December 18 Friday, December 19 The Entomological Society
The Geographic Society
The Philosophical Society
The Electrical Engineers
The Geological Society
The Medical Society
The Chemical Society
The Geographic Society
The Biological Society
The Anthropological Society
The Historical Society

The Engineering Society
The Medical Society
The Academy

The Geographic Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Mathematical Physics.—Appell's equations. R. J. SEEGER				
Botany.—The genus Trichanthera. EMERY C. LEONARD	485			
Entomology.—New Coccinellidae from the West Indies. Edward A. Chapin				
Proceedings				
The Entomological Society.	496			
SCIENTIFIC NOTES AND NEWS	500			
This JOURNAL is indexed in the International Index to Periodicals.				



WASHINGTON ACADEMY OF SCIENCES

BOARD OF EDITORS

EDGAR W. WOOLARD
GEORGE WASHINGTON UNIVERSITY

EDGAR T. WHERRY UNIVERSITY OF PENNSYLVANIA

C. WYTHE COOKE U. S. GEOLOGICAL SURVEY

ASSOCIATE EDITORS

H. E. MERWIN PHILOSOPHICAL SOCIETY

E. A. GOLDMAN BIOLOGICAL SOCIETY

AGNES CHASE
BOTANICAL SOCIETY

HAROLD MORRISON
ENTOMOLOGICAL SOCIETY

G. W. STOSE GEOLOGICAL SOCIETY

J. R. SWANTON
ANTHROPOLOGICAL SOCIETY

ROGER C. WELLS CHEMICAL SOCIETY

PUBLISHED SEMI-MONTHLY
EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY

BY THE

WASHINGTON ACADEMY OF SCIENCES

Mt. Royal and Guilford Aves. Baltimore, Maryland

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the fifth or the twentieth of the month will ordinarily appear, on request from the author, in the issue of the Journal for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors: they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication. To facilitate the work of both the editors and printers it is suggested that footnotes be numbered serially and submitted on a separate manuscript page.

Illustrations in limited amount will be accepted, drawings that may be reproduced

by zinc etchings being preferable.

Proof.—In order to facilitate prompt publication no proof will be sent to authors unless requested. It is urged that manuscript be submitted in final form; the editors

will exercise due care in seeing that copy is followed.

Authors' Reprints.—Fifty reprints without covers will be furnished gratis. Covers bearing the name of the author and title of the article, with inclusive pagination and date of issue, and additional reprints, will be furnished at cost when ordered, in accordance with the following schedule of prices:

Copies	4 pp.	8 pp.	12 pp.	16 pp.	Covers
50					\$2.00
100	\$.50	\$.55	\$.60	\$1.10	2.50
150	.90	1.00	1.10	1.60	3.00
200	1.15	1.50	1.60	2.10	3.50
250	1.65	2.00	2.10	2.60	4.00

An additional charge of 25 cents will be made for each split page.

Envelopes for mailing reprints with the author's name and address printed in the corner may be obtained at the following prices. First 100, \$4.00; additional 100,

As an author will not ordinarily see proof, his request for extra copies or reprints should invariably be attached to the first page of his manuscript.

The rate of Subscription per volume is	\$6.00*
Semi-monthly numbers	.25
Monthly numbers (July, August, and September, Nos. 13, 14, and 15)	.50

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. G. Avers, Coast and Geodetic Survey, Washington, D. C.

Exchanges.—The JOURNAL does not exchange with other publications.

Missing Numbers will be replaced without charge provided that claim is made within thirty days after date of the following issue.

Volume I, however, from June 19, 1911, to December 19, 1911, will be sent for \$3.00. Special rates are given to members of scientific societies affiliated with the Academy.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 20

DECEMBER 19, 1930

No. 21

PALEONTOLOGY.—On the fossil Mammalia of the first interglacial stage of the Pleistocene of the United States.¹ Oliver P. Hay.

The writer accepts the conclusion of most recent geologists that there have been in North America four, possibly five, distinct glacial, and three, possibly four, interglacial stages. He holds, with most geologists, that during each glacial stage there prevailed at and beyond the border of the ice an arctic climate, which compelled the animals and plants either to retreat or to perish. Evidently at the beginning of the Pleistocene there existed an abundant fauna and at its end a meager one. If we seek the prime cause of the disastrous effects on the living things it will be found in the successive glacial climates.

I can not accept the view of the Iowa geologists that the fossil animals found in the western part of the State, except perhaps a musk ox, existed there during the height of a glacial stage; nor is there sufficient evidence for us to believe that elephants existed there before the Nebraskan stage.

Unfortunately the fossil remains found in the Aftonian deposits in Iowa are too often fragmentary; but according to our present knowledge, the following mammals inhabited that region at that time.

Megalonyx jeffersonii Mylodon harlani Equus complicatus E. niobrarensis E. scotti E. laurentius E. excelsus Mylohyus? temerarius Elephas imperator E. columbi E. boreus Camelops? sp. indet.
Alces shimeki
Aftonius calvini
?Symbos cavifrons
Bison sp. indet.
Stegomastodon mirificus
Mammut progenium
M. americanum
Castor canadensis
Castoroides ohioensis
Eugretos americanus

¹ Received Oct. 22, 1930.

These fossils form the corner stone of our knowledge of the succession of North American Pleistocene vertebrates.²

West of Missouri River the Equus beds of Cope, the Sheridan beds of Scott, extend from the glaciated region of South Dakota to the Gulf. They appear to be a continuation of the Aftonian of Iowa and to contain some of the same species and many in addition. On the Plains these beds are widely overlain by deposits of loess, sometimes very deeply.

In Nebraska, about Seneca, have been collected Equus niobrarensis, E. excelsus, Camelops?, Platygonus, and probably Elephas imperator and Stegomastodon mirificus.³ Some of these species have been referred to the Pliocene, but the geologists inform us that, at the close of the Pliocene, glacial conditions were already approaching in Great Britain. Migration in higher latitudes must therefore have been somewhat difficult for large, and more so for small, mammals.

Near Grayson (Peters), Nebraska, a half mile or more from Niobrara River and from 50 to 100 feet above it, have been collected many genera and species found in the Aftonian of Iowa. Eighty per cent are extinct. These include *Elephas imperator*, three species of camels, two of horses and a saber-tooth tiger.⁴ Since these animals lived, the Niobrara has cut down its channel 50 to 100 feet deeper and moved a mile away.

Afton, Oklahoma, offers us a case in which a first interglacial fauna occurs near the surface of the Equus beds. A spring there, at which mammals for thousands of years quenched their thirst, has never been smothered by a deposit of loess. Besides later fossils, it has furnished five species of horses, two species of camels and *Elephas imperator*. Seventy-three per cent are extinct.⁵

At Frederick, Oklahoma, deep down in an old filled-up river bed on the top of a ridge 100 feet above the surrounding region, the stream now flowing ten miles away, have been collected 25 species of mammals, among them *Elephas imperator?*, *E. haroldcooki*, *Stegomastodon*, *Glyptodon*, five or six species of horses, and at least two kinds of camels. All species are exinct.⁶

² O. P. HAY. Carnegie Inst. Washington Pub. 322A: 286-301.

³ O. P. HAY. Op. cit. 302.

⁴ O. P. HAY. Op. cit. 100, 304.

⁵ O. P. HAY. Op. cit. 94, 254.

⁶ O. P. Hay and H. J. Cook. Proc. Colorado Mus. Nat. Hist. 9, No. 2.

At Rock Creek, in Tule Canyon, Briscoe County, Texas, has been collected a large fauna in still other conditions. In late Pliocene or early Pleistocene times, during an uplift, a stream cut a gorge about 100 feet deep into Miocene deposits. Later there was a depression during which were laid down four distinct Pleistocene beds amounting to about 90 feet. Then occurred another change. A quickened stream cut down through all the Pleistocene, through the Miocene and into the Triassic. In the Pleistocene of this canyon have been collected Glyptodon, two elephants (one of them Elephas imperator), from four to six horses, and four kinds of camels, twenty or more species, all of which are extinct.7

Along Brazos River, at Waco, Texas, are three terraces, the highest standing 100 feet above the river. On this terrace have been found remains of Elephas imperator and of camels.8

At Pittbridge, Brazos County, 13 species of mammals have been collected, including Chlamytherium, Megatherium, a horse, a camel, three species of mastodons, and Elephas imperator. All belong to extinct species.9

In Austin County, on Brazos River, 80 miles from the Gulf, near San Felipe, have been collected nine species of extinct mammals, among them Elephas imperator, a horse, a camel, two species of mastodons, and a long-horned bison. 10

Along the shores of Galveston Bay skeletons of elephants are frequently found. One at least of these was Elephas imperator.

At Keeran Point, on the Gulf Coast, bones of a large camel have been collected. With these was associated an elephant, possibly E. imperator.11

A comparison of the lists of fossils cited above as collected in Iowa, Nebraska, Oklahoma and Texas must convince one that all belong to an early stage of the Pleistocene and all to the same stage. Some of the collections cited, and most of those to be cited, contain three groups of species: (a) Species which do not occur in more recent deposits; (b) Species becoming extinct in later stages; (c) Species living into historical times.

O. P. Hay. Carnegie Inst. Washington Pub. 322A: 85, 222, 232, fig. 2.
 O. P. Hay. Op. cit. 88, 127, 161, 227, 243.

⁹ O. P. HAY. Op. cit. 244, 245. 10 O. P. HAY. Op. cit. 246.

¹¹ O. P. HAY. Op. cit. 21, 64, 163, 248.

On map 25 of the author's work, Publication 322A, of the Carnegie Institution of Washington, are shown the localities in the middle region of the United States where extinct species of the genus Bison have been discovered. In Texas are 16 of these. On map 26 are indicated finds referred to Bison bison. Seven in Texas are thus identified, but the writer can not be sure that even one of these is at once Bison bison and older than the late Pleistocene. Had this animal lived in Texas with the species shown on map 25, it is hard to explain why no skull or even horn core has been discovered in association with early Pleistocene species. These extinct species were apparently buried when Texas was at a higher elevation and since that time the streams have spent their energy in deepening and widening their valleys. Satisfactorily identified remains of Bison bison appear to occur in Texas only on lower river terraces.

I come now to deal with the earliest known Pleistocene mammals of Florida. In this state are some six localities where such remains have been collected. Details regarding these and citations of papers discussing them may be found in the writer's *Publication 322* of the Carnegie Institution of Washington and in Dr. G. G. Simpson's article in the Twentieth Annual Report of the Florida Geological Survey, on pages 231 to 279.

There is general agreement that the collections of the six localities mentioned below are of the same geological age; but there is disagreement as to what that age is.

In "stratum No. 2" (now denominated Melbourne beds) at Vero, St. Lucie County, have been collected 29 species of mammals, of which 21 are extinct, 67 per cent. Among these are 4 species of edentates, 3 species of horses, a capybara, an undetermined camel, and the Florida saber-tooth tiger. Three miles away, in a corresponding formation, was found a jaw of *Elephas imperator*. 12

From Melbourne, Brevard County, a collection of forty species of mammals has been reported, at least 60 per cent of which are extinct. Among these are *Chlamytherium*, a species of glyptodon, a camel, and *Elephas imperator*. 13

Seminole Field, Pinellas County, has contributed 46 mammalian species. At least 27 of these are no longer living, 59 per cent. Five

¹² O. P. HAY. Op. cit. 163.

¹³ G. G. Simpson. Florida Geol. Survey Ann. Rept. 20: 268.

species of edentates, two horses, three camels, and a saber-tooth are among the number.¹⁴

Not far from Sarasota, Sarasota County, have been collected 23 species of mammals, of which at least 15 species, 65 per cent, are extinct. Among these are a *Glyptodon*, a camel, a horse, and a sabertooth tiger.¹⁵

About seven miles east of Sarasota have been secured 14 species of mammals, 11 of which, 80 per cent, are extinct. These include a camel, *Chlamytherium* and a horse. 16

Near Arcadia, DeSoto County, along Peace Creek, have been found 12 species of land mammals, of which 11, 91 per cent, are extinct. These include *Glyptodon*, two horses and *Elephas imperator*. ¹⁷

These Melbourne beds and their fossils are now to be compared with those of western Iowa and those found from South Dakota to the Gulf. Certainly the fossils of Florida resemble in a general way those collected in the western region. There are in both states numerous edentates (such as ground sloths, and glyptodons), wolves, bears, great cats, elephants, mastodons, horses, tapirs, peccaries, camels, deer, bisons, gigantic beavers, and gigantic capybaras. Nearly every family of mammals found in Florida occurs also on the Plains. Of 51 genera of Melbourne mammals recorded by Simpson¹⁸ 18 are found also in Texas. Of 70 species of Melbourne mammals 14 are known in Texas; and quite certainly more collecting in the two states will increase the numbers of species possessed in common. Of the genera occurring in the Melbourne beds 23 are recorded from the deposits regarded as Aftonian of the region from western Iowa to the Gulf of Mexico.

The collections made in Florida contain usually more species than those of the western region. This is simply because the Florida fossils were buried in ponds and slowly flowing streams, while those of western Iowa and of the Plains were deposited by swift waters which swept away the bones of the small creatures. At Vero, Florida, occur 29 species, of which seven are small, 24 per cent of the whole. At Melbourne were found 44 species of which four were small, 9 per cent.

At Lecanto 26 species were collected of which eight were small, 30 per cent. At Seminole Field 44 species were secured, 12 of which were small, 27 per cent.

¹⁴ G. G. SIMPSON. Op. cit. 264.

¹⁵ G. G. SIMPSON. Op. cit. 274.

¹⁶ G. G. SIMPSON. Op. cit. 275.

¹⁷O. P. Hay. Carnegie Inst. Washington Pub. 322: 381.

¹⁸ G. G. Simpson. Florida Geol. Survey Ann. Rept. 20: 251.

On the other hand, in the Cox pit, near Missouri Valley, Harrison County, Iowa, have been collected 19 species, all of them large. At Peters, Nebraska, have been taken 21 species, only two small, 9 per cent. At Frederick, Oklahoma, have been collected at least 23 species, none small. From Rock Creek, Texas, have been reported 18 species, none small. At Pittbridge, Texas, have been secured 14 species, none small.

If in this region the microfauna were duly represented, the collections would be quite as large in species as those of Florida and probably the number of species common to both regions would be augmented.

It is in order now to determine in what way Florida is related in its Pleistocene mammalian paleontology to that of the Great Plains. In looking over the records it is found that 50 species have been discovered in the collections made in Texas and referred by the writer to the early Pleistocene and that, of these, 16 species are regarded as common to Florida, that is, 32 per cent, and few small species occur. In Nebraska there have been collected apparently 22 species of mammals, very few small forms, and, of these 22, only six are known from Florida, 27 per cent. In Iowa have been secured 25 species of which apparently eight, none small, are known from Florida, 32 per cent.

Now are these differences in the composition of the various collections such as we can or can not expect? Do they indicate different geological stages of existence? Taking into consideration the distance of the Plains from Florida, but more especially the differences in latitude and of faunal zones, what do we find at the present day? So far as I can determine there exist now in Texas 111 species of mammals. Of these 23 live in Florida, 20 per cent. In Nebraska there are approximately 50 existing mammals, of these 11 seem to belong also in Florida, 22 per cent.

It will hardly be questioned that these existing mammals of Florida, Texas, and Nebraska belong to the same geological time; but what reason is there that quite similar differences should not be expected in the case of the animals of an early Pleistocene stage?

The reader who is interested in this discussion is now invited to examine the lists of fossils taken at various European localities from deposits which Mayer and Roman call the "Pliocène récent" and the "Pléistocène ancien." This "Recent Pliocene," however, corre-

¹⁹ O. P. Hay. Carnegie Inst. Washington Pub. 322A: 296.

²⁰ Mayer and Roman. Ann. Univ. Lyon (n.s.) fasc. 42: 22-68.

sponds to the first and second glacial and first and second interglacial stages of North American geology. Most of the lists cited belong to the first glacial stage, known to us as the Nebraskan, but the deposits lie well outside the glaciated region. The Red Crag, however, is placed by Haug at the top of his period Neogene.²¹ The pages of Mayet and Roman's work on which each list begins is here cited.

- 1. Sables de Chagny (p. 22). The list presents 18 species, of which all are extinct; no small species. Sixteen genera (including subgenera); five of them extinct, 31 per cent.
- 2. Perrier (p. 29). Thirty-six species, all except one extinct; four or five small. Twenty-seven genera, four extinct, 14 per cent.
- 3. Du Puy (p. 35). Thirteen species, all extinct; none small. Nine genera, three extinct, 33 per cent.
- 4. Val d'Arno (p. 50). Thirty-five species, all extinct. Four or five species small. Twenty-five genera, six extinct, 24 per cent.
- 5. Red Crag (p. 58). Eighteen species of land mammals, all extinct, one small. Sixteen genera, three extinct, 19 per cent.
- 6. Cromer Forest bed (p. 66). Thirty-eight species, 14 extinct, 37 per cent. Twenty-seven genera, four extinct, 15 per cent. Ten species small.

This locality and its fossils are arranged by the French authors at the top of the Old Pleistocene (Yarmouth). They employ the prevailing nomenclature. It is now believed, however, that most of the species need revision; also many of the genera.

It will be observed that these lists, like those of our country, differ in number of species from place to place and often in the identity of species; but in all of them, for identification of geological position, are a few prominent forms, such as primitive elephants, mastodons, rhinoceroses, Equus, etc.; as in America we must rely on Elephas imperator, E. haroldcooki, Stegomastodon, Equus, and the Camelidæ. In both these countries these fossils, for the most part, bind the formations to the early Pleistocene; the Cromer fossils attach the Cromer beds apparently to the first or second interglacial stages.

Therefore as regards the Melbourne beds of Florida, the writer is confident that, notwithstanding the prevalent theories of successive Pleistocene submergences and consequent terraces, of dissolution of fossils from these terraces by percolating waters, of terraces formed within 15,000 years; of the notion that Florida was a land where the

²¹ HAUG. Traité de géologie. 1620.

mammals were protected from glacial storms until rude barbarians came and slew them with their arrows and clubs and stones—notwith-standing these theories, those Melbourne beds belong to the first interglacial stage.

The writer will now consider briefly the Pleistocene paleontology of a portion of the Pacific Coast region. It is necessary to mention only two localities, Fossil Lake, Oregon, and La Brea, near Los Angeles, California.

In deposits of an ancient desiccated lake, now Fossil Lake, have been collected 22 species of mammals and 50 of birds. Of the mammals 12 species, 52 per cent; of the birds 16, 32 per cent, are extinct. Of the mammals three species only are small. Ten of the genera are found in Florida and at least two species. Four species of camels, one horse, and *Elephas imperator* have been collected.²²

La Brea furnishes a vast number of finely preserved, but disarticulated, skeletons of mammals in deep pits of asphaltum mingled with sand. Forty-four species are recorded, a few not determined specifically. Of these at least 23 are extinct, 57 per cent. Five of the species are known from Florida. Thirty-six genera are present, of which 11 are extinct, in North America at least. Twenty-two of the genera occur also in Florida. About ten species are small. Three species of large edentates, one horse, a bison, five dogs, four large cats (among them a saber-tooth tiger), a camel, and *Elephas imperator* are present. Only five of the species are recorded in Florida. ²³

These localities furnish fossils which indicate first interglacial animals. The essential species are present. In Oregon and California not many are found which are known from the states of the Plains and from Florida; but this is exactly what is to be expected. Let us see how the existing mammals of the Pacific region agree in species with those of the eastern third of the United States.

From Mr. G. S. MILLER'S Mammals of North America, 1924, I make out that in the states east of Mississippi River there are close to 116 species of mammals. In the 11 States, New Mexico, Colorado, Wyoming, Montana, and those between these and the Pacific Ocean, there are approximately 356 species. Of these there appear to be about 27 species common to the two regions, about 7 per cent of those of the western region, and about 23 per cent of those of the eastern.

²² O. P. HAY. Carnegie Inst. Washington Pub. 322B: 243.

²³ O. P. HAY. Idem. 183.

In Florida there exist about 40 species of mammals; in California approximately 190. I find only eight species common to the two states.

If the fossils of Fossil Lake and of La Brea are not regarded as contemporaneous with those of the Plains and of Florida, geologists of some zons hence who may have in hand fossils of the present day mammals of the eastern third of our country and of the western third would, on the same grounds, be justified in referring them to quite different geological stages or epochs.

ETHNOLOGY.—The music of the American Indians at public gatherings (Abstract). Frances Densmore, Bureau of American Ethnology.

Music was an important factor in public gatherings of the Indians and they derived much pleasure from it, yet there were no concerts and the European custom of ballad singing was unknown. The American Indian never sang for the approval of others, neither did he sing in order to be paid for his performance. His pleasure in music was not connected with technic but with the melodies, their words, and certain associations of the songs. In the old days every Indian song was an inspiration, not a creation of man according to rule and precept.²

After describing the Indian custom of "receiving songs in dreams" the writer considered her subject under four divisions: poetry, drama, dancing and games. The accompanying instruments were various forms of drums and rattles producing rhythm but not melody.

The poetry of the Indians is contained in the words of songs and rituals. There is no attempt to interpret these words by the manner of rendering the songs. Many song-cycles of southwestern tribes relate the journeys of mythical personages, and the people dance during a portion of these songs. The beauties of nature form the subject of many songs, the words being few but highly poetic.

Primitive drama is closely associated with music. There is rich

¹ Received Oct. 9, 1930. The paper of which this is an abstract was read by Miss Elizabeth Burchenal, September 1, 1930, at the International Congress of Popular Arts, held at Antwerp. It was the only paper from the United States on the program. The other papers were from England, Spain, Holland, Belgium, Germany, France, and Italy.

² With reference to my paper on the music of the American Indian (this JOURNAL 18: 395–408, 1928), Prof. Constans Maltezos, a member of the Academy of Athens and a student of ancient oriental and Peruvian music, who had thought that there might be an intelligent system underlying the music of the American Indians, writes me as follows: "Je trouve que vous avez raison: vos Indiens ne pouvent avoir eu une idée de intervalle du ton. Cette musique n'a pas passé par le mains de théoreticiens."

pageantry, as well as music, in the ceremonies to bring rain. The Sun Dance of the Plains tribes had its ceremonial songs, and the warrior dramatized his victory over the enemy. Among the Sioux, the man who had received a vision acted it out, that all might know he had the elk or the bear as his spiritual helper, and he sang the song given in his vision. The history of Indian tribes is replete with drama in ritual and ceremony.

Dancing differs in style among the various tribes, some maintaining a dignified manner while others have contests in acrobatic dancing with many contortions. There are dances of individual expression, dances imitating birds and animals, and dances in which the people stand still, flexing the knees, but in a majority of Indian dances the people move in a circle around a large drum.

Games of pure skill and calculation, like chess, are unknown among the American Indians, their games being contests of dexterity or games of chance. Success in games was formerly attributed to supernatural aid, and songs were sung to ensure that aid.

In closing, the writer described various customs connected with Indian music and noted the absence of self-aggrandisment on the part of Indian musicians. It was the old belief that songs were given by friendly spirits, and their use was chiefly associated with securing help and benefit to human beings.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

421st meeting

The 421st regular meeting of the Entomological Society of Washington was held at 8 p.m., Thursday, June 5, 1930, by special invitation at the University of Maryland, beginning with an informal picnic and basket dinner from 6 to 8 p.m. on the campus and continuing with the formal session at 8 p.m. in the University Auditorium at College Park, Maryland. J. E. Graf, president, presided. H. L. Parker, European Parasite Laboratory, Hyères, Var, France; Newell E. Good, Bureau of Entomology, Washington, D. C.; and James Zetek, Barro Colorado Island Biological Laboratory, Canal Zone, were elected to membership in the society.

A brief informal address was given by H. J. Patterson, Director of Maryland Agricultural Experiment Station, in which he greeted the society and extended welcome for all to the University. He then read a note from R. A. Pearson, the President of the University, expressing regret at inability to be present and writing in highly appreciative terms of Doctor Howard and their personal associations. Doctor Patterson expressed hope that all the scientific

organizations of Washington would continue more and more to make regular use of the facilities of the University for various gatherings and assured a hearty welcome to all. He also referred to the practical value of entomological work and the annual savings effected through such research, and made very brief mention of the work of some of the early entomologists connected with the Maryland Station or the University, and the publications issued therefrom dealing with entomological topics. He stated that all were honored by the presence at the meeting of Doctor Howard, and an especial welcome was extended to him

E. N. Cory also made a very brief address of welcome to the society and referred appreciatively to the work of the various entomologists connected with the Maryland institution, many of whom were later with the Federal

Bureau.

Program: L. O. Howard, of the U. S. Bureau of Entomology, Some early entomologists. Apropos of the letter from Doctor Pearson just read, Doctor Howard spoke appreciatively of the association reaching back for thirty years or more with Doctor Pearson, and of the latter's ability to "pull ideas down from the sky." It was due to one of these ideas that Doctor Howard first was made one of the trustees of Cornell University. In discussion of his subject, Doctor Howard placed especial emphasis on reminiscences of the careers of certain of the early entomologists who had been connected in one way or another at various periods of their lives with the work of the Maryland Station. The first of these to whom consideration was given was Townend Glover, who later was the first entomologist of the U.S. Department of Agriculture, and a brief résumé of his biography was given with special emphasis on his very strongly marked individuality and his personal eccen-All interested were advised to read the vivid and colorful biography of Glover by Charles Richard Dodge, published in 1888 as U. S. Division of Entomology Bulletin, old series, No. 18. Several extracts were read by the speaker from various papers not yet published dealing with sundry phases of Glover's career. There was also considerable discussion by the speaker of other entomologists connected at one time or another with the Maryland Station, including C. V. Riley, R. S. Lull, W. G. Johnson, E. D. Sanderson, and others. Slides bearing portraits of these and a number of their contemporaries in entomological work were shown and various phases of the career of each individual were given brief consideration.

W. D. Pierce discussed some entomological experiences in the Philippines, under the title *The sugar-cane insect problem in Negros*; an abstract of this will be published later in the Proceedings of the Entomological Society of Washington. Doctor Pierce's remarks were discussed by Graf, Gahan,

BISHOPP, and HOWARD.

A. B. Gahan reported the recent rearing by McCreary, of the University of Maryland, of *Dicymolomia julianalis* Walker, a small moth which he found to be feeding on the eggs of the common bagworm of evergreens (*Thyridopteryx ephemeraeformis* Haw.). Mr. Gahan first observed this insect in a similar relation to the bagworms some fifteen years ago in the same locality, while connected with the University of Maryland. So far as he knew, no other like observation had been made by any other person since that time. The normal habit of the moth is said to be to infest the heads of the common cattail or Typha.

Professor Cory reported the recent finding of Argentine ant (*Iridomyrmex humilis* Mayr) in a greenhouse in Baltimore, Maryland. This is a new dis-

tribution record and is the northernmost point of the known spread of this pest.

Austin H. Clark, *Notes on some local butterflies*. This has been published in the Proceedings of the Entomological Society of Washington, 32:

80-82, 1930.

On motion of F. C. Bishopp, a vote of thanks was extended by the society to the authorities of the University of Maryland and to Professor Cory and his associates for the generous hospitality and for the splendid welcome given our society at the 421st meeting.

J. S. Wade, Recording Secretary.

Obituary

OLIVER PERRY HAY, a member of the Academy and of the Biological and Geological societies, died November 2, aged 84. He was born at Saluda, Jefferson County, Indiana, May 22, 1846, and studied at Eureka College, Yale University, University of Indiana, and the University of Chicago. After teaching several years at Eureka College and at Butler College, he became, in 1895, an associate curator in the Field Museum. He was engaged in research work at the National Museum from 1897 until 1900, when he was appointed assistant and later associate curator in the department of vertebrate paleontology of the American Museum of Natural History. In 1907 he returned to Washington. He was a collaborator of the Carnegie Institution of Washington from 1902 to 1906; research associate, 1912 to 1916; and associate from 1917 until his retirement in 1926.

He was the author of many papers on vertebrate paleontology. His longer works include a Bibliography and catalogue of the fossil Vertebrata of North America (1902), The fossil turtles of North America (1908), The Pleistocene age [of Indiana] and its Vertebrata (1912), The Pleistocene mammals of Iowa (1914), and three volumes on The Pleistocene of North America and its vertebrated animals (1923, 1924, 1927). Dr. Hay was a frequent contributor to this Journal. His last contribution, which appears in this number, was

handed to the editor only a few days before his death.

INDEX TO VOLUME 20

An * denotes the abstract of a paper before the ACADEMY or an affiliated society.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Biological Society of Washington. Proceedings: 84, 346.

Entomological Society of Washington. Proceedings: 15, 114, 153, 185, 384, 438, 495, 510.

Geological Society of Washington. Proceedings: 29, 151, 241, 354, 435.

Philosophical Society of Washington. Proceedings: 12, 28, 118, 137, 149, 183.

Washington Academy of Sciences. Proceedings: 68, 340, 418.

AUTHOR INDEX

- Adams, L. H. The compressibility of rubber. 213.
- --- *The creation of the earth. 340.
- Albright, H. M. *Some biological problems in National Park administration. 349.
- ALDRICH, J. M. *Notes on the life zones of northern Europe. 84.
- *Recent entomological experiences in Europe. 114.
- --- *Reminiscences. 495.
- Anderson, E. G. *Colored light measurements on various photometers.

 13.
- Austin, L. W. Note on a comparison of sunspot numbers, terrestrial magnetic activity, and long wave radio signal strength. 73.
- Bailey, Vernon. *Some biological problems of the Grand Canyon region. 352.
- Balduf, W. V. *Remarks on the use of a mite in cheese making. 189.
- Balk, Robert. *Structural survey of the Adirondack anorthosite. 241.
- Barth, Tom. F. W. Pacificite, an anemousite basalt. 60.
- Bartsch, Paul. *Collecting in the Caribbean Islands. 351.
- Bennett, H. H. *Contributions by the Bureau of Soils to the problem of erosion. 30

- Berkson, Joseph. On the equation for the reaction between invertase and sucrose. 157.
- Berry, Edward W. A new *Pterophyllum* from the Shinarump conglomerate in Utah. 458.
- —— *The origin and evolution of plants. 344.
- -- *The history of the Andes. 69.
- BERRY, WILLARD. A new hypural fan from the Miocene of Maryland. 41.
- Contributions to the paleontology of Peru, IV: "Orthophragmina" (Discocyclina) meroensis W. Berry, n. sp. 432.
- Bowie, William. The scientific and practical value of triangulation. 53.
- Bridge, Josiah. *Early structural history of the Ozark region. 151.
- Brooks, H. B. *The sensitivity of a galvanometer as a function of its resistence. 118.
- Campbell, M. R. *The problem of the scientific classification of coal. 435.
- CARTER, E. E. *The 1929 scientific explorations in Alaska: Forestry. 71.
- Carter, Walter. *Some phases of the sugar-beet leafhopper problem. 153.
- Case, E. C. Discovery of Permo-Carboniferous vertebrates in the Dunkard formation of West Virginia. 370.

- Chamberlin, R. T. *Isostasy from the geological point of view. 454.
- CHAPIN, EDWARD A. New Coccinellidae from the West Indies. 488.
- ---- *Remarks on exotic Scarabaeidae imported into the United States. 499.
- Chrisler, V. L. *Absorption of sound at oblique angles of incidence. 28.
- CLARK, AUSTIN H. *Evolution. 68.
- COBB, N. A. The demanian vessels in nemas of the genus *Oncholaimus*; with notes on four new Oncholaims. 225.
- Coe, E. F. *America's own tropics. 85.
- COLEMAN, L. V. *Museums in South America.
- COLLINS, H. B. *The 1929 scientific explorations in Alaska: Archeology.
- COOKE, C. WYTHE. Pleistocene seashores. 389.
- Cushman, Joseph A. The interrrelation of Foraminifera and Algae. 395.
- DACHNOWSKI-STOKES, ALFRED P. Peat profiles of the Everglades in Florida: the stratigraphic features of the "Upper" Everglades and correlation with environmental changes. 89.
- —— Peat profiles in Maine: The South Lubec "heath" in relation to sea level. 124.
- —— Peat profiles in the Puget Sound Basin of Washington. 193.
- DAVENPORT, CHARLES B. The mechanism of organic evolution. 317, *345.
- DENSMORE, FRANCES. The music of the American Indian at public gatherings.
- Drechsler, Charles. Some new species of *Pythium*. 398.
- DRYDEN, H. L. *Effect of turbulence in wind-tunnel experiments. 137.
- Evans, O. F. The antiquity of man as shown at Frederick, Oklahoma: a criticism. 475.
- FAIRCHILD, JOHN G. The volumetric determination of fluorine by the use of ferric chloride. 141.
- Ferguson, H. G. *Vein quartz of the Alleghany district, California. 151.
- FISK, HARLAN W. *Secular variation of magnetic intensity, and its accelerations in Pacific countries. 13.

- FRIEDMANN, HERBERT. The geographic variations of Neocichla gutturalis (Bocage). 434.
- --- *Parasitism in birds. 85.
- Gahm, O. E. *Insect pests and mites related to the mushroom industry. 384.
- ---- *Note on Linopodes antennaepes Banks. 155.
- Galtsoff, Paul S. *Old and new concepts of the organism in the light of experimental studies on sponges. 344.
- Gibson, R. E. The compressibility of rubber. 213.
- GOLDMAN, E. A. A new pocket mouse from Lower California. 223.
- —— A new racoon from Lower California, 82.
- GOLDMAN, MARCUS I. *Types of silicification in the Paleozoic of Virginia. 356.
- Goranson, R. W. *Some problems in isostasy. 447.
- Gregg, W. R. *The 1929 scientific explorations in Alaska: Meteorology. 71.
- GUTENBERG, B. Hypotheses on the development of the earth. 17.
- Hall, Maurice C. *Parasites of elk and other wild ruminants. 87.
- HAY, OLIVER, P. On the fossil Mammalia of the first interglacial stage of the Pleistocene of the United States. 501.
- Remarks on Dr. George G. Simpson's work on the Pleistocene paleontology of Florida. 331.
- Hewett, D. F. *Genesis of iron-manganese carbonate concretions in Central South Dakota. 243.
- HEYL, P. R. *Absorption of sound at oblique angles of incidence. 28.
- HIGGINS, ELMER. *Great Lakes investigations. 348.
- HITCHCOCK, A. S. Four new grasses. 381.
- Howard, C. S. *Suspended matter in the Colorado River. 30.
- HOWARD, L. O. *Observations on some entomologists and their work, during a recent western trip. 15.

- Howard, L.O. Some early entomologists.
- HOLLANDER, FRANKLIN. On the equation for the reaction between invertase and sucrose. 157.
- Howell, A. H. *Recent notes on birds and mammals of the Everglades. 85.
- Hrdlička, Aleš. *The 1929 scientific explorations in Alaska: Anthropology. 70.
- HULBERT, E. O. *Ions and electrical currents in the upper atmosphere. 29.
- HUMPHREYS, W. J. The Philosophical Society of Washington through a thousand meetings. 245.
- Johnson, C. D. *The strength of metal tubing for structural purposes. 185.
- Kalmbach, E. R. *Notes on waterfowl sickness in 1929. 86.
- KILLIP, ELLSWORTH P. Ten new species of *Passiflora*, mainly from Colombia and Peru. 374.
- —— The identity of the South American fish poisons, "cube" and "timbó."
- *Over the Peruvian Andes and down the Amazon for plants. 352.
- Kirk, Edwin. *Trophocrinus*, a new Carboniferous crinoid. 210.
- Kuethe, A. M. *Effect of turbulence in wind-tunnel experiments. 137.
- LANE, A. C. *Geotherms. 450.
- Lang, Walter B. Note on temperature gradients in the Permian basin. 121.
- Larson, A. O. *Bean-weevil infestations. 438.
- LEONARD, EMERY C. The genus Trichanthera. 484.
- LONGWELL, CHESTER R. *Some problems of mountain structure and mountain history. 441.
- Marsh, C. D. *The poisonous laurel. 350
- Martindale, P. N. *Intimate habits of wild animals. 349.
- McComb, H. E. *Some recent instrumental investigations in terrestrial magnetism and seismology. 149.
- MERRIAM, C. HART. Little-known tribes of the Salmon, New, and Trinity Rivers in northwestern California. 148.

- MERTIE, J. B., JR. *Mountain building in Alaska. 354.
- METCALF, MAYNARD M. *Origin and evolution of the higher one-celled animals 346.
- MORTON, C. V. A new cannon-ball tree from Panama. 396.
- —— A new species of Calathea from Panamá. 372.
- A new species of *Esenbeckia* from Texas. 135.
- Munns, E. N. *Some forestry observations in Europe. 349.
- MURIE, O. J. *Elk studies in the Jackson Hole region. 87.
- Nelson, E. W. A new pocket mouse from Lower California. 223.
- A new raccoon from Lower California. 82.
- Nolan, Thomas B. Paleozoic formations in the Gold Hill quadrangle, Utah. 421.
- Peters, H. S. *External parasites of birds. 351.
- Petrenko, S. N. *The strength of metal tubing for structural purposes. 185.
- PITTIER, H. Botanical notes on, and descriptions of, new and old species of Venezuelan plants.—III. Old and new species of Euphorbiaceae. 3.
- Poos, F. W. *Leafhopper injury to legumes. 116.
- PUTNAM, G. R. *Isostasy: what gravity measurements reveal. 336.
- RAPER, KENNETH B. Myxamoebae in soil and decomposing crop residues. 362.
- RAPPLEYE, HOWARD S. *Observers' patterns. 118.
- RATHBUN, MARY J. A new Callianassa from the Cretaceous of South Dakota.

 1.
- Hoploparia westoni Woodward. 180 REESIDE, JOHN B., JR. A Cretaceous pelecypod with color markings. 59.
- The Cretaceous faunas in the section on Vermilion Creek, Moffat County, Colorado. 35.
- Rich, W. H. *Alaska salmon investigations. 347.
- Roeser, W. F. *Thermoelectric pyrometry. 183.
- ROHWER, S. A. *Note on the pink bollworm in Arizona. 189.

- ROHWER, S. A. *Pink bollworm in Arizona and Mediterranean fruit fly in Florida. 439.
- Ross, C. P. *Classification of the ore deposits of south-central Idaho. 436.
- Rossby, C.-G. On the effect of vertical convection on lapse rates. 33.
- SARGENT, R. H. *Photographing Alaska and its glaciers from the air. 343.
- Schrader, F. C. *Antimony deposits. 436.
- Schreiner, Oswald. *Biological science in the East Indies. 354.
- SEEGER, R. J. Appell's equations. 481. Sette, O. E. *Mackerel investigations. 347.
- SHAMEL, H. HAROLD. A new murine opossum from Argentina. 83.
- SHOEMAKER, CLARENCE R. Descriptions of two new amphipod crustaceans (Talitridae) from the United States.
- SMITH, A. C. The identity of the South American fish poisons, "cube" and "timbó." 74.
- SMITH, FLOYD F. *Studies of the black vine weevil. 185.
- SMITH, PHILIP S. *The 1929 scientific explorations in Alaska: Geology. 71.
- SNODGRASS, R. E. *How insects fly. 115. *Reviews of some European literature on insect morphology. 15.
- SNYDER, W. F. *Absorption of sound at oblique angles of incidence. 28.
- STILES, C. W. *Proposals submitted as amendments to International Rules of Zoölogical Nomenclature. 86.
- STOSE, G. W. *Review of the peneplains and gravel terraces of the northern Appalachians. 152.

- STUART, R. Y. *The 1929 scientific explorations in Alaska: Forestry. 71
- TAYLOR, L. S. *Standardization of X-ray dosage. 184.
- THOM, CHARLES. Myxamoebae in soil and decomposing crop residues. 362.
- TILTON, L. W. *Variations in the optical density of glass. 12.
- TITUS, HARRY W. The symmetry of the autocatalytic curve. 357.
- TUCKERMAN, L. B. *The strength of metal tubing for structural purposes.
- Wallis, W. F. *A comparison of magnetic disturbance at different stations.
- WARREN, F. A. *Along the trails of Mount Rainier. 350.
- Wells, R.C. The solubility of some rareearth nitrates in ether. 146.
- Wensel, H. T. *Optical pyrometry. 184.
- WESTOVER, H. L. *Plant exploration in Turkestan. 353.
- WHERRY, EDGAR T. A long-lost Phlox. 25.
- Plants of the Appalachian shalebarrens. 43.
- Whipple, R. W. Discovery of Permo-Carboniferous vertebrates in the Dunkard formation of West Virginia. 370.
- Wiebe, A. H. *Some observations in increasing pond productivity. 350.
- WILLIAMS, R.S. Haitian mosses collected by E. C. Leonard. 173.
- --- Mosses collected in Brazil and Argentina by J. N. Rose in 1915. 465.
- Willis, J. E. *Recent experiments with timekeepers. 138.

SUBJECT INDEX

- Anthropology. *Alaska, scientific explorations in 1929. ALEŠ HRDLIČKA. 70.
- Man, antiquity of, at Frederick, Oklahoma. O. F. Evans. 475.
- Archeology. *Alaska, scientific explorations in 1929. H. B. Collins. 70.
- Biography. *Reminiscences. J. M. Ald-RICH. 495.
- Biology. *East Indies, biological science in. Oswald Schreiner. 354.
 - *Grand Canyon, biological problems of. Vernon Bailey. 352.
 - *Life zones of northern Europe. J. M. Aldrich. 84.
 - Myxamoebae in soil and decomposing crop residues. Charles Thom and Kenneth B. Raper. 362.
 - *National Park administration, biological problems of. H. M. Albright. 349.
- Botany. Appalachian shale-barrens plants. Edgar T. Wherry. 43.
 - Calathea, new species from Panama. C. V. Morton. 372.
 - Cannon-ball tree, new, from Panama. C. V. Morton. 396.
 - "Cube" and "timbó," South American fish poisons, identity of. E. P. KILLIP and A. C. SMITH.
 - Esenbeckia, a new species of, from Texas. C. V. Morton. 135.
 - Euphorbiaceae, Venezuelan. H. PITTIER. 3.
 - *Forestry in Europe. E. N. Mun s. 349.
 - Grasses, four new. A. S. HITCHCOCK. 381.
 - Haitian mosses. R. S. WILLIAMS. 173. *Laurel, the poisonous. C. D. Marsh. 350.
 - Mosses from Brazil and Argentina. R. S. WILLIAMS. 465.
 - Passiflora, new species from Colombia and Peru. Ellsworth P. Killip. 374.

- *Peruvian Andes and the Amazon, expedition to. E. P. KILLIP. 352.
- Phlox, a long lost. Edgar T. Wherry. 25.
- Pythium, new species of. Charles Drechsler. 398.
- Trichanthera. Emery C. Leonard.
- *Turkestan, plant exploration in. H. L. Westover. 353.
- Chemistry. Fluorine, volumetric determination of. John G. Fairchild. 141.
 - Invertase and sucrose, reaction between.

 JOSEPH BERKSON and FRANKLIN HOLLANDER. 157.
 - Rare-earth nitrates, solubility in ether. R. C. Wells. 146.
- Entomology. *Bean-weevil infestations. A. O. Larson. 438.
 - *Black vine weevil. FLOYD F. SMITH. 185.
 - Coccinellidae, new West Indian. EDWARD A. CHAPIN. 488.
 - *Experiences in Europe. J. M. Aldrich. 114.
 - *How insects fly. R. E. SNODGRASS.
 - *Insect morphology, European literature on. R. E. SNODGRASS. 15.
 - *Leafhopper injury to legumes. F. W. Poos. 116.
 - *Mite (Tyroglyphus siro) used in cheese making. W. V. Balduf. 189.
 - *Mushroom industry, insect pests and mites related to. O. E. Gahm. 384.
 - *Mushroom mite Linopodes antennaepes.
 O. E. Gahm. 155.
 - *Pink bollworm in Arizona. S. A. Rohwer. 189.
 - *Pink bollworm in Arizona and Mediterranean fruit fly in Florida. S. A. ROHWER. 439.
 - *Scarabaeidae, imported exotic. E. A. Chapin. 499.

*Western entomologists, work of. L.O. HOWARD. 15.

Ethnology. Indian tribes of California. C. Hart Merriam. 148.

Music of the American Indian. Frances Densmore. 509.

Evolution. *Earth, creation of. L. H. Adams. 340.

*Evolution. Austin H. Clark. 68.

*Higher one-celled animals, origin and evolution of. MAYNARD M. METCALF. 346.

Organic evolution, mechanism of. Charles B. Davenport. 317. *345.

*Organism, the, old and new concepts of. Paul S. Galtsoff. 344.

*Plants, origin and evolution of. E. W. Berry. 344.

Forestry. *Alaska, scientific explorations in 1929. R. Y. STUART and E. E. CARTER. 71.

General Science. The Philosophical Society of Washington through a thousand meetings. W. J. Humphreys. 245.

Geodesy. *Observers' patterns. How-ARD S. RAPPLEYE. 118.

Triangulation, scientfic and practical value of. William Bowie. 53.

Geography. *Alaska and its glaciers from the air. R. H. SARGENT. 343.

*American tropics. E. F. Coe. 85.

Geology. *Alaska, mountain building in. J. B. Mertie, Jr. 354.

*Alaska, scientific explorations in 1929. Philip Smith. 71.

*Andes, history of. Edward W. Berry. 69.

*Anorthosite, Adirondack, structural survey of. Robert Balk. 241.

*Antimony deposits. F. C. Schrader. 436.

*Alleghany district, California, vein quartz of. H. G. Ferguson. 151.

Cretaceous faunas on Vermilion Creek, Colorado. John B. Reeside, Jr. 35.

*Coal, scientific classification of. M. R. Campbell. 435.

*Erosion, contributions by the Bureau of Soils to the problem of. H. H. Bennett. 30.

Gold Hill quadrangle, Utah, Paleozoic

formations in. Thomas B. Nolan. 421.

*Idaho, classification of ore deposits of. C. P. Ross. 436.

*Iron-manganese carbonate concretions, genesis of. D. F. Hewett. 243.

*Ozark region, early structural history of. Josiah Bridge. 151.

*Peneplains and gravel terraces of the northern Appalachians. G.W. Stose. 152.

Pleistocene seashores. C. W. Cooke. 389.

*Silicification, types of, in the Paleozoic of Virginia. MARCUS I. GOLDMAN. 356.

Geophysics. Development of the earth, hypotheses on. B. Gutenberg. 17.

*Geotherms. A.C. Lane. 450.

*Gravity measurements, what they reveal. G. R. Putnam. 336.

Isostasy, abstracts of papers on. 441.

*Isostasy from the geological point of view. R. T. Chamberlin. 454.

*Isostasy, problems in. R. W. Goranson. 447.

*Mountain structure, problems of. Chester R. Longwell. 441.

Sunspot numbers, terrestrial magnetism, and long-wave radio signal strength, comparison of. L.W. Austin. 73.

Temperature gradients in the Permian basin. Walter B. Lang. 121.

*Terrestrial magnetism and seismology, instrumental investigations in. H. E. McComb. 149.

Hydrology. *Colorado River, suspended matter in. C. S. Howard. 30.

Mathematical physics. Appell's equations. R. J. Seeger. 481.

Mathematics. Autocatalytic curve, symmetry of. HARRY W. TITUS. 357.

Meteorology. *Alaska, scientific explorations in 1929. W. R. Gregg. 71.

Vertical convection, effect of, on lapse rates, C.G. Rossby. 33.

Museums. *Museums in South America. L. V. Coleman. 86.

L. V. COLEMAN. 86.

Necrology. Ault, James Percy. 120.

Fewkes, Jesse Walter. 420. Franklin, William Suddards. 420. Hall, Asaph. 172. HAY, OLIVER PERRY. 512.

JENISON, HILBERT A. C. 190.

KATZ, FRANK JAMES. 480.

ORTON, WILLIAM ALLEN. 88.

SIEBENTHAL, CLAUDE ELLSWORTH. 191

TONDORF, FRANCIS ANTHONY. 16.

WILEY, HARVEY WASHINGTON. 420.

WOOD, GEORGE McLane. 480.

Ornithology. *Everglades, the, birds and mammals of. A. H. Howell. 85.

Neocichla gutturalis, variations of.
HERBERT FRIEDMANN. 434.

*Parasites, external, of birds. H. S. Peters. 351.

*Parasitism in birds. Herbert Fried-Mann. 85.

*Waterfowl sickness in 1929. E. R. Kalmbach. 86.

Paleobotany. Pterophyllum, new, from Utah. Edward W. Berry. 458.

Paleontology. Callianassa, new, from the Cretaceous of South Dakota. Mary J. Rathbun. 1.

Color markings on a Cretaceous pelecypod. John B. Reeside, Jr. 59.

Dunkard formation of West Virginia, Permo-Carboniferous vertebrates in. R. W. Whipple and E. C. Case. 370.

Hoploparia westoni Woodward. Mary J. Rathbun. 180.

Hypural fan, new, from the Miocene of Maryland. WILLARD BERRY. 41.

Mammalia of the first interglacial stage of the Pleistocene. OLIVER P. HAY. 501.

"Orthophragmina" (Discocyclina) meroensis. Willard Berry. 432.

Pleistocene of Florida, Simpson's work on. Oliver P. Hay. 331.

Trophocrinus, a new Carboniferous crinoid. Edwin Kirk. 210.

Petrography. Pacificite, an anemousite basalt. Tom. F. W. Barth. 60.

Physical chemistry. Rubber, compressibility of. L. H. Adams and R. E. Gibson. 213.

Physical geography. Everglades, the, peat profiles in. Alfred P. Dach-NOWSKI-STOKES. 89.

Puget Sound Basin of Washington, peat profiles in. Alfred P. Dachnowski-Stokes. 193.

South Lubec "heath", Maine, peat profiles in. Alfred P. Dachnowski-Stokes. 124.

Physics. *Absorption of sound at oblique angles of incidence. P. R. Heyl, V. L. Chrisler, and W. F. Snyder. 28.

*Atmosphere, upper, ions and electrical currents in. E.O. HULBERT. 29.

*Galvanometer, sensitivity of. H. B. Brooks. 118.

*Magnetic disturbance, comparison of. W. F. Wallis. 138.

*Magnetic intensity, secular variation of, and its accelerations in Pacific countries. Harlan W. Fisk. 13.

*Metal tubing, strength of. L. B. Tuckerman, S. N. Petrenko, and C. D. Johnson. 185.

*Optical density of glass, variations in. L. W. Tilton. 12.

*Optical pyrometry. H. T. Wensel. 184.

*Photometers, colored-light measurements on. E. G. Anderson. 13.

*Thermoelectric pyrometry. W. F. Roeser. 183.

*Timekeepers, recent experiments with. J. E. Willis. 138.

*Wind-tunnel experiments, effect of turbulence in. H. L. DRYDEN and A. M. KUETHE. 137.

*X-ray dosage, standardization of. L. S. Taylor. 184.

Scientific Notes and News. 31, 52, 71, 88, 119, 139, 156, 171, 190, 244, 388, 419, 463, 479, 500.

Zoölogy. Amphipod crustaceans (Talitridae), new American. Clarence R. Shoemaker. 107.

*Caribbean Islands, collecting in. PAUL BARTSCH. 351.

*Elk studies in the Jackson Hole region. O. J. Murie. 87.

*Everglades, the birds and mammals of. A. H. HOWELL. 85.

Foraminifera and Algae, interrelation of. Joseph A. Cushman. 395.

*Great Lakes investigations. Elmer Higgins. 348.

*Mackerel investigations. O. E. Sette. 347.

Nemas of the genus *Oncholaimus*, demanian vessels in. N. A. Cobb. 225.

*Nomenclature, proposed amendments to international rules. C. W. Stiles. 86.

Opossum, new murine, from Argentina. H. Harold Shamel. 83.

Pocket mouse, new, from Lower California. E. W. Nelson and E. A. Goldman. 223.

- *Parasites, external, of birds. H. S. Peters. 351.
- *Parasites of wild ruminants. Maurice C. Hall. 87.
- *Pond productivity, increasing. A. H. Wiebe. 350.
- Raccoon, new Lower Californian. E. W. Nelson and E. A. Goldman. 82.
- *Salmon investigations, Alaskan. W. H. Rich. 347.
- *Wild animals, intimate habits of. P. N. Martindale. 349.





OFFICIAL COMMUNICATIONS

THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

Philosophical Society

The address by W. J. Humphreys, The Philosophical Society of Washington through a thousand meetings, which appeared in the issue of this JOURNAL for July 19, 1930, has been published in pamphlet form by the Philosophical Society. Copies, bound in stiff covers, may be obtained for forty cents each, postpaid, from the Treasurer, Capt. N. H. Heck, U. S. Coast and Geodetic Survey, Washington, D. C.

Announcements of Meetings

Friday, December 19
Saturday, December 20
Wednesday, December 24
The Geographic Society
The Philosophical Society
The Geological Society
The Medical Society

Friday, December 26
Saturday, December 27
Wednesday, December 31
Thursday, January 1
Friday, January 2
Saturday, January 3
The Redical Society
The Geographic Society
The Entomological Society
The Geographic Society
The Philosophical Society

The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the eleventh and twenty-fifth day of each month.

OFFICERS OF THE ACADEMY

President: WILLIAM BOWIE, Coast and Geodetic Survey.

Corresponding Secretary: L. B. Tuckerman, Bureau of Standards. Recording Secretary: Charles Thom, Bureau of Chemistry and Soils.

Treasurer: HENRY G. AVERS, Coast and Geodetic Survey.

CONTENTS

ORIGINAL PAPERS

Paleontology.—On the fossil mammalia of the first interglacial stage of the Pleistocene of the United States. OLIVER P. HAY	
Proceedings	
The Entomological Society	
Indexes	
Author indexSubject index	513 517
This JOURNAL is indexed in the International Index to Periodicals	



