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# WASHINGTON ACADEMY OF SCIENCES

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EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY
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GEOLOGY.—*Recent German theories about structural geology.*[1] CURT TEICHERT, University of Freiburg, Germany. (Communicated by CARLE H. DANE.)

The development of new ideas in Germany in the field of structural geology had already begun during the war when as a first impetus Wegener's book *Die Entstehung der Kontinente und Ozeane* appeared. This book has certainly caused more discussion among geologists of all countries than any other book in this line before or since. The fact that it has been translated into many languages and so far has appeared in four editions shows best the deep interest it has aroused everywhere. Although WEGENER's ideas meet with the objection of the majority of the geologists they certainly have been a great stimulus to the consideration of many questions of structural geology. Since Wegener's book has been translated into English and has been given much attention in English and American literature I shall not enter into any discussion of this theory.

Several attempts have been made to modify Wegener's ideas, most of them by geophysicists who generally have more widely adopted the hypothesis of shifting continents than geologists have done. Only one such attempt has been made on a bigger scale and that by a geologist, RICHARD STAUB, now head professor of geology at the University of Zurich.[2] For a long time Staub has been a very diligent and successful student of stratigraphical and structural problems in the Alps. His *Bau der Alpen,* a comprehensive study of the structure of the Alps, published in 1924, has met with deep interest among European geolo-

[1] Received November 28, 1930.

[2] RICHARD STAUB. *Der Bewegungsmechanismus der Erde.* (Berlin, 1928.) Although Staub is a Swiss geologist, his ideas may be considered in this place because his book is written in German and published in Germany.

gists and many of his conclusions are rather generally accepted by other prominent students in this field. Thus it is entirely natural that Staub should start out from the Tertiary mountain ranges of the earth. He is one of the extreme "Nappisten," one of the believers in that theory founded by ALBERT HEIM that the Alps were built by a series of tremendous overthrusts. Staub himself has done much to strengthen this hypothesis as far as the structure of the Alps is concerned but on the other hand he is inclined to see all the Tertiary mountain ranges of the earth from the same viewpoint as he sees the Alps. He and many other European geologists like to speak of the Tertiary mountain ranges of the earth as "the Alpine mountain ranges." This is a rather dangerous terminology because it suggests not only a contemporaneous origin, but also a building plan and structure for all Tertiary mountain ranges similar to that of the Alps, which is apparently not the case.

Staub studies the Tertiary mountain ranges of the earth, and as a result of these studies he finds that they all form a great uniform system. There is no such thing as the mediterranean system in contrast to a circum-Pacific system, no particular Eastern Asiatic or Australic ranges. All the high Tertiary ranges are a unit. The backbone of this great system is the eastwest trending range of the Alps which continues eastward into the Himalaya and which has also a westward prolongation through the Atlantic ocean to Middle America. (Thus Staub disregards the obvious uniformity of the mid-Atlantic ridge.) In Middle America the main system branches into one great system of mountain ranges trending northward into Alaska and embracing the Pacific ocean on its northeastern side, and into another system trending southward along the west coast of South America and continuing into Antarctica thus embracing the Pacific on its southeastern side. In the same way the eastern end of this central system branches into two minor systems of ranges, one following the northwestern border of the Pacific up to Kamchatka, the other going southward and continuing into the ranges of New Zealand.

As a result one obtains a picture of a great uniform system dividing the main continental masses into two parts, the northern of which is called *Laurasia* and the Southern *Gondwana,* and branching out east and west into gigantic arms which embrace on all sides the big mass of the Pacific ocean. This is the way in which Staub sees connected the great "Alpine" mountain ranges of the earth.

How to explain this picture, is the next question Staub is going to answer. This is certainly not a structure due to a contraction of the earth. The only explanation of this, as far as he can see, is a shifting of these two big northern and southern masses towards the equator. It is in this respect that he modifies the original theory of Wegener. It is not the continents themselves that are shifting, but only Laurasia and Gondwana, each as a whole and more or less untouched in its interior. For the Teritiary period he regards the southern mass as the active one. All continents of the southern hemisphere (and this includes also India) are shifting northwards, driving back the northern continents and building up at their front the big range of mountains of the mediterranean system. The explanation of the east and west branches of this system is not so very conclusive. Staub speaks of an additional westward drift which has partly caused the great mountains bordering the western shores of North and South America; but of course there is

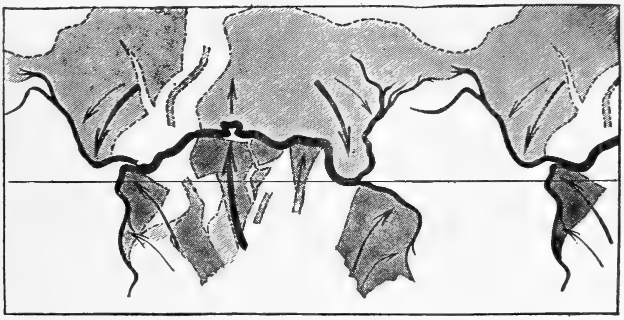

Fig. 1. Diagram and explanation of the alpine system of the earth. Black: The alpine orogen, with Laurasia in the north and Gondwana in the south. (After R. Staub.)

the resistance of the Pacific body which can cause the building up of mountains at its borders. For the bottom of the Pacific, Staub supports the idea of Pickering that this is the place where the moon originated; and, moreover, he favors Wegener's idea that the bottom of the Pacific consists of heavier material which is generally supposed to underlie the lighter continents.

What is true for the last mountain-building period must also be true for the preceding ones. One of the main objections made against Wegener's theory is that he disregards the older orogenic periods, chiefly of the Paleozoic. Staub avoids this objection and he draws the following picture that during the history of the earth there were repeated movements of the continental masses of the northern and southern hemisphere (Laurasia and Gondwana) alternately towards the equator and the poles. He begins with Caledonian time which was a time of continental masses drifting towards the equator. This was followed by a drift towards the poles in post-Caledonian times and this again by a period of drifting equatorward in the late Paleozoic. Again shifted apart in Mesozoic times, the continents turn toward each other in the Tertiary and are now probably drifting apart again.

The force which drives the continents towards the equator if they are situated near the poles is simply the centrifugal force. The collision of the continents near the equator line causes the building up of mountains in the first place and in consequence a displacement of magma below the mountain zones. Thus the magma is forced to flow from the equator on both sides towards the poles and takes the continents with it. This will explain the force which causes the drifting of the continents towards the poles in the intermediate periods between the great mountain-building phases.

Staub's conception of the structure of the earth, thus based on the existence of the *centrifugal force, west drift* and the *backflow of the magma* is certainly fine and very simple, but I dare say it is perhaps too simple to be true.

Another geologist trained in the study of the Alps is LEOPOLD KOBER, professor of geology at the university of Vienna. While Staub came to conclusions that were more or less in agreement with ideas of Wegener and were at any rate opposed to any ideas pertaining to a shrinkage of the earth as the mountain building force, Kober claims quite the contrary.[3] Like Staub he is looking for the connection of the Tertiary mountain ranges, but he traces these connections in an entirely different way. He starts with an examination of the mountain ranges of the Tertiary type and comes to the conclusion that fundamentally all known Tertiary mountain ranges are two-sided, that their overthrusts extend northward and southward or eastward and westward, whatever the direction of the mountain range. Moreover he finds out that all Tertiary mountain ranges have a more or less circular arrangement around areas which are not affected by any kind of Tertiary orogenetic movement. He calls this central area the *kratogen* and the surrounding mountains make the *orogenic ring.* Kratogen plus orogenic ring build an *orogen* or a *geotectonic unit.* There are eight of these geotectonic units distinguishable on the surface of the earth: Eurasia, Africa, Indo-Australia,

[3] LEOPOLD KOBER. *Der Bau der Erde.* (Berlin; 1st edition 1921, 2nd enlarged edition 1929.)

North America, South America, North Pacific, South Pacific, and Antarctica.

As an example of such an orogen I shall only give Kober's picture of Africa. Continental Africa itself is the kratogen, largely unaffected by the Tertiary movements. The surrounding orogenic ring consists of the Atlas mountains in North Africa, the Appenines in Italy, some of the mountain ranges of the western and southwestern Balkan peninsula which continue into the ranges along the South coast of Asia Minor and into ranges in Persia. Here the trend of the mountains suddenly changes direction—as Kober assumes—and runs southward,

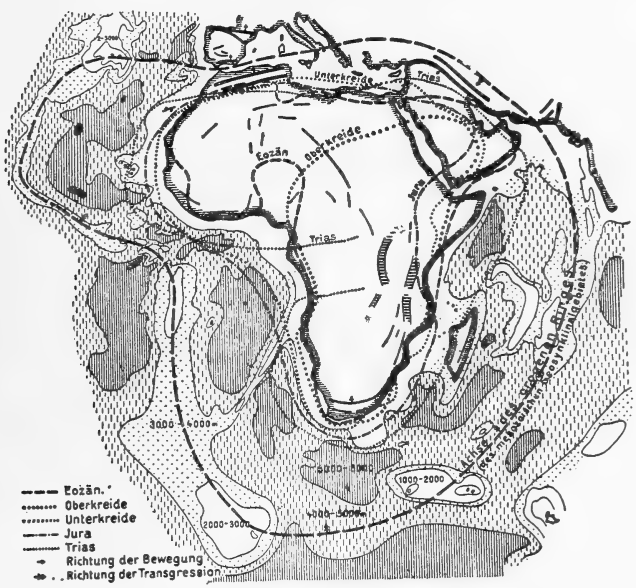


Fig. 2. The African orogen. (After L. KOBER.)

thus striking out into the Indic. All the rest of the orogenic ring of Africa is submerged and consists partly of the eastern half of the mid-Atlantic ridge and of other submarine upliftings of the sea bottom around the African continent. This rather dangerous procedure of tracing structural connections under the sea is applied in a great deal of Kober's constructions.

What, however, is the meaning of the picture thus drawn? Kober is in favor of the idea of the contraction of the earth as the main force of mountain building. If the earth contracts, then a destruction and folding of the surface of the earth cannot take place in certain areas of resistance, these being stiffened by old intrusions or by former folding processes. The surface can only be folded between and around those areas, and this is the explanation of Kober's picture. The kratogens are the areas of resistance which cannot be folded any more. As soon as the whole body of the earth contracts, these great blocks settle down a little, tending towards the center of the earth. Thus the space between them becomes smaller and the surface between, which is not yet stiff enough, can and must be folded. These are the orogenic rings which surround the kratogens. A similar process also took place in previous times of orogeny. Originally the kratogens were smaller and they grew to their present dimensions gradually in consequence of the gradual folding and stiffening of their borders.

If we look at the real background of these ideas, we will find some remarkable similarities to ideas expressed by R. T. CHAMBERLIN and R. RUEDEMANN as to the distribution of the original ancient continents, although much of the developments assumed by Kober are highly hypothetical and sometimes too much generalized. Kober's aim is largely one of physiographical explanation rather than that of historical consideration of the development of given surface forms. His question is, how to explain the present physiographical configuration of the earth's surface mainly in the light of the latest mountain-building movements.

Another main defender of the theory of the contraction of the earth is HANS STILLE, head professor of geology at the University of Göttingen. His book[4] is undoubtedly one of the most profound books ever written about structural questions. He has made a thorough examination of all the existing literature of the world dealing with structural and particularly orogenetic questions. Thus he came to the postulation of certain tectonic laws.

The first one and certainly that which he regards as the main result of his studies is the *law of orogenetic contemporaneity,* which means that orogenic processes are restricted to certain short periods or *phases* as Stille calls them, and that at those periods orogeny is liable to take place with more or less worldwide distribution. The times between these orogenic phases are absolutely free from any movements of that kind. Only epeirogenesis takes place. The boundary between

[4]HANS STILLE. *Grundfragen der vergleichenden Tektonik.* (Berlin, 1924.) Since Prof. SCHUCHERT has given a long review of this book (Am. Jour. Sci. **12**: 277–292. 1926), Stille's ideas will be considered here only briefly. The multitude of facts and ideas laid down in his book cannot be adequately dealt with in a few sentences anyhow.

epeirogenesis and orogenesis is drawn very sharply by Stille and according to him it is of much importance to distinguish between purely epeirogenetic and purely orogenetic times.

Thus in studying the orogenic movements of the past he establishes between 30 and 40 of those orogenic phases which are distributed in about equal amounts in the Paleozoic, Mesozoic and Tertiary.

Among the orogenic movements he distinguishes two kinds: first the *Alpine type,* consisting of folds, overfolds, and overthrusts; second the *Germanic type,* consisting of fault-fold mountains and block

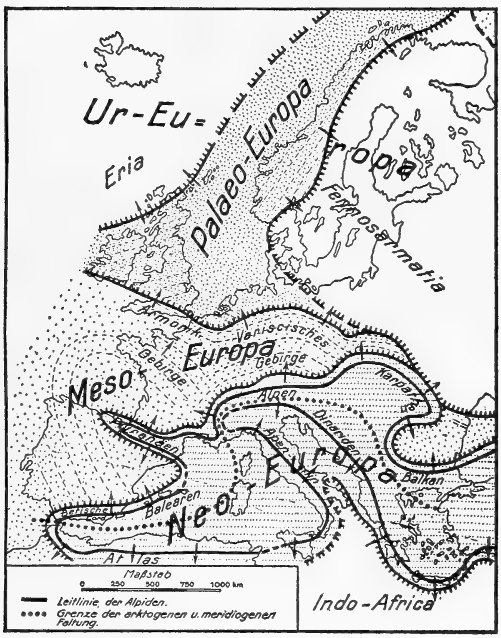


Fig. 3. The tectonic structure of Europe. (After H. STILLE.)

mountains. Both are orogenic and both kinds of movements may occur at the same time in different regions during orogenic phases. Even Stille, however, cannot neglect the fact that there are sometimes orogenic movements during epeirogenic times, but he thinks they are of minor importance and calls them *synepeirogenetic movements.* On the other hand epeirogenic movements during orogenic times, also always of minor importance, are called *synorogenic movements.*

The *law of the contemporaneity of orogenic forms* expresses the fact that all kinds of orogenic movements may occur at the same time and the *law of the identity of orogenic force* holds that the same force causes all kinds of orogeny. This force is the contraction of the earth.

Like Kober, Stille claims that certain areas are more fit for orogeny than others and especially he thinks that a stiffening by former orogenies prevents a certain area from being folded again. As soon as a region has experienced the Alpine type of orogeny with folding and overthursts, it can only be affected by the Germanic type in later orogenies. Thus only the border regions of these stiffened blocks can be folded, but not the interior, and the result is the steady growth of the stiffened blocks which cannot be folded any more. This conception is very similar to Kober's ideas of the growing kratogens, but is more founded on historical considerations than Kober's were.

How Stille came to the conclusion of the growing continental blocks may be illustrated by a picture of the structural conditions of Europe. There are the stiffened blocks of the Precambrian in the North as *Archeurope* ("Ureuropa"), the Caldonian ranges folded in early paleozoic times as *Paleo-europe* ("Paleuropa"), Middle Europe, folded and stiffened in the late Paleozoic, as *Meso-europe* and finally the recently folded area around the Mediterranean sea as *Neo-europe.* Thus a steady growth of the European block during geologic times has taken place and there remains only one mobile area at the present time, the present Mediterranean sea. This process of progressive folding of the borderlands is called by Stille the *folding of the frames* and plays a great rôle in his considerations. The question whether the orogenic zones are one-sided or two-sided is of minor importance to Stille. If the area affected by folding is very narrow then there would be a two-sided pressure. If this area is broad, each border will appear as a separate branch folded only to one side.

I cannot refer to the many details of Stille's book and I have to omit even some of the more important questions touched upon by him. I may say a few words more about his definitions. If we speak, for instance, of a geosyncline, we think immediately of an area of more or less intensive folding after the deposition of sediments there. This, according to Stille, is a misconception and he defines a geosyncline as any depressed area of large extent with sinking tendency thus accumulating large amounts of sediments, regardless of its later development. There are a number of geosynclines on the earth which never have been folded or affected by any type of Alpine orogeny. This is an important and decided step towards the liberation of the word "geosyncline" from the burden of partly or wholly wrong conceptions which it has carried now for decades.

To summarize Stille's opinions: tectonics is a function of the intensity of the tectonic force, of the capability of reaction of the material involved and in certain cases of particular local conditions. The only tectonic force is the contraction of the earth which does not take place steadily, but abruptly at certain phases; and every time the shrinkage of the earth causes worldwide orogenic movements. Thus for Stille the site of orogeny is the outer crust of the earth and the cause of orogeny are processes which pertain to the whole body of the earth. If subcrustal magmatic material is involved in orogenic processes, this can be only secondary. Stille neglects the importance of isostasy, as well as the magma; in fact, isostasy is hardly mentioned in his book.

The antithesis of these ideas is the basis for the most recent theory promoted in Germany by ERICH HAARMANN, geologist of the Prussian Geological Survey. It is remarkable that in a comparatively short period after the appearance of Wegener's revolutionary book, such a book, not less revolutionary and yet on entirely different suppositions

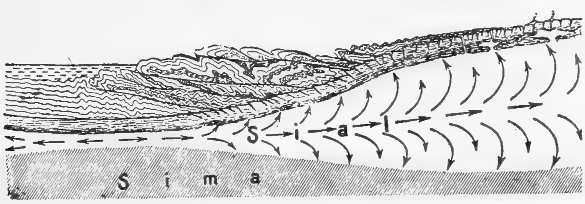


Fig. 4. The formation of a geotumor and free gliding. (After E. HAARMANN.)

has appeared.[5] Like Wegener, Haarmann abandons most of the conceptions formerly regarded as sure and irrefutable and enters into a discussion of the fundamental principles of our science. For him, the main force which causes diastrophism at the surface is the movement of the subcrustal magma. This flows from one place to another, causing uplifting of the crust where it is accumulating and depressions where it is streaming away. Therefore the influence of such magmatic movements upon the behavior of the outer crust causes the appearance of widespread up-and-down movements. Haarmann calls an uplifted area a *geotumor*, a depressed area a *geodepression*, terms which correspond largely with "geoanticline" and "geosyncline." Thus Haarmann is going a step farther than even Stille, who confined himself to a redefinition of these old expressions. But in fact a geotumor is not exactly identical with geoanticline and a geodepression not exactly like a geosyncline as we shall see.

[5] ERICH HAARMANN. *Die Oszillationstheorie.* (Stuttgart, 1930.)

The building of geotumors and geodepressions is a steady process which is always taking place somewhere. Haarmann seeks the cause of this eternal up and down, or rather of the movements of the subcrustal magma which causes this, in oscillations of the axis of rotation of the earth which give rise to changes of the balance between the masses of the earth and thus force the masses to change their position.

One may however regard this as a doubtful explanation. It is not at all the main point with which the theory of Haarmann is concerned.

Another old conception abandoned by Haarmann is the strong distinction made so far between epeirogenesis and orogenesis as two different kinds of movements due to two entirely different kinds of causing forces. He abandons the terms "epeirogenesis" and "orogenesis" and calls any kind of tectonic movements on the earth *tectogenesis.* The type of movements which we so far have considered, the upward and downward oscillation of the surface of the earth constitute *primary tectogenesis* because these movements are the primary features without which all kinds of tectonic facts cannot be understood. Primary tectogenesis in the conception of Haarmann is only partly identical with epeirogenesis in the older sense.

The building of folded and overthrust mountain structures is the consequence of primary tectogenesis. All we know as folds, overfolds, overthrusts, faulting and similar processes is the result of gliding. No gliding can take place without an oblique base and therefore without preceding uplift, without primary tectogenesis. All these movements which eventually result in the building of faulted, folded, overthrust ranges constitute consequently *secondary tectogenesis,* which is in every case a gliding phenomenon and dependent upon the precedence of primary tectogenesis. Thus for the first time the attempt is made to connect causally the side-by-side existence of epeirogenetic and orogenetic or rather vertical and horizontal movements.

This theory explains also the existence of tension areas on the back side of overthrust ranges. Moreover the appearance of tension has to be expected behind a sedimentary complex gliding downward from the top of an uplifted dome. In this way fissures, magmatic intrusions and volcanic activity on the opposite side of the direction of the movement are satisfactorily explained. Also the rather common appearance of an arrangement of the mountain ranges in arcs is to be understood in the light of this theory.

In accordance with the different kinds of folding structures, Haarmann distinguishes several kinds of gliding. The first is *free gliding* ("Freigleitung") which takes place in not yet entirely filled geodepressions where the gliding is not hindered by any obstacles. This kind of gliding has taken place in all the late-Tertiary mountain ranges and has caused folds, overfolds, overthrusts and the arclike outline of many of the ranges.

Secondly, there is *full-trough gliding* ("Volltroggleitung") which takes place in nearly filled geodepressions where not the whole sequence of sediments is able to glide, but only the upper strata, whereas compression with irregular movements and steep folds and faults appear in the deeper zones. Full-trough gliding may take place before free gliding and may thus add considerably to the complication of structures.

The third kind of gliding is *fault gliding* ("Bruchgleitung") which depends upon the existence of a competent surface of the sedimentary series and an incompetent gliding basis at the bottom. The results are downward movements of larger coherent blocks and dislocation along usually steep faults.

The fourth kind depends upon some special conditions and is called *squeeze gliding* ("Expressionsgleitung"). It applies to the only kind of secondary tectogenesis which does not take place as a downward but as an upward movement. Mobile members of the sedimentary series are squeezed and pressed up by the pressure of less plastic sediments. We see this process in deposits of clay, salt, coal, diatomite, ore and also sometimes in magmatic intrusions.

All these gliding processes take place in deeper zones, at least below sea level. The present height of the mountains is the result of later uplifting. Thus the former areas of geodepression have mostly assumed to-day the appearance of geotumors; on the other hand, the old geotumors in back of the present mountain ranges have to-day largely subsided and have become geodepressions and a new cycle of tectogenetic activity is going on.

Surface features of the moon seem to support Haarmann's ideas, the well known craters here being an equivalent to the geodepression of the earth.

Contrary to the view of Pickering and Wegener that the moon originated where now the Pacific ocean lies, Haarmann believes that we have to look for the original place of the moon rather where is now the greatest accumulation of sial material—in Asia. At the time when the moon was detached from the earth, the then already existing continental cores still had the ability to float and shift over the magmatic surface and filled up the hole left by the detachment of the moon's body. Afterwards, shifting of the continents could no longer take place because it was prevented by the gradual cooling of the surface.

Some severe objections as to the possibility of application of Haarmann's ideas to some American problems have already recently been mentioned by C. R. Longwell[6] in a short review of Haarmann's book. Objections certainly will also come from the side of European geologists; but nevertheless nobody can and will doubt that Haarmann's book on diastrophism must be regarded as one of the most stimulating ones of the present time.

It may be noted that Haarmann, to his own advantage, could have made more use of E. O. Ulrich's *Revision of the Paleozoic systems.* Ulrich was the first one to consider oscillatory movements as the primary feature of diastrophism, although he was more concerned with diastrophism as a factor in paleogeography. This side of the problem has not been given so much attention in Haarmann's book. The study of oscillatory movements in their combined effects on tectonics and paleogeography might prove one of the most promising efforts of future geology.

BOTANY.—*A new* Limonium *from Haiti.*[1] S. F. Blake, Bureau of Plant Industry.

One of the most interesting plants collected by Mr. and Mrs. Emery C. Leonard in their exploration of northwestern Haiti in 1928–29 is a species of sea-lavender (*Limonium*) which was found growing plentifully on the coral rocks and cliffs east of Bord du Mer, in the vicinity of Jean Rabel. No species of the genus is reported in Urban's *Flora Domingensis* (1920–21), and only two species have hitherto been found in the Bermudan-Bahaman-Antillean region. These are *Limonium lefroyi* (Hemsl.) Britton, treated by Britton in the Flora of Bermuda as identical with *L. carolinianum* (Walt.) Britton but in the writer's opinion a distinct species endemic in Bermuda,[2] and *L. bahamense* (Griseb.) Britton, a Bahaman endemic remote from any other described American species and most closely related to a group of the genus found in the Mediterranean region and southern Africa.[3] The plant from Haiti is closely related to *L. bahamense* and very similar to it in general appearance, but is well distinguished by its different bracts

[6] Am. Jour. Sci. **20**: 219–220. 1930.

[1] Received November 22, 1930.

[2] See Blake, Rhodora **18**: 54. 1916.

[3] Grisebach briefly compared his species with "*Statice caspia* Willd.," which it closely resembles in habit. If Boissier's series *Steirocladae* and *Hyalolepideae* are to be distinguished, however, both *L. bahamense* and *L. haitiense* are to be referred to the series *Steirocladae*, not to the *Hyalolepideae*, to which "*Statice caspia*" belongs.

and calyx. In *L. bahamense* the third bract of the spikelet is glabrous; the calyx is glabrous at the oblique base and short-pilose on two of the ribs from base for about half their length, and sometimes similarly pilose on one or two other ribs for a short space near their middle; and the upper half of the ribs is glabrous. In the Haitian plant the third bract is rather densely short-pilose above; the calyx is barbate-pilose all around at base, pilose with decidedly longer hairs (than in *L. bahamense*) on two of the principal ribs for about half their length and on the three other ribs near the middle, and similarly pilose to a greater or less extent on the very obscure intermediate ribs; and all five principal ribs are shortly pilosulous above the middle, sometimes nearly to the tip. The new plant may be called

**Limonium haitiense** Blake, sp. nov.

*Limonio bahamensi* affine, differt bractea tertia sursum pilosula, calycis basi piloso-barbati costis 2 e basi ad medium sublonge pilosis, 3 prope medium pilosis, omnibus supra medium saepe paene ad apicem breviter pilosulis.

Perennial, glabrous but obscurely scurfy; root rather short, vertical, with horizontal branches; stems very numerous and entangled, about 20 cm. long, leafy only below, divergently alternate-branched, articulate, angled, densely pustulate, the lower branches sterile, tipped with bracts like those of stem, only the uppermost branches floriferous; leaves spatulate, 2–5 cm. long including petiole (this often twice as long as blade), 3–8 mm. wide, obtuse or acute, cuspidate, cuneate at base, fleshy, somewhat lepidote-scurfy, 1-nerved; bracts of stem deltoid, acute, about 1.5 mm. long, with thick-herbaceous body and rather narrow scarious margin, glabrous; spikes numerous, corymbosely panicled, recurving, about 8–12 mm. long, the spikelets 3–4-flowered, densely and distichously imbricate; outermost bract suborbicular-ovate, rounded, glabrous, 2–2.5 mm. long, with subherbaceous body and rather broad scarious margin, the margin about half as broad as the width of the body; secondary bract hyaline, broadly and shallowly emarginate, about 1.7 mm. long; tertiary bract obliquely obovate in side view (suborbicular when flattened), rounded, rather densely spreading-pilosulous on upper half, 4.5 mm. long, with thick-herbaceous body and broad scarious margin (about 1 mm. wide); bracteoles elliptic-oblong, obtuse, glabrous, about 3 mm. long, hyaline throughout, the brownish costa evident only toward base or to above the middle; pedicels glabrous, 0.7 mm. long or less; calyx funnelform, 4–4.2 mm. long, whitish or lavender-tinged below, pilose-barbate all around at the oblique base, pilose from base to middle on 2 principal ribs, pilose near middle on the remaining principal ribs, pilose on one of the very indistinct intermediate ribs throughout its length and on the remainder at their tips, and very shortly pilosulous on the 5 principal ribs from middle often nearly to apex; calyx lobes deltoid, obtuse, about 0.5 mm. long, the intermediate teeth obsolete; petals apparently lavender.

HAITI: Common on coral rocks, shore cliffs east of Bord du Mer, vicinity of Jean Rabel, Dept. Nord-Ouest, 6 March 1929, *E. C. & G. M. Leonard* 13786 (type no. 1,452,380, U. S. Nat. Herb.); rocky cliffs east of Bord du Mer, 5 Feb. 1929, *Leonard & Leonard* 12881; dry coral rock, sea bluff east of Bord du Mer, 5 Feb. 1929, *Leonard & Leonard* 12889.

BOTANY.—*Five new grasses from Colombia.*[1] JASON R. SWALLEN, Bureau of Plant Industry. (Communicated by A. S. HITCHCOCK.)

Among the grasses collected by E. P. KILLIP and ALBERT C. SMITH in Colombia in 1926–27, four species are described as new. The fifth was collected by W. A. ARCHER in June, 1930, in Department Antioquia.

### **Chusquea tuberculosa** Swallen, sp. nov.

Culmi dense tuberculosi, 6 mm. crassi, nodis pubescentibus vel villosis; vaginae papillosae; ligula minuta; laminae culmorum basi cordatae, 9–10 cm. longae, 3 cm. latae, ramorum fasciculatae minores, ovatae vel lanceolato-ovatae, glabrae, 2–3 cm. longae, 4–10 mm. latae, marginibus scabris; paniculae patentes, 7–10 cm. longae, 5–6 cm. latae; ramis divergentibus, dense pubescentibus; spiculae appressae, 6–7 mm. longae; glumae obsoletae vel minutae; lemmata sterilia duo, subaequalia, 5 mm. longa; lemma fertile acutum, 7-nervium, 6 mm. longum.

Culms woody and vine-like, solid, very densely and prominently tuberculate, more or less pubescent or villous at the nodes, as much as 6 mm. thick, bearing fascicles of sterile or flowering branches at the nodes, 5–30 cm. long; sheaths papillose-hispid to nearly smooth; ligule minute; blades of the main culm cordate-clasping, 9–10 cm. long, 3 cm. wide, those of the fascicled branches reduced, ovate or ovate-lanceolate, scarcely cordate, 2–3 cm. long, 4–10 mm. wide, all the blades smooth on both surfaces, scabrous on the margins; panicles open, 7–10 cm. long, 5–6 cm. wide, the branches stiffly spreading, the axis and branches densely soft-pilose; spikelets short pediceled, appressed, 6–7 mm. long; glumes obsolete; sterile lemmas two, subequal, 3-nerved, 5 mm. long; fertile lemma acute, 7-nerved, 6 mm. long.

Type in the U. S. National Herbarium, no. 1,353,497, collected on the edge of woods between California and Vetas, alt. 2500 m., Department Santander, Colombia, January 15–22, 1927, by E. P. KILLIP and ALBERT C. SMITH (no. 18005).

Known only from the type collection.

The prominently tuberculate culms are characteristic.

### **Neurolepsis mollis** Swallen, sp. nov.

Culmi robusti, erecti, 1.5–4.5 m. alti; vaginae glabrae, in ore fimbriatae; ligula 1–2 cm. longa; laminae planae, 20–75 cm. longae, 2–4 cm. latae, petiolatae; panicula angusta, stricta, 0.45–1.5 m. longa, ramis pubescentibus, anguste ascendentibus, superioribus approximatis, inferioribus remotis; spiculae valde immaturae, 2 mm. longae, 3-florae, flosculis duobus inferioribus imperfectis; glumae subaequales, obtusae, quam spicula duplo breviores; lemmata firma, acuta vel cuspidata, scaberula.

Culms robust, erect from short knotty rhizomes, 1.5–4.5 m. tall; sheaths smooth, glabrous, at least the lower ones long-fimbriate at the mouth; blades flat, narrowed toward both ends, 20–75 cm. long, 2–4 cm. wide, sparsely pilose above, smooth below, scabrous on the margins, the bases of at least the lower

[1] Received October 5, 1930.

ones indurate and petiole-like, much narrower than the mouth of the sheath; ligule membranaceous, brownish, more or less lacerate above, 1–2 cm. long; panicles narrow, strict, 0.45 to more than 1.5 m. long, the spikelike branches appressed or narrowly ascending, the upper ones short and approximate, the lower distant, as much as 20 cm. long, these bearing rather distant fascicles of appressed branchlets, both the main axis and the branches densely and softly pubescent; spikelets (all immature) about 2 mm. long, three-flowered, the upper floret fertile, the lower two florets sterile; first and second glumes subequal, obtuse, more or less apiculate, about half as long as the spikelet; lemmas firm in texture, acute or minutely cuspidate, scaberulous.

Type in the U. S. National Herbarium, no. 1,351,648, collected in woods in the mountains east of Las Vegas, Department of Santander, Colombia, alt. 3000–3300 m., December 20–21, 1926, by E. P. KILLIP and ALBERT C. SMITH (no. 15830).

The only other specimen of this species seen is KILLIP and SMITH no. 20699, collected at Páramo del Hatico, alt. 2900 m., Department Norte de Santander, Colombia. As both specimens are immature the floral measurements of mature plants may be somewhat larger than those given. The soft dense pubescence on the axis and branches of the panicle is characteristic.

**Muhlenbergia erectifolia** Swallen, sp. nov.

Perennis caespitosa; culmi erecti, glabri, 15–20 cm. alti; folia basi aggregata; vaginae glabrae vel scaberulae; ligula acuta, 3–5 mm. longa; laminae erectae, rigidae, teretes, scabrae, pungentes, 5–10 cm. longae, basi quam vaginae angustiores; panicula angusta, 5–6 cm. longa, vix laminis longior; spiculae appressae, pedicellis crassis, 1–4 mm. longis; glumae aequales, truncatae, 1–1.3 mm. longae; lemma 2.5 mm. longum, infra pubescens supra scabrum; arista erecta, crassa, scabra, 3–5 mm. longa.

Densely tufted perennial; culms erect, 15–20 cm. tall, glabrous; leaves mostly crowded toward the base; sheaths smooth or somewhat scabrous; ligule membranceous, acute, 3–5 mm. long; blades erect, rigid, terete, scabrous, pungently pointed, narrower than the sheaths at the base, 5–10 cm. long; panicles narrow, erect, scarcely exceeding the blades, 5–6 cm. long, rather few-flowered, the branches appressed; spikelets appressed to the branches, the pedicels comparatively stout, 1–4 mm. long; glumes equal, 1–1.3 mm. long, truncate, more or less erose, tinged with bronze and purple; lemma 2.5 mm. long, somewhat pubescent below, scabrous toward the summit, tapering into a stout erect scabrous awn 3–5 mm. long.

Type in the U. S. National Herbarium no. 1,353,062, collected on Paramo de Santurbán, near Vetas, alt. 3,950–4,160 m., Department Santander, Colombia, January 17, 1927, by E. P. KILLIP and ALBERT C. SMITH (no. 17470).

Known only from the type collection.

The short terete, pungent blades are unlike those of any other species of this genus.

**Panicum longiculme** Swallen, sp. nov.

Culmi graciles, erecti vel decumbentes, ad nodos inferiores radicantes, 125 cm. longi, pilosi vel papilloso-pilosi, nodis barbatis; vaginae papilloso-pilosae;

ligula 1–2 mm. longa; laminae 2–5.5 cm. longae, 3–5 mm. latae, pubescentes, marginibus scabris; panicula 5 cm. longa, 4.5 cm. lata, ramis patentibus, axillis villosis; spiculae 2.4–2.6 mm. longae, pilosae; gluma prima acuta, 1–1.2 mm. longa.

Culms slender, wiry, erect or long-decumbent at the base and rooting at the lower nodes, as much as 125 cm. long, pilose or papillose-pilose, the nodes mostly densely retrorsely bearded; sheaths much shorter than the internodes, papillose-pilose; ligule hairy, 1–2 mm. long; blades flat 2–5.5 cm. long, 3–5 mm. wide with a white, scabrous, cartilaginous margin, softly pubescent on both surfaces; panicles few flowered, 5 cm. long, nearly as broad as long, the branches mostly widely spreading, the axis pilose; spikelets 2.4–2.6 mm. long, sparsely pubescent; first glume acute, 1–1.2 mm. long, l-nerved; fruit pointed, equaling the second glume and sterile lemma.

Type in the U. S. National Herbarium, no. 1,444,529, collected in mountains above Bello, Quebrada del Ato, Department Antioquia, Colombia, June 17, 1930, by W. A. Archer (no. 160).

This species is allied to *P. venezuelae* Hack., but differs in having spikelets evenly distributed in the panicle, and fruit as long as the second glume and sterile lemma.

**Ichnanthus angustifolius** Swallen, sp. nov.

Probabiliter perennis; culmi graciles, glabri vel pubescentes, basi decumbentes radicantes, 110 cm. longi, internodis inferioribus brevibus, superioribus elongatis; vaginae pilosae vel papilloso-pilosae internodos aequantes vel 2–3-plo breviores; ligula obsoleta; laminae sublineares, acuminatae, pilosae, basi subcordatae, 7–9 cm. longae, 3–5 mm. latae; panicula longe exserta, 8 cm. longa, ramis ascendentibus vel patentibus, pilosis; spiculae 3.5 mm. longae, pilosae, appressae, solitariae vel binae; gluma prima acuta vel acuminata 1.8–3.5 mm. longa; gluma secunda acuta, lemma sterile aequans; lemma sterile obtusum; lemma fertile 2.4 mm. longum, basi appendicibus obsoletis.

Probably perennial; culms slender, straggling, long-decumbent at the base and with stilt roots at some of the nodes, more than 110 cm. long, glabrous, or sparsely pubescent, the lower internodes short, the upper ones elongate; lower sheaths as long as the internodes, the upper ones 1/3–1/2 as long as the internodes, pilose or papillose-pilose, especially on the margin and the collar; ligule nearly obsolete; blades linear or linear-lanceolate, acuminate, subcordate 7–9 cm. long, 3–5 mm. wide, pilose on both surfaces; panicle long-exserted, 8 cm. long, the axis and the ascending or spreading branches mostly short-pilose; spikelets 3.5 mm. long, more or less pilose or papillose-pilose, solitary or in pairs, appressed to the branches, the pedicel of the lower one of a pair less than 1 mm., that of the upper about 3 mm. long; first glume 3-nerved, acute or acuminate, from half as long to as long as the spikelet; second glume and sterile lemma equal, 5-nerved, the glume acute, the sterile lemma obtusish; fertile lemma 2.4 mm. long, the wings reduced to scars.

Type in the U. S. National Herbarium, no. 1,351,267, collected in woods, on the northern slope of Mesa de los Santos, alt. 1000–1500 m., Department Santander, Colombia, Dec. 11–15, 1926, by E. P. Killip and Albert C. Smith (no. 15385).

Known only from the type collection.

The long-decumbent culms with stilt roots and narrow blades are typical.

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| Tuesday, January 13 | The Institute of Electrical Engineers |
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| Wednesday, January 14 | The Geological Society |
| | The Medical Society |
| Thursday, January 15 | The Academy |
| Friday, January 16 | The Geographic Society |
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## CONTENTS



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② JOURNAL

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Vol. 21 January 19, 1931 No. 2

STATISTICS.—*Some elementary properties of moments-of-frequency distributions.*[1] A. J. Lotka, New York, N. Y.

In the course of a special investigation it became necessary to develop certain simple theorems regarding the moments of frequency distribution. It may be found convenient for others, as it was for the writer, to have a record of these theorems and their proof collected together in one place. Although some of them may seem evident almost at sight, one is, nevertheless, better satisfied when a definite proof is at hand.

*1. Definition.*—Given any frequency distribution $z = f(x)$, we may form the function $x^n z = x^n f(x)$ and regard this as a new distribution $F(x)$. We may, further, determine the *mean* of this new distribution

$$\bar{x}_n = \frac{\int_a^b x\, F(x)dx}{\int_a^b F(x)dx} = \frac{\int_a^b x^{n+1}\, f(x)dx}{\int_a^b x^n\, f(x)dx} = \frac{R_{n+1}}{R_n} \tag{1}$$

*2. Theorem.*—The mean $\bar{x}_n$ defined as above moves in the direction of increasing x as n increases, provided that $f(x) \geqslant o$ for $a < x < b$. That is, under this condition, $\bar{x}_n > \bar{x}_{n-1}$

*Proof.*—By definition

$$R_{n+1} = \int_a^b x^2\, F(x)dx \tag{2}$$

$$R_n = \int_a^b x\, F(x)dx \tag{3}$$

[1] Received November 12, 1930.

$$R_{n-1} = \int_a^b F(x)dx \tag{4}$$

$$R_n^2 = \int_a^b x\,F(x)dx \int_a^b y\,F(y)dy \tag{5}$$

$$= \int_a^b \int_a^b xy\,F(x)\,F(y)dydx \tag{6}$$

$$R_{n-1}\,R_{n+1} = \tfrac{1}{2}\left\{\int_a^b \int_a^b F(x)y^2\,F(y)dydx + \int_a^b \int_a^b F(y)x^2\,F(x)dydx\right\} \tag{7}$$

$$= \tfrac{1}{2} \int_a^b \int_a^b (x^2 + y^2)\,F(x)\,F(y)dydx \tag{8}$$

By comparison of equations (6) and (8) it is seen that for every term $xy\,F(x)\,F(y)dydx$ in $R^2{}_n$ there is a corresponding term

$$\tfrac{1}{2}\,(x^2 + y^2)\,F\,(x)\,F(y)\,dydx \text{ in } R_{n-1}\,R_{n+1}.$$

Now x and y being both real, we have

$$(x - y)^2 \geqslant 0 \tag{9}$$

$$x^2 - 2\,xy + y^2 \geqslant 0 \tag{10}$$

$$\tfrac{1}{2}\,(x^2 + y^2) \geqslant xy \tag{11}$$

the equal sign applying only in the special case that $x = y$. Every term in (8) being positive and greater than or at least equal to the corresponding term in (6), it follows at once that

$$R_{n+1}\,R_{n-1} > R_n^2 \tag{12}$$

the equality sign being here excluded, since in the double integral, in general, $x \neq y$.

The result (12) may also be written

$$\frac{R_{n+1}}{R_n} > \frac{R_n}{R_{n-1}} \text{ i.e. } \bar{x}_{n+1} > \bar{x}_n \tag{13}$$

which proves the theorem.

*3. Theorem.*—The mean $\bar{x}_n$ of the distribution $x^n\,f(x)$ approaches the value b as n increases, if $f(x) = 0$ for all values of x greater than b.

*Proof.*—From the theorem (*2*) it is clear that $\bar{x}_n$ must either increase indefinitely as n increases, or else must tend continually to an upper limit.

We may split up the expression for $x_n$

$$\bar{x}_n = \frac{\int_a^p x^{n+1} f(x)dx}{\int_a^b x^n f(x)dx} + \frac{\int_p^b x^{n+1} f(x)dx}{\int_a^p x^n f(x)dx + \int_p^b x^n f(x)dx} \tag{14}$$

$$= \frac{I_{ap}}{J_{ab}} + \frac{I_{pb}}{J_{ap} + J_{pb}} \tag{15}$$

Now it is clear that for any assigned value of $p < b$, we can always, by choosing n large enough, make the ratios $I_{ap}/I_{pb}$ and $J_{ap}/J_{pb}$ less than any assigned positive value $\epsilon$. Hence, in the limit, for sufficiently large n, we have

$$\bar{x}_n = \frac{I_{pb}}{J_{pb}} = \frac{\int_p^b x^{n+1} f(x)dx}{\int_p^b x^n f(x)dx} \tag{16}$$

where p may be made (less than but) as nearly equal to b as we please. But in the limit, as p approaches b, (16) reduces simply to

$$\bar{x}_n = \frac{b^{n+1} f(b)dx}{b^n f(b)dx} = b \tag{17}$$

which proves the theorem.

*4. Theorem.*—The median between the limits $x = a$ and $x = b$ of the distribution $F(x) = x^n f(x)$ moves in the direction of increasing x as n increases.

*Proof.*—The median $\xi$ of $F(x)$ is defined by the relation

$$\int_a^\xi F(x)dx = \int_\xi^b F(x)dx \tag{18}$$

It follows at once that

$$\int_a^\xi x\, F(x)dx < \int_\xi^b x\, F(x)dx \tag{19}$$

since each term on the right of the inequality (19) is obtained from the corresponding term in the right hand member of the equation (18) by multiplication with a value of $x \geqslant \xi$, while each term on the left is similarly obtained from the corresponding term in the left hand member of the equation (18) by multiplication with a value of $x \leqslant \xi$. In order, therefore, to divide the integral $\int_a^b xF(x)dx$ into equal parts, we must add something to the first integral of the inequality (19), and deduct something from the second. But this means that in the defining equation for the median of x F(x)

$$\int_a^\eta x\, F(x)dx = \int_\eta^b x\, F(x)dx$$

we must have $\eta > \xi$, that is, the median of x F(x) lies "to the right of" that of F(x). This proves the theorem.

5. *Theorem.*—The mode of the distribution $F(x) = x^n f(x)$, where x and f(x) both assume only positive values, moves in the direction of increasing x as n increases.

*Proof.*—The mode of F(x) is defined by

$$\frac{dF(x)}{dx} = 0$$

while that of x F(x) is defined by

$$x \frac{dF(x)}{dx} + F(x) = 0$$

$$\frac{dF(x)}{dx} = -\frac{F(x)}{x}$$

Now according to hypothesis, F(x) and x are both positive. Hence the mode of x F(x) falls at a point at which the curve for F(x) has a downward slope, that is, to the right of its mode. This proves the theorem, for unimodal frequency curves lying entirely in the plus x field.

If the curve has two or more modes, we can divide it into sections having only one mode and then apply to each section the argument set forth above.

*Summary.*—If f(x) is a frequency distribution and if both x and f(x) assume only positive values, then the mean, median and mode of $x^n$ f(x) all move in the direction of increasing x as n increases.

MATHEMATICS.—*On Fermat's Last Theorem, III*[1]. VAL. MAR. SPUNAR, Chicago, Ill. (Communicated by EDGAR W. WOOLARD.)

In the attempt to show that

$$x^n + y^n = z^n \qquad (1)$$

$n$ being any positive integer, cannot be solved in integers all different from zero if $n > 2$, it is sufficient to consider the case in which $x, y, z$ are relatively prime and $n$ is an odd prime $\lambda \geq 3$.[2] One method of attack that has been employed is to exclude certain values for $\lambda$ either by more or less general criteria or by direct computation; and some results obtained by this method have been presented in the two preceding papers[3] by the present writer.

It is the object of the present paper to extend the results of Dickson[4] and of Beeger[5], who have, respectively, proved Fermat's Last Theorem for $n < 7000$ and $n < 14{,}000$. It has been established that any value of $\lambda$ for which

$$x^\lambda + y^\lambda = z^\lambda \qquad (2)$$

is satisfied by integers not divisible by $\lambda$, must satisfy

$$r^{\lambda - 1} \equiv 1 \pmod{\lambda^2} \qquad (3)$$

for $r = 2$[6]; 3[7]; 5[8]; 11 and 17[9]; and also 7, 13, and 19 if $\lambda \equiv 5 \pmod 6$, i. e., $\lambda = 6k - 1$.[10] Thus, (2) is impossible in integers prime to $\lambda$ for all prime values of $\lambda$ that do not satisfy (3) for all the preceding values of $r$. It may be noted that (3) will likewise be satisfied by the product of these numbers, each raised to any power, viz.,

$$2^a \cdot 3^b \cdot 5^c \cdot 7^d \cdot 11^e \cdot 13^f \cdot 17^g \cdot 19^h,$$

in which $a, b, c, \ldots, h$ may each be any positive integer or zero unless $\lambda = 6k + 1$ in which case we must take $d = f = h = 0$. The following generalization of these results appears to be new:

[1] Received June 30, 1930.
[2] CARMICHAEL, *Theory of Numbers*, p. 91. New York, 1914.
[3] This JOURNAL, **18**: 389–395. 1928; **19**: 395–401. 1929.
[4] Quar. Jour. Math. **40**: 27–45. 1908.
[5] Mess. Math. (2), **55**: 17–26. 1925.
[6] WIEFERICH, Crelles Jour. für Math., **136**: 293–302. 1909.
[7] MIRIMANOFF, Crelles Jour. für Math., **139**: 309–324. 1911.
[8] VANDIVER, Crelles Jour. für Math., **144**: 314–318. 1914.
[9] FROBENIUS, Sitz. Berl., 1914, pp. 653–681.
[10] FROBENIUS, *loc. cit.*

*Theorem.*—If, in $M = m\lambda \pm N$, $\lambda$ be an odd prime, $m$ any integer prime to $\lambda$, and $M$ and $N$ both satisfy (3), then this value for $\lambda$ is excluded from (2).

The proof requires the following *Lemma*: If $r$ is an integer, not zero, prime to any odd prime $\lambda \geq 3$, and satisfies (3), then obviously $[m\lambda - (m\lambda \pm r)]^{\lambda-1} \equiv 1 \pmod{\lambda^2}$, whence, upon expanding by the binomial theorem, we find that $-(\lambda - 1)\, m\lambda\, (m\lambda \pm r)^{\lambda-2} + (m\lambda \pm r)^{\lambda-1} \equiv 1 \pmod{\lambda^2}$; consequently, it is impossible that

$$(m\lambda \pm r)^{\lambda-1} \equiv 1 \pmod{\lambda^2} \ldots\ldots\ldots\ldots\ldots (4)$$

Thus, no value of $\lambda$ which satisfies (4) can satisfy (3), nor, therefore, (2).

Now, if we put

$$m\lambda = M \mp N \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where $\lambda$, $m$, $M$, $N$, are all prime to each other, and $N$ is any number $r$ that satisfies (3), then since $m\lambda = (m\lambda \pm r) \mp r$, we have $M = m\lambda \pm r$; and if also

$$M^{\lambda-1} \equiv 1 \pmod{\lambda^2} \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

i.e.,

$$(m\lambda \pm r)^{\lambda-1} \equiv 1 \pmod{\lambda^2},$$

then by the Lemma, $\lambda$ cannot satisfy (3) nor (2). That is, if $m\lambda$ can be expressed as the sum or difference of two numbers both of which satisfy (3), then Fermat's Theorem is true for this value of $\lambda$. E. g., taking $m = 1$ for convenience, we have $7013 = 7 \cdot 10^3 + 13$, whence Fermat's Theorem holds for $\lambda = 7013$; similarly $7019 = 7 \cdot 10^3 + 19$, $7027 = 5^2 \cdot 17^2 - 2 \cdot 3^2 \cdot 11$, and so on. The writer is now engaged in constructing tables of such results which will prove Fermat's Theorem for $\lambda < 50{,}000$. The result

$$6^{\lambda}\, \lambda^{2\lambda+1} < x < y < z$$

established in the first paper[11] shows that for $\lambda = 50{,}021$, the solutions, if any exist, must be such that

$$10^{513{,}722} < x < y < z$$

[11] This JOURNAL, **18**: 395. 1928.

The Theorem of the present paper likewise holds for $m = m' \lambda^k$, if $m'$ be prime to $\lambda$, and $M$ and $N$ are both perfect $\lambda^k$-th powers. The more general identity $\pm m \lambda = (\pm rm \lambda \pm n) \mp [(r-1) m\lambda \pm n]$ may also be used; e.g., $\lambda = 8311 = 2^7 \cdot 11 \cdot 17 - 5^6 = 23{,}936\text{–}15{,}625$ is in the form $\lambda = (3\lambda - p) - (2\lambda - p)$ or $\lambda = (2\lambda + n) - (\lambda + n)$ where $m = 1, r = 3, p = 1000, n = 7314$.

The writer has obtained a proof, to be published shortly, that (2) has no solution in integers at all if $\lambda = 6k - 1$ and $xyz \not\equiv 0 \pmod{\lambda}$

ENTOMOLOGY.—*A new longhorn beetle from Costa Rica (Coleoptera: Cerambycidae).*[1] W. S. FISHER, Bureau of Entomology, United States Department of Agriculture. (Communicated by HAROLD MORRISON.)

### **Cosmotoma fasciata,** new species

Elongate, and moderately robust; head and antennae reddish-brown, the latter becoming darker toward apices; pronotum reddish-brown anteriorly, becoming dark-brown on basal half; scutellum and elytra black, the latter with a broad, transverse, reddish-brown fascia in front of middle, which is more or less interrupted at the sutural margins, and the surface ornamented with white pubescent markings; beneath brownish-black, with the legs dark reddish-brown.

Head with the front quadrate, feebly convex, slightly concave between the antennal tubercles, which are slightly elevated, the surface densely, finely punctate, and sparsely clothed with long, recumbent, yellow hairs; eyes rather small, very deeply emarginate, with the upper lobes very small and narrow; antenna considerably longer than body, the fourth joint armed on the upper surface with a thick tuft of long, black hairs, the second, third, and fifth joints with thin pencils of hairs at their tips, and clothed with a few long hairs similar to the other joints, first joint slightly expanded toward apex, about three-fourths as long as the third joint, which is slightly shorter than the fourth, the following joints becoming gradually shorter toward tip of antenna.

Pronotum slightly wider than long, strongly constricted along base and anterior margin, the sides with a slight conical protuberance near middle; disk with a large obtuse tubercle on each side of middle; surface densely, obsoletely punctate, a few large, coarse punctures in the transverse apical and basal constrictions, rather densely clothed with long, recumbent, yellow pubescence. Scutellum elongate, finely, densely punctate, and rather densely clothed along margins with recumbent, white pubescence.

Elytra nearly three times as long as pronotum, slightly wider than it at base; humeral angles broadly rounded and feebly elevated; sides nearly parallel to apical fourth, then arcuately narrowed to the apices, which are obliquely truncate internally; surface densely, obsoletely punctate, with a few scattered coarse punctures intermixed, rather densely clothed with short, black pubescence, which has a pinkish tinge in certain lights, with numerous long, erect, stiff, black hairs, and each elytron ornamented with white pubescent markings

[1] Received November 21, 1930.

as follows: three narrow, transversely oblique fasciae on the transverse reddish-brown area in front of middle, the fasciae more or less connected toward the sutural margin, and a narrow transverse fascia near apex, and armed with a median basal crest, which is clothed with long, black hairs.

Body beneath densely, obsoletely punctate, and rather densely clothed with short, recumbent, silvery-white pubescence; last abdominal segment rather coarsely punctate toward apex, and clothed with long, semierect hairs.

Length, 5–7.5 mm.; width, 2–3.2 mm.

*Type locality.*—Hamburg farm, Costa Rica.

*Type* and *paratype.*—Cat No. 43174, United States National Museum.

*Paratypes.*—Collection Ferd. Nevermann.

Described from four examples (one type), all of which were collected at the type locality, April 2, 1925, by Ferd. Nevermann.

This species is very closely allied to *rubella* described by Bates from the Amazon region, but it differs from that species in having the sides of the pronotum more obtusely angulated, dorsal tubercles on the pronotum more feebly elevated, base and apex of the elytra entirely black, and the elytra not so abruptly angulated at the apices.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## THE ACADEMY

### 235TH MEETING

The 235th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club at 8:15 P.M. on Thursday, November 20, 1930. President BOWIE introduced as the speaker Dr. ADOLPH H. SCHULTZ of the Johns Hopkins Medical School, who delivered the seventh of the series of lectures upon origin and evolution. About 175 persons were present.

*Program*: ADOLPH H. SCHULTZ: *Man's place among the primates.* (Illustrated with lantern slides.)—All the investigators agree that man must be assigned to the order of primates but there exist widely differing claims in regard to man's exact place within this mammalian order. The evidence supporting these claims includes a wide variety of specialities ranging from fetal membranes to blood-serum reactions. Skulls and teeth of primates have been studied in much greater detail than other bodily parts, adult animals and men have been examined much more frequently and thoroughly than physiological studies.

In the address some of the less widely known evidence was used for the reconstruction of the primate family tree and of the exact place thereon of the human branch. The author discussed chiefly growth, the skeleton and variations, with lantern slides illustrating a very heterogenous mass of data to emphasize the necessity of representing a pedigree as a compromise between the results from many different fields of investigation.

The theme that man has a definite place among the primates was developed and illustrated by lantern slides showing size, growth, the recapitulation theory, tail, nasal cartilages, shoulders and neck, nipples, arm proportions, limb proportions in general, variations; skeleton: spine, sternum, pelvis and foot. This was followed by a comparative study of hair and its distribution in the group.

The data were marshalled to show that man is not only a member of the mammalian order of primates but resembles most closely the large anthropoid apes, which must have had one and the same ancestor with man; that in many respects man is still more primitive than his simian cousins, which have become more highly specialized in regard to the conditions of the spine, the sternum, etc.; that in other respects man has departed farther from the common ancestral condition than have the apes, but the difference between man and some apes is rarely greater than the difference in the same feature between that ape and some other ape. Man's greatest specializations exist chiefly in those parts which had to be changed with (and by) the assumption of an erect posture. This is clearly evident in man's pelvis, foot, skull, and length of lower limb.

Many evolutionary changes consist in the loss of a structure which previously had served a definite purpose. Examples were cited: the third eyelid, or nictitating membrane, and loss of the thumb in monkeys in America and Africa. Sometimes new characters appear, such as extreme webbing between the second and third toes. Some evolutionary changes are observed right now if we examine large series of individuals, such as loss of third molar. The same evolutionary trend prevails independently in the American spider monkey, among which 15% lack 3rd molars. This was shown in slides on variations in monkey skulls, human fetuses, relative ear sizes, etc., which are variations that run in families (are hereditary). Such variations are already present before birth. Everywhere we turn we find ample material for selection in the form of individual variations of a congenital nature.

The author concludes that 99 out of every 100 variations are indifferent in regard to value to their owner. Most variations have no selective significance by themselves. Nevertheless, evolutionary changes can occur with such indifferent but selected variations as stepping stones. This is possible and even unavoidable because different variations of one and the same body are correlated to one another as clearly shown by the modern study of human constitutions. We have learned to recognize distinct constitutional types by their definite combinations of variations. One type, for instance, has long limbs, a slender trunk and little body hair on the chest and limbs. Many investigations have demonstrated that one type is more susceptible to certain diseases than the other type. These diseases are clearly selective agencies, which select not only relative immunity to a disease but with it relative length of limb and amount of hair. We are just beginning to realize that some constitutional types thrive better in a tropical climate than do other types. There are many other factors which might select the different constitutions. Such types are not restricted to man but have been demonstrated among primitive monkeys, shot in their native jungles. Malaria and other diseases are known to be shockingly prevalent among these monkeys. It is not at all unlikely, though not yet proved, that different constitutions in monkeys, as in man, are differently susceptible to some diseases and that in this way one type may gradually become eliminated from the population of the species. In this way we can understand that variations in limb length, ear size, hairiness, etc. become selected not because they are directly advantageous but because they happen to be combined with physiological variations, which cause a different resistance to disease, climate, or diet.

"The problem of man's place among primates includes two separate questions: (1) What is this place? and (2) How did man come to occupy such a place? The first question I have tried to answer on the basis of careful comparisons between man and other primates, that is, by the approved taxonomic methods. Such comparisons force us to the conclusion that man is most nearly related to the anthropoid apes. The second question is far more complicated and difficult to answer and one has to deal mostly with possibilities and probabilities. I have given you ample evidence for the conclusion that evolution is not only a theory but a philosophy without which no student of nature can understand nature. We cannot escape the evidence from all scientific observations that species have changed in the past and are continuing to change today, and that man does not form an exception to this rule. I have not been able, however, to tell you definitely how and why these changes take place. A great deal more work will have to be done before we can prove the exact working method or the many methods of evolution. We can demonstrate with certainty that there exists a constant and abundant supply of variations from which to select new forms. The working of these selections is still a matter of speculation and an inducement for future intensive research." (*Author's abstract.*)

CHARLES THOM, *Recording Secretary.*

## GEOLOGICAL SOCIETY

### 467TH MEETING

The 467th meeting of the Society was held in the Assembly Room of the Cosmos Club, Wednesday evening, October 29, 1930, President G. R. MANSFIELD presiding.

*Informal communications:* DAVID WHITE reviewed the autumn meeting of the National Academy of Sciences. He called attention to papers by DAVIS on limestone caves, SETCHELL on the activity of algae in limestone formation, MILLIKAN on the radioactivity of glacial drifts and the rate of elevation of the Hudson Bay country and by LYMANN on pre-Cambrian bacteria. Discussed by Messrs. THOMPSON and COOKE.

R. C. WELLS announced a series of round-table discussions of geochemistry which are being held fortnightly in the Chemical Laboratory of the U. S. Geological Survey.

*Program:* CURT TEICHERT, University of Freiburg, Germany: *Recent German theories.* (A paper on this subject appears in this JOURNAL **21**: 1–12.)

Discussed by G. R. MANSFIELD.

E. G. ZIES: *The geologist and analyst—a study in coöperation.*—A plea was entered for better coöperation between geologist and analyst. Evidence was presented which brought out the wide variation in results obtained when a synthetic silicate was submitted for analysis to a number of chemists actively engaged in such work. The composition of this material had previously been accurately determined both by synthesis of the pure materials and by analysis of the final product. It was further shown that accurate chemical and physical methods were available for determining the various constituents.

Much of the difficulty is caused by the fact that analysis can quite easily become a deadly routine, utterly devoid of creative possibilities if the analyst neither has nor is given an interest in the application of his results to the problem which is being investigated. A great amount of poor work is being done by the chemist and accepted by the geologist because there is no mutual understanding of their respective problems.

Analysis at its best is a science, an art, and a state of mind. Following RUSKIN, it is a science because we should not talk before we know, an art because we should not talk before we do, and it is a state of mind because the analyst should not undertake an analysis unless he feels confident that his methods and his ability will serve the purpose in hand. The geologist should know how to appraise the analyst and how to evaluate the results. Furthermore, the geologist must know the requirements of his problem so that the analyst can determine whether the required accuracy is within the limitations of his methods. Such coöperation will encourage the analyst to search for more accurate methods in the event that the present ones are too crude for the purpose in hand. (*Author's abstract.*)

Discussed by Messrs. WELLS and RUBEY.

### 468TH MEETING

The 468th meeting of the Society was held in the Assembly Room of the Cosmos Club, Wednesday evening, November 12, 1930, President G. R. MANSFIELD presiding.

*Informal communications:* A. C. SPENCER called attention to a probable rock glacier in a small tributary of Difficult Run which joins the Potomac River from the west a short distance below Great Falls.

Discussed by Messrs. MERTIE and THOMPSON.

C. W. COOKE: *Radial calcite concretions in marine beds in Georgia.* Several years ago, while examining the section of the Marks Head marl at Porters Landing, Savannah River, Georgia, I found a hard lump which at first glance appeared to be a fossil organism, perhaps a coral or a calcareous alga. I broke it open in order to examine the internal structure and was surprised to find that it consists of a mass of radiating acicular crystals. Some of the crystals appear to be curved, but the apparent curvature is probably due to the interpolation of shorter crystals toward the periphery rather than to actual bending of any one crystal. The crystals are crossed by unevenly spaced concentric white to brownish color bands which are not everywhere at right angles to the longer axes of the crystals but which follow the somewhat uneven contour of the surface of the nodule. The mineral effervesces freely with hydrochloric acid and, according to Mr. NOLAN, has the optical properties of calcite.

Although the nodule was lying loose on the bank of the river it had evidently fallen from the fine gray sand of the Marks Head marl which contains calcareous nodules as large as 2 feet in diameter. Most of the nodules show no evidence from the outside that their structure is crystalline, but all that I broke open proved to consist of radial crystals. The one exhibited had evidently been rolled around enough to fracture the ends of the crystals and produce a rough surface somewhat like that of a calcareous alga. Calcareous concretions have been known at Porters Landing since at least as long ago as 1908, when EARLE SLOAN described the section there, but nobody seems to have noticed anything unusual about them.

There are similar concretions in the Upper Cretaceous Eutaw formation at Ochillee, Chattahoochee County, Georgia. Both the Eutaw formation and the Marks Head marl are marine. (*Author's abstract.*)

A. C. SPENCER showed radial concretions of pyrite, barite and a carbophosphate and suggested that the carbophosphate concretion was pseudomorphous after barite.

S. F. TURNER exhibited a concretion of radiating crystals of aragonite from the Cave of the Winds, Colorado; a chalcedony replacement of aragonite crystals from the gravels of the Canadian River in Texas; and aragonite crystals from the Pierre shale of Colorado.

The communications on concretions were discussed by Messrs. WHITE, RESSER, GOLDMAN and SCHALLER.

W. R. ATWOOD showed three specimens from a single log found in the Petrified Forest of Arizona. The specimen from one end was a silica replacement, but the specimen from the other end was lignite. The intermediate portion of the log was partly silica and partly lignite. Discussed by Messrs. WHITE, GOLDMAN, and SPENCER.

*Program:* C. H. DANE: *Uncompahgre Plateau and related structural features.*—The Uncompahgre Plateau is a topographic elevation closely coincident with an anticlinal uplift, oval in shape, some 90 miles in length with its longer axis extending northwest to southeast. Most of the uplift is within the State of Colorado but the plunging north end extends into Grand County, Utah. The folding occurred at the close of the Cretaceous period and the pre-Cambrian granitic and metamorphic core of the Plateau uplift acted as a bulwark, the direction of which is reflected by parallel smaller folds to the southwest. The Plateau is located along the western margin of an ancient land mass which extended southeastward through western Colorado into northern New Mexico during Pennsylvanian, Permian, and lower Triassic time. The northern limit of this old land area is concealed beneath the Cretaceous and Tertiary sediments of the Uinta Basin. An estimate of the volume of clastic sediments derived from the erosion of this land suggests that it may have been a mountain range, the crest of which stood at least a mile above the margins although the land was less than one hundred miles in width. The coarseness of the conglomeratic sediments deposited near the margins suggests a rugged topography compatible with the probable great height of the old range. Although the range was peneplained before or during upper Triassic time, sediments deposited during the Jurassic period thin toward the area of the old land and are missing over parts of it. The area was completely submerged by the marine invasion of the Upper Cretaceous, but the post-Cretaceous folding which formed the Uncompahgre Plateau anticline followed the trend of the old land and uplifted part of its western margin. (*Author's abstract.*)

Discussed by Messrs. W. R. ATWOOD, SPENCER, BAKER and GOLDMAN.

W. R. ATWOOD: *Mid-Tertiary glacial deposits in southern France.*—In the vicinity of Mt. Aigoual at the southern margin of the great Central Massif of France, distinct evidence of an ancient glaciation has been found in the form of tillite and striated bed rock. The tillite is characteristically physically and lithologically heterogeneous and is firmly consolidated wherever it has been recently uncovered. The stones found in the matrix vary in size from very small pebbles, to large boulders more than a meter in diameter. The larger boulders are predominantly of gray granite porphyry originating in the immediate vicinity. They are rarely striated, probably because they were not carried far, or because they disintegrate rapidly. The smaller stones that are less than a foot in diameter are not always typically glacial in form, but they are almost invariably well striated.

The scarcity of glacial phenomena; the entire absence of the topographic situations where alpine glaciers could have formed; and the fact that the tillite has no topographic expression in the landscape—a landscape which has been but slightly changed since mid-Tertiary time—would indicate that the streams of that period had quite thoroughly removed the glacial debris and destroyed the glacial topography before the close of the mid-Tertiary erosion period.

Had the glaciers that deposited the tillite been Pleistocene in age, the abundant debris, which must have been present, could not have been so nearly removed without appreciably altering the mid-Tertiary landscape. The glaciers that left the tillite must have been mountain glaciers that originated in Oligocene or early Miocene mountains which are known to have existed in this region following the uplift and faulting which took place during Oligocene time.

A review of the literature shows that PJETURSSON reports Miocene glacial deposits in Iceland, SCHARDT reports Miocene glaciation in Italy, MAZZUOLI also reports Miocene in Italy and the present author, in collaboration with WALLACE W. ATWOOD, has twice reported positive proof of Eocene or Oligocene glacial deposits in western United States. Glaciation during the mid-Tertiary is therefore recognized in several localities, and it is logical to believe that in the Cevennes we have another proof of this ancient glacial epoch. (*Authors abstract.*)

Discussed by Messrs. MERTIE, ALDEN, SEARS, SPENCER and RUBEY.

## 469TH MEETING

The 469th meeting of the Society was held in the Assembly Room of the Cosmos Club, Wednesday evening, November 26, 1930, President G. R. MANSFIELD presiding.

*Informal communications:* JAMES GILLULY discussed a recent paper by EDWARD GREENLY on *Foliation and its relation to folding in the Mona complex at Rhoscolyn, Anglesey.* GREENLY attributes monoplanic schists to flat-angled overthrusting—the common occurrence of folded monoplanic schists to later warping of the planes of schistosity. GILLULY pointed out that the stretching phenomena shown by the monoplanic schists of the Adirondack region do not support a similar interpretation but seem to indicate the origin of a foliation concomitant with its warping.

Discussed by Mr. HESS.

M. I. GOLDMAN showed specimens of polygonal columns formed by weathering of a silty grit in Permian red beds cropping out on an anticlinal nose which extends eastward from the Harz Mountains, Germany. A photograph of the outcrop was shown as a lantern slide.

Discussed by Messrs. BRIDGE and HUBBARD.

*Program:* F. L. HESS: *A unique Bolivian tungsten deposit.*

Discussed by Mr. BURCHARD.

B. R. HUBBARD, S. J., Univeristy of Santa Clara, California: *Geologic features of Aniakchak and Veniaminof craters, Alaska.*—Aniakchak and Veniaminof craters were discovered by a Geological Survey party under R. H. SARGENT in 1922, and W. B. SMITH, geologist of the party, entered Aniakchak crater. In a second expedition in 1925 R. S. KNAPPEN was geologist of the party. Aniakchak Crater, latitude 56° 45′, longitude 158° 9′, is situated midway along the Alaska Peninsula and has a base circumference of approximately 100 miles. Starting at sea level it rises to an elevation of 4,200 feet and has a rim whose perimeter is 21 miles. It appears to be an explosive crater that ejected about 19 cubic miles of material. Bombs with texture similar to rocks within the crater are found 25 miles away and the Aniakchak River cuts through ejected material all the way to Aniakchak Bay. Many interesting phenomena subsequent to the great explosion are found in the 30-square-mile area within the crater walls. A rift begins in Bering Sea and extends across the crater. Thence it traverses the block of sedimentary rocks that comprises the mountains through which the Aniakchak River has cut a canyon somewhat in the form of an attenuated letter S. This rift might account for the depression on the west side of the crater and the V-shaped notch of the eastern rim out of which the river flows. Fossiliferous Jurassic strata form part of the walls to the left of the V-shaped entrance. Lava muds and basalts top the crater walls. A minor cone, here called Vent Mountain, has a crater 1,000 feet in diameter and rises 2,200 feet above the main floor. Surprise Lake, 2½ miles long, is formed by the impounding of water by deltas. Two lava cones and soda-iron bicarbonate springs occur at the head of the lake. Iron soda springs rise likewise from the lake bottom. Two explosion pits lie below the general level between Vent Mountain and Black Nose. In the western side of Aniakchak Crater a crescentic sub-crater about two miles in diameter contains a cinder cone from which as a center radiate lava flows that have concentric arcs of flowage lines. Near this cinder cone are several active fumaroles. Obsidian with columnar structure protrudes from the wall of the subcrater in many exposures. Here, too, active fumaroles, whose vapors come out under pressure, occur along fissure lines. A lava cone whose crater is filled with water, and a second cinder cone are found near the depression of the rim at the western wall.

Veniaminof Crater southwest of Black Lake is approximately 100 miles in circumference at the base and rises to a rim about 20 miles in circumference at an elevation of 8,400 feet. It contains a crater glacier that spills over the depressed rim and extends over a wide area for 25 miles towards Perryville. The ice also escapes through notches in the walls and forms lesser glaciers, notably Cone Glacier and Crab Glacier. A cone which smokes and throws ashes and black sand down its sides rises over a thousand feet above the ice. (*Author's abstract.*)

Discussed by Messrs. Sargent and Capps.

E. O. Ulrich: *Highlights of the past two seasons' work. I. Origin and stratigraphic horizon of the zinc ores of the Mascot district of East Tennessee.* In April, 1929, Drs. Butts, Bridge, Captain Pond, and I devoted about a week to the study of problems connected with the stratigraphic position, origin, and probable areal distribution of zinc ores in what we formerly knew as the Knox dolomite of East Tennessee. The Mascot mine is the most notable and successful of the zinc mines in the Appalachian Valley and is one which has earned more than the operators put into it.

We began our investigation at Jefferson City where extensive but shallow deposits were successfully worked, many years ago. In recent years prospect drilling along the strike of the rocks has disclosed some promising deposits that are now showing good ore. Our studies were not concerned so much with the prospects and mines themselves as with the reasons for their being, that is, why such deposits happen to occur here; and what relation the mineralized zones bear to stratigraphic horizons, character of country rock, and other conditions that may have been responsible for the local enrichment of the favoring zones to commercial proportions.

The formerly generally prevailing and still commonly entertained interpretation of these deposits is that they occur in fault breccias and that the mineral-bearing solutions travelled upward along the fault planes. In essential respects then they would fall in the category of fissure veins. In my opinion they are neither fissure veins, nor connected with real faults—either of normal or thrust types, and the solutions did not come from below. Of course I shall not go into details of the complicated processes of mineral deposition. It must suffice to state my opinion that the minerals come from the country rock and were carried in solution by ground waters which, when surcharged with surface-derived organic acids, tended to precipitate as ores in favorable spots. Two conclusions may be reached from the facts observed:

1. All the commercially valuable and the as yet unproved deposits of sphalerite in the belt extending from Knoxville to Morristown were found at a definite stratigraphic horizon—namely, in a rather fine-grained, low-magnesian limestone zone with a maximum thickness of about 100 feet. This limestone apparently is exceptionally favorable to replacement by sphalerite. It carries fossils that place it in the horizon of the Jefferson City dolomite of Missouri where, as in Tennessee, the corresponding formation is underlain by the Roubidoux formation and overlain by the Cotter formation. In Tennessee as in the Ozark region, the underlying and overlying formations are characterized by profuse development of secondary chert on weathering and by easily distinguishable fossils faunas. Formerly, I was inclined to the belief that the horizon of the ore was at the unconformable contact between the Ozarkian and Canadian systems but that proved to be in error for it lies well up toward or rather above the middle of the Canadian, in the lowest of the five or six formations now recognized as constituting the sequence of Upper Canadian deposits.

2. The second conclusion is that the highly soluble Upper Canadian limestone was first honey-combed with sinkholes and caverns. Earthquakes and minor movements of the stratified crust caused fracturing and "spalling" of the roof and walls of the caverns, the pieces of rock making the accumulations of mainly angular fragments commonly referred to by geologists as breccia. Under favoring conditions, these accumulations of broken rock were cemented and in varying degrees replaced metasomatically by crystalline minerals. Often, as at Jefferson City, the greatest development of the ores occurred beneath the old sink holes whose position is indicated today by fossiliferous residual material of the Cotter formation which has slumped down into the horizon of the Jefferson City formation. As far as observed, the mineralization is largely and perhaps entirely confined in the areas of east Tennessee under consideration to the lower only very slightly cherty formation.

In conclusion, in the mines at Mascot and in the vicinity of Jefferson City the ores are confined to a definite stratigraphic horizon and this fact is simply and positively fatal to the conception that they occur in anything like true fissure veins or in fault breccias. (*Author's abstract.*)

Discussed by Messrs. Hess, Mendenhall, R. C. Wells, Gilluly, Goldman, Burchard, Miser, C. S. Ross, Hewett, Bridge.

### 470th meeting

The 470th meeting of the Society was held at the Cosmos Club December 10, 1930, President G. R. Mansfield presiding. Vice President Meinzer took the chair during the presentation of the presidential address: *Problems of the Phosphoria formation in the Rocky Mountains.*

### 38th annual meeting

The 38th annual meeting was held at the Cosmos Club after the adjournment of the 470th regular meeting, President G. R. Mansfield presiding. The annual report of the Secretaries was read. The Treasurer presented his annual report showing an excess of assets over liabilities of $1122.09 on December 8, 1930. 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: O. E. Meinzer.

Vice Presidents: F. L. Hess and R. C. Wells.

Secretaries: C. H. Dane and A. M. Piper.

Treasurer: C. Wythe Cooke.

Members-at-Large of the Council: W. H. Bradley, Josiah Bridge, James Gilluly, W. D. Johnston, Jr., J. B. Mertie, Jr.

Nominee as Vice President of the Washington Academy of Sciences representing the Geological Society: G. R. Mansfield.

James Gilluly, C. H. Dane, *Secretaries*

## SCIENTIFIC NOTES AND NEWS

Because of the greatly increased activities of the Water Resources Branch of the Geological Survey, John C. Hoyt has been relieved of his administrative duties in order to permit him to render expert services along technical engineering phases of water-resources investigations and to serve as a consultant to the Director and Chief Hydraulic Engineer. Carl G. Paulsen succeeds Mr. Hoyt as Chief of the Division of Surface Water.

The vacancy in the position of Division Engineer in charge of the Pacific Division of the Topographic Branch of the Geological Survey caused by the death of T. G. Gerdine has been filled by the transfer of H. H. Hodgeson. Col. Glenn S. Smith, for some time past on occasional duty status, succeeds Mr. Hodgeson as Division Engineer in charge of the Central Division.

The Carnegie Institution of Washington is sending a group of scientists to Guatemala to explore the geology, flora, and fauna of that part of the little-known Peten District which is accessible from the camp of the Institution's Division of Historical Research at Uaxactun. The party will include Prof. H. H. Bartlett, chairman of the department of botany of the University of Michigan; Dr. C. Wythe Cooke, geologist, U. S. Geological Survey; Dr. A. Murie, assistant curator of mammals, University of Michigan; and Dr. J. Van Tyne, assistant curator of birds, University of Michigan. They sail January 23rd from New Orleans to Belize, British Honduras, whence they proceed by river boat to El Cayo, and thence by pack train to Uaxactun.

Dr. C. G. Abbot, Secretary of the Smithsonian Institution, has been named a member of the National Council for Intellectual Cooperation, which represents the United States in the newly organized Inter-American Institute of Intellectual Cooperation. The purpose of this institute is to mobilize the intelligence and the culture of the three Americas by organizing in each of the 21 American republics a council for promoting such policies as the interchange of students and research workers, the removal of prejudiced statements from geographies and histories, and finding ways and means of making available to all the information resources of the different countries.

## OFFICIAL COMMUNICATIONS

### THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

#### Announcements of Meetings

| | |
|---|---|
| Tuesday, January 20 | The Anthropological Society |
| | The Historical Society |
| Wednesday, January 21 | The Society of Engineers |
| | The Medical Society |
| Friday, January 23 | The Geographic Society |
| Saturday, January 24 | The Biological Society |
| Wednesday, January 28 | The Geological Society |
| | The Medical Society |
| Friday, January 30 | The Geographic Society |
| Saturday, January 31 | The Philosophical Society |
| Tuesday, February 3 | The Botanical Society |
| Wednesday, February 4 | 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.

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*Corresponding Secretary:* L. B. Tuckerman, Bureau of Standards.
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## CONTENTS

### Original Papers



### Proceedings



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OF THE

# WASHINGTON ACADEMY OF SCIENCES



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## 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.

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JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 21 FEBRUARY 4, 1931 No. 3

PHYSICAL CHEMISTRY.—*Adsorption and base exchange.*[1] P. G. NUTTING, Geological Survey.

One substance is adsorbed by another when it is not removable by a neutral solvent. Dyes are adsorbed by textile fibers, salts by soils, dark components of petroleum by filtering clays, so that they cannot be washed off by solvents, such as water, alcohol or gasoline. In a more general sense, a substance is adsorbed when its fugacity is lowered from what it would be were the second substance not present, its concentration increases and its vapor and solution tensions decrease as the adsorbing surface is approached. Adsorption is not necessarily limited to the visible surface and in some cases shades off into true chemical reaction in stoichiometric proportions or into true solution, long before molecular dimensions are reached.

Adsorption is naturally very sensitive to changes in temperature and pressure (or concentration) but reaches a true reversible equilibrium given time enough. In a few cases, a slight rise in temperature is sufficient to remove all or nearly all the moisture adsorbed on salts or minerals or the organic vapors adsorbed on charcoal. In comparatively few cases also, lowering the concentration (vapor or solution) may remove an adsorbed film. In general however adsorption-temperature and adsorption-concentration relations present the widest variety of forms and ranges.

The material adsorbed may be either molecular or ionic, positive ions depositing on an electronegative particle and vice versa. Polar molecules are adsorbed with like ends attached to the adsorbing surface, presenting a new adsorbing surface of the same charge as the

[1] Published by permission of the Director of the U. S. Geological Survey. Received December 11, 1930.

original one. Similarly positive and negative ions may pile up in alternate layers. In the case of adsorbed water, H and OH constitute the alternate layers and in thick films are indistinguishable from adsorbed molecular water. In crystallization from solution ions are adsorbed in pairs. Nonpolar molecules also vary in concentration near a surface of discontinuity but this is a purely physical phenomenon, the seat of surface tension and adhesion. This form of surface film yields readily to solvents and is not considered adsorption proper.

Base exchange is concerned with single layers of adsorbed ions, practically in chemical combination with the surface and in extreme cases, with every combinable atom present, whether the dispersion be partial or complete. It is not unusual to find one base completely replaceable while another is only partly replaceable in the same granular substance. Weak bases are replaced by stronger ones, and every other base by H by means of an acid treatment. The mass law holds and equilibrium constants may be found without great difficulty. Particles settling out carry adsorbed charges down with them. Table 1 shows the complexity of the behavior of even the simplest water suspensions.

Since two or more of these are usually present in any given sample of soil colloid, it is to be expected that conflicting results would be obtained in working with such samples.

Table 1 is somewhat idealized, for in water at room temperature the adsorption is probably many pairs of ions deep in all cases. However, the innermost layer is by far the most effective and dominates the behavior of the micelle. At higher temperatures, the outer less strongly held layers would be set free and this may account for the better results sometimes obtained at elevated temperatures in practical filtration, dyeing, etc.

Oil sands sometimes but rarely consist of well formed quartz crystals free from adsorbed coatings. Such sands usually consist of ill-formed, rough quartz grains, coated with ferrous or ferrous-aluminum silicates or with adsorbed black hydrocarbon which cannot be washed off with even the most powerful solvents. Grain coatings of carbonates (Fe, Ca, Mg) are not uncommon. The well known Bradford oil sand is coated first with colloidal iron, then with black hydrocarbon. The Tensleep oil sand is pure quartz heavily coated with a hydrocarbon. The pore walls of oil-bearing limes are black with hydrocarbon.

It is possible to peel off these two layers from a Bradford sand and even to restore them. The hydrocarbon is removed with chromic acid ("wet combustion"), the iron with ordinary acids. The grains thus peeled are active and if thoroughly washed and dried will re-adsorb coatings of either iron (from dialized iron in dilute suspension) or hydrocarbon from crude oil in a few hours. It was found easily possible to activate even sea sand or the faces of a quartz crystal by first attacking with alkali, then washing with acid, then with water, and drying. Such an activated silica surface, freed from H and OH by heating to 200°C., will freely adsorb all kinds of positive ions, even

TABLE 1. CLASSES OF WATER SUSPENSIONS

| Class | Micelle | Surface | Exchangeable ion | Dispersing effect |
|---|---|---|---|---|
| 1 | Negative | H | H | Acid |
| 2 | Positive | OH | OH | Alkaline |
| 3 | Negative | OH inner<br>H outer | H | Alkaline |
| 4 | Positive | H inner<br>OH outer | OH | Acid |

1. Silica gel, acid clay, humus.
2. Colloidal $Ca_3(PO_4)_2$, dialized iron (?).
3. Calcium permutites, zeolites, neg. $Al(OH)_3$.
4. Electropositive $Al(OH)_3$.

amphoteric colloidal alumina and probably anything less negative than silica.

Well-aged dialized iron is inert toward even strong acids or alkalis, but even a very dilute suspension (1 part per million) is readily adsorbed by active silica. Iron stains in old bath tubs are readily explained if it be supposed that the long-continued drip of fresh water on the porcelain leaches out sufficient alkali to leave an active alkali silicate surface to adsorb the very dilute iron from tap water. There is abundant geological evidence for the solution and redeposition of silica by water, hence it is not surprising to find oil sands generally activated and coated as well as silica cemented.

Classes 1 and 3 of Table 1 after thorough drying make good clarifying filters for mineral oils such as petroleum but do not filter vegetable oils or mineral fats containing OH. If the normal hydrogen has been replaced by an alkali (K, Na), the filter must first be acid treated. On the other hand classes 2 and 4, or clays containing these in excess, make the best filters for animal and vegetable oils. That the presence of the hydroxyl ion is the vital factor is readily shown by adding a little alcohol, linseed oil or glycerine (all rich in OH) to a crude petroleum; filtration is inhibited.

One filtering clay is known which filters all three classes of oils about equally well. Chemical analysis shows this to contain a little alkali, enough to give it an amphoteric dispersing character; $SiO_2$ 69, $Al_2O_3$ 13, $Fe_2O_3$ 3, (Ca, Mg)O 2, and $(K,Na)_2O$ 2.5 per cent, the rest chiefly water.

All good filtering clays retain 12 to 22 per cent of water when room-dry at low humidities and part with most of it only on heating to well over 150° or 200°C. This is as it should be with H and OH firmly adsorbed. Driving these off as water would leave open bonds ready to attack the more basic colored constituents of oil. If they be not driven off (moist filter), only bases stronger than H and OH and therefore capable of replacing them would be adsorbed and filtered out. It is found that a filter not thoroughly dried will filter black petroleum to a yellow but not to water white as a dry filter will.

Since adsorbed moisture leaves an active silicate surface only at high temperatures, a high-temperature (250°C.) water treatment is a means of producing an active surface on silica or a silicate. The H and OH bonds (toward silica) are in a labile state at such temperatures provided the water is confined to prevent its escape. Release of that pressure leaves the bonds open. Even a carbonate may be converted to a hydrate by high-temperature steam treatment if the $CO_2$ is allowed to escape while the supply of $H_2O$ is maintained.

Many other colloidal oxides besides silica and the silicates may be prepared as good filters. Their action is similar in principle as regards adsorption and base exchange even when the micelle is electropositive. The writer has prepared three (Fe, Al and Si) so powerful as to crack even paraffin and heavy laxative oils, reducing them from clear to a black condition. This is done by preparing the gel in maximum dilution. Active colloidal iron, in the form of a dark red-brown powder, will even filter dialized iron from a very dilute yellow suspension, leaving clear water. This form of autoadsorption between colloids is akin to crystallization (adsorption of ions in pairs). The deposit of colloidal iron on and near the surface of siliceous pebbles in stream beds is very common.

ENTOMOLOGY.—*Two new hymenopterous parasites of* Tachypterellus consors *Dietz*.[1] A. B. GAHAN, U. S. Department of Agriculture, Bureau of Entomology. (Communicated by HAROLD MORRISON.)

Two species of Chalcidoidea which appear to be new to science are herewith described. These were reared by GEORGE M. LIST of the Colorado Agricultural College in connection with his studies of their host, a curculionid which is said to be causing considerable injury to cherries in the vicinity of Fort Collins, Colorado. Mr. LIST intends to describe the host insect as a new variety of *T. consors Dietz.*

## Family PTEROMALIDAE

### **Habrocytus lividus**, new species

This resembles *H. piercei* Crawford in size and shape but may be distinguished by the darker, less metallic color of the body and the dark brown or black tibiae, by the shorter ocellocular line which is barely longer than the diameter of an ocellus, and by the shorter propodeum which is without a distinct neck. Differs from *H. obscuripes* Ashmead by the differently colored body and legs, by the more strongly transverse head, and by the less strongly sculptured propodeum.

*Female.*—Length 2.6 mm. Antennae inserted at middle of head; scape cylindrical, extending a little above the vertex; pedicel about twice as long as broad, slender; two ring-joints distinct but transverse; first funicle joint about as long as and a little thicker than the pedicel, not quite twice as long as broad; second to fifth funicle joints each distinctly longer than broad, subequal in length to pedicel, the sixth barely longer than broad; club short ovate, one half wider than the sixth funicle joint and about as long as the fifth and sixth combined. Head strongly transverse, thin antero-posteriorly at vertex, concave behind, reticulate-punctate all over, the sculpture a little finer on vertex and cheeks than on frons and face; ocellocular line very slightly longer than the diameter of a lateral ocellus; eyes bare, malar space equal to about half the height of eye; right mandible four-toothed, the left three-toothed but with the inner tooth broadly truncate and a little concave at apex. Thorax sculptured like the head but with the punctures appearing a little deeper; mesoscutum broader than long, the parapsidal grooves absent on posterior half; scutellum and axillae a little more finely sculptured than the mesoscutum; propodeum short, with a median carina, the lateral folds more or less incomplete, represented at base by deep fossae on either side of the middle and at apex by similar fossae, the two fossae on each side sometimes joined to each other by a very weak longitudinal groove; spiracular groove deep and distinct, spiracles elliptical; propodeum medially with weak reticulation, usually with some foveae along the anterior margin, outside the folds practically smooth. Marginal vein of forewing twice as long as stigmal, the post-marginal very slightly shorter than marginal; discal cilia absent behind submarginal vein. Abdomen twice as long as thorax and about as wide as

[1] Received December 22, 1930.

thorax, conic ovate, sessile, the first tergite occupying less than one fourth the length of abdomen, smooth, following tergites weakly reticulated. General color bluish black; scape yellowish testaceous; flagellum dark brown; wings hyaline, venation pale brownish; coxae bluish, all femora and tibiae brownish black, the knees narrowly, extreme apices of hind tibiae and all tarsi yellowish testaceous; abdomen mostly black but with the basal tergite metallic blue green. The head, propodeum, underside of thorax, and the hind femora show strong steel-blue tints in some lights.

*Male.*—Length 2 mm. Similar to the female except that the antennal pedicel is hardly twice as long as thick, the club is very little broader than the preceding joint, the tibiae are brownish testaceous with the same color pattern as the female but not so dark, and the abdomen is not longer than the thorax.

*Type-locality.*—Fort Collins, Colorado.

*Type.*—Cat. No. 43263, U. S. N. M.

*Host.*—*Tachypterellus consors* Dietz.

Two females and five males received from G. M. List with the statement that they were reared from the above-named host infesting cherry. The type bears the date July 17, 1929, while other specimens bear dates ranging from July 13 to July 17, 1929. One male paratype was returned to the collector.

## Family EULOPHIDAE

### **Entedon tachypterelli,** new species

This species is similar to *E. occidentalis* Girault but differs by having the clypeus much smaller and less prominent, by having the post-marginal vein distinctly a little longer than the stigmal, and by having the abdomen distinctly conic-ovate and longer than the head and thorax combined. The first funicle joint is also shorter than in *E. occidentalis* and the hind tibiae are less extensively black.

*Female.*—Length 3 mm. Antennae inserted nearly on a line with the lower extremities of the eyes; consisting of eight joints and a very short terminal spine; scape cylindrical, slightly curved and attaining the level of the front ocellus; pedicel about two and one-half times as long as thick and somewhat more slender than first funicle joint; one small ring-joint; funicle three-jointed, the first joint a little more than two and one-half times as long as broad and slightly longer than the pedicel, second joint shorter than the first but longer than the third, the latter usually slightly less than twice as long as broad; club 2-jointed, about as long as first funicle joint, ovate and terminating in a very short spine.

Head viewed from above four times as broad as long; vertex perpendicularly truncated behind; occiput very slightly concave; eyes large, conspicuously hairy; ocelli in an obtuse triangle, the ocellocular line very slightly longer than the diameter of lateral ocellus; frontovertex strongly rugoso-punctate; face below antennae, cheeks, and temples more finely rugulose-punctate; clypeus not prominent, its anterior margin not reflexed. Thorax robust; prothorax short, much narrower and on a much lower level than the mesonotum; mesoscutum convex, coarsely rugoso-punctate, the punctures somewhat coarser on posterior half of the median lobe than elsewhere, the parapsidal grooves complete and each terminating posteriorly in a deep depression; scutellum rather large, convex, sculptured like the mesoscutum, usually with a broad shallow transverse depression near the middle; axillae broadly separated and sculptured like the scutellum; propodeum shining, more or less weakly reticulated, the median carina distinct but without a foveolate furrow along either side of it, lateral folds represented by very broad deep furrows or depressions which cause that portion of the propodeum between these folds to appear as an elevated area with sharp lateral margins; propodeal spiracles round, the spiracular areas appearing as rather large tubercles or raised areas surrounded by deep grooves; marginal vein longer than submarginal and distinctly somewhat thicker at base than at apex; postmarginal longer than the stigmal; hind coxae dorsally rather coarsely reticulated, laterally and beneath more finely sculptured.

Abdomen conic-ovate, subsessile, about one-fourth longer than the head and thorax together, usually slightly narrower than the thorax, the first, second, third, and fourth tergites weakly reticulated; first, sixth, and seventh tergites subequal in length and each a little longer than any of the other tergites; ovipositor originating at or very near base of abdomen and not extending beyond the apex.

Head, thorax, all coxae, and first tergite bluish green, occiput black; antennal flagellum brownish black, the scape bluish green; mandibles black, with their apices brown; all trochanters, all femora, a band of varying width (sometimes embracing half their length) on the middle and hind tibiae near base, and the anterior and posterior margins of front tibiae, dark bluish to black; knees, all tibiae except as indicated, and all tarsi pale yellow; abdomen except first tergite bronzy black; wings hyaline with the venation dark brown.

*Male.*—Length 2.5 mm. Similar to the female but with the scape distinctly though not greatly thickened, the flagellum somewhat more tapered toward apex, the club more distinctly separated into two joints, the ocellocular line equal to the diameter of a lateral ocellus, abdomen not longer than the thorax, elliptical in outline, distinctly petiolate, the petiole about as long as broad. The color agrees with that of the female except that the front is deep purplish.

*Type-locality.*—Fort Collins, Colorado.

*Type.*—Cat. No. 43262, U. S. N. M.

*Host.*—*Tachypterellus consors* Dietz.

Described from eight females and eight males received from GEO. M. LIST of the Colorado Agricultural College with the information that they were reared from the above named curculionid. One paratype of each sex returned to the collector.

## HERPETOLOGY.—*New Bahaman reptiles.*[1] DORIS M. COCHRAN, U. S. National Museum. (Communicated by C. WYTHE COOKE.)

During the summer of 1930 an extensive collecting trip through the Bahama Islands was carried out by Dr. PAUL BARTSCH of the United States National Museum, supported by the WALTER RATHBONE BACON Scholarship Fund. Islands which no naturalist had hitherto visited

[1] Received December 29, 1930. Published by permission of the Secretary of the Smithsonian Institution.

were explored for the first time scientifically. Excellent series of lizards obtained from many localities have already proved valuable in studies of variation among species which before have been poorly represented in any museum collection.

### **Leiocephalus inaguae,** new species

*Diagnosis.*—A distinct lateral fold; four scales (an internasal and three prefrontals) between the rostral and the supraorbital ring; the second prefrontal large and in contact with its fellow; body scales moderately large, 70 to 82 dorsals between occiput and beginning of tail, 16 to 20 in the distance between end of snout and occiput; males with a row of large squarish black blotches on the shoulder region, continuing down the sides and fading out rapidly; faint traces of two more rows of squarish blotches on the back.

*Type* .—U. S. N. M. Cat. No. 81277, an adult male from Man of War Bay, Great Inagua Island, collected August 8, 1930.

### **Leiocephalus carinatus punctatus,** new subspecies

*Diagnosis.*—Closely resembling the Cuban *Leiocephalus carinatus*, but differing from it in having a larger scale at the upper anterior region of the ear as well as in possessing a more vivid color pattern with a somewhat different arrangement of light and dark pigment especially on the head.

*Type.*—U. S. N. M. Cat. No. 81560 (collector's number 135), a male taken on the north shore of the bay at Jamaica Wells, Acklin Island, July 6, 1930.

### **Cyclura carinata bartschi** new subspecies

*Diagnosis.*—Nasals broadly in contact with the rostral and with each other; a pair of supranasals also closely in contact with each other; the scales of the prefrontal region quite uniform in size and shape, and grading into the smaller frontal and parietal scales; supraorbital semicircles barely differentiated by an occasional somewhat enlarged scale; scales of the supraocular region distinctly smaller than the other supracephalic scutes; two to four enlarged vertical canthals on each side of the head; nuchal and caudal crests widely separated from the dorsal crest, which is 12 mm. high (in adult males) and is composed of 60 to 73 spines (average in 6 specimens, 63.5); nuchal crest composed of 16 to 20 spines (average 17.1), the highest of which measures 15 mm.; 4 vertical rows of small scales between the fifth and sixth verticils of the tail; 8 supralabials (rarely 9) to a point below the center of the eye; rostral wider than the mental; three to four enlarged tibial scales equaling the vertical diameter of the tympanic membrane.

*Type.*—U. S. N. M. Cat. No. 81212 (collector's number 172), an adult male from Booby Cay, east of Mariguana Island, Bahamas, collected July 21, 1930.

### **Anolis leucophaeus mariguanae,** new subspecies

*Diagnosis.*—Similar to *Anolis leucophaeus* Garman, but differing from it in coloration. Ground color drab gray above, lavender-gray beneath, often with a wide clove-brown lateral band which originates on the loreal region, passes through the eye and above the ear, and widens above the shoulder continuing onto the base of the tail and gradually fading out; a light area usually bounding its lower border; a second dark lateral stripe beginning on the malar region just behind the mental, continuing back beneath the ear and merging in front of the shoulder with the upper lateral stripe in some cases, in other cases widening and suffusing the entire side of the throat and upper-arm region with a dusky mottling; skin of gular fan lavender-gray, the scales white or olive-yellow. The young have dark latero-ventral reticulations, and the throat usually has a series of dark longitudinal lines. In adult males the tail fin is large and its upper edge is indistinctly mottled with dark in the region of the rays. Limbs sometimes unmarked, sometimes with wide, irregular dark bars. Scales on limbs a little smaller than in *leucophaeus* proper; scales of tail a little larger.

*Type.*—U. S. Nat. Mus. Cat. No. 81346, an adult male from Mariguana Cay, taken July 18, 1930.

ZOOLOGY.—*Flagellate spermatozoa in a nematode* (Trilobus longus).[1] B. G. CHITWOOD, The George Washington University. (Communicated by PAUL BARTSCH.)

The spermatozoa of nematodes are usually thought of as ameboid, *Ascaris* having been the example studied for years. Yet Professor

Figure 1. Anterior end of a single sperm; from a section stained with dahlia and eosin.

Figure 2. A testis of a male *Trilobus longus* showing the flagellate spermatozoa. ×415.

E. B. WILSON in 1925[2] says "In others such as those of *Ascaris*, the sperm may be regarded as a much shortened and thickened flagelliform cell with a relatively large amount of cytoplasm and a very short and non-vibratile tail." If his conception is correct, one would expect to find among the free-living nematodes forms in which the spermatozoa retain their tail and are capable of movement.

While examining collections from the beach sand at White Lake, North Carolina, attention was drawn to the rather obvious spermatozoa of *Trilobus longus*. They may be readily seen in living specimens of both male and female. The spermatozoa (Fig. 1) are approximately 60$\mu$ long. The head is blunt and expanding quickly posteriorly, and of oval outline in transverse section. The small nucleus is situated

[1] Received November 6, 1930.

[2] *The cell in development and heredity*, p. 298.

at the extreme anterior end of the head. The tail is long and tapering. From a casual observation of both living and sectioned testes (Fig. 2), I am inclined to believe that spermatogenesis is normal. Primary and secondary spermatocytes as well as spermatids are present.

When a living specimen is mashed and the spermatozoa liberated on the slide they move with a slow serpentine motion. Spermatozoa thus freed are short-lived, lasting at best only about three minutes. In the female the activity of the spermatozoa is best observed. When mature females are examined, these almost always contain a somewhat twisted ball-shaped mass of spermatozoa in a definite place in each uterus, the spermatheca. Here they may be seen slowly squirming over one another.

Probably many other nematodes have flagellate spermatozoa. *Trilobus longus* is described by Dr. N. A. Cobb in Ward and Whipple's *Fresh Water Biology,* a book available to most zoologists. The nematode is widespread, common on the sandy bottom of lakes and streams between the depths of six inches and two feet. The cytologist might find the spermatogenesis of *Trilobus* an interesting problem.

## PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

### PHILOSOPHICAL SOCIETY

#### 1004TH MEETING

The 1004th meeting was held in the Cosmos Club Auditorium, March 15, 1930, President Lambert presiding.

*Program:* W. J. Rooney: *Earth-resistivity survey at Huancayo, Peru, and relation of resistivity to earth-current potential records.*—This survey, carried out near the Huancayo (Peru) Magnetic Observatory of the Department of Terrestrial Magnetism in the high Andes, is one of a series of earth-resistivity surveys made in connection with the study of earth-currents at observatories where potential gradient registration is in progress. The general resistivity of the region and its variation with position, depth, direction of current flow and rainfall, were determined. All may affect potential records and are indicative of the geological structure.

The resistivity of soil near the surface varied from over 100,000 to less than 2000 ohm-cm., depending on the character of the overburden. The mean values tended to converge to a value around 10,000 ohm-cm., as earth to depths of 200 to 300 meters was included in the measurements. These results are typical for an underlying structure of sedimentary rocks. A local area of high resistivity (values three times the mean for the region as a whole) was found near one earth-current line and explains the high-potential gradient records obtained from that line. The results were found to be independent of the orientation of the survey lines, indicating that the region is laterally isotropic. The seasonal variation was small and relatively unimportant. (*Author's abstract.*)

Discussed by Messrs. Gish and Lambert.

C. B. Watts: *The transit instrument and the synchronous motor.*—A new driving mechanism for the traveling-wire micrometer of a transit instrument has been developed at the Naval Observatory. It consists of a small synchronous motor, weighing only a few ounces, mounted on the micrometer and geared directly to the screw. The speed at which the traveling wire moves is adjusted to suit the declination of the star under observation by changing the frequency of the current which drives the motor.

A true alternating current is not required to run the motor, and it has been found convenient in practice to change a direct current by means of a rapidly revolving commutator into a rough approximation to a two-phase alternating current. The commutator is made to revolve at a speed corresponding to a particular declination by means of a friction drive. The observer can also cause the brushes which take the current from the commutator to rotate slowly in one direction or the other and thus alter the frequency by such amounts as are necessary to keep the star bisected. This auxiliary apparatus is controlled by means of a push button in the observer's hand. By this means very satisfactory results have been secured, the probable error of a single observation, including errors of star places, being $0^s.12$.

The possibility of applying similar motors to a photographic transit instrument is also being investigated, the plate being moved in such a way as to compensate as nearly as possible for the motion of the star images. (*Author's abstract.*)

Discussed by Messrs. White, Kracek, Curtis, and Lambert.

R. E. Gibson and L. H. Adams: *The volume change of rubber under pressure.*—Direct measurements were made of the fractional change in volume undergone by samples of rubber when subjected to pressures up to 12,000 megabaryes. The samples investigated were:—hard rubber containing 27 percent of sulphur, and two specimens of soft rubber containing 10 and 5 percent of sulphur, respectively. Between 1 and 12,000 mb. the changes in volume for the specimens in descending order of sulphur content are 13.3, 16.1 and 18.5 percent of the volume at 1 mb. respectively. The compressibilities of the samples arranged in like order fall from 19.2, 35.2 and 36.6 at 1 mb. to 6.3, 5.9 and 6.3 at 12,000 mb. The compressibilities are fractional volume changes expressed in parts per million per megabarye. The course of the compressibility curve for soft rubber is strongly suggestive of that of a liquid. (*Author's abstract.*)

Discussed by Messrs. Canfield, Gish, Hawkesworth, Dryden, Kracek, L. H. Adams, and Curtis.

## 1005th meeting

The 1005th meeting was held in the Cosmos Club Auditorium, March 29, 1930, President Lambert presiding.

*Program:*

C. G. McIlwraith: *Radio frequency standards:* Discussed by Messrs. Brown, Crittenden, Humphreys and Tuckerman.

H. Diamond: *Radio aids to air navigation.*—Research work on a visual-type radio-beacon system for use on the airways of the United States has been under way at the Bureau of Standards during 1926–1929. As a result of this work a system has been developed which fulfills the requirements for course navigation on the civil airways. A directional transmitter is employed on the ground making possible the use of simple apparatus on board the airplane. A single receiving set is sufficient to make use of all the radio aids provided. Visual indication is provided by means of a tuned-reed course indicator. The pilot observes the vibration amplitudes of two reeds. On the course, the amplitudes are equal. Off the course, they are unequal, the reed vibrating with the greater amplitude being on the side to which the airplane has deviated.

Two types of beacon transmitters are described, the double-modulation and the triple-modulation. The former is capable of serving either two courses at 180° with each other or four courses at arbitrary angles. The latter serves twelve courses at arbitrary angles, and is better adapted for use at airports located at the junction of a large number of airways. Reed indicators for use with the double-modulation and triple-modulation beacons are described.

A discussion of the receiving set and receiving antenna system employed is included. Airplane engine ignition shielding is also discussed.

A marker-beacon system has been developed whereby the pilot is given visual indication of his exact position at definite intervals along the route.

Special adaptations of the beacon system are described for facilitating landing in fog. (*Author's abstract.*)

### 1006TH MEETING

The 1006th meeting was held in the Cosmos Club Auditorium, April 12, 1930, Vice President Curtis presiding.

The program consisted of five illustrated papers discussing various phases of the scientific work during the seventh cruise of the *Carnegie*. The discussion of the papers was deferred until they had all been presented.

*Program:* J. A. Fleming: *Terrestrial magnetism.*—Of the 110,000 nautical miles planned for the seventh cruise of the *Carnegie*, nearly one-half had been completed since her departure from Washington, May 1, 1928, upon her arrival at Apia, November 28, 1929. The work done has realized practically in every detail the extensive scientific program planned to determine magnetic secular-variation, to extend the atmospheric-electric survey, and to undertake more comprehensive work in physical and chemical oceanography and in marine biology and meteorology. An outstanding feature had been the successful development of the practical technique and instrumental appliances for oceanographic work on a sailing vessel—an accomplishment of which Captain Ault and his men had good reason to be proud. During the first six cruises chief emphasis was placed on the magnetic and electric programs, with only a moderate amount of atmospheric-electric and meteorological observations. In Cruise VII those high standards planned under the energetic directorship of Dr. Bauer and his coworkers, and so well developed by the vessel's first commander, W. J. Peters, and his successor, Captain J. P. Ault, were being maintained.

But Cruise VII was tragically the last of the seven great adventures represented by the world-cruises of the *Carnegie*. It was shortly after one o'clock November 29, 1929, while in harbor at Apia, Western Samoa, and completing the storage of 2,000 gallons of gasoline, that an explosion took place as the result of which Captain Ault and Cabin-Boy Kolar succumbed, the engineer, mechanic, and three seamen were injured, and the vessel with all her equipment was destroyed by the resulting fire.

Thanks to that characteristic promptness of Captain Ault, however, all records, reports, and samples obtained to arrival at Pago Pago, American

Samoa, November 18, 1929, had been mailed or forwarded by freight from that port, and all have now been received in Washington.

The standard instruments for the program in terrestrial magnestism were the collimating-compass for declination, the deflector for horizontal intensity, and the marine earth-inductor for inclination. Mr. F. M. SOULE, one of the scientific staff on Cruise VII, had been carrying on experimental work aboard during the cruise with the inductor for the determination of horizontal intensity, and the progress made which will be described elsewhere gives promise that this method will ultimately be more reliable than the deflector method. The summary of the ship's log and magnetic observations during May 1928 to November 1929 shows that in a total of 376 days actually at sea 44,877 sea miles had been covered by the vessel, and that the magnetic declination, horizontal intensity, and inclination had been determined at 520, 175, and 174 stations, respectively. Shore observations were also obtained at repeat-stations in Iceland, Barbados, Easter Island, Peru, Western Samoa, Guam, Japan, and California, including intercomparisons of magnetic standards at the following observatories: Seddin (Germany), Huancayo (Peru), Apia (Western Samoa), and Kakooka (Japan).

The preliminary values of the magnetic elements and the average annual-changes based on over 100 intersections with previous cruises of the *Carnegie* in the Atlantic and Pacific oceans have been published. The values obtained through September 1929 have been utilized by the United States Hydrographic Office in preparing its revised isomagnetic world-charts for the epoch 1930 only recently issued. The annual-change values show that the recent isomagnetic charts are substantially correct. The agonic line, however, is nearer the western coast of South America than indicated on the charts. The area of rapid increase in magnetic inclination in the western Caribbean and off the coast of northwestern Peru extends westward to the line of no annual change passing from the Gulf of Alaska past the neighborhood of Samoa. The annual-change values of horizontal intensity are not quite so consistent as are those of other elements—a condition to be expected in view of the greater difficulty in precise determinations of this element.

In view of the fact that the Institution's magnetic-distribution survey of the oceans has been practically completed in the work already done by the *Carnegie* and because of the large sum—probably twice the original cost—which would be required to construct and equip a second and like non-magnetic ship, the trustees of the Carnegie Institution of Washington have decided not to replace the *Carnegie.* It is hoped, however, that steps may be initiated through cooperation of oceanographic interests in the United States for a ship specially designed for oceanographic researches including occasional magnetic and electric observations in all oceans in continuation and development of the plans which were being executed on the *Carnegie.* It is in this way chiefly that the experience and technique acquired in many years of preparation, of development of instruments, and of cruising could be capitalized to benefit future oceanographic research.

The high esteem and regard for Captain AULT and his work have been demonstrated by the many cablegrams, letters, and resolutions of condolence received from all parts of the world. These too have furnished much additional evidence of that universal good-will which has, throughout the cruises of the *Carnegie* and her predecessor, the *Galilee,* so marked these activities. (*Author's abstract.*)

F. N. Soule: *Oceanography.*—The actual work of observation and collection in the field of physical oceanography on Cruise VII of the *Carnegie* consisted of the collection of bottom-samples and the measurement of depths, temperatures, and salinities. Various bottom-sampling devices were used. Depths were measured with thermometers, wire lengths, and sonic-soundings. Temperatures were measured by means of deep-sea reversing thermometers, and water-samples were collected with Nansen water-bottles. Salinities were measured by the conductivity method using the Wenner salinity-bridge. The extent of the work is described as well as the method of collection and measurement. (*Author's abstract.*)

H. W. Graham: *Biology and chemistry.*—The biological program of the *Carnegie* was designed for the study of the planktonic organisms in the upper 100-meter layer in the open ocean. Silk nets were towed at the surface, at 50 meters, and at 100 meters for the capture of qualitative samples, and a Pettersson plankton-pump was operated at the same levels to obtain samples for quantitative studies.

The chemical program was confined to a study of the conditions affecting the distribution of organisms in the sea. All water-samples collected were analyzed for hydrogen-ion concentration, phosphates, silicates, and dissolved oxygen. The results in the Pacific show that the waters may be divided into three general layers: An upper layer where an active plant and animal life is maintained, a middle layer in which a decomposition of organic remains is taking place, and a lower layer which represents water that has been conducted from polar regions. The upper layer shows high values of dissolved oxygen but low values of phosphates, silicates, and hydrogen-ion concentration. The middle layer is low in oxygen but high in phosphates and silicates, and is relatively less alkaline. The lower layer tends toward conditions at the surface with again higher values of dissolved oxygen and lower of phosphates, silicates, and hydrogen-ion concentration. (*Author's abstract.*)

J. H. Paul: *Meteorology.*—An abbreviation of the usual magnetic investigations made it possible to undertake a complete meteorological program during Cruise VII of the non-magnetic vessel *Carnegie.* In addition to the ordinary observations, a study of several special problems in atmospheric circulation over the oceans was initiated. Temperature and humidity lapse rates from quarter-deck to masthead were recorded automatically by a Hartmann and Braun electric-resistance multi-thermograph with three pairs of thermal elements (wet and dry) at various heights. Continuous thermograms of sea-surface temperature were obtained by a bulb-and-capillary recorder. Continuous humidity measurements were also obtained by a recording aspiration psychrometer of Negretti and Zambra manufacture for immediate use aboard and as a control on the multi-thermograph. These instruments were all intercompared with standard thermometers daily. A continuous record of atmospheric pressure was kept by an aneroid barograph which was daily checked by readings on standard mercurial barometers. In addition to these records, soundings of the upper air were made almost daily in the Pacific with hydrogen-inflated pilot balloons for direction and velocity of the air currents to great heights. Measurements of the rate of evaporation were carried out when conditions were favorable. Projected studies in total solar and sky radiation, although of great interest, had to be abandoned because of the difficulties encountered in working on a vessel with lofty sails and because of pressure of other work.

The great interest of meteorologists in the work of the *Carnegie* is due to the fact that she sailed in regions from which data is very scanty and was working with instruments whose accuracy is known, something one can not claim for the commercial vessels from which ocean observations are ordinarily obtained. (*Author's abstract.*)

O. H. GISH: *Atmospheric electricity.*—Work on previous cruises of the *Carnegie* has shown not only that satisfactory measurements of the elements of atmospheric electricity could be made on a moving vessel at sea but also that the electrical state of the atmosphere over ocean areas is little affected by local factors such as give a confusing complexity to these phenomena over land. It was due to this circumstance that S. J. MAUCHLY was able to conclude, from the comparatively small amount of data obtained on Cruises IV, V, and VI, that the regular change during the day of the electric intensity, or potential gradient, over the oceans proceeds on a universal schedule everywhere. This important discovery has been verified by the extensive data obtained on Cruise VII. Much encouraged by the outcome of earlier cruises a more intensive and elaborate program was planned for Cruise VII, general facilities and sundry instrumental features were improved, a photographic recorder for potential gradient was installed at Washington (May 1928) and a recorder of conductivity at San Francisco (August 1929), an additional instrument for measuring the penetrating radiation and of a different type from that used on the Carnegie since 1915 was provided. These and an Aitken "dust" counter constituted the new instrumental equipment.

As a measure of the work accomplished, the following is significant: Aside from over 200 complete daily programs and a number of diurnal-variation series (24 consecutive hours each) not completed due to the development of bad weather, the number of complete diurnal-variation series with eye-reading instruments were obtained as follows: conductivity, 22; ionic-content, 20; mobility (indirect), 20; penetrating radiation, 26; condensation nuclei (with Aitken dust counter), 15; and with photographic recorders satisfactory complete daily records of potential gradient, free from negative potential, were obtained for 194 days and of conductivity for 56 days, the latter from San Francisco to Apia. The diurnal-variation series by eye-readings were obtained at about twice the rate for previous cruises, and the recorder yielded satisfactory data at more than tenfold the rate previously attained by eye-reading methods. The gratifying success of this program is in a great measure due to the enthusiasm, diligence, and skill of W. C. PARKINSON, senior scientific officer, who was in charge of the work on board throughout the cruise, and O. W. TORRESON, executive officer, from Washington to San Francisco, and S. E. FORBUSH, executive officer, San Francisco to Apia, who assisted in some aspects of the work. (*Author's abstract.*)

The papers were discussed by Messrs. HECK, PETERS, SVERDRUP, CURTIS and HAWKESWORTH.

OSCAR S. ADAMS, *Recording Secretary*

## SCIENTIFIC NOTES AND NEWS

GEORGE OTIS SMITH, Director of the Geological Survey since 1907, resigned December 22, 1930 to accept appointment as Chairman of the Federal Power Commission. WALTER C. MENDENHALL, formerly chief geologist, has been designated acting director by the Secretary of the Interior. T. W.

Stanton is now acting chief geologist; John B. Reeside, Jr., is acting geologist in charge of the section of paleontology and stratigraphy; and H. D. Miser has been designated acting chairman of the committee on geologic names. Messrs. Reeside and William W. Rubey have been added to the committee.

H. G. Barber of Roselle, New Jersey, has been appointed a specialist in Hemiptera in the Bureau of Entomology and placed in charge of the collection in the National Museum.

Dr. Wm. A. Hoffman, of the Porto Rican School of Tropical Medicine, and Dr. Joseph Bequaert, of the Harvard University Medical School, were visitors at the Division of Insects of the National Museum in December.

Dr. Carleton R. Ball, formerly principal agronomist in charge of the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, went to California early in January to take charge of a survey of federal, State, and local (county and city) relationships in the diverse agricultural activities in that State. The survey of agriculture, which is the first of a series planned to cover these relationships in all human activities in California, is conducted by the Bureau of Public Administration of the Department of Political Science of the University of California at Berkeley with funds from the Rockefeller Foundation. It is hoped to complete and publish the agricultural survey in 1931.

Dr. David G. Fairchild, botanist and agricultural explorer now attached to the Office of Foreign Plant Introduction of the Department of Agriculture, has been awarded the George Robert White medal by the Massachusetts Horticultural Society.

## Obituary

George Gooding Ainslie, of Knoxville, Tenn., since 1908 connected with the U. S. Bureau of Entomology, died suddenly in Washington December 19, 1930. He was born in Rochester, Minn., March 7, 1886. He studied at the University of Minnesota, where he was assistant to the State Entomologist from 1906 to 1908. During 1909–1910 he was assistant in entomology at Clemson College.

Frederick J. Pritchard, plant physiologist of the Bureau of Plant Industry since 1910 and a member of the Academy, died suddenly at his office January 13, 1931. He was born at Camanche, Iowa, December 24, 1874. He received the degree of bachelor of science from the University of Nebraska in 1904 and later served as instructor in botany and bacteriology at the North Dakota Agricultural College, where he became assistant professor in botany and pathologist at the college experimental station in 1905. In 1907 he was made assistant in plant breeding at Cornell University and in 1909 became botanist at the Wisconsin Experimental Station while an agent of the Department of Agriculture. He specialized in breeding disease-resisting varieties of tomatoes.

## OFFICIAL COMMUNICATIONS

### THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

#### Announcements of Meetings

| | |
|---|---|
| Wednesday, February 4 | The Society of Engineers |
| | The Medical Society |
| Thursday, February 5 | The Entomological Society |
| Friday, February 6 | The Geographic Society |
| Saturday, February 7 | The Biological Society |
| Tuesday, February 10 | The Institute of Electrical Engineers |
| Wednesday, February 11 | The Geological Society |
| | The Medical Society |
| Thursday, February 12 | The Chemical Society |
| Friday, February 13 | The Geographic Society |
| Saturday, February 14 | The Philosophical Society |
| Tuesday, February 17 | The Anthropological Society |
| | The Historical Society |
| Wednesday, February 18 | The Society of Engineers |
| | The Medical Society |
| Thursday, February 19 | The Academy |

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:* N. A. Cobb, Bureau of Plant Industry.
*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
*Treasurer:* Henry G. Avers, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings



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OF THE

# WASHINGTON ACADEMY OF SCIENCES



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## 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.

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*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. 21 FEBRUARY 19, 1931 No. 4

BOTANY.—*A new spiral-orchid from the southern states.*[1] EDGAR T. WHERRY, University of Pennsylvania.

While studying the soil-reaction relations of native plants in the south, I have repeatedly observed in boggy pinelands a spiral-orchid (ladies-tresses) not corresponding to any species included in Small's Flora.[2] It is closely related to the Slender Spiral-orchid [*Ibidium gracile* (Bigel House)], and search for morphological differences between them has not been particularly successful. They are, however, more or less distinct in flower color, sepal length, habitat, range, and blooming period, and show no evident intergradation. The southern plant is accordingly here described as a new species.

Lateral sepals little exceeding the bend in the green-centered lip; growing in moderately acid grassy fields, S. C. to Tex. and northward to N. S. and Man.; blooming in summer............................*Ibidium gracile*

Lateral sepals decidedly exceeding the bend in the yellow-centered lip; growing in strongly acid moist pine-lands, Fla. to Tex. and northward to central S. C.; blooming in spring..................*Ibidium floridanum*

**Ibidium floridanum** Wherry, sp. nov.

FIG. 1.

*I. gracili* similis, sed floribus vernalibus et labii medio intense flavo.

Resembling *I. gracile;* roots several; principal leaves basal, appearing in autumn and withering the following summer, more or less petioled, the blades elliptic, 1 to 4 cm. long and 5 to 20 mm. wide; stem 15 to 40 cm. tall, bearing 4 to 7 remote scale-like leaves; raceme 3 to 10 cm. long, single ranked, often strongly spiralled; flowers usually opening in March or April (occasionally as early as mid-December or as late as mid-May); color creamy white with the middle of the lip deep yellow [in this respect resembling *I. plantagineum* (Raf.) House]; lateral sepals about 5 mm. long, often projecting rather markedly beyond the bend in the lip; callosities stubby, 1 mm. long.

[1] Contribution from the Botanical Laboratory of the University of Pennsylvania. Received November 26, 1930.

[2] Flora of the Southeastern United States. 319. 1903.

Type in U. S. National Herbarium, no. 1,466,427, collected by Edgar T. Wherry April 14, 1930, near Loretto, Duval County, Florida. Named from the fact that it is widespread and abundant in this state, specimens having been seen from the following counties: Broward, Duval, Flagler, Gadsden, Hillsborough, Jackson, Lake, Lee, Marion, Orange, Pinellas, St. Johns, and Walton.

Noteworthy specimens are as follows:

FLORIDA:

Tampa Bay, *Burrows*, 1834; the earliest known collection (New York Botanical Garden)

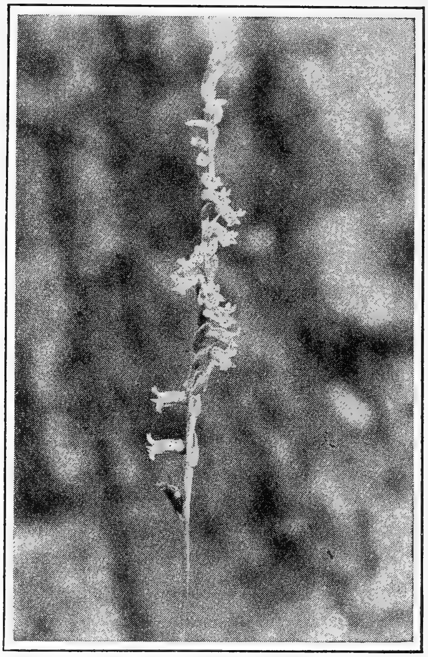

FIG. 1. *Ibidium floridanum*
Type locality. Natural size.

Fort Myers, *Standley*, December 14, 1919; an unusually early blooming date (United States National Herbarium)

Fort Lauderdale to Miami, *Small & Carter*, February, 1911; the southernmost known station (N. Y. B. G.)

GEORGIA:

Milledgeville, *Boykin*, 1836 (N. Y. B. G.).

Wrightsboro, *Chapman* (N. Y. B. G.)

SOUTH CAROLINA: Anderson, *Davis*, April 9, 1919; the northernmost known station (U. S. N. H.)

ALABAMA: Mobile, *Mohr*, May, 1868 (U. S. N. H.)

MISSISSIPPI: Koshtaw, *Tracy*, May 20, 1898. (N. Y. B. G.)

LOUISIANA: Alexandria, *Hale*, April. (N. Y. B. G.)

TEXAS: Houston, *Hall*, April 1, 1872; the westernmost known station (N. Y. B. G.)

The southernmost occurrences of *I. gracile* represented among specimens seen are:
SOUTH CAROLINA: Aiken, *Ravenel*, September, 1869 (U. S. N. H.)
ALABAMA: Auburn, *Pollard & Maxon*, July 9–11, 1900 (U. S. N. H.)
ARKANSAS: Texarkana, *Heller*, August, 1898 (N. Y. B. G.)
The ranges of the two species thus barely overlap.

PALEONTOLOGY.—*Revision of the names of three fossils from the Castle Hayne and Trent marls in North Carolina.*[1] L. B. KELLUM, University of Michigan. (Communicated by C. WYTHE COOKE.)

In Professional Paper 143 of the United States Geological Survey, 1926, the writer described a number of new species of invertebrate fossils from the Castle Hayne and Trent marls of North Carolina. His attention has since been called to the preoccupation of two of the specific names used in that paper, and to an earlier description of a species which he described and named as new. The names incorrectly used in Professional Paper 143 are *Cassidulus berryi* Kellum, applied to an echinoid from the Castle Hayne marl, *Terebratula crassa* Kellum, for a brachiopod from the Trent marl, and *Macrocallista minuscula* Kellum, applied to a mollusk from the Trent marl. New specific names are therefore proposed for the first two of these fossils and an earlier name replaces the third.

**Cassidulus (Pygorhynchus) sabistonensis** Kellum, nom. nov.

New name for *C. berryi* Kellum, 1926, described and figured in U. S. G. S. Prof. Paper **143**: 15, pl. 1, f. 4–7. The specific name *berryi* was used by M. W. TWITCHELL in 1915 for a *Cassidulus* occurring in the Waccamaw marl at Neills Eddy Landing, Cape Fear River, N. C. This was published in U. S. G. S. Monograph 54 on *The Mesozoic and Cenozoic Echinodermata of the United States.* As the name is therefore preoccupied in this genus, I propose the specific name *sabistonensis* for the form collected two miles north of Jacksonville, Onslow County, N. C. on the farm of E. W. SABISTON.

**Terebratula posteriora** Kellum, nom. nov.

New name for *T. crassa* Kellum 1926. The specific name *crassa* is preoccupied in this genus, having been used by D'ARCHIAC in 1846. The writer's attention was called to this fact by WILLIAM HEALEY DALL in a letter dated October 20, 1926. Dr. DALL says: "Now there is an earlier *Terebratula crassa* of D'Archiac 1846; see Soc. Geol. France mém. 2me ser. 2, p. 318, pl. 18, figs. 8*a-d*, 9—according to CARUS and ENGLEMANN."

As this new species from North Carolina has been found at only one locality and all specimens collected are broken along the anterior margin, the new name *posteriora* is indicative of the part of the shell usually preserved.

**Callista (Callista) nuesensis** (Harris)

*Synonym: Macrocallista minuscula* Kellum 1926. This species was described and figured by G. D. HARRIS in 1919 in the Bulletin of American

[1] Received December 17, 1930.

Paleontology vol. 6, No. 31, p. 136, pl. 43, figs. 4–7, 10, as *Meretrix neusensis* In February 1927, Katherine Van Winkle Palmer in a monographic study of the Veneridae of Eastern America, Vol. 1, No. 5, assigned this species to the genus *Callista*. The specimens figured by these authors are casts of the interior and exterior, except for one pseudomorph. The valve figured by the writer in Prof. Paper 143, pl. 10, figs. 1–2, is an almost perfectly preserved shell.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## THE ACADEMY

### 236th meeting

The 236th meeting of the Academy was held in the Assembly Hall of the Cosmos Club on Thursday, December 18, 1930. About ninety persons were present. President Bowie called the meeting to order at 8:15 and introduced the speaker of the evening, Prof. A. M. Banta of Brown University and Research Associate of the Carnegie Institution.

*Program:* A. M. Banta: *What the crustacean tells us about evolution.*—Studies in parthenogenetic inheritance in *Cladocera* have revealed the occurence of certain mutations—some morphological, others physiological in their effects. By means of selection some of these changes have been progressively increased or decreased in accord with the direction sought in selection. Since selection and return selection have been successful in whichever direction attempted, it appears that further genetic changes (new mutations) are occurring. Such derivation of two different and relatively stable types from a single ancestor seems to represent evolution in its simplest form and it is believed that these studies may throw some light upon one of the methods of evolution.

As one of the results of the study of some of the mutant characters in *Daphnia longispina* in sexual reproduction it was found that the characters studied were inherited, as anticipated, in typical mendelian fashion. An unexpected result of the studies in sexual reproduction was the finding of evidence that many physiological mutations occur during parthenogenesis. Further studies on this point have shown that after a long and uninterrupted succession of parthenogenetic generations, numerous lethal, sublethal and other physiological recessive mutations (not present or present in very limited numbers in the early parthenogenetic generations) have accumulated during the long period of parthenogenesis. This was demonstrated by (1) inbreeding among the members of a parthenogenetic pure line or clone early in its parthenogenetic history and (2) again after the lapse of a large number of parthenogenetic generations. Few of these recessive lethal and other physiological characters manifest themselves in the early inbreeding; many manifest their presence in the later inbreeding experiments.

One character, "thermal," which appeared in the inbreeding of a clone long parthenogenetic was of more than usual interest. It is a recessive which presumably occurred as a mutation during parthenogenesis but in simplex or hetorozygous condition and manifested itself only when it became duplex or homozygous in one of the sexually produced offspring derived from inbreeding the clone involved. Individuals of this derived thermal clone were more resistant to high temperatures, less resistant to lower temperatures, had a higher optimum temperature and in other ways manifested their thermal character as contrasted with individuals of other related but non-thermal clones. Such an origin of thermalness offers the possibility of explanation of the origin of thermal races in nature by mutation rather than by a long period of acclimatization as we have been wont to assume. (*Author's abstract.*)

## 237TH MEETING

The 237th meeting of the ACADEMY, being the 33rd annual meeting, was held in the Assembly Hall of the Cosmos Club at 8:15, on Thursday, January 15, 1931, with 125 persons present. Vice-President J. M. COOPER called the ACADEMY to order at 8:15 and introduced the retiring President, WILLIAM BOWIE, who addressed the ACADEMY upon, *Shaping the earth.*

At the close of the address the Vice-President announced the annual business meeting and declared a recess, with the request that members of the ACADEMY remain. Then President BOWIE called the meeting to order.

The minutes of the 32nd annual meeting were read by the Recording Secretary and approved. The report of the Corresponding Secretary, L. B. TUCKERMAN, recorded an addition of 31 new members during the year 1930, and the election of Dr. FRANK WIGGLESWORTH CLARK, Dr. WILLIAM H. HOLMES and Dr. LELAND O. HOWARD as honorary members. The members of the ACADEMY stood for a moment in respectful memory of the following members who died during the year:

E. C. CHILCOTT
ASAPH HALL
OLIVER P. HAY
FRANK J. KATZ
LOUIS MACKALL
WILLIAM A. ORTON
DANIEL W. SHEA

The membership was summarized for the year as 18 honorary members, 3 patrons, 1 life member and 560 members. Total membership 582, of whom 381 reside in or near the District of Columbia. The report of the Corresponding Secretary was approved.

The report of the Recording Secretary showed that 8 meetings had been held, of which one was a joint meeting with the Geological Society. Seven of the meetings were devoted to the series of lectures upon *Origin and evolution.* The names of the speakers and titles were given. The minutes of these meetings and abstracts of the addresses given had been prepared for publication in the Journal. The report of the Recording Secretary was ordered accepted.

The Treasurer, H. G. AVERS, reported in full upon the investments, receipts and expenditures of the ACADEMY. The summary showed receipts during the year, $7,805.34. Bank balance January 1, 1930, $2,798.70. Total to be accounted for, $10,604.04. Disbursements, $9,584.35. Bank balance, December 31, 1930, $1,019.47.

### FINANCIAL STATEMENT

| ASSETS | | LIABILITIES | |
|---|---|---|---|
| Cash | $1,019.47 | Dues prepaid | $20.00 |
| Investments | 21,133.87 | Subscriptions prepaid | 294.70 |
| Accounts receivable | 50.00 | Accounts Payable (Estimated) | 350.00 |
| Dues unpaid (21) | 105.00 | | |
| | $22,308.34 | Estimated net worth | 21,643.64 |
| | | | $22,308.34 |

The report of the Auditors was received and both reports were declared approved.

Professor E. W. Woolard, Senior Editor, reported for the Journal of the Academy that volume 20 consists of 520 pages, including 85 half-tones and 47 line-cuts. It contains 56 original papers occupying 418.6 pages and representing 14 different branches of science; the proceedings of the Academy and affiliated societies occupy 74.4 pages; notes and news, and obituaries occupy 19 pages. The total cost of producing and distributing the Journal was $3531.52. The report of the Editor was approved.

An informal report of the Meetings Committee was given by Dr. W. J. Humphreys.

L. V. Judson, Chairman of the Board of Tellers, announced the election of the following officers for 1931:

N. A. Cobb, President
Cyrus Adler and W. D. Coolidge, Non-resident Vice-Presidents
Paul E. Howe, Corresponding Secretary
Charles Thom, Recording Secretary
H. G. Avers, Treasurer.
L. B. Tuckerman and N. M. Judd, Managers for the term of three years ending January, 1934.

The Corresponding Secretary then read the nominations for Vice-Presidents of the Academy as received from the affiliated societies, and the Recording Secretary was authorized to cast one ballot for the Academy, electing the following members as Vice-Presidents:

| | |
|---|---|
| Anthropological, | Dr. John M. Cooper |
| Archaeological, | Dr. Walter Hough |
| Bacteriological, | Dr. L. A. Rogers |
| Biological, | Dr. Alexander Wetmore |
| Botanical, | Dr. H. B. Humphrey |
| Chemical, | Dr. R. E. Gibson |
| Electrical Engineers, | Dr. G. W. Vinal |
| Engineers, | Mr. W. E. Parker |
| Entomological, | Dr. Harold Morrison |
| Foresters, | Dr. F. C. Craighead |
| Geographic, | Dr. F. V. Coville |
| Geological, | Dr. G. R. Mansfield |
| Helminthological, | Dr. Paul Bartsch |
| Historical, | Mr. Allen C. Clark |
| Mechanical Engineers, | Mr. H. L. Whittemore |
| Medical, | Dr. Henry C. Macatee |
| Military Engineers, | Colonel C. H. Birdseye |
| Philosophical, | Dr. H. L. Curtis |

At the close of the business meeting, President Bowie appointed Past-President W. J. Humphrey to escort President-elect N. A. Cobb to the Chair. The new President spoke briefly, and there being no further business, declared an adjournment at 10:25.

Charles Thom, *Recording Secretary.*

## PHILOSOPHICAL SOCIETY

### 1007th meeting

The 1007th meeting was held in the Cosmos Club Auditorium, May 10, 1930, President Lambert presiding.

*Program:* G. H. KEULEGAN: *Measurement of the elastic hysteresis by means of tuning forks.*—The damping of the vibrations of a tuning fork when freely suspended is due mainly to elastic hysteresis, provided that the material of which the fork is made has negligible elastic afterworking. The damping, therefore, can be predicted from pure statical results provided that the statical flexure of the forks differs very little from that realized during the free vibrations. Statical and dynamical data obtained for a U-shaped fork of Armco-iron illustrate this point. This investigation makes it possible to measure elastic hysteresis by means of a freely vibrating fork instead of the tedious, time-consuming and less sensitive statical method. (*Author's abstract.*)

Discussed by Messrs. TUCKERMAN, BROWN, and HAWKESWORTH.

L. V. JUDSON: *New instruments and methods in length measurements of high precision.*—An extensive program of intercomparisons and calibrations of graduated meter and decimeter bars has been carried out at the Bureau of Standards during the past three years using the new high-precision longitudinal comparator made by the Société Genevoise d'Instruments de Physique. The author described the comparator and discussed the measurements made with this instrument. He pointed out that in the case of standards with good surfaces and lines, the residuals generally average less than 0.05 micron, and that the probable errors of the computed values for the differences in length of two standards or for the relative lengths of the subintervals of a standard are rather consistently of the order of 0.02 or 0.03 micron.

The manner by which the corrections to intervals as short as 0.1 mm. are determined using as the basis the U. S. national prototype meter was briefly outlined. Allusion was made to computations, still in progress, to determine the reliability of the several possible methods of obtaining the corrections to the subintervals of a graduated scale.

It was pointed out that the measurement of angles is a natural extension of measurements of length as the same general fundamental principles govern and somewhat similar equipment is used. With the Bureau's one-meter circular dividing engine several circles have been graduated and one 9-inch circle has been tested in some detail using the circle-testing equipment of the Bureau. With this latter instrument consistent and repeated settings and calibrations are possible to 1 second or better, and in the case of the circle just referred to, no errors in the graduation of the circle were found in excess of 2 seconds. It was concluded that these two instruments, both made by the same Swiss firm as the length comparator, are, like that comparator, instruments of high precision. (*Author's abstract.*)

Discussed by Messrs. HEYL, CURTIS, BROMBACHER, and FERNER.

### 1008TH MEETING

The 1008th meeting was held in the Cosmos Club Auditorium, May 24, 1930, President LAMBERT presiding.

*Program:* PAUL R. HEYL: *The place of reason in nature.*—Most thinking persons, especially scientific men, hold reason in the highest esteem. There are, however, several schools of thought that regard it differently. These are the philosophy of pessimism, one branch of theology, the pragmatic philosophy of Peirce and William James, and the irrational philosophy of Bergson.

It was pointed out that while reason is undoubtedly equal to all quantitative demands, there may be criticisms of a qualitative nature made against it. (*Author's abstract.*)

## 1009TH MEETING

The 1009th meeting was held in the Cosmos Club Auditorium, October 11, 1930, President LAMBERT presiding.

*Program:* M. F. PETERS: *An investigation of the effectiveness and reliability of electric sparks in automotive ignition.*—The effectiveness of ignition sparks was determined by measuring the volume (or mass) of hydrogen and of oxygen which combines at low pressures. The sparks were generated by a magneto and an ignition spark coil. It was found that with constant energy the amount of reaction increases as the capacitance component of the spark increases. The use of a series spark gap may decrease or increase the amount of reaction, the effect depending upon the amount and the distribution of capacitance in the circuit. So far as the work has progressed, it has been found that sparks reported by other investigators as being most efficient for igniting lean mixtures cause the largest amount of reaction. Differences between the amount of reaction with a magneto spark and an ignition spark coil were noted. The method appears to offer a means of determining the most efficient spark generator for internal combustion engines as well as determining a relation between the character of spark, energy and effectiveness in igniting inflammable mixtures.

Further details of this investigation are given in a report which is to be issued as National Advisory Committee for Aeronautics Technical Report No. 369. (*Author's abstract.*)

Discussed by Messrs. HULBURT, WHITE, and SILSBEE.

W. G. BROMBACHER. *Temperature coefficient of the modulus of rigidity of instrument-diaphragm and spring materials.*—In cooperation with the National Advisory Committee, the Bureau of Standards is determining experimentally the temperature coefficient of the elastic moduli of commonly used spring and diaphragm materials in the temperature range $-50°$ to $+50°$ Centigrade. Such data are of particular interest in determining the effect of temperature on the performance of air-craft instruments.

The temperature coefficient m is defined by the relation

$$m = \frac{1}{G_o}\frac{dG}{dT}$$

in which G and $G_o$ are the moduli of rigidity at temperatures T°C. and 0°C.

The description of the apparatus and the methods of procedure were presented for determining this coefficient by means of the torsion pendulum.

Results were given for monel metal, brass, phosphor bronze, coin silver, nickel silver, oil-tempered steel, piano wire, chromium-vanadium steel, chromium-molybdenum steel and a stainless steel and also the effect of heat treatment on the coefficient for a number of the materials.

A full description of the work is given in National Advisory Committee for Aeronautics Technical Report No. 358. (*Author's abstract.*)

Discussed by Messrs. CANFIELD, HUMPHREYS, WHITE, and MEHL.

## 1010TH MEETING

The 1010th meeting was held in the Cosmos Club Auditorium, October 25, 1930, PRESIDENT LAMBERT presiding.

*Program:* C. L. GARNER: *An outline of the expanded program of geodetic work of the Coast and Geodetic Survey.*—To explain the future program for geodetic work, it is necessary to review some of the events leading up to the present. In 1925, Congress passed the Temple Act, which authorized the completion of the topographic map of the United States in a period of twenty years. This Act apparently implied that appropriations would be made from year to year, as required to carry on the work. Topographic maps are a result of cooperative surveys of the Coast and Geodetic Survey and the Geological Survey, the former Bureau performing that part of the work known as control surveys, consisting principally of first-order triangulation and leveling. Up to this fiscal year, there was no increase in the funds annually made available for the Coast and Geodetic Survey, and the Bureau did not take any part in the program, other than to extend such control surveys as its limited funds permitted. The appropriations for the current year carried an increase of some $240,000 for the execution of control surveys as the Coast Survey's initial part of the program for completing the topographic map of the United States. For the most part these control surveys will consist of first-order triangulation and leveling, the triangulation being the means of determining the latitudes and longitudes of marked stations, and the azimuths and distances between them, while the leveling furnishes the elevations of bench marks.

Approximately 27,000 miles of triangulation, measured along the axes of the various schemes, have been completed, and the work under the new program is to divide the open areas by a sufficient number of arcs so that few places in the country will be more than twenty-five miles from a triangulation station. Schemes of first-order triangulation will generally be about one hundred miles apart, while second-order schemes will be run midway between the first-order arcs, thus placing the arcs or bands of triangulation at intervals of about fifty miles. Other arcs of triangulation, at right angles to those described, will be run at intervals of about one hundred miles for the purpose of coordinating the entire scheme in one rigid framework, for purposes of adjustment. This additional work will require about forty thousand miles of triangulation, as measured along the line of progress, consisting of about equal amounts of first- and second-order work.

During the earlier work, arcs of triangulation were extended mostly over mountainous or rolling country where long lines could be used to extend control as rapidly as possible with the cash outlays available. The difficulty of transporting the parties and equipment into isolated sections also contributed toward the same end. As a result long lines over 100 miles in length were very ordinary, while some were in excess of 170 miles. After the Atlantic and Pacific Coasts were connected and there were other arcs sufficient for adjustment purposes, long lines were no longer important. Further than this, with the extension of triangulation into the more settled and developed regions, which are also on comparatively level ground, it is impossible because of the curvature of the earth, and in many places because of tall trees, to secure long lines even though it were desired. Considering the fact that schemes with short lines do not decrease the accuracy of triangulation when extended across country, and to the further fact that short lines have the effect of placing a larger number of stations in any unit area than where long lines are used, the value of the stations to local engineers or surveyors is increased correspondingly. It is difficult and expensive for a local engineer to connect to a triangulation station which is a considerable distance from any particular project he has in mind, while it is comparatively simple and inexpensive to make connections to stations which are nearby. For that reason, the lengths of future lines of first and second order triangulation will be held to an average of between 10 and 12 miles, with few lines exceeding 15 miles in length except in mountainous regions where due to topography and transportation it may be impracticable to hold to this lower limit. In such cases it may be necessary to allow a few lines with lengths of about 25 miles.

Recent accomplishments of first-order triangulation are the completion of five moderately short arcs during the summer of 1930, as follows: From La Crosse to Fond du Lac, Wis., from Columbus, Nebr., to Joliet, Ill., and three arcs radiating east, north and west from Cairo, Ill., to Nashville, Tenn., to the 39th-parallel triangulation in the vicinity of Belleville, Ill., and to Poplar Bluff, Mo., respectively. Other arcs to be started in the near future and due to be completed by June 30, 1931, are from Fort Smith, Ark., south to Port Arthur, Tex., from Shreveport, La., to Forest, Miss., and from Mobile, Ala., closely paralleling the Gulf Coast, to Corpus Christi, Tex. All of this work is particularly important because of the need for an adjustment of the triangulation network of the United States east of the 98th meridian. An adjustment of the triangulation net of the United States west of the 98th meridian was made in 1927. These two adjustments, when completed, will be based on a large network strong and securely tied together at frequent intervals, and will cover the entire country with the most reliable positions obtainable. These will be held final, and on all future arcs of triangulation it will merely be necessary to adjust them between the junction points with arcs of the above framework.

It should be said that in first-order triangulation average triangle closures of 1 second or less are required, while the maximum allowable closure for a single triangle is 3 seconds. On second-order work the average closure is required to be 3.0 seconds or less, while the maximum closure of a single triangle should not exceed 8.0 seconds. The experience of over one hundred years of observations shows clearly that where maximum single triangle closures are not allowed to exceed 3 seconds, the average closure for a season will very seldom exceed 1.0 seconds, and consequently this criteria is used in classifying the order of triangulation.

In the extension of first-order levels, the same principle holds regarding distribution of marks as with the triangulation stations, that is, for few places in the country to be further than 25 miles from a bench mark. Lines will be run largely along the important lines of communication, such as railroads and highways, in areas which have not been given attention before. Bench marks and triangulation stations are of most value when they are readily accessible at or near the highways, and while it is not practicable to establish all triangulation stations along a railroad or highway, it is entirely possible to so locate the bench marks, and this has been the custom throughout the history of leveling. Incidentally it may be mentioned that formerly the leveling of the country was extended almost wholly along the railroads. This was because of the easy grades encountered and the resultant increased progress and correspondingly reduced cost of the work. As leveling is extended into the intermediate regions, however, it is seen that railroads will, in the majority of cases, not be available, and it will be necessary to extend the lines along highways or even totally unimproved roads. Work of this character is slow and expensive as the grades are much steeper than along railroads, and this requires many more instrument stations and slows up the work. At the same time, the marks are perhaps of more use to the average citizen than in other areas, as in many cases the lines will be along avenues of development where engineering or surveying projects are in operation and where the elevations of the marks will be of immediate use.

Approximately 60,000 miles of first and second order leveling will be required to complete the program. First-order lines will be run at intervals of about 100 miles, while such intervals will each be divided by one line of second-order levels.

It is believed that this program will be complete in about twelve years. (*Author's abstract.*)

Discussed by Messrs. LIFEROCK, PRIEST, BOWIE, RAPPLEYE, CANFIELD, HUMPHREYS and MARMER.

F. S. BORDEN: *Recent developments in the hydrographic work of the Coast and Geodetic Survey with special reference to the survey of Georges Bank.*

Of the four major classes of transportation, namely: rail, water, highway and air, it can be said that the first mentioned is the only one which has reached real standardization. The highway is making rapid strides in that direction but it will probably be many years before water transportation reaches the high degree of standardization the railroad now enjoys. It will be still longer in the case of the newest means of travel, that by air.

The question may well arise as to why water transportation, one of the earliest methods known to man, has not yet reached the degree of standardization of the railroad and that which we can foresee for the highway. One of the reasons would seem to be that the ocean liner has no well defined path to follow along the shortest practicable route such as has the express train or the automobile. Instead, on each of its journeys a new path must be determined and, under favorable conditions, this is seldom the shortest practicable route and quite frequently not the safest. If an automobilist passes a cross-road onto which he should have turned off, he is only slightly inconvenienced, but should the navigator at some critical point along his route, determine and steer an erroneous course, the result would undoubtedly be disaster with possible loss of life.

The principal aid to the navigator in keeping his vessel on the track which he desires to follow and on one which will avoid the numerous dangers that beset his path, is his chart. The extent to which his chart serves this purpose depends on the detail and accuracy of the information shown thereon and, in this respect, much is demanded by the present-day scientifically equipped navigator.

In order to bring our charts into keeping with the resources of modern science, it has been necessary to devise new and improved methods of surveying those extensive areas which lie out of sight of land but still fall on the shelves which border our coasts. On the Pacific Coast these methods have been well standardized and rapid progress is now being made toward the completion of a new series of standard charts. On the Atlantic Coast the standardization of methods has been somewhat slower, but this process is now reaching the final stage and we can foresee within a few years the same rapid progress that is being made on the Pacific Coast.

I hope to be able with the aid of a few slides to show the reason for the demand for more adequate surveys, and the steps we are taking to meet this demand, some of the difficulties encountered, and finally an outline of the methods actually employed on one of our most recent projects.

*Slide No. 1*

The old and the new—a month or more to cross the Atlantic as compared with a few days—wooden sailing vessels drawing 15 feet as compared with steam vessels of steel drawing 40 feet. Aids to navigation, very limited, as compared with those of the modern liner having precise sextants, gyro compasses, electric logs, echo soundings, radio bearings and powerful lighthouses. And, in order to obtain the maximum usefulness and the highest degree of security from these present-day resources, the liner *must* have a modern chart.

*Slide No. 2*

*Echo Sounding*—Proceeding at full speed, the modern ocean liner has a continuous record of the depths over which it is passing. If the chart shows the configuration of the bottom accurately and in sufficient detail, these records can be used in fixing the position of the ship. On the other hand, if the chart does not portray a true contour map of the ocean bottom, the position of the ship becomes uncertain. This uncertainty means greater precautions, slower voyages, delayed arrivals and increased operating expenses. This new device has had considerable to do with the increased demand not only for more accurate and more detailed surveys but also for the extension farther seaward of such surveys.

*Slide No. 3*

One type of echo sounding device—the *Fathometer*—and the one used principally on the surveying vessels of the U. S. Coast and Geodetic Survey. This slide shows the recording part of the instrument. Into it comes the impulse of the echo from the ocean bottom transmitted from an oscillator on the vessel. The impulse is received by a hydrophone in the bottom of the vessel and is amplified sufficiently to cause a red flash on the revolving dial, measuring the elapsed time of sound travel to and from the ocean floor, but calibrated to read the depth directly in fathoms. The dial of this particular instrument revolves at a speed of 246 revolutions per minute corresponding to a velocity of sound of 820 fathoms (4920 feet).

*Slide No. 4*

The velocity of sound in salt water varies over an extreme range of from about 790 fathoms to about 870 fathoms per second depending on the temperature, salinity and pressure of the water through which the sound travels. Roughly, it may be stated that the velocity increases 0.2 of one per cent for every increase of 1° in the temperature, is augmented 0.11 per cent for every 100 meter depth and increases 0.1 per cent for every 1 per cent increase in the salinity. On any surveying project, sufficient measurements are made of the salinity and temperature at various depths to correct the echo soundings.

*Slide No. 5*

Comparison between the frequency and speed of echo and hand-lead soundings.

*Slide No. 6*

*Installation on the Lydonia*—The Fathometer there provides both the navigator and the hydrographer with an excellent method of obtaining depth, but the concern of the hydrographer does not stop here. For every practical purpose, a charted sounding must be considered as having three dimensions. A measurement of depth is of value not simply in proportion to the accuracy with which it was made, but equally in proportion to the accuracy with which we locate the point on the ocean's surface from which it was made. A group of accurate soundings plotted on the chart in their correct positions relative to each other will give an accurate indication of a submarine valley or any other characteristic feature suitable for use by the navigator in fixing his position. The same soundings incorrectly placed with reference to one another may give a seriously erroneous picture. Let us consider that the depth determination furnishes us with the first dimension of our sounding and turn to the second and third dimensions, it being assumed that we are out of sight of land and can not depend on shore objects to fix the sounding vessel's position.

*Slide No. 7*

Again we make use of the transmission of sound through water, in this case horizontally. Here we have a depth bomb of TNT fired from astern of the vessel. The sound travels to a hydrophone planted near the shore, the position of which is accurately known. Here the impulse is picked up and amplified and automatically and instantaneously passes through the shore station back to the vessel by radio. The time interval, as recorded on the tape of the sounding vessel's chronograph, between the reception of the bomb and the returning signal from the shore station plus the time it has taken the sound to travel from the bomb to the ship's hydrophone gives a measure of the distance between the bomb and the shore station hydrophone—and we have our second dimension of the sounding taken at the time the bomb was dropped.

*Slide No. 8*

And adding a second shore station to our equipment, we, in the same way, obtain the third dimension of our sounding.

*Slide No. 9*

*Shore Station on the Pacific Coast*—Unfortunately we can not boast of any such shore stations on the Atlantic Coast or that we have thus far been able to employ the exact methods of obtaining the second and third dimension that work so successfully on the Pacific Coast and in Alaska. However, we learned very definitely during the past summer that the method can be used, at least off the New England Coast, provided floating stations are substituted for the shore stations and are anchored in sufficient depths of water. The slides from now on, in so far as the hydrophone station is concerned, pertain to a floating station rather than to a shore station as shown here.

*Slides Nos. 10–27*

*Georges Bank Project*—Showing methods employed in the survey of Georges Bank and a slide of the submarine valley found along its southeastern edge. The valley is 2 miles wide and cuts back into the shelf for a distance of 8 miles. It makes an ideal submarine landmark for westbound transatlantic steamers approaching Georges Bank. (*Author's abstract.*)

Discussed by Messrs. HECK, CANFIELD, CURTIS, DORSEY, HAZARD, and SERAN.

OSCAR S. ADAMS, *Recording Secretary*

## SCIENTIFIC NOTES AND NEWS

Dr. DAVID WHITE, senior geologist of the Geological Survey and home secretary of the National Academy of Sciences, was awarded the Penrose Medal of the Society of Economic Geologists at the Toronto meeting in December, 1930. This medal is given not oftener than once every three years "in recognition of unusually original work in the earth sciences."

Miss Frances Densmore, Bureau of Ethnology, who has been in Washington for a few weeks, has left for Florida to study the music and songs of the Seminole Indians.

Dr. Norman L. Bowen of the Geophysical Laboratory has been awarded the Bigsby medal of the Geological Society (London) in recognition of the value of his study of the physical chemistry of igneous rocks. The last recipient of the medal in the United States was the late Charles D. Walcott who was awarded it in 1895.

## CORRECTIONS TO 1930 "RED BOOK"

The following corrections to the list of ACADEMY members are arranged, so that if desired they may be cut out and pasted in the Red Book.

| | |
|---|---|
| **ASHLEY, George H.,** State Capitol, Harrisburg, Pa. | A Gl |
| **BARTLETT, Edward P.,** Dupont Ammonia Corp., Wilmington, Del. | A |
| **BROWN, Thomas B.,** 155 Scituate St., Arlington, Mass. | A P |
| **CURTIS, Heber, D.,** Detroit Observatory, Ann Arbor, Mich. | A |
| **HARPER, D. R., 3rd,** 222 Gladstone Rd., Pittsburgh, Pa. | A |
| **HRDLICKA,** Ales, National Museum. 2900 Tilden St. | A An M |
| **HUNNEWELL, F. A.,** Coast Guard. 14 W. Irving St., Ch. Ch., Md. | A E |
| **JACOBY, Henry S.,** 3000 Tilden St. | A E |
| **JARDINE, William M.,** Tower Bldg., 14th & K Sts. The Mayflower. | A |

The following name appears twice:

| | |
|---|---|
| **LOHR, L. R.,** 160 N. LaSalle St., Chicago, Ill. | A |

In place of the first, substitute:

| | |
|---|---|
| **LOEB, Leo,** Wash. Univ. School of Medicine, St. Louis, Mo. | A |
| **MICHELSON, Truman,** Smithsonian Institution. 1710 Que St. | A An |
| **PIENKOWSKY, Arthur T.,** Bureau of Standards. 2923 Tilden St. | A P |
| **PINCHOT, Gifford,** Milford, Pike County, Pa. | A B F |
| **SCHULTZ, Eugene S.,** Bureau of Plant Industry | A |
| **SHAPOVALOV, M.,** University of California, Berkeley, Calif. | A |
| **SMITH, Charles Meldrum,** 424 Allison St. | A |
| **SMITH, George Otis,** Federal Power Commission. 2137 Bancroft Place. | A E G Gl |
| **STEBINGER, Eugene,** 710 Edificio Banco Boston, Buenos Aires, Argentina | A Gl |
| **WHERRY, Edgar T.,** University of Pennsylvania, Philadelphia, Pa. | A C Gl |

## OFFICIAL COMMUNICATIONS

### THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

ANNOUNCEMENTS OF MEETINGS

| | |
|---|---|
| Friday, February 20 | The Geographic Society |
| Saturday, February 21 | The Biological Society |
| | The Helminthological Society |
| Wednesday, February 25 | The Geological Society |
| | The Medical Society |
| Friday, February 27 | The Geographic Society |
| Saturday, February 28 | The Philosophical Society |
| Tuesday, March 3 | The Botanical Society |
| Wednesday, March 4 | 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.

## OFFICERS OF THE ACADEMY

*President:* N. A. COBB, Bureau of Plant Industry.
*Corresponding Secretary:* PAUL E. HOWE, Bureau of Animal Industry.
*Recording Secretary:* CHARLES THOM, Bureau of Chemistry and Soils.
*Treasurer:* HENRY G. AVERS, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings



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JOURNAL

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WASHINGTON ACADEMY OF SCIENCES

Vol. 21 March 4, 1931 No. 5

BOTANY.—*Plants new to Arizona. (An annotated list of species added to the recorded flora of the state or otherwise interesting).** By Thomas H. Kearney, Bureau of Plant Industry.

Arizona has a rich and remarkable flora. The great diversity of natural conditions produces a corresponding diversity of life forms and floral elements. There could scarcely be a greater contrast than that between the Sonoran flora of the hot deserts of the southwestern part of the state, only a few hundred feet above sea-level, where cacti and other xerophytic forms predominate, and the arctic-alpine flora of the summit of San Francisco Mountain, with an altitude of nearly 13,000 feet. The mean annual rainfall ranges from 3.5 inches at Yuma to 30 inches at Crown King in Yavapai County.

Several floral provinces meet and overlap in Arizona. On the grass-covered plains of the eastern section, there are numerous species characteristic of the Great Plains region from Kansas to Texas. The Rocky Mountain flora is well represented on the higher mountains. The Great Basin region of Utah and Nevada shares many of its species with northern Arizona. Constituents of the flora of the Mohave Desert region are found in large number near the western edge of the state. In southwestern Arizona there are many species that occur elsewhere only along and near the Gulf of California. A large number of Mexican and Central American species, more or less tropical in their affinities, just cross the southern border of the state. There are even, in southeastern Arizona, a few species whose main center of distribution is the Atlantic and Mississippi Valley States. Finally, of course, many Old World species have become established as weeds.

During the past five years, extensive collections of the flowering plants and ferns of Arizona have been made by members of the Bureau of Plant Industry, U. S. Department of Agriculture, whose headquarters

*Received February 6, 1931.

are the U. S. Field Station at Sacaton, on the Gila River, some 45 miles southeast of Phoenix. This group includes George J. Harrison, Robert H. Peebles, Harold F. Loomis, Harold J. Fulton, Chalmers J. King, and the writer. Frank A. Thackery, A. R. Leding, and M. French Gilman of the Bureau of Plant Industry and W. J. Osborn of the Forest Service, with headquarters at Flagstaff, also have contributed materially to the Sacaton collection.

A list of the flowering plants and ferns of Arizona, with keys to the families, genera and species, is being compiled by Ivar Tidestrom of the Bureau of Plant Industry, with the collaboration of other botanists. The time therefore seems opportune to publish notes on plants collected by the Sacaton botanists, many of which, so far as the writer can ascertain, have not been recorded hitherto as occurring in Arizona. Our collections have added some 55 species and varieties to the known flora of the state, of which 18 were found only in the region lying between the Gila River and the Mexican frontier and between the Baboquivari Mountains and the Colorado River. This is the country of the Papago Indians and includes much of the territory known to the early Spanish missionaries as "Papaguería." The additions to the flora discovered in this region are chiefly species that occur in Lower California and the adjacent Colorado Desert of California or in Sonora and other parts of Mexico. The relative inaccessibility of much of this area and the rarity of sufficient precipitation to permit the growth of plants make it likely that other species not known to belong to the flora of Arizona and of the United States will be discovered there in the future.

In our explorations of southwestern Arizona we have observed a tendency to the rapid eastward spread of species mainly characteristic of the region near the mouth of the Colorado River. Such are *Aristida californica*, *Sphaeralcea orcuttii*, *Asclepias erosa*, and *Palafoxia linearis*. All of these plants have readily disseminated seeds. Since they have been noticed chiefly along the highway from Yuma to Phoenix, it may be conjectured that paved roads and automobile traffic have aided their dispersal.

The area centering in the Pinal Mountains, a few miles north of the Gila River, has yielded several additions to the recorded flora. The southeastern part of the state, between the Baboquivari Mountains and the New Mexican boundary, has been much explored by other botanists, but we have found there a good number of species not hitherto recorded as belonging to the Arizona flora. The area north of the Gila River, between longitude 112° and the Colorado River, like the southwestern corner of the state, is difficult of access and is characterized by very low and very sporadic precipitation. Exploration of this region on the rare occasions when conditions have been favorable to plant growth, is likely to reveal the presence of many species of southeastern California and southern Nevada that have not yet been collected in Arizona.

Ten of the 99 species and varieties listed in this paper are not known to occur elsewhere than in Arizona. The principal distribution of the others, outside this state, may be summarized as follows:

| | |
|---|---|
| Pacific coast region (Washington to Lower California) | 10 |
| California deserts (Colorado, Mohave, etc.) | 6 |
| Gulf of California region (Lower California, western Sonora) | 14 |
| Mexico (not confined to the preceding region) and southward | 33 |
| Rio Grande region (western Texas, southern New Mexico and adjacent Mexico) | 4 |
| New Mexico only | 4 |
| Plains region (Kansas, Texas, etc.) | 2 |
| Atlantic and Mississippi Valley States | 5 |
| Old World and indigenous in Arizona | 1 |
| Old World (introduced species) | 9 |
| Tropical America (introduced species) | 1 |

It will be noted that the distribution outside of Arizona, of nearly half of the species and varieties listed is in the Gulf of California region or elsewhere in Mexico and tropical America. This does not signify a corresponding preponderance of these elements in the flora of Arizona, but merely that our explorations have been carried on largely in portions of the state where they are likely to be found in the greatest numbers.

Fascinating problems in plant geography are encountered in studying the Arizona flora. One of these is the occurrence, well toward the center of the state and especially in the Pinal Mountain region, of species identical with or very closely related to constituents of the chaparral of the mountains and coast of California. Such are *Dryopteris arguta* (Kaulf.) Watt, *Grossularia quercetorum* (Greene) Cov. & Britt., *Cercocarpus douglasii* Rydb., *Rhus ovata* Wats., *Rhamnus californica* Eschs. (represented by *R. ursina* Greene), *Rhamnus crocea ilicifolia* (Kellogg) Greene, *Ceanothus integerrimus* H. & A. (represented by *C. mogollonicus* Greene), and *Lonicera interrupta* Benth. None of these are found in the intervening deserts. Another remarkable case of interrupted range is afforded by a few species having their main center of distribution in the Atlantic States and the Mississippi Valley and occurring also in southern Arizona but apparently not in western Texas and southern New Mexico. Examples are: *Phytolacca americana* L., *Crotalaria sagittalis* L., *Clitoria mariana* L., *Isanthus brachiatus* (L.) B. S. P., and *Galium pilosum* Ait.

In the following list, species and varieties which, so far as the writer knows, have not been recorded in a previous publication as occurring in Arizona are indicated by a single asterisk. Double asterisks indicate that the plant is believed to be new to the recorded flora of the United States, also. Four of the species listed were described for the first time from our collections. None of these is known to occur outside of Arizona. The assistance of authorities who have identified some of the plants, as mentioned in the footnotes, is acknowledged with gratitude.

## POLYPODIACEAE[1]

ASPLENIUM PALMERI Maxon. Collected on the western side of the Baboquivari Mts. in Pima Co. by Harrison in 1927. This is considerably farther west than the previously known station in Arizona, the Mule Mts. in Cochise Co., where it was collected by L. N. Goodding. This fern also occurs in the Organ Mts., New Mexico.[2] It is chiefly a Mexican species, of rare occurrence in the United States.

CETARACH DALHOUSIAE (Hook.) C. Chr. (*Asplenium alternans* Hook). Collected on the western side of the Baboquivari Mts. by M. French Gilman, thus extending the known range considerably to the west, the only previously recorded stations in Arizona, both in Cochise Co., being the Huachuca Mts. (*J. H. Ferris*) and the Mule Mts. (*L. N. Goodding*). This fern is not known to occur anywhere else in the western hemisphere, but is found in the Himalayas and in Abyssinia. This remarkable distribution has been discussed by W. A. Poyser, J. H. Ferris, and W. N. Clute.[3]

CHEILANTHES LENDIGERA (Sav.) Sw. Collected by Peebles and Loomis in Cave Creek Canyon, Chiricahua Mts., Cochise Co. The only locality previously known for this fern in Arizona and in the United States is the Huachuca Mts., in Cochise Co., where it was collected by J. G. Lemmon and by M. E. Jones. The species is widely distributed in tropical America.

CHEILANTHES VILLOSA Davenp. Collected in the Sierra Estrella, south of Phoenix, Maricopa Co., by Kearney, Harrison, Peebles, and Loomis in 1926. This is considerably farther west than the stations previously known in Arizona, which are the Santa Catalina, Santa Rita, Huachuca, and Chiricahua Mts.[4] Occurs also in New Mexico, western Texas, Chihuahua, and Coahuila.

[1] Identified by W. R. Maxon, who supplied much of the information given in the notes on this family.

[2] W. R. Maxon in Am. Fern Journ. **18**: 105. 1921.

[3] Fern Bull. **19**: 33-42. 1911. See also W. R. Maxon in Am. Fern Journ. **3**: 110. 1913. Similar distribution of another fern was noted by C. W. Hope (Bull. Torr. Club **26**: 58-62. 1919), who considers *Asplenium glenniei* Baker, found in the Huachuca Mts., Arizona, and in Mexico, to be identical with *A. exiguum* Bedd., of India and southern China.

[4] See W. R. Maxon in Proc. Biol. Soc. Wash. **31**: 142-4. 1918.

*Dryopteris arguta (Kaulf.) Watt. Collected by Harrison in Devils Canyon, near Superior, in Pinal Co., in 1926. Known previously to occur only from southern California to western Oregon.[5]

Phanerophlebia auriculata Underw. Collected on the west side of the Baboquivari Mts., Pima Co., by A. R. Leding in 1925, and previously in the same mountains by Forrest Shreve. These stations are considerably farther west than any known hitherto for this fern in Arizona.

Woodsia plummerae Lemmon. Collected near Prescott, Yavapai Co., by Harrison in 1927, extending the known range considerably to the northwest.

## POACEAE

Tripsacum lanceolatum Rupr.[6] (*T. lemmoni* Vasey). Collected by Harrison and Kearney in the Mule Mts. near Bisbee, Cochise Co., and by Loomis near Patagonia, Santa Cruz Co. These are apparently the only collections of this grass in Arizona and in the United States, except that of Lemmon in the Huachuca Mts. (type of *T. lemmoni*). The species is widely distributed in Mexico.

**Panicum lepidulum Hitchc. & Chase.[7] Collected by Kearney and Harrison near Nogales, Santa Cruz Co., in 1927. Mrs. Chase informed the writer that ours was the first collection of this species in Arizona and in the United States. It was previously known only from Mexico (Chihuahua, Durango, and near Mexico City).

**Schismus barbatus (L.) Chase (*S. marginatus* Beauv.).[8] Thoroughly naturalized and apparently spreading rapidly in Maricopa and Pinal counties; first collected by Loomis and Peebles in 1926. This Old World grass had not previously been reported as occurring in the United States.

## CYPERACEAE

*Cyperus wrightii Britton.[9] Collected by Kearney and Harrison in the Huachuca Mts., Cochise Co., and by Kearney and Fulton in the Santa Rita Mts., Pima Co., apparently for the first time in Arizona. The range of the species, as previously known, is Texas, southern New Mexico, and Chihuahua.

## RAFFLESIACEAE

Pilostyles thurberi Gray. This interesting little parasite on the stems of a leguminous plant, *Parosela emoryi* (Gray) Heller, was found in 1930 by Harrison and Kearney and by Peebles and Loomis in considerable abundance between the north end of the Gila Mts. and the Gila River, Yuma County, beginning to flower about the first of April. The locality is probably very near the place where the plant was first discovered by Thurber in 1852. There seems to be no record of the occurrence of *P. thurberi* elsewhere east of the Colorado River, but J. B. Norton told the writer that he had found the plant in the Colorado Desert, Calif., in 1927.

[5] For the characters distinguishing *D. arguta* from the related *D. filix-mas* see W. R. Maxon in Am. Fern Journ. **11**: 3, 4. 1921.

[6] Identified by J. R. Swallen.

[7] Identified by Agnes Chase.

[8] Identified by A. S. Hitchcock.

[9] Identified by N. L. Britton.

## POLYGONACEAE

*Polygonum camporum Meisn.[10] Collected by Kearney, Harrison, and Peebles at a roadside in the Colorado River Valley below Yuma. In a letter to the writer, Dr. Small states that our plant "seems to be most closely related to *Polygonum camporum*, where I would place it, at least for the time being. It is true the akene is rather small, but we have never had enough material of *P. camporum* to properly understand the species." The range of the species, as previously known, is Nebraska to Louisiana and New Mexico, and in South America. Apparently it has not previously been collected in the United States west of El Paso, Texas.

*Persicaria fusiformis Greene. Collected by Kearney at the edge of running water in Sabino Canyon, Santa Catalina Mts., Pima Co. This is apparently the first collection in Arizona, although the species was described from specimens collected on the Colorado River, in California. The Arizona specimens have less pointed akenes than the California specimens, but otherwise are similar.

## NYCTAGINACEAE

*Mirabilis jalapa L. Collected by Kearney and Harrison in Cave Creek Canyon, Chiricahua Mts., Cochise Co., in 1929, where the plants were growing wild although possibly as an escape from cultivation, this being the common four-o'clock of gardens. Apparently the first collection in Arizona, the previously known range of the species in the wild being from southern Texas through Mexico to Central and South America.

*Boerhaavia gracillima Heimerl. Collected in Baboquivari Canyon, Pima Co., by Loomis, and previously by M. E. Jones in the Huachuca Mts. The recorded range of the species is southwestern Texas and southern New Mexico to Oaxaca and Lower California.

## PHYTOLACCACEAE

*Phytolacca americana L. (*P. decandra* L.) Collected in shaded alluvial ground along the Sonoita near Patagonia, Santa Cruz Co. Although the plants grew wild, their progenitors may have been introduced by man, this species, the common pokeberry of the eastern states, not having previously been known to occur farther west than Texas.

## PORTULACACEAE

*Calandrinia ambigua (Wats.) Howell. (*C. sesuvioides* Gray). This species was collected by Peebles and Harrison in 1928 near Dome, Yuma County, and previously in Arizona, probably by J. J. Thornber, but apparently the plant has not been recorded as occurring outside the Colorado Desert, in California.

## SILENACEAE

*Silene anglica L. (*S. gallica* L.). Collected by Peebles on hillsides along Salt River below the Roosevelt Dam in Maricopa Co. and previously, probably by J. J. Thornber, in the Santa Rita Mts., Pima Co. Although extensively naturalized on the Pacific Coast, this European plant apparently has not been recorded as occurring in Arizona.

[10] Identified by J. K. Small.

*SAPONARIA OFFICINALIS L. This Old World species, thoroughly naturalized in many parts of the United States, is well established in the vicinity of Prescott, where a peculiar form with inflated calyx was collected by Fulton.

## BRASSICACEAE

*LEPIDIUM DRABA L. Collected near Prescott by Loomis, presumably for the first time in Arizona. Introduced from Europe and naturalized in many parts of the United States.

*SISYMBRIUM IRIO L. Abundantly naturalized near Sacaton and Casa Grande, Pinal Co., and in the Salt River Valley, Maricopa Co. Introduced from Europe.

*LYROCARPA COULTERI Hook. & Harv. Found by us at several stations between Maricopa and Yuma, growing among bushes in partial shade. There are specimens in the Gray Herbarium of Harvard University collected in Arizona by Palmer and either in Arizona or northern Sonora by Pringle, but the occurrence of the species in this state seems not to have been definitely recorded hitherto. The range outside of Arizona is California (Colorado Desert) to Lower California and Sonora.

## CRASSULACEAE

GRAPTOPETALUM ORPETTII E. Walther.[11] Collected in 1926 by Harrison on the high plateau between Superior and Miami, in Pinal Co. The type of the species is a subsequent collection by Ed. Howard, at or near the same locality.

*TILLAEA ERECTA H. & A. Collected by Peebles and Loomis in Baboquivari Canyon, Pima Co., and by Kearney, Harrison, and Peebles in Paradise Valley, Maricopa Co., where it was rather abundant at a roadside. This represents apparently the first collection of any species of the genus in Arizona. The range of *T. erecta*, as previously recorded, is Oregon to Lower California, and in Chile.

## GROSSULARIACEAE

*GROSSULARIA QUERCETORUM (Greene) Coville & Britton.[12] Collected by Harrison and Fulton on Superstition Mountain, northern Pinal Co., at an elevation of about 4,000 feet. Previously collected by J. J. Thornber in the Sierra Estrella, Maricopa Co., and on Superstition Mountain by L .N. Gooding. These Arizona collections, as Dr. Coville points out, greatly extend the range of the species which previously had been known only from middle California to Lower California.

## ROSACEAE

*CERCOCARPUS DOUGLASII Rydb.[13] Common in Devils Canyon near Superior, Pinal Co., where it was collected by Kearney and Harrison. This locality is far outside the previously recorded range of the species, which is California and southern Oregon, near the coast.

[11] Walther, Eric. A new species of Graptopetalum. Journ. Cactus and Succulent Soc. Amer. **1**: 183-186. 1930.

[12] Identified by Frederick V. Coville.

[13] Identification confirmed by P. A. Rydberg.

## MIMOSACEAE

Mimosa laxiflora Benth.[14] The first collection of this species in Arizona and in the United States appears to have been by the late Professor J. Arthur Harris at Quijotoa, in the Papago Indian Reservation, Pima Co., in 1925. Harrison subsequently found it to be rather abundant in a wash near Sells, (Indian Oasis), in the same reservation, growing as a much branched shrub about 4 feet high. The species was previously known to occur only in Chihuahua, Sonora, and Sinaloa, Mexico.

## CAESALPINIACEAE

Hoffmanseggia microphylla Torr.[15] Rather abundant on rocky foothills of the Gila and Tinajas Altas Mts., in Yuma County, where it was collected by Harrison in 1927. The range as previously recorded is southern California (Colorado Desert) to Lower California and Sonora.

## FABACEAE

*Crotalaria sagittalis L. Collected by Kearney and Harrison in Garden Canyon, Huachuca Mts., Cochise Co. and in a sandy "wash" near the Patagonia Mts., in Santa Cruz Co. Previously collected in Arizona by T. E. Wilcox in the Huachuca Mts.[16] and by J. C. Blumer in the Chiricahua Mts., Cochise Co. The range of the species in the United States, as previously recorded, is New England to Minnesota, Florida, and Texas. Apparently it does not occur in western Texas and New Mexico, but many specimens collected in Mexico and Central America have been identified as *C. sagittalis*. The Arizona plant looks very different from the common form of the eastern United States, having shorter stems, shorter and relatively broader leaves, inconspicuous or obsolete and not decurrent stipules and smaller pods. It has been given a different species name, but since this name appears not to have been published it is omitted here, in order not to increase the synonymy of this perplexing group. Occasional specimens of *C. sagittalis* from east of the Mississippi, e.g. specimens collected by Oakes at Plymouth, Mass., are practically identical with the Arizona form. Very similar specimens collected in Mexico are: *C. Wright* 1019, from Santa Cruz, Sonora; *E. Palmer* 712, from Alamos, Sonora; and *Townsend & Barber* 307, from near Colonia Garcia.

**Lupinus succulentus brandegei C. P. Smith.[17] Collected by Kearney, Harrison, and Peebles near Camp Creek, Maricopa Co., and near Roosevelt, Gila Co., in 1928. These collections represent a great extension of range of the variety *brandegei*, known previously only from Lower California. Specimens of a more typical form of *L. succulentus* Doug., were collected by Miss Alice Eastwood near Roosevelt, Ariz.[18]

**Trifolium amabile H. B. K. Collected in Garden Canyon, Huachuca Mts., Cochise Co., by Kearney in 1928, and previously in the same vicinity by F. X. Holzner. These appear to be the only collections in Arizona and in

[14] Identification confirmed by N. L. Britton.

[15] Identification confirmed by J. N. Rose.

[16] Britton, N. L. and Kearney, T. H., Jr. An enumeration of the plants collected by Dr. Timothy E. Wilcox, U. S. A., and others in southeastern Arizona during the years 1892-1894. Trans. N. Y. Acad. **14**: 21-44. 1894. In this publication the species is listed doubtfully as *C. rotundifolia* (Walt.) Poir.

[17] Identified by Charles Piper Smith.

[18] C. P. Smith in Bull. Torr. Bot. Club **49**: 203. 1922.

the United States of this species of clover, which is widely distributed in Mexico and Central America.

*PAROSELA JAMESII (Torr.) Vail. Collected near Sonoita, Santa Cruz Co., by Peebles and Loomis in 1928, presumably for the first time in Arizona. The range as previously recorded is Kansas and Colorado to New Mexico, Chihuahua and Coahuila.

*PETALOSTEMON STANDLEYANUS Rydb.[19] Collected near Prescott by Harrison, Peebles, and Kearney in 1927, presumably for the first time in Arizona. The species was known previously only from northern New Mexico.

SPHINCTOSPERMUM CONSTRICTUM (Wats.) Rose. Collected near Nogales by Kearney in 1927 and previously at Tucson by J. J. Thornber. These apparently are the only localities in the United States where this interesting little annual, with curiously constricted seeds, is known to occur. It is found also in Sonora and Lower California.

ZORNIA DIPHYLLA (L.) Pers. Specimens collected by Kearney, Harrison, and Peebles near Nogales, Santa Cruz Co., differ from the form commonly occurring in Arizona in their long, very narrow, long-acuminate leaves, longer and more acuminate bracts, and absence of pubescence except on the margins of the bracts. Similar specimens have been collected in Mexico and Central America.

MEIBOMIA GRAMINEA (Gray) Kuntze. This species, characterized by long, narrow, unifoliolate leaves, was collected in Baboquivari Canyon, Pima Co., by Kearney, Harrison, and Peebles in 1925. Apparently the only previous collection in Arizona was that of the type of *Desmodium gramineum* Gray by C. Wright on Sonoita Creek, in what is now Santa Cruz County.[20] The species ranges southward, to Costa Rica. Its occurrence in New Mexico is mentioned by Miss Vail,[21] but it is not included by Wooton and Standley in their flora of that state.[22]

*MEIBOMIA WRIGHTII (Gray) Kuntze. Collected in Baboquivari Canyon by Kearney, Harrison, and Peebles in 1925. The range of this species, as previously recorded, is Texas, New Mexico and Mexico. A. K. Schindler (MS.) apparently does not recognize *M. wrightii* as distinct from *M. psilophylla* (Schlecht.) Kuntze, but specimens of the latter from Mexico and Guatemala have narrower leaves and smaller joints of the fruit than the specimens of *M. wrightii* from Texas, New Mexico and Arizona.

CLITORIA MARIANA L. This species, collected by us in the Santa Rita Mts., Pima Co., and Sierra Ancha, Gila Co., but previously known to occur in southern Arizona, has an interrupted range similar to that of *Crotalaria sagittalis*. It ranges from New York to Missouri and south to Florida and central Texas, and apparently does not occur in western Texas and New Mexico.

## GERANIACEAE

**GERANIUM WISLIZENI Wats. Collected in fruit in the Huachuca Mts., by Kearney, Harrison, and Peebles in 1926. The occurrence of *G. wislizeni* in Arizona and in the United States seems not to have been reported hitherto, the range as given by J. K. Small[23] being northern Mexico (Chihuahua and

[19] Identification confirmed by P. A. Rydberg.

[20] Gray, A., Plantae Wrightianae **2**: 46. 1853.

[21] Vail, Anna M., in Bull. Torr. Bot. Club **19**: 116. 1892.

[22] Wooton, E. O., and Standley, Paul C., Contr. Nat. Herb., vol. 19, 1915.

[23] North American Flora **25**: 11. 1907.

Durango). It may, however, be the plant collected in the Huachuca Mts., by J. G. Lemmon and referred by Trelease[24] to *G. mexicanum* H. B. K.

## BURSERACEAE

**ELAPHRIUM ODORATUM (Brandeg.) Rose (*Bursera odorata* Brandeg.)[25] Collected by M. French Gilman near Fresnal, at the western base of the Baboquivari Mts., Pima Co., in 1927, apparently for the first time in Arizona and in the United States. A few small trees 10 to 15 feet high are growing at this station, on a hot southern slope sheltered by cliffs. The plant is remarkable for the vivid green color of the new bark, the thin, papery, easily detachable old bark, and the strong odor, resembling that of tangerines. The range of the species, as previously known, is in Mexico, from Sonora and Lower California to Morelos and Puebla.

## EUPHORBIACEAE

**CROTON SONORAE Torr. A small shrub, collected by Harrison, Kearney, and Fulton on the dry rocky slopes of Table Top Mountain, in western Pinal Co., in 1930. The range of the species, as previously recorded, is Sonora to Oaxaca, Mexico.

**DITAXIS BRANDEGEI (Millsp.) Rose & Standl. Of rather frequent occurrence on dry rocky slopes of the Gila Mts., near Yuma where it was collected by Peebles in 1927. The species was previously known only from Lower California and northwestern Sonora, ours having been apparently the first collection in the United States, as well as in Arizona. In the Arizona specimens the stems are barely lignified at base.

**ACALYPHA PRINGLEI Wats. A shrubby plant, collected by the late Professor J. Arthur Harris at Quijotoa in the Papago Indian Reservation, Pima Co., in 1925. Previously known only from Mexico, where it occurs in northwestern Sonora and at San Luis Potosí (*Parry & Palmer* 824).

JATROPHA SPATHULATA (Orteg.) Muell. Collected by Kearney and Harrison in 1930 in the Tinajas Altas Mts., Yuma County, and previously there by E. A. Goldman. Both collections are of the small-leafed western form of this apparently variable species.

**SAPIUM BILOCULARE (Wats.) Pax. Collected by Harrison near Gila Bend, Maricopa Co., where it occurs in considerable numbers along a "wash" and on adjacent slopes. The plant is conspicuous because of the dark green, shining foliage. The stems here reach a height of 15 feet. The staminate flowers are very fragrant, with an odor suggesting that of plum blossoms. The species had been collected previously near Gila Bend, probably at the same station, by H. E. Hasse, and had been observed near Ajo, Pima Co., by J. J. Thornber, but the fact of its occurrence in Arizona and in the United States seems not to have been recorded hitherto. The plant is interesting as being one of the hosts of the "jumping bean" insect, larvae of which were present in the seeds at the Arizona station. With the exception of these localities in Arizona, the species is known only from Sonora and Lower California.

## ANACARDIACEAE

*RHUS INTEGRIFOLIA (Nutt.) Benth. & Hook. Collected by Harrison and Kearney on the lower eastern slope of the Tinajas Altas Mts., Yuma County,

[24] In Gray and Robinson, Syn. Fl. N. Am. $1^1$: 359.

[25] Identified by P. C. Standley.

and previously at or near the same locality by E. A. Goldman. Although these specimens have narrower and more oblong leaves than most specimens from California, they seem clearly to belong to this species, which was known previously to occur only in southern California and Lower California, chiefly near the coast.

## RHAMNACEAE

Colubrina californica I. M. Johnston.[26] Collected by Peebles and Harrison in Fish Creek Canyon, at the eastern end of Maricopa Co., in 1926. It occurs also on adjacent dry mountain sides, and has since been found by Harrison in a "wash" at the base of the San Tan Mts., Pinal Co. At the Arizona stations, this shrub reaches a height of 5 to 10 feet. Previously known only from Las Animas Bay, Lower California. Dr. Ivan M. Johnston, who confirmed the writer's identification of the Arizona specimens, found them to differ from his Lower California material only in the smaller size of the fruits. The genus, as well as the species, is new to Arizona.

## MALVACEAE

Abutilon pringlei Hochr. This species, nearly related to *A. incanum* (Link) Sweet but apparently sufficiently distinct, seems to be more frequent than the latter in southern Arizona. Most of the specimens collected by us have longer pedicels than the type collection of *A. pringlei* by C. G. Pringle near Tucson.

*Abutilon theophrasti Med. A single plant was found by Kearney in a cotton field in the Salt River Valley in 1929, this being apparently the first known occurrence in the state of this Old World species, which is naturalized in other parts of the United States. There is no evidence of its having become established as a constituent of the Arizona flora.

*Horsfordia alata (Wats.) Gray. Collected by Harrison at the foot of the Tinajas Altas Mts. in 1927, presumably for the first time in Arizona and in the United States.[27] It proves to be fairly abundant in "washes" at the base of the Gila and Tinajas Altas mountains in Yuma County. It is a shrub, reaching a height of 8 feet, with petals of a pale violet blue. The stems are less pubescent in the Arizona specimens than in specimens from Mexico. The range of the species, as now known, is Lower California and Sonora to southeastern California and southwestern Arizona.

*Sphaeralcea orcuttii Rose. Collected by Kearney near Wellton, Yuma County, in 1927, presumably for the first time in Arizona. It has since been found to occur abundantly along the highway from Yuma to Phoenix as far east as Mohawk, Yuma County, sometimes covering whole fields and giving every appearance of being a recent and rapidly spreading introduction. Previous to our collections it seems to have been known only from the Colorado Desert in California and adjacent Lower California. The species is a well-marked one, evidently related to *S. coulteri* Gray in the characters of the fruit. Like the latter, it is annual or at most biennial in habit.

Anoda crenatiflora Orteg. (?). Collected by Kearney and Harrison in rich soil among pines in Cave Creek Canyon, Chiricahua Mts., Cochise Co.,

[26] See Kearney, T. H. Plants of Lower Californian relationship in central Arizona. Journ. Wash. Acad. Sci. **19**: 70, 71. 1929.

[27] The species has since been found at the edge of the Coachella Valley, California, and a note by Davidson on its occurrence there (Bull. Southern Cal. Acad. Sci. **29**: 100. 1930) is the first published reference to its occurrence in the United States.

in 1929. The specimens were very young and had flowers with yellow petals, but no fruit. Whether they really belong to this species can not be decided until more mature specimens have been collected. *A. crenatiflora* apparently has been known only from Mexico and Lower California, but the likelihood of its being found in Arizona is mentioned by Gray and Robinson.[28]

**HIBISCUS BISEPTUS Wats. Collected by Harrison, Peebles, and Kearney in the Baboquivari Mts., Pima Co., and in Devils Canyon, Pinal Co., in 1926. These are apparently the first collections in Arizona and in the United States identified as *H. biseptus*, although it is likely that some of the Arizona specimens previously identified as *H. coulteri* Harvey belong here. The range of *H. biseptus*, as previously known, is Lower California to Chihuahua, Jalisco and Sinaloa, Mexico. The hairs of the stems in the Arizona specimens are mostly stellate, not simple.[29]

## PASSIFLORACEAE[30]

*PASSIFLORA BRYONIOIDES H. B. K. (*P. inamoena* Gray). Collected by Harrison near Nogales in 1928, apparently for the first time in Arizona The range of the species, as previously known, is from Texas to Oaxaca, Mexico.

*PASSIFLORA FOETIDA L. Collected by Harrison in the Baboquivari Mts., Pima Co., in 1927, a peculiar form with deeply dissected leaves. This was presumably the first collection of the species in Arizona. The range of *P. foetida*, as previously known, is from southern Texas and southern Florida to South America.

## ONAGRACEAE

*OENOTHERA CARDIOPHYLLA SPLENDENS Munz & Johnston. (Section Chylismia.) This large-flowered variety, as well as the typical form, *O. cardiophylla* Torr., is of frequent occurrence at the base of the Gila and Tinajas Altas ranges in Yuma County. Harrison and Peebles found no intergradations between the two forms. Munz[31] cites only California stations for var. *splendens*, but the writer is informed by Dr. B. L. Robinson that this variety had been collected previously in Arizona by E. Palmer.

*CIRCAEA PACIFICA Asch. & Magn. Collected by Kearney, Peebles, and Harrison in 1927 on Mt. Graham, Graham Co., where it grows abundantly in rich soil in woods at an elevation of about 6,000 feet. This is presumably the first record of the occurrence of any species of this genus in Arizona. The range of *C. pacifica*, as previously known, is California to Utah and northward.

## APIACEAE

*ANETHUM GRAVEOLENS L. A single plant was found along an irrigation canal at Sacaton, Pinal Co., by C. J. King in 1926, but no specimens have been observed since. The evidence does not warrant the conclusion that this Old World species, which yields the condiment dill, has become a constituent of the Arizona flora.

[28] Syn. Fl. N. Am. **1**[1]: 321.

[29] P. C. Standley, Trees and Shrubs of Mexico. Contr. U. S. Nat. Herb. **23**: 778. 1923.

[30] Identified by E. P. Killip.

[31] P. A. Munz in Am. Journ. Bot. **15**: 227. 1928.

## APOCYNACEAE

AMSONIA KEARNEYANA Woodson. First collected by F. A. Thackery on the western side of the Baboquivari Mts., Pima Co., in 1926, and the species is thus far known only from the mouths of canyons in that desert range.[32]

AMSONIA POGONOSEPALA Woodson. Collected by Kearney in a sandy wash near the Salt River, eastern Maricopa Co., in 1928. Apparently this is the only locality in southern Arizona where this species is known to occur, the only other known station being the type locality, San Francisco Mts., Coconino Co.[32]

## ASCLEPIADACEAE

*ASCLEPIAS ALBICANS Wats. Collected at the base of the Tinajas Altas Mts. by Harrison in 1927, presumably the first collection in Arizona. This peculiar, leafless, desert milkweed proves to be of frequent occurrence in the foothills of the Tinajas Altas and Gila ranges, Yuma Co. It was previously known to occur only in the Colorado Desert, California, and in Lower California and Sinaloa, Mexico (doubtless also in Sonora). The stems, sometimes as many as 50 from one root, are somewhat lignified towards the base and reach a height of 10 feet and a diameter of $\frac{3}{4}$ inch.

**ROULINIELLA LIGULATA (Benth.) Standley. (*Enslenia ? ligulata* Benth.; *Roulinia ligulata* Pittier). Flowering specimens of a herbaceous climbing Asclepiad, provisionally identified as *R. ligulata*, were collected in shaded alluvial ground along the Sonoita near Patagonia, Santa Cruz Co., by Peebles in 1927. They differ from Mexican specimens of *R. ligulata* in the more deeply cordate leaves, somewhat larger flowers, and longer, more attenuate segments of the corona. *R. ligulata* is known from the States of Morelos, Puebla, and Oaxaca in Mexico. There is apparently no record of the occurrence of this genus in Arizona, and the species, whether it is *ligulata* or an undescribed one, probably is new to the United States. It is quite distinct from *R. unifaria*, which occurs in southern Texas and is the only member of the genus previously known to occur north of Mexico.

## CONVOLVULACEAE

**JACQUEMONTIA PALMERI Wats. Collected in Baboquivari Canyon, Pima Co., by Peebles in 1925, presumably for the first time in Arizona and in the United States. The species had previously been known only from Sonora and Lower California.

*IPOMOEA LINDHEIMERI Gray. Collected by Harrison and Kearney near Tombstone, Cochise Co., in 1929, presumably for the first time in Arizona. The range, as previously known, is southern Texas to southwestern New Mexico and Chihuahua and Coahuila, Mexico.

## BORAGINACEAE

*PECTOCARYA LINEARIS (R. & P.) DC. Collected by us at several localities throughout Pinal Co. and near Hot Springs Junction, at the northern edge of Maricopa Co. In his revision of the North American species of Pectocarya, Ivan M. Johnston[33] does not record the typical form of *P. linearis*

[32] Woodson, R. E., Jr. Studies in the Apocynaceae, III. A monograph of the genus Amsonia. Ann. Missouri Bot. Garden **15**: 379–434. 1928.

[33] Johnston, I. M. Studies in the Boraginaceae, II. (Contr. Gray Herb. **70**: 3–55. 1924), pp. 36 and 39. In the publication cited, *P. linearis* is referred to *P. gracilis* (R. & P.)

as occurring in Arizona, all North American specimens cited by him being from California and the neighboring islands.

## VERBENACEAE

*Lantana camara L. Collected by Kearney, Harrison, and Peebles in 1926 along a large "wash" near Sells (formerly Indian Oasis) Pima Co., where it appeared to be well established. The conditions under which the plants were growing preclude the idea that they were introduced by man, although *L. camara* is often cultivated as an ornamental. Migrating birds may have brought the seeds from some locality in Mexico, since it occurs in nearly all parts of that country. It is found also in the southeastern United States from Georgia to southern Texas. Ours was apparently the first collection of this species in Arizona.

Bouchea prismatica (Jacq.) Kuntz. (*B. ehrenbergii* Cham.). This plant, although previously known as occurring in Arizona, is rare in that state and is found only very near the Mexican border. We have collected it, one or two individuals at a time, in the Chiricahua and Huachuca Mts., Cochise Co., and near Nogales, Santa Cruz Co. Our specimens belong to var. *brevirostra* Grenzeb., the range of which, as given by Grenzebach,[34] is New Mexico to Salvador.

## MENTHACEAE

*Isanthus brachiatus (L.) B. S. P. This plant is widely distributed in the eastern United States, ranging from Quebec and Ontario to Minnesota, Georgia, and central Texas. Its occurrence in Arizona, but apparently not in New Mexico, therefore parallels the interrupted distribution of *Crotalaria sagittalis* and of *Clitoria mariana*. Collected by Harrison in the White Mts. in 1927, and previously in the Mogollon region by C. A. Purpus.

*Salvia aethiopis L.[35] Abundant at roadsides and in pastures near Kirkland, south of Prescott, where it was collected by Kearney, Harrison, and Peebles in 1926. This seems to be the second record of the establishment of this Old World species anywhere in the United States, the only other locality known to the writer being at Lakeview, Oregon, where it was collected by A. N. Steward in 1920.

Salvia confinis Fernald. This apparently rare shrub was collected by Peebles and Loomis near Patagonia, Santa Cruz Co., in 1930. The only other stations in Arizona where it occurs, so far as the writer knows, are Fort Huachuca (the type locality) and Lowell, both in Cochise Co. It is found also in Sonora, Mexico.

Salvia mohavensis Greene. Collected by Harrison and Peebles in the Sierra Estrella, Maricopa Co., in 1928. This station extends the known range considerably to the east, the only previous collection in Arizona, so far as the writer knows, having been at Chemehuevis Mountain in Mohave Co., by M. E. Jones. The type locality is in the Mohave Desert, California. The species has also been collected by D. T. MacDougal at Pinacate, northwestern Sonora.[36]

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Johnst., but Dr. Johnston has since concluded that this name is untenable. Our specimens of *Pectocarya* were identified by him.

[34] Ann. Mo. Bot. Garden **13**: 80, 81. 1926.

[35] Identified by P. C. Standley.

[36] P. A. Munz in Bull. So. Calif. Acad. Sci. **26**: 23. 1927.

## SOLANACEAE

*LYCIUM MACRODON Gray. The occurrence of this species in Arizona does not seem to have been definitely recorded, although it is not unlikely that the type was collected there rather than in California or Nevada. It is widely distributed and fairly common in Pinal County, where it was collected by David Griffiths, W. F. Gilman, Alice Eastwood, and subsequently by our group. It was collected also at the eastern base of the Tinajas Altas Mts., Yuma Co., by Kearney and Harrison in 1930. This species occurs also in Sonora, Mexico. The peculiar bony fruit, somewhat resembling that of *L. cooperi* Gray, was collected in a mature condition at Sacaton by Peebles in 1930, apparently for the first time.

*LYCIUM PARISHII Gray (*L. pringlei* Gray). Collected at Mohawk, Yuma Co., by Kearney, Harrison, and Peebles in 1927, and at several other localities in Yuma County and between Casa Grande and Gila Bend (in Pinal or Maricopa Co.) by Kearney and Harrison in 1930. It had previously been collected by E. Palmer on the Williams Mountains in southern Mohave Co., and by David Griffiths on the Papago Reservation in Pima Co., so the species evidently ranges pretty well throughout the southwestern part of the state. It occurs also in southern California and in northern Sonora.[37]

SARACHA SESSILIS Greene. This apparently rare plant, previously known only from the Chiricahua and Huachuca Mts., Cochise Co., was collected in Baboquivari Canyon, Pima Co., by Peebles in 1925 and near Nogales Santa Cruz Co., by Kearney, Harrison, and Peebles in 1928, thus extending the known range considerably westward. Mr. C. V. Morton of the U. S. National Herbarium informs the writer that he regards *S. sessilis* as not specifically distinct from *S. edulis* (Schlecht.) Thellung, a species of wide distribution in Mexico.

CAPSICUM BACCATUM L. Collected by Harrison and Peebles in Baboquivari Canyon, Pima Co., in 1925. The known range of the species is Florida, southern Texas, and southern Arizona, southward to South America. It seems to be absent in New Mexico and very rare in Arizona.

**SOLANUM DEFLEXUM Greenm. Collected in the Baboquivari Mts., Pima Co., by Harrison in 1927, and by Kearney, Harrison and Peebles near Nogales, Santa Cruz Co., in 1928, both stations being very near the Mexican boundary. Our specimens correspond well with Greenman's description[38] except in having shorter pedicels and a smaller corolla. This species is widely distributed in southern Mexico, as far north as Sinaloa, and in Central America, apparently occurring also in Lower California. It does not seem to have been reported previously as occurring in Arizona or even close to the border in Mexico. As the fruits are fleshy, transportation of the seeds by birds migrating northward seems not improbable.

*SOLANUM HETERODOXUM Dunal. Collected near Kirkland, south of Prescott, Yavapai Co., by Kearney, in 1930, apparently for the first time in Arizona. The plant is well established and is abundant at roadsides in this locality. The Arizona specimens are of the small-flowered form (*S. novomexicanum* Bartlett). *Solanum heterodoxum* occurs also in New Mexico, western Texas, and Mexico.

*NICOTIANA CLEVELANDI Gray. Collected by Kearney near Wellton in 1927 and by Kearney and Harrison near the eastern edge of Yuma County in

[37] All of these specimens were identified by C. L. Hitchcock of the Missouri Botanical Garden, who has concluded that *L. parishii* and *L. pringlei* are not distinct species.

[38] Proc. Am. Acad. Sci. **32**: 301. 1897.

1930. Apparently not previously known as occurring outside of southern California.

## SCROPHULARIACEAE

Antirrhinum cyathiferum Benth. (*A. chytrospermum* Gray). This species, apparently rather rare in Arizona, has been collected by Peebles and Loomis on Picacho Peak and on the San Tan Mts., both localities being in Pinal County. It prefers partly shaded situations at the base of cliffs. These collections extend the known range considerably eastward, the only previously recorded locality in Arizona being Ehrenberg on the Colorado River in Yuma Co. This species occurs also in Lower California and Sonora.

Maurandya acerifolia Pennell. Discovered in Fish Creek Canyon, at the eastern end of Maricopa County, by Peebles in 1928.[39]

Pentstemon microphyllus Gray. Shrubby, with a short and wide corolla of a clear yellow color, belonging to a section of the genus (Fruticosi) that is otherwise confined to California and Lower California. The type locality is on the Williams River in western Arizona, but we have collected it at several localities as far east as southern Gila County, between Winkelman and Globe.

## ACANTHACEAE

Beloperone californica Benth. This showy, scarlet-flowered plant, very attractive to hummingbirds, is locally abundant on rocky mountain sides in southern Arizona. Our collections have extended the known range eastward as far as the Superstition and Picacho Mountains, in Pinal County. The range as now known is from Lower California, Sonora, and Sinaloa to southern California and northeastward to about latitude 33.5 and longitude 111.5 in Arizona.

## RUBIACEAE

*Galium pilosum Ait.[40] Collected by Kearney, Harrison, and Peebles in 1927 in rich woods on Mt. Graham, Graham Co., where it grew with *Circaea pacifica*. The discovery of this species in southeastern Arizona gives it an interrupted range similar to those of *Crotalaria sagittalis*, *Clitoria mariana*, and *Isanthus brachiatus*, as it was not previously known to occur farther to the southwest than central Texas. Our specimens have broader and thinner leaves than is usual in *G. pilosum*, but according to Mr. Standley, in a letter to the writer, they "agree very well with shade forms of this species from the Chicago region. . . . . I do not see how it is possible to distinguish the Arizona material, even varietally."

*Galium spurium L. (*G. vaillantii* DC.).[41] Collected in Devils Canyon, Pinal Co., by Kearney Harrison, and Peebles, in 1928. This European species, naturalized in many parts of the United States, seems not to have been reported previously as occurring in Arizona.

## CAPRIFOLIACEAE

Lonicera interrupta Benth. This is another plant of the mountains of California that reappears in south-central Arizona, having been collected by Harrison and Peebles in 1926 in Devils Canyon, Pinal Co., where it is fairly abundant. It had been collected previously in the Santa Catalina Mts. by Pringle and Lemmon and in the Pinal Mts. by Jones.

[39] Pennell, Francis W. A new Maurandya from Arizona. Journ. Wash. Acad. Sci. **19**: 69, 70. 1929.

[40] Identified by P. C. Standley.

[41] Identified by P. C. Standley.

## LOBELIACEAE

*NEMACLADUS LONGIFLORUS Gray.[42] Collected in sandy soil at a roadside between Tucson and Ajo, Pima Co., by Kearney, Harrison, and Peebles, in 1927. In a letter to the writer Dr. Munz states that ours is the first collection of this species in Arizona known to him, and adds: "There is some question as to whether *Nemacladus longiflorus* might not be divided so as to recognize a desert variety. Your plant matches exactly some four or five collections from the western edge of the Colorado Desert in California. These are all smaller than the species ordinarily is. Your plant is another example of a group of species that is found primarily on the California coast but straggle occasionally into the Tucson region."

## ASTERACEAE[43]

SOLIDAGO WRIGHTII ADENOPHORA Blake. The type of this variety was collected by Harrison in the Santa Catalina Mts., Pima Co., in 1926, but the same form had been collected previously at other localities in southern Arizona and New Mexico.[44]

ERIGERON OXYPHYLLUS Greene. Collected in the Sierra Estrella, Maricopa Co., by Peebles and Harrison in 1928. This represents a considerable southeastward extension of the range, the species having been known previously only from Yucca, Mohave Co., Arizona, where the type was collected by M. E. Jones. The stems are woody towards the base.

**GNAPHALIUM PRINGLEI Gray. Collected by Peebles in Baboquivari Canyon, Pima Co., in 1925, this being apparently the first collection in Arizona and in the United States. Collected subsequently by Harrison and Peebles in the Santa Rita Mts. (Pima or Santa Cruz Co.) and by Kearney, Harrison, and Peebles in the Huachuca Mts., Cochise Co. The species was known previously from Chihuahua and San Luis Potosí, Mexico.

NOCCA DECIPIENS (Hemsl.) Kuntze. This plant is apparently very rare in Arizona and confined to the immediate vicinity of the Mexican boundary. It was collected by F. A. Thackery at the western base of the Baboquivari range, Pima Co., in 1926, and had been collected previously in Pima Co. by E. A. Mearns. The known range of the species is from southern Arizona to Chihuahua, Sonora and Jalisco, Mexico.

*XANTHIUM SPINOSUM L. Well established in the vicinity of Prescott, Yavapai Co., where it was collected first by B. E. Fernow. Naturalized from tropical America.

TITHONIA THURBERI Gray. Collected in Baboquivari Canyon, Pima Co., by Kearney in 1925 and in the vicinity of Nogales, Santa Cruz Co., by Harrison and Peebles in 1927. These are the first collections of any member of the genus in Arizona and in the United States.[45] *T. thurberi* was known hitherto only from northern Sonora.

VIGUIERA OVALIS Blake. Collected in the Chiricahua Mts., Cochise Co., by Kearney and Harrison in 1929, this being the third time the species has been collected and the second collection in Arizona (previously by J. G. Lemmon, without record of the locality). It is known only from southeastern Arizona and southern New Mexico.

[42] Identified by Philip A. Munz.

[43] Identified by S. F. Blake, to whom the writer is indebted for much of the information in the following notes.

[44] S. F. Blake in Journ. Wash. Acad. Sci. **19**: 269. 1929.

[45] S. F. Blake in Proc. Biol. Soc. Wash. **39**: 145. 1926.

PERITYLE CILIATA (Dewey) Rydb. (*Laphamia ciliata* Dewey). Rare but widely distributed in Arizona. Collected near Prescott, Yavapai Co., by Kearney in 1926 and previously by D. T. MacDougal near Pine, Gila Co., by J. W. Toumey in the Tucson Mts., Pima Co. and by J. B. Leiberg on Elden Mesa, near San Francisco Mt., Coconino Co.

LAPHAMIA GILENSIS Jones. This plant, known previously only from the type collection by M. E. Jones on the Gila River,[46] was collected in Devils Canyon in Pinal Co. by Harrison in 1926 and subsequently in Fish Creek Canyon at the eastern end of Maricopa Co., by Peebles, Harrison, and Kearney.

HYMENOTHRIX LOOMISII Blake. The type was collected by Loomis near Ashfork, Yavapai Co., in 1926, although the species had previously been obtained by several other collectors in northern and northwestern Arizona.[46] In 1930, *H. Loomisii* was found by us growing in considerable abundance 30 miles south of Prescott, in Yavapai Co., this station being the southernmost yet known.

PLUMMERA AMBIGENS Blake. The type and only known collection of this species was on the lower slopes of Mt. Graham, Graham Co., by Kearney, Harrison, and Peebles in 1927.[47] It occurs abundantly on a dry, unshaded slope at that locality.

**PECTIS URCEOLATA (Fernald) Rydb. (*P. prostrata* Cav. var. *urceolata* Fernald). Collected near Nogales, Santa Cruz Co., by Harrison and Peebles in 1927, and considerably farther north, in the Sierra Ancha, Gila Co., by Kearney and Harrison in 1928. It had been collected previously by E. A. Mearns south of Bisbee, Cochise Co., but apparently the occurrence of this species in Arizona and in the United States has not hitherto been recorded. *P. urceolata* ranges from southern Arizona through Sonora and Chihuahua to El Salvador.

## PALEONTOLOGY.—*The mastodon of Thomas Jefferson.*[1] MARGARET R. HITCHCOCK, University of Virginia. (Communicated by C. WYTHE COOKE.)

The upper and lower jaw bones of a *Mastodon americanus* (Leidy) do not, in themselves, constitute a rare fossil. The species has been well described by writers for many years, and the work on the Proboscidea, which is in progress, under the direction of Dr. Osborn at the American Museum of Natural History, would, of course, cover many descriptions of such remains. The bones described below, however, are interesting for two reasons, first, because of the historical significance attached to them, and second, because of an unusual position of the teeth in the lower right jaw, which resulted in a real malformation.

The fact that Thomas Jefferson, in addition to being a law giver, architect, educator, and inventor, was also a paleontologist, has been

[46] S. F. Blake in Proc. Biol. Soc. Wash. **40**: 49, 50. 1927.

[47] S. F. Blake in Journ. Wash. Acad. Sci. **19**: 276–278. 1929.

[1] Received January 13, 1931.

brought to our attention again quite recently by Dr. Osborn. In an address delivered in Washington in 1929, Dr. Osborn[2] brought out the keenness of Jefferson's interest in paleontology, and the persistency with which he pursued his studies. From his letters we can see that

Fig. 1.—View looking down on the lower mandible, showing the differences in the two sides.

interest marching along side by side with the affairs of the nation, for on the same day letters were written dealing with fossil remains, and others with national policies. A proof of this avocation of his rests

[2] H. F. OSBORN. *Thomas Jefferson, the pioneer in American paleontology.* Science, n.s., **69**: 710–713. 1929.

at the University of Virginia which he planned and founded. In the museum there are the jaw bones of a mastodon which were probably given to the School of Natural Science by Jefferson himself.

There is some question as to the locality from which these bones were collected, and by whom collected. Tradition has it that they were collected by Thomas Jefferson. It seems unnatural, however, for a man who had so great an interest in the study of such fossils, and who wrote so many letters on the subject, not to have mentioned in some of these an event of such importance as his own personal collection of so

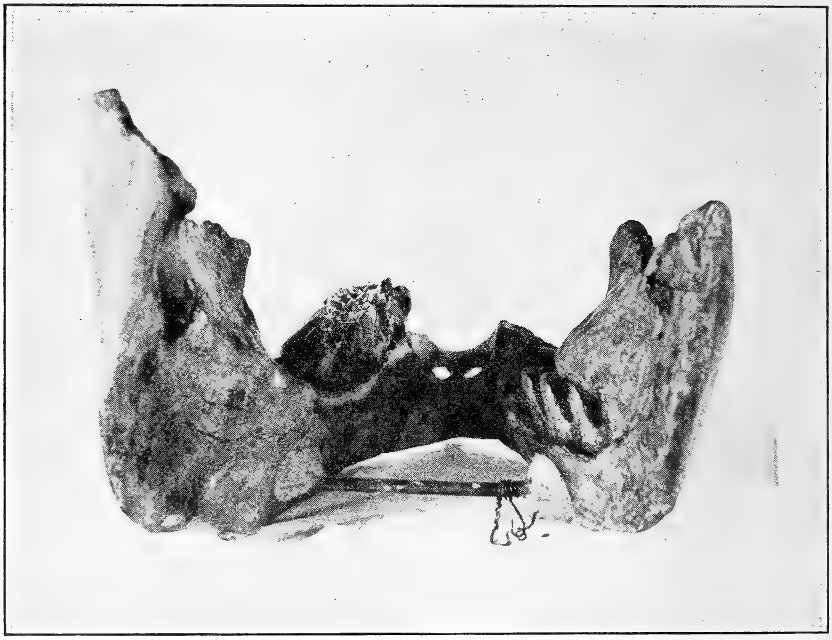

Fig. 2.—Lower mandible from the rear, showing adjustment caused by the impacted tooth at right (as figured).

great a find. In a letter to Dr. Caspar Wistar dated February 25, 1807, he writes, ". . . . Being acquainted with Mr. Ross, proprietor of this big bone lick, I wrote him for permission to search for such particular bones as the society might desire, and I expect to receive it in a few days. Captain Clarke (companion of Captain Lewis) who is now here, agrees, as he passes through that country, to stop at the lick, employ labourers and superintend the search at my expense, not that of the society, and to send me on the specific bones wanted, without further trespassing on the deposit. . . . . But send me the list if you please without delay, as Captain Clarke returns in a few days, and we should lose the opportunity."[3] Later in the same year there is a letter to General George Rogers Clarke, thanking him for sending on the bones which have been collected, and another to Dr. Wistar in which the list of bones is again discussed, and in which Jefferson's cabinet at Monticello is mentioned, as a few of the bones were especially gathered for it.[4] Whether the jaws, which are in the museum at the University of Virginia are some of those collected by the Clarke brothers, or had been owned by Jefferson before that time, we may be fairly certain that they were a part of his collection at Monticello, for George Tichnor wrote from there of the "os frontis" of a "mammoth" in the "cabinet," and that they were given from there to the University, where they are another evidence of his interest in the natural sciences.

The upper jaw with a portion of the skull is probably the better preserved of the two members as far as teeth are concerned, but in the

TABLE 1.—DIMENSIONS OF THE LOWER JAW

| | Left side | Right side |
|---|---|---|
| | *cm.* | *cm.* |
| Length of jaw | 65 | 68 |
| Width of jaw in front of front molar | 8 | 13 |
| Width of jaw behind first molar | 15 | 19 |
| Length from the inside of the symphysis to the beginning of the coronoid process | 35 | 38 |
| Width at the beginning of the coronoid process | 14 | 14 |
| Height of the coronoid process from the top to the jaw bone. | 14 | 13[a] |

[a] The original length of the broken process must have been a little greater than 16 cm.

consideration of the bony structure as a whole, it is a less complete specimen. All of the more porous parts of the upper portion of the skull have been broken off, so that only the traces of the air cells have been left, and only the base of the brain cavity, still showing, however, the processes which divide these. Nevertheless the fine porosity of the bones is well shown and an excellent idea of the general structure of the skull may be obtained. The length of this piece is about 50 cm., while the width is between 35 and 40 cm.; there are two molars in place on each side. Of these the front ones are the most worn, and so well worn that there are no cusps, but ridges, while only the front two cusps are worn on the back ones. All the transition stages can be seen from the well worn in front to the perfect cones in back, which must have

[3] The writings of Thomas Jefferson. **9**: 158. 1907.
[4] The writings of Thomas Jefferson. **9**: 403, 405. 1907.

been still covered by the gums. On the right side, the bony process in front has been broken off until it shows the long curved roots of the first molar. The right side seems to have had more use, as the teeth are more worn down than those on the left side, and this seems to be connected with a slight warping of the upper jaw, which might otherwise have been considered a result of the replacement accompanying fossilization, but which seems to correspond with a malformation of the lower mandible, which does away with that conjecture.

As the lower jaw is not symmetrical and has been broken, it presents several problems. The break occurs just to the right of the symphysis but owing to the recency of the mending of this, very probably within the last twenty years, it would seem to be surely one complete lower jaw, and not the patched up fragments of the jaws of two different individuals. It seems necessary to decide this fact because of the lack of similarity of the two sides, in several ways (see figures 1 and 2). This difference is, perhaps, best brought out in a comparison of the measurements taken of the two sides, listed in Table 1.

It is interesting to note that the actual difference in length in the two jaws is only 3 cm., as the apparent difference is so great. This is most probably due to the more massive appearance of the left side, which is also the shorter side, and this tends to magnify the inequality. This shortness of the left side persists in all parts of the jaw, except in the tooth sockets, which seem to be the same size in all dimensions as those on the right. This, of course, has the effect of making them appear much larger in proportion. The vertical thickness of the two sides is so nearly the same that no measurements in this direction were taken until the coronoid process was reached. The shape of the two sides of the jaws differs greatly. The curve from the symphysis on the left side is quite abrupt, going into a fairly straight line almost immediately, while on the right side the curve is slower and continues to the coronoid process, where the bone narrows on both sides. This narrowing occurs to a certain degree in both sides, but on the right side it narrows quickly and leaves a decided angle on the inside of the jaw, while on the left side there is a slow and more rounded narrowing (see figures 1 and 2). The width of the two sides, just in front of this process and behind the second molar, is the same on the two sides. This is as it should be, but in this case, where the entire left side is smaller, it makes this side proportionately too broad at that spot. The massive appearance above mentioned is due to this swelling and the lack of angularity of curve behind it.

The height of the coronoid process varies on the two sides. The right side of the specimen has been broken at this point, but even in that state, the right side measures 13 cm. while the left measures 14 cm., and the necessary additional height to complete the process on the right side would make that side at least measure up to 16 cm. This is the only great difference in vertical height in the two sides.

The teeth of the lower mandible are not all present, but those still in place are in a state of good preservation, and again show the different stages of wear, and are, in general, less worn than those of the upper mandible. The teeth of the right side are two in number, molars of three and five ridges or cones. The first molar, three-coned, is slightly worn down, the front cone as is natural being the most worn, and the second, the five-coned tooth, has no sign of wear on the back two cones. Even the slight depression into two cusps on the last cone of this tooth shows perfectly. These teeth are in place and there is apparently no room for any others between the last one and the coronoid process, and no spot in this process which is thick enough to conceal another later molar. The teeth of the left jaw which correspond to those of the right jaw are missing. These have very evidently been lost since the specimen was found. Perhaps they were given to other museums by Jefferson in the early days at Monticello, or they may have been misplaced since becoming the property of the University of Virginia. The sockets in which the roots of these teeth rested are perfectly clear and clean of any foreign material, which is not true of some of the air cells and cavities in the skull, which still contain small pebbles and sand, and have been broken and chipped away. These sockets show that they originally contained first a three-coned tooth, and second a five-coned tooth, exactly corresponding to the two on the other side, though they seem to have been placed a little farther forward on the jaw bone nearer the symphysis than those on the right side. In addition to these, there is, as a third tooth, a large molar, the first two cones of which are now visible in front of the coronoid process, the last three of which are beneath this and only visible from the inside of the jaw, where the bone has been broken away (see figure 2). This molar is as large as the one on the right side, which would correspond to the original second tooth on the left jaw, and is in perfect condition, not worn at all; in fact, it could never have appeared above the gum, as the top of the cones is still below the original surface of the slope leading from the jaw bone proper to the coronoid process. The bone of the process above it is much thicker through than the corresponding bone of the left jaw, and seems to have thickened and changed the angle of growth in order to accommodate this peculiar tooth. If the curve of the connection between the jaw bone proper and the process were not broken, it would be possible to see how completely surrounded this tooth is by bone. As it is, a reconstruction of this material can be postulated and the line of the original bony material drawn which would cut the tooth at such an angle, that it would be impossible for the tooth ever to have appeared above the surface, either in a vertical or in an inclined horizontal direction. In the latter and only possible direction the bone which has recently been broken off would have intercepted and broken off the second cone of the tooth, which, of course, would have stopped its progress. This tooth, then, seems to be one which is completely misplaced, and which, due to this, has caused a thickening and changing of the shape of the process in which it is found. The changes in bone building necessary to accommodate this tooth would lower the coronoid process, causing the difference in vertical height between the process on the left jaw and the corresponding process on the right jaw. This difference probably amounted to as much as 2 cm., at least, and this, with the greater thickness, would throw the balance of the jaw to an entirely different center from the normal one of the right jaw. In this way may be explained the difference in length of the two jaws as well as their great difference in shape.

In addition to this, it is interesting to note that the upper mandible seems to be slightly warped and one-sided. As mentioned above, this seems to be a real malformation, and not an effect of fossilization, and appears to be an attempt of the upper mandible to conform to the distortion of the left lower jaw, in order to give as good occlusion as possible. In this way the occurrence of one tooth in the wrong position has caused the warping and malforming of the entire head of the mastodon.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## PHILOSOPHICAL SOCIETY

### 1011TH MEETING

The 1011th meeting was held in the Cosmos Club Auditorium on November 8, 1930, President LAMBERT presiding. The program consisted of six reports on various phases of the meeting of the International Union of Geodesy and Geophysics held in Stockholm, Sweden on August 15–23, 1930. The discussion of the papers was deferred until the end of the program.

W. BOWIE: *An outline of the organization and purpose of the Union, and Proceedings of the Section of Geodesy.*—The International Geodetic and Geophysical Union is one of the branches of the International Research Council.

At stated periods delegates from the different countries meet under the auspices of this Union to confer on questions of geodesy and of geophysics which are world wide in their extent, and to lay out comprehensive plans of attack on these problems.

Before the world war, there were a number of scientific associations, each of which covered a certain branch of science. These associations either went out of existence during the war or were very much reduced in size and importance. In 1919, the Allied Powers reorganized international scientific work at a meeting in Brussels, Belgium, at which the International Research Council and several of its Unions were formed. Later, other Unions were created.

There are now 38 countries adhering to the International Research Council and the International Geodetic and Geophysical Union. Delegates from 32 of these countries were present at the Stockholm meeting, and also guests from Germany, Austria, Latvia, Lithuania and Esthonia. In all, there were about 180 official representatives and 70 invited guests at the meeting. The guests took part in the scientific discussions, but did not vote.

One of the most important things which came before the Union was the revision of the Statutes. The Council and its Unions are, at present, working under what is called a convention which somewhat resembles a treaty among the different countries. This convention will expire on December 31, 1931, when some new arrangement must be provided. The International Research Council has had a committee working on the revision of the present convention and statutes and, according to present advice, the new arrangement will take the form merely of statutes rather than a convention. This will mean that the Council will not be quite so formal as it now is.

The new statutes will use the designation association instead of section for each branch of the Unions. This designation carries more weight and dignity, and the change was unanimously approved. Another change in the statutes relates to the term of office of the President of the Union, who hereafter will hold office only during the period between two general assemblies and will not be eligible for immediate reëlection. Still another change deals with the matter of financial contributions from the adhering countries. The largest of the countries, including the United States, pay annually eight units and, at present, a unit is 900 gold francs. The unit hereafter will be 2000 Swiss francs, and thus the annual contribution from the United States will be slightly more than $3000 in U. S. currency.

The International Geodetic and Geophysical Union embraces 7 associations, as follows: Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology, and Scientific Hydrology.

The Stockholm meeting of the Section of Geodesy was a very successful one. There were approximately 70 delegates and guests present. As usual, national reports from each of the countries represented, giving in some detail its geodetic accomplishments during the preceding three years and including discussions of improvements in methods and instruments and results of scientific research, were received. These reports were all in printed form and the chairmen of the various national delegations simply gave abstracts.

There were 21 standing and special committees, all of which held meetings and reported their findings and recommendations to the Association. A number of resolutions were adopted by the Association relating to recommended arcs of triangulation, gravity observations at sea, etc.

Only one scientific paper was presented, and that was by Dr. F. A. Vening Meinesz, a member of the Dutch Geodetic Commission. He described his recent gravity-at-sea work in the waters of the East Indies, during which he established about 235 stations. He has already made an approximate isostatic reduction of these stations, and finds that the East Indies, as a whole, are in isostatic equilibrium but that there are some rather interesting and remarkable local anomalies.

The delegates were unanimous in expressing their admiration of the splendid arrangements which had been made by the local committee, headed by Dr. Pleijel. Every facility was afforded the Union and the Associations to carry on their work in the smoothest possible way. The Swedish people are noted for their ability in organizing and handling such meetings as that of the International Geodetic and Geophysical Union. (*Author's abstract.*)

H. H. Kimball: *Proceedings of the Section of Meteorology.*—The several commissions of the Section held numerous meetings prior to the convening of the Section, listening to papers, and discussing and amending resolutions that were later presented to the Section for action. In spite of this preliminary work, the Section had not time to properly discuss important questions that came before it.

With a view to remedying this condition the Section, by resolution, limited its future activities to the consideration of meteorological questions that call for collaboration with other branches of geophysics, or that may require discussion by experts before they can be recommended to the Meteorological Organization for consideration in connection with the solution of practical problems.

As illustrating the significance of this resolution, it was noted that there are important relations between the extensions of polar ice and the seasonal character of the weather over large areas. It was suggested to the Meteorological Organization (made up of directors of meteorological services) that more complete data on this subject be collected, especially during the polar year 1932–33. Also, the attention of the Meteorological Organization was invited to the possibility of introducing into the publication of daily observations the data necessary for the calculation of the *entropy of the air*, and of defining *air turbidity* with a view to eventually including it in synoptic wireless issues.

The Section recommended that the Union accept the invitation of the Meteorological Organization to cooperate in organizing and carrying out a second polar year in 1932–1933, and that an effort be made to obtain the active cooperation of governments and scientific institutions.

These are only a few of the subjects passed upon by resolutions, the complete text of which is published in the Monthly Weather Review, August, 1930, **58**: 313–316.

The budget of the Section has to its credit for expenditure during the period of 1930–33, about 365,000 French francs, ($14,600.00). Of this $2,000 is allotted to the Bureau of the Section for its expenses. The rest is distributed among various projects, such as the publication of reports on the exploration of the high atmosphere, the preparation of weather charts of the Northern Hemisphere, the publication of a bibliography of solar radiation, a grant to the Polar Year in the form of a prize for the first model of an automatic meteorological station giving satisfactory results, and to M. Giâo for experiments in weather forecasting. (*Author's abstract.*)

N. H. Heck: *Proceedings of the Section of Seismology.*—The meeting of the Section of Seismology started off under unusually good conditions. Professor H. H. Turner of Oxford University as Chairman presented an unusually fine report. He called attention to the great advances being made in seismology in nearly all parts of the earth, but especially in the United States. He also presented the discussion of earthquakes of unusually deep focus, showing that such earthquakes occur around the rim of the Pacific. His theories are of interest because of the apparent conflict of such depth of focus with the principle of isostasy.

Just as the second session was about to start, Professor TURNER leaned forward, put his hand to his forehead and never had a conscious moment, dying three days later. It was necessary, of course, for the meeting to go on and after his removal to the hospital, the various national reports were received, including that for the United States which I presented and which was commended.

The division of the somewhat increased funds was discussed and it was decided to divide them into three parts, one for continuing the international seismological summary at Oxford, another for the work of the Central Bureau at Strasbourg, and the third to finance special investigations or to be held in reserve. Travel time curves and tables of earthquakes were discussed and Dr. MACELWANE agreed to revise his tables and Professor ROTHÉ agreed to publish them on behalf of the International Bureau. A code for international transmission of seismic data was revised.

Special reports and papers of interest included one by Miss LAHMENN of Denmark who gave the results of studies of an earthquake in the Yonga Deep and one in Mexico, these occurring at such distances from Europe as to give results of particular interest in regard to certain phases passing through the core. Dr. IMAMURA presented a very complete discussion of earth tilts in Japan as relating to earthquakes. He showed that after a great earthquake there is for a long time tilting in one direction, then a reversal, and finally, just before a great earthquake, there are very sudden changes in the tilt which serve to give a few hours advance warning. He was able from geological records to apply the theory to early earthquakes long before the period of accurate instrumental observations. Dr. WENNER discussed his torsion seismometer and presented a design for a strong-motion instrument to be used in the central region of a strong earthquake. Dr. MACELWANE described the recent performance of the Wood-Anderson seismometer, an important matter because the presentation of this subject at the Madrid meeting of the Union was unfortunate. He also gave an analysis of the time as obtained from records from important stations throughout the earth and proved that the errors may be much greater than ordinarily assumed. A representative of Portugal called attention to recent monumental work on the geological features of the great Lisbon earthquake. Dr. ROTHÉ gave a memorial address on Dr. WIECHERT, the great German seismologist who died since the last meeting. Dr. ANGENHEISTER, a German seismologist who was present as a guest and Dr. CONRAD of Vienna who was present agreed to publish both addresses in the Beiträge Zur Geophysik.

These were the principal activities though many other matters were discussed.

After the removal of Professor TURNER proceedings were handicapped by the inability of Acting Chairman ODDONE and Secretary ROTHÉ to speak English and interpreters had not been provided as Professor TURNER always performed this function extremely well. The results were very unsatisfactory to the English speaking delegates who comprised about half the number. I was able to understand about 80 per cent, but not enough for intelligent action on important matters. Assurance was given that interpreters will be provided in the future.

In conclusion, I consider the meeting as generally successful. We must have, from time to time, consultation on international issues. At the next meeting the matter of publication must be given more attention. Certain activities now national could well become international and thereby relieve each part of the earth of routine work and thereby make possible special studies which will increase our knowledge. The importance of personal contacts with geophysicists of other countries will undoubtedly be emphasized by the speaker dealing with the general features of the meeting. (*Author's abstract.*)

J. A. Fleming: *Proceedings of the Section of Electricity and Magnetism.*—Six scheduled and well-attended meetings of the Association of Terrestrial Magnetism and Electricity at Stockholm were held during August 1930, and the Association also took part in four joint sessions one with the Associations of Geodesy and Seismology, one with the Association of Meteorology, and two with the International Scientific Radio Union. The agenda for the meeting held an unusually great number of items, all of which were actively reported upon and discussed despite the comparatively short time available.

Detailed progress reports of magnetic-survey work and investigations were received from twenty countries including three reports from the United States—the Coast and Geodetic Survey, the American Geophysical Union, and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Numerous publications relating to these reports were distributed, and one was impressed not only with the amount of useful work in the fields of the Association being done throughout the world but also with the vast amount still to be done.

The report of the special committee on the preparation of a photographic atlas of aurora with type descriptions and instruction for photographic and visual observation was received and approved, and authority was given that copies of the atlas be distributed without charge to observatories and organizations where worth-while auroral observations might be made. Following the report of the special committee on criteria of measures of magnetic activity, the formulas for characterization of days $(HR_H + ZR_Z)/10,000$ or $(NR_N + WR_W + ZR_Z)/10,000$ were adopted, where $R$ represents the absolute daily range of the element indicated for the Greenwich day, and arrangements were proposed that data derived by one or the other formula be published by the International Commission of Terrestrial Magnetism and Electricity in its regular publication of magnetic character of days.

The importance of continuing comparisons of standard electromagnetic instruments of various governments was emphasized, as also the design of portable apparatus of this character. It was agreed that the various suggestions on the subject of a uniform terminology be published for further consideration. The adoption of Greenwich mean time for the publication of magnetic data was referred for further consideration to a special committee. A reporter was appointed to summarize the progress in the studies of theories of terrestrial magnetism.

The importance of standardizing ion counters was emphasized, and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington was appointed as a central office to which matters could be referred pertaining to ion counters for compilation, discussion, and determination of the standards. Following discussion of the electric field of the atmosphere, it was agreed that tabulations to determine electric character of day might best be limited to electrically calm days.

Among the communications of particular interest in atmospheric electricity was one on the direct recording of air-earth current at the Kew Observatory by the C.T.R. WILSON method; such records may be compared with indirect determination through the records also being made of the conductivity and potential gradient of the atmosphere.

Considerable attention was given economic aspects of the Association's activities. These included the application of geophysical principles to the investigation of the earth's crust; it was agreed that a committee be appointed jointly by the associations of Seismology, Geodesy, and Terrestrial Magnetism and Electricity to collaborate in the solution of problems in geology through geophysics. Another economic aspect was the development of machine methods to facilitate the complex computations and compilations required in studying the numerous data accumulated by many observatories. An example of this was brought out in the report of a special committee on international collaboration for the advancement of studies of the influences of the moon on geophysical phenomena developing a plan for the assembling of data making use of Hollerith methods for compilations. The report was favorably considered and satisfaction expressed that a practical trial of the application of such a method was in prospect, thus paving the way for a definite proposal for international cooperation later.

Much attention was also given the proposal for the Jubilee Polar Year of 1932–33 of the Polar Commission of the International Meteorological Committee, and the desirability of adherence in the undertaking of all governments was stressed. Following a joint meeting of the Associations of Meteorology and of Terrestrial Magnetism and Electricity and the deliberations of a special joint committee, the following resolution was prepared for and later adopted by the General Assembly:

"The Union accepts the invitation of the International Meteorological Committee to cooperate in organizing and carrying out a second Polar Year with a similar object to that of the first Polar Year 1882–1883, and appoints the following Commission for this purpose: STÖRMER (*Chairman*), CHAPMAN, LA COUR, MAURAIN, and WEHRLÉ."

Other resolutions proposed by the joint committee were adopted by the Association. One emphasizes the very great importance for the advancement of geophysical science for the Polar Year as planned and its approval that the observations should not be confined only to polar regions. The Association, realizing the desirability that all cameras, plates, and spectroscopes used in the observations of the aurora should be of equal sensitivity, voted 15,000 gold francs for the provision of instruments of a standard type. It was further unanimously resolved that all observations should be reduced according to an agreed plan and that the Commission for the Polar Year should consider the best method for making the detailed results available for all those interested, further suggesting that all published volumes should be put on sale and that the various associations of the Union should subscribe for a number of copies.

Regarding possible overlapping of the work being done by the Association of Terrestrial Magnetism and Electricity and the Commission on Terrestrial Magnetism and Electricity of the International Meteorological Committee, it was unanimously agreed upon that it is not necessary to set a rigorous definition of the domain of each organization, as no difficulties have been met with in practice and no unnecessary duplications have been encountered, and as the respective officers can continue their effective cooperation in avoiding these.

The importance of study of the correlation of the reception of wireless signals and geophysical phenomena was referred to two joint meetings with the International Scientific Radio Union, the Association expressing itself as approving any program assuring the broadcasting of cosmic phenomena to facilitate the study of correlations concerning radio communication and the magnetic and electric condition of the Earth.

Recognizing the vital need of a better world-wide distribution of observatories, especially in the southern hemisphere, a special committee was appointed to consider existing and desirable distribution of magnetic and electric observatories and to consider plans for better coordination of work and publications of existing observatories. The economic impossibility of realizing more than a limited number of observatories and the reports on secular-variation investigations submitted stressed the need of systematic field work, and a special committee was appointed to plan and to accomplish means to secure through cooperation of interested governmental and private organizations well-distributed secular-variation data. In connection with this subject, appreciation of and generous comment was expressed on all sides on the magnetic and electric work at sea secured by the *Carnegie* together with expressions of regret that the work that vessel and her commander and staff had so well done could not have been continued as planned.

The election of officers for the period to the next Assembly at Lisbon in 1933 resulted as follows: J. A. Fleming, United States, *President;* Carlheim-Gyllensköld, Sweden, *Vice-President;* Ch. Maurain, France, *Secretary* and *Director of Central Bureau.* The Executive Committee of the Association, besides these officers, includes A. Crichton Mitchell of Great Britain, J. Jaumotte of Belgium, D. la Cour of Denmark, L. Palazzo of Italy, and A. Tanakadate of Japan. (*Author's abstract.*)

G. W. Littlehales: *Proceedings of the Section of Oceanography.*—The significant events of the meeting of the International Section of Oceanography at Stockholm were on the administrative side—not that there were no important reports and communications brought and deliberated upon.

The Spaniards, in relation to the project for connecting Spain and Morocco by tunneling under the bed of the intervening waters, presented details of their oceanographical operations in the Strait of Gibraltar, portraying the submarine conformation of the Strait and the hydrological mechanism of its waters; the International Hydrographic Bureau at Monaco, through the President of its Directing Committee, submitted an account of the considerations of the Bureau, accompanied by an appeal for advice, in relation to the transaction with the Oceanographical Museum of Monaco by which the Bureau had accepted the charge of the upkeep of the *Carte générale bathymétrique des océans;* Dr. Vening Meinesz furnished a discussion of the facts of observation resulting from his campaigns for measuring the distribution of the intensity of gravity on the ocean; the British delegation brought a mathematical discussion of the action of the tides in narrow channels; the Department of Terrestrial Magnetism of the Carnegie Institution of Washington presented, in a series of reports of unexcelled form and substance, the oceanographical results of the last cruise of the Carnegie, and, in addition, the American delegation presented a comprehensive report of developments in oceanography for the years intervening since the meeting of the International Section of Oceanography in 1927.

But to return to the administrative side: When the International Research Council was established at Brussels in 1919, among the unions that were formed to compose the institution was the Union of Geodesy and Geophysics, in which provision was made for a Section of Physical Oceanography

—the intended place for Biological Oceanography being in the contemplated Union of the Biological Sciences.

Inasmuch as the Union of Biological Sciences did not develop as intended, the aspiration soon manifested itself to have formed a separate Union of Oceanography which should include both physical oceanography and biological oceanography. This proposal was advanced before the International Research Council, but the Council did not change the Statute as originally framed.

Biological oceanographers have, however, largely adhered to the International Section of Oceanography, and the Section has been under the administration of biological oceanographers from the time of the meeting of the International Union of Geodesy and Geophysics at Rome in 1922 until the election, which was brought about at Stockholm, which resulted in the installation of a physical oceanographer in the Chairmanship and also a physical oceanographer in the Secretaryship. (*Author's abstract.*)

F. WENNER: *Impressions of the excursions and entertainments.*—The entertainments and excursions arranged for the delegates included a banquet at the City Hall given by the City of Stockholm; an excursion on Lake Mälaren to Mariefred, with a visit to the old Gripsholm Royal Castle, and luncheon; an excursion into the archipelago of Stockholm and luncheon; reception by the Crown Prince and Princess at the Royal Palace; visit to the University of Uppsala; banquet given by the Swedish Organization Committee; three excursions arranged especially for the ladies at times when the delegates were supposed to be attending meetings, and two excursions after the close of the meetings, one to northern Sweden and one to Göteborg via the Trollhättan Canal. In addition there were many privately arranged luncheons, dinners, and other social gatherings, visits to the Swedish Geological Survey, the Magnetic Laboratory, etc. The entertainments and excursions were for the most part well planned so that they constituted an exceptional opportunity for the formation of acquaintances and friendships among the delegates and their accompanying ladies. They also furnished numerous opportunities for the discussion of questions arising in the meetings. Finally they served as a means for giving us a better understanding of the Swedish people and their customs than otherwise would have been possible in so short a time.

While the excursions and entertainments were most profitable as well as enjoyable, of those in which I participated the one most worth while was the excursion to Göteborg, which is on the west coast. This was planned by Mrs. JENSEN of Göteborg and conducted by Major RICHARD SMEDBERG of Stockholm and Mrs. JENSEN assisting. The first day was spent in tramping, under the guidance of Civil Engineer WILLIAM MOBERG through a trackless country in the neighborhood of Degerfors, which is in the south-central part. The second day was spent on the Canal and in visiting the locks and various hydroelectric plants along the route, points of interest being discussed by Professor Baron STEN DE GEER. The third day was spent in seeing points of interest in and in the vicinity of Göteborg under the guidance of Baron STEN DE GEER. In the evening we were guests at a dinner given by the Governor of the Province of Göteborg and Mrs. VON SYDOW. While this dinner was not as elaborate as others, evening dress with decorations was specified. By that time the party of about 35 representing eleven different nations were fairly well acquainted, considering the language difficulty, there being seven languages represented. Further, for this group this was the final formal social function of the meeting, so someone from each of the countries gave a short talk and toast to our hosts. The fourth day we were guests of the Swedish Hydrographic and Biological Commission aboard the Coast Guard vessel SKAGERAK into the Göteborg archipelago. When the party broke up on the afternoon of the fourth day, we were as happy a group of people as I had ever seen. The various difficulties which had been continually coming up in the meeting had largely disappeared and we parted with a feeling of mutual understanding and of real friendship towards each other. The friendships formed and the understandings reached on this excursion will no doubt have a marked effect upon the progress of geophysics. (*Author's abstract.*)

The report as a whole was discussed by Messrs. CRITTENDEN, MEYER, and HUMPHREYS.

OSCAR S. ADAMS, *Recording Secretary*

## BIOLOGICAL SOCIETY

### 751ST MEETING

The 751st meeting was held in the new assembly hall of the Cosmos Club October 18, 1930 at 8.10 p.m. with President WETMORE in the chair and 38 persons present.

ALEXANDER WETMORE mentioned the observation of a flock of Forster Tern in Maryland near the mouth of the Potomac on September 28, 1930. One specimen was collected.

HOWARD BALL announced his capture of a specimen of Baird Sandpiper that day at Alexander Island, Virginia.

S. F. BLAKE presented a note on the domestic turkey made during the past summer in Maryland. While driving on the highway to Point Lookout, a female turkey was observed in the road brooding a dead young one which had evidently been run over by an automobile a short time before. The turkey stood up, took the head of the young one in her beak, and shook it as though trying to arouse it. At the approach of another automobile she left it and walked across the road.

The regular program was as follows:

ALEXANDER WETMORE: *The International Ornithological Congress.*—The speaker gave an interesting account of this Congress held at Amsterdam in June 1930, at which about 300 delegates were present. Several excursions were made to points of ornithological interest. The next meeting will be held in England in 1934.

L. M. ESTEBROOKE: *The Inter-American Conference on Agriculture.*—The speaker outlined the subjects discussed at the First Inter-American Conference on Agriculture held in Washington in September, which covered the whole field of agriculture and marketing, and spoke of some of the more important resolutions presented.

WATSON DAVIS: *Recent Biological Literature.*—The speaker mentioned briefly some recently announced scientific discoveries and exhibited several lately published books. He also commented on several recently exhibited fraudulent moving pictures purporting to show African wild life.

A. S. HITCHCOCK: *Nomenclature at the International Botanical Congress.*—The speaker presented an account of some of the results in nomenclature at the International Congress held in Cambridge, England, last August, with an account of the preliminary work leading up to the Congress.

## 752D MEETING

The 752d meeting was held in the new assembly hall of the Cosmos Club on November 1, 1930 at 8.10 p.m. with President WETMORE in the chair and 78 persons present. New members elected: A. V. SMITH, Mrs. VIOLA S. SNYDER.

T. S. PALMER gave an account of the recent meeting of the American Ornithologists' Union at Salem, Massachusetts, and that of the National Association of Audubon Societies at New York, and the coming annual trip of the local Audubon Society to the Zoological Park. He also mentioned that the strict embargo on the importation of parrots has now been modified to permit the entrance of certain species.

The regular program was as follows:

W. L. SCHMITT: *Exhibition of a rare isopod* (illustrated).—The speaker exhibited specimens of the giant isopod, *Bathynomus giganteus*, eight specimens of which were captured by an expedition of which he was a member last summer near the Dry Tortugas, and gave an account of its history.

J. I. HAMBLETON: *The behavior of the honey bee* (illustrated).—The speaker exhibited moving pictures showing the life of the honey bee, particularly its method of ventilating the hive and of gathering pollen, accompanying the pictures with an account of the habits of bees.

H. C. BRYANT: *Fancy and fact in natural history*.—The speaker mentioned ancient and modern fables relating to supposed remarkable habits of various birds and other animals, such as the hibernation of swallows, the transformation of a horsehair into a worm, the hoop snake, the connection between toads and warts, and so on. He then described in contrast even more remarkable facts in the life history of various fish, such as the return of king salmon to the streams in which they were hatched, and the spawning of grunion on moonlight nights in the sand at the time of highest tide. The eggs hatch at the next tide of the same height, which comes ten or twelve days later, the young fish popping out of the egg as soon as it is washed out by the water. The eggs can live until another high tide a month later.

J. W. SPENCER: *Observations on Colorado elk herds*.—During the past year occurred the first open season on elk for thirty years in four counties in Colorado. At the time there was much adverse comment in the newspapers based on the supposition that the elk, which had become very tame, would be slaughtered in large numbers. It was found that a day or two of hunting restored all their wariness and vigilance. About 500 young are born per year in the counties concerned, and the total number killed was less than this. The region was overstocked, which forced the elk to do considerable damage to farm products. The speaker believes that with proper care and the provision of sufficient natural winter range the elk can be preserved indefinitely in much of the western country. He considers that the practice of feeding hay to elk during the winter is in the long run harmful to the species.

## 753RD MEETING

The 753rd meeting of the Biological Society was held in the new assembly hall of the Cosmos Club November 15, 1930 at 8.10 p.m., with President WETMORE in the chair and 115 persons present. New member elected: Mrs. JUDSON D. COBB.

The regular program was as follows:

F. G. ASHBROOK: *Fur farming in Europe*.—The speaker gave an account of the International Fur-Trade Exposition and Congress held in Leipzig last May, at which he represented the United States, and of his observations on the breeding and marketing of fur animals in Europe. Fur farming is best developed in Norway, Sweden, Germany, and France, but cannot yet be considered an important source of supply for raw furs. The production of rabbits for meat and fur is further advanced than that of other animals. The speaker also exhibited moving picture films showing the fur trade of the United States from the trapping of wild animals and the breeding of fur animals on farms to the finished product.

MELBOURNE WARD, Australian Museum: *Natural history of the Barrier Reef of Australia* (illustrated).—The speaker gave an account of the general features of the fauna of the Barrier Reef with particular reference to that of Northwest Isle in the Capricorn group, illustrating his talk with colored slides and moving pictures showing the characteristic animals.

### 754TH MEETING

The 754th meeting was held in the new assembly hall of the Cosmos Club November 29, 1930 at 8.10 p.m., with President WETMORE in the chair and 165 persons present. New members elected: E. P. CHEATUM, H. W. GRAHAM, ROBERT OVERING.

A. WETMORE announced that the new reptile house at the Zoological Park will probably be ready for occupancy early in the coming year.

The regular program was as follows:

H. M. SMITH: *Some new and curious Siamese fishes* (illustrated).—The speaker exhibited numerous excellent drawings of new species of Siamese fish prepared by native artists, and described the habits of some interesting species. The climbing perch climbs trees only when their roots or trunks are in the water. It can pass over the ground between bodies of water, moving with a jerky motion. It has a special chamber over the gills permitting it to breathe air directly in case of need.

The shooting fish captures insects perched near the water by shooting a drop of water from its mouth, or if necessary a series of drops. Its effective range is about 1 m., and it can eject water to a distance of 4 m. The speaker has occasionally seen lizards knocked into the water by a drop ejected by the fish and has twice seen cigarettes in the hands of people on verandas over the water put out. The fish has a long narrow lower jaw, and forcibly compresses its gill covers while the mouth is held open, ejecting water held at the back of the gill cavity. Its eyes function very well in the air.

A large number of species of the codfish group occur, some up to 3 m. long. In several species the eggs are incubated in the mouth of the male, which takes six or seven weeks. The eggs are about 1 cm. in diameter and as many as 49 have been found in a fish's mouth. During this period the fish cannot eat and becomes very thin. In one case the speaker found a second batch of eggs was taken in before the first batch had hatched. It is possibly an adaptation to prevent the loss of the eggs in the very muddy river bottom.

G. M. DYOTT: *Motion pictures of jungle life* (illustrated).—The speaker showed moving pictures taken in Assam, Ecuador, and Central Brazil. The pictures from Assam consisted mostly of remarkable views of tigers, showing them sleeping by their prey, interrupting a feast of vultures on a carcass, and crossing a stream. Those from Ecuador were devoted principally to enlarged views of living insects of various orders. The pictures from central Brazil showed the speaker and his companions at different points on their expedition in search of FAWCETT, the English explorer.

755TH MEETING

The 755th meeting was held in the new assembly hall of the Cosmos Club December 13, 1930 at 8.10 p.m., with President WETMORE in the chair and 125 persons present. The President announced the election of Dr. WM. R. MAXON as one of the board of trustees of the Permanent Funds.

A. WETMORE gave briefly the results of his recent work on Pleistocene bird remains from Florida. He has identified 66 species, apparently the largest number of fossil forms yet found at any locality in the United States.

The regular program was as follows:

MELBOURNE WARD, Australian Museum: *Wanderings in North Australia* (illustrated).—The speaker described the fauna and natives of Thursday Island, Murray Island, and the region about Albany Passage, illustrating his talk with still and motion pictures, and concluded with a moving picture of a native dance in which he took part, accompanying the picture with a native chant.

C. W. STILES: *Is international zoological nomenclature practicable? Report on Padua Congress.*—The speaker gave a general review of the development of the International Rules of Nomenclature and especially a history of the Berlin agreement of 1901, according to which the unanimous approval on the part of the Commission at the meeting was prerequisite to the presentation to the Congress of any proposal regarding the Rules.

He then reported on the meeting at Padua, especially on the adoption of the Horn resolution by the Congress on the basis, not of unanimous recommendation by the Commission, but by majority vote in the Section on Nomenclature. He contended that the action by the Congress was (*a*) invalid from a parliamentary standpoint, (*b*) contrary to all precedents in nomenclature from 1898 to 1930, (*c*) contrary to the spirit and effect of the 1901 Berlin Agreement, (*d*) contrary to the words of the same except that the Horn resolution was presented as a "definition" while in effect it amends, (*e*) contrary to the By-laws of the Commission, (*f*) contrary to the Padua 1930 vote 14 to 1 in the Commission on Nomenclature against Proposition 1930*A*, (*g*) a proposition even more radical than proposition 1930*A* which has been consistently opposed by American zoologists, (*h*) that it makes procedure in nomenclature subject to a chance majority vote (and on any motion suddenly introduced from the floor, without international notice) determined by the geographical locality of the meeting of the Congress, and (*i*) makes the Rules of Nomenclature subject to sudden and recurrent (three to five year) changes, thus making them unstable and without reasonable protection to the views of the minority present or to the views of countries and specialties not represented or poorly represented at the Congress.

He suggested that the Biological Society call a meeting of various American, especially Washington, members of committees on nomenclature to consider the situation and to make recommendations. (*Author's abstract.*)

S. F. BLAKE, *Recording Secretary.*

756TH MEETING

The 756th meeting of the Biological Society was held in the new assembly hall of the Cosmos Club January 10, 1931 at 8.10 p.m., with President WETMORE in the chair and 135 persons present. New members elected: DORIS M. COCHRAN, ALMA RUTLEDGE.

FRANK THONE presented the following report on the so-called *autosynthetic cells* recently exhibited by Dr. GEORGE W. CRILE before the American Association for the Advancement of Science.—Dr. Crile made three extracts from living protoplasm. Ether took out the lipoids; saline solutions removed proteins; after ashing the residue, water took up minerals. These extracts were remixed and they reunited in more or less definite proportions, resembling protoplasm. Small units were formed resembling some of the protozoa. These units seemed to respire, to assimilate proteins, to reproduce by division, to respond to poisons, and to have several other reactions similar to that of protoplasm. They were without the structure characteristic of cells.

The regular program was as follows:

H. F. Prytherch: *Spawning, setting and development of the oyster* (illustrated).—The most critical period in the life history of the oyster is the setting, during which the fully developed larva cements itself to some clean submerged surface such as old shells or stones and then undergoes a metamorphosis into a spat and adult oyster. A study of the setting reaction under natural conditions in Milford Harbor, Conn., showed that it occurred during the low water stage of the tide, or, in other words, when river discharge had its greatest effect on the physical and chemical condition of the water over the oyster beds. Experiments with oyster larvae under controlled laboratory conditions showed that changes in temperature, salinity, hydrogen ion concentration, oxygen content, $CO_2$ tension, and water pressure would not induce in a single instance the setting reaction. However, if in reducing the salinity, river water was used instead of distilled water, the larvae gave a positive setting reaction, which indicated that there was some substance in the river water which served to stimulate and control their attachment and metamorphosis. Further experiments involving variations in the amount and proportion of the cations and anions of the neutral salts were found to be ineffective in producing setting of the larvae, as were also the compounds of iron, zinc, tin, lead, aluminum, and silver. The only element of those tested which produced a positive setting reaction was copper in the form of a pure metal or as a carbonate, sulphate, or chloride. This heavy metal was effective in concentrations of one part copper to 5 million or 10 million parts of sea water and initiated almost immediately the setting process. In the river water, copper was found to be present in relatively this same amount and is apparently the specific element that is necessary for the attachment, metamorphosis and survival of the oyster. River water from which the copper had been removed by precipitation and filtration was no longer effective in producing setting.

Copper plays an important part in the respiratory processes of the oyster, and its assimilation by the larva would serve to increase the oxygen-carrying capacity of the blood and release cells during metamorphosis for carrying out this function, both of which would greatly facilitate its rapid growth and development into the adult form. Though copper, like other heavy metals, may have a beneficial and stimulating effect in infinitesimal amounts, it will in slightly higher concentrations quickly produce cytolysis and death of the oyster larva.

These studies indicate that in the development, distribution, and survival of marine animals, traces of certain mineral elements in their environment are of considerable biological significance and may constitute some of the chief limiting factors.

By the use of copper in the form of a pure metal or salt, it was possible in 1928 to observe in detail for the first time the setting and metamorphosis of the oyster larva, a brief description of which has been given in Bureau of Fisheries Document No. 1068. (*Author's abstract.*)

R. A. NESBIT: *Biological aspects of conservation of marine fishery resources, New York and New Jersey* (illustrated).—The chief cause of fluctuations in marine fisheries is virtual failure to reproduce in many or most years, with occasional great success. When successful spawning occurs, the whole increase in abundance constitutes a surplus available to the fishery, for successful reproduction is, within wide limits, independent of the size of the spawning reserve. Studies of the scup in New Jersey have shown that its fluctuations in abundance are largely due to variation in success of reproduction and that it is not in need of protection. Studies of squeteague, known also as weakfish, gray trout, and sea trout, have shown that its fluctuations in numbers are due to more complex causes. The fishery does not take a fair cross-section of the population, suggesting the existence of reserve stocks not ordinarily available to the fishery. The absence of yearling squeteague north of Virginia together with their abundance south of Delaware Bay suggests that northern stocks seldom succeed in reproducing and are maintained by migration from southern nursery grounds. This is supported by studies indicating failure of spawning in Delaware Bay in 1929 and 1930. Pending further studies, no additional restrictions of the fishery for squeteague are recommended. (*Author's abstract.*)

W. B. BELL: *Reestablishment of muskoxen in Alaska* (illustrated).—The speaker reviewed action leading up to the granting of an appropriation of $40,000 by Congress for the purpose of securing a herd of muskoxen to be placed in Alaska. As soon as the funds were assured, steps were taken to secure the desired animals from northeastern Greenland through a dealer in Norway who sends expeditions into this region. Thirty-four animals were obtained which were shipped by way of Norway to New York. They were kept in quarantine for a month at the Bureau of Animal Industry Quarantine Station at Athenia, N. J. They were changed abruptly from the native feed, which they had been given en route, to alfalfa hay, which they ate with apparent relish and upon which they continued to thrive. At the close of the quarantine period they were shipped by express to Seattle, thence by boat to Seward, Alaska, where they were placed in box cars and shipped via the Alaska Railroad to the Biological Survey Experiment Station at College, near Fairbanks, Alaska.

A short motion picture film was shown of the animals taken a few days after their arrival at College, showing them apparently content in the Experiment Station inclosure where they are being held. The original circumpolar distribution of muskoxen and their relatives was traced, showing a vivid contrast with their present limited distribution and numbers in northeastern Greenland, a few Arctic islands, and a herd of about 250 animals on the Thelon Reservation in Canada. The subject was further illustrated by a motion picture film entitled, *The Arctic patrol*, which was made available through the courtesy of O. S. FINNIE, Director of the Northwest Territories & Yukon Branch, Department of Interior, Ottawa, in which were shown remarkably fine pictures of muskoxen taken at Devon Island by the expedition sent out by the Canadian government in 1929.

The herd of muskoxen is being established in Alaska for experiments in feeding, breeding, and management, and in determining possibilities for their production as a source of meat and other valuable products. (*Author's abstract.*)

A. A. DOOLITTLE, *Recording Secretary pro tem.*

## BOTANICAL SOCIETY

### 219TH MEETING

The 219th meeting was held at the Cosmos Club October 1, 1929.

*Program:* C. S. SCOFIELD: *The effect of boron on citrus in California* (illustrated).—In 1918 attention was focused on the toxic effects of boron on field crops in this country through its presence in potash salts from California used as fertilizers in the East. In 1927 it was found that boron in irrigation waters in California was causing injury to citrus and walnuts in that State. A survey of irrigation supplies and of tree crops in southern California has shown that boron occurs in all of the irrigation waters from 0.1 ppm. to 7.0 ppm. of elemental boron. Where the concentration exceeds 0.5 ppm. in the irrigation water there is usually some evidence of injury in the leaves of lemons and walnuts. As the concentration increases more crops are injured until at 7.0 ppm. very few tree crops are free from symptoms of injury. These concentrations refer to the irrigation supply. The concentration of boron in the soil solution is usually five to eight times as high as in the irrigation water. The symptoms of boron injury appear in the leaves, discoloring or killing the leaf tissue and often causing premature shedding. These symptoms may be confirmed by determining the boron content of mature leaves. In lemons the normal boron content of dried leaves is 50 to 100 ppm.; where boron injury occurs the boron content may be ten to twenty times that much. It has not been found that boron toxicity from these low concentrations is manifested in other parts of the plants. The indications are that boron injury occurs through derangement of the processes of translocating the products of photosynthesis in the leaf tissues. Boron in irrigation water above very low concentrations causes injury to a number of perennial crop plants. The indicated remedy is to locate the sources of boron contamination and withhold the high-boron waters from the general supply or divert them to other uses. As to whether or not boron in low concentrations is essential to plant growth, the evidence is also fairly conclusive. There seems to be no doubt that boron is a normal constituent of practically all the higher plants and that in most cases where the matter has been carefully tested these plants grow better when boron is present in low concentrations in the nutrient solution than when it is absent or occurs as a mere trace. Culture experiments with a wide variety of plants have shown that better growth is obtained when the nutrient solution contains 0.2 to 0.5 ppm. of boron than when the concentration is in the order of 0.05 ppm. or less. All of the crop plants so far tested take up boron readily when it is available in the nutrient solution and the quantity absorbed is at least approximately proportional to the concentration in that solution. (*Author's abstract.*)

E. B. LAMBERT: *Studies on the relation of temperature to the growth, parasitism, thermal death points, and control of* Mycogone perniciosa.—The cardinal temperatures for the growth of *M. perniciosa* were found to be 8°C., 24°C., and 32°C. The most vigorous growth was made between 21°C. and 28°C., which is considerably higher than the range of temperatures in which mushrooms are usually cultivated. When the casing soil was infested with an abundance of innoculum there was 100 per cent infection at 21°C. and 15°C., but only occasional diseased specimens appeared at 10°C. The pathogene was killed by prolonged exposure to moderately high temperatures. It was suggested that commercial growers might be able to eradicate *Mycogone* from their casing soil by subjecting this soil to the high temperatures generated in mushroom houses while the manure is going through with its final heat. (*Author's abstract.*)

The meeting was followed by the annual meeting and the election of officers. H. B. HUMPHREY was elected president; GEORGE M. DARROW, vice president; MARION ZEHNER, treasurer; L. H. FLINT, recording secretary; N. R. SMITH, corresponding secretary.

### 220TH MEETING

The 220th meeting was held at the Cosmos Club November 5, 1929.

*Program:* M. F. WARNER: *The pathological tulip.*

F. L. MULFORD: *Early-flowering hardy chrysanthemums.*

D. N. SHOEMAKER: *Fall flowers of spring-flowering groups* (illustrated).

K. A. RYERSON: *Bamboos.*

DAVID GRIFFITHS: *How we make more bulbs* (illustrated).

The last paper (the retiring presidential address) was a discussion of methods of propagation in *Narcissus, Tulipa, Hyacinthus, Lilium, Muscari, Chionodoxa, Puschkinia, Trillium, Brodiaea, Tigridia, Ornithogalum,* and a few others. Contrary to the general impression, propagation by seed is one of the most important methods of increasing stocks of bulbs. It is not only the most important method in some genera but is used in nearly all and is the only method employed in some. Lilies are propagated by several methods. Some are reproduced by seed only, while scale, layered stem, stem bulblet, stem bulbil, and division of bulbs contribute to increase stocks, some species being adapted to one and some to other methods. The propagation of the hyacinth was described as natural and artificial. The former includes the seed method, used in producing new varieties mainly, and division of the bulb employed in the Roman and a few seminaturalized American strains. The artificial methods consist in scooping, scoring, and coring, the two former being universally employed in commercial production. The production of bulb stock by seed was discussed in detail, and the methods employed in handling lily and other bulb seed under open-field conditions at the U. S. Bulb Station, Bellingham, Washington, were described. Whenever this form of reproduction is applicable in increasing stocks it is the cheapest method known. (*Author's abstract.*)

### 221ST MEETING

The 221st meeting was held at the Cosmos Club December 3, 1929.

*Program:* NEIL E. STEVENS: *Forecasting the keeping quality of cranberries* (illustrated).

W. T. SWINGLE: *First American visit to date regions of Morocco* (including 2-reel film on "Pollination and pruning of date palms in North Africa").

### 222ND MEETING

The 222nd meeting was held at the Cosmos Club January 7, 1930.

*Program.* P. L. RICKER: *Motion pictures of eastern wild flowers.*

J. E. McMURTREY: *Some malnutrional diseases of tobacco* (illustrated).

P.S. GALTSOFF: *Rôle of living matter in the chemistry of the ocean.*

### SPECIAL MEETING

On January 15th a special meeting of the Botanical Society was held at the Cosmos Club to hear Dr. A. E. DOUGLASS, Director of the Steward Observatory of the University of Arizona on *Tree rings and climate* (illustrated).

### 223RD MEETING

The 223rd meeting was held at the Cosmos Club February 4, 1930.

*Program:* H. METCALF: *Willow scab.*

R. F. GRIGGS: *A remarkably preserved fossil palm* (illustrated).

W. W. DIEHL: Ephelis, *a cause of floret sterility in grass* (illustrated).

R. D. RANDS: *The Java meetings of the Pacific Science Association and the International Society of Sugar Cane Technologists* (illustrated by a 3 reel film).

### 224TH MEETING

The annual dinner of the Botanical Society was held at Meridian Mansions Hotel on the evening of March 4, 1930. Reindeer steak was served with Department of Agriculture specialties. The dinner was followed by the regular program.

H. L. WESTOVER: *Forage-crop explorations in Russia and Turkestan* (illustrated).

W. E. WHITEHOUSE: *Observations on Persian horticulture* (illustrated).

### 225TH MEETING

The 225th meeting was held at the Cosmos Club April 1, 1930.

*Program:* R. R. HILL: *On a thousand hills* (one-reel moving picture from the Forest Service).

A. S. HITCHCOCK: *A botanical trip to South and East Africa* (illustrated).—As the guest of the South African Branch of the British Association for the Advancement of Science, the speaker reached Cape Town July 19, 1929, having had opportunity to botanize a few hours on the islands of Teneriffe and St. Helena. During the meetings at Cape Town excursions were made to the surrounding region. Though it was winter many plants were in bloom. A two-day excursion on a special train through the Karoo allowed botanists to examine the curious xerophytic flora of this arid region. At the close of the meetings there was an excursion to Victoria Falls and other points in Southern Rhodesia, the members living on the special train for twelve days. The Victoria Falls of the Zambesi River are 420 feet high and a mile and a quarter wide. Stops were made at Motopos Hills and at the Zimbabwe Ruins. The excursion ended at Beira in Portuguese East Africa. A short stop at Zanzibar gave opportunity to make a good collection on the island. Landing at Tanga in Northern Tanganyika the speaker visited Amani Agricultural Institute, then went to Moshi and Marangu, whence he ascended Mt. Kilimanjaro to the limit of vegetation, about 14,000 feet. The alpine grasses belong to such temperate genera as *Festuca, Poa, Deschampsia* and *Agrostis.* He next visited Nairobi, whence a two-day motor trip was made to the vicinity of Mt. Kenya, though there was not time for the ascent. Through the courtesy of Government officials a trip through Uganda was arranged, crossing Lake Victoria to Entebbe, thence to Kampala and Jinja with one-day stops at several places to collect. The grasses collected in South Africa were only 112, it being winter, but in the more northerly regions grasses were more plentiful, those of the alpine regions being of especial interest. In all, including Teneriffe and St. Helena, 1184 numbers of grasses were collected. (*Author's abstract.*)

L. H. FLINT, *Recording Secretary.*

## OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcements of Meetings

| | |
|---|---|
| Thursday, March 5 | The Entomological Society. |
| Friday, March 6 | The Geographic Society. |
| Saturday, March 7 | The Biological Society. |
| Tuesday, March 10 | The Institute of Electrical Engineers. |
| Wednesday, March 11 | The Geological Society. |
| | The Medical Society. |
| Thursday, March 12 | The Chemical Society. |
| Friday, March 13 | The Geographic Society. |
| Saturday, March 14 | The Philosophical Society. |
| Tuesday, March 17 | The Anthropological Society. |
| | The Historical Society. |
| Wednesday, March 18 | The Society of Engineers. |
| | The Medical Society. |
| Thursday, March 19 | The Academy. |

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:* N. A. Cobb, Bureau of Plant Industry.
*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
*Treasurer:* Henry G. Avers, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings



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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.

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JOURNAL

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VOL. 21 MARCH 19, 1931 No. 6

GEOPHYSICS.—*Shaping the earth.*[1] WILLIAM BOWIE, United States Coast and Geodetic Survey.

### THE CRUST OF THE EARTH

It is generally recognized that the earth has had a surface of solid material for something like a billion and a half years. At the beginning of this time, the earth's surface was irregular and there have been vertical and horizontal changes occurring continuously during this long interval. These changes have been due to erosion and sedimentation and to forces which are acting on the materials forming the outer fifty or one hundred miles of the earth.

If the earth's material were in a liquid or highly plastic condition, and if there were no rotation, its surface would be a true sphere. With such a body undergoing rotation, the surface would be a spheroid. It has been found by geodetic measurements that the shape of the mean sea level surface approximates very closely a true spheroid. The deviations between the spheroid and the water surface, or geoid, are probably not greater than 100 meters. These forms are, of course, due to the continuous gravitational attraction of the particles of the earth for each other. The earth's surface is irregular because of the presence of material of different densities near the earth's surface. Under the continents the densities are less than they are for the material under the oceans. There is rigidity in the outer portion of the earth for otherwise there would be a slumping down of the high areas and the moving material would fill up valleys and ocean basins and bring the earth's surface to a true spheroid.

[1] Presidential address delivered before the ACADEMY, January 15, 1931. Received February 9, 1931.

FORMATION OF OCEANS AND CONTINENTS

One of the most interesting problems of geology involves the formation of oceans and continents. Some geologists will say that this is a subject that need not be considered for we may accept oceans and continents as having come into being prior to the present geological age and that our attention should be given to the problem of unfolding the geological record since the beginning of sedimentation. The mind of a human being cannot be confined to any particular subject or group of subjects nor to any particular phase of a subject. It is bound to consider any question that presents itself.

It does seem very strange that we should have great masses of material standing above sea level, as continents and islands, and great troughs or basins below the waters of the oceans. We have enough geodetic evidence to prove conclusively that the ocean bottoms are depressed because of the greater density of the material in the crust below them, and that the continental and island masses stand above sea level because the density of the material in the crust below them is less than normal; but how could these abnormal densities have arisen? Why is it that under the continents we have a layer, which some claim is about twenty miles in thickness, of light rocks called granites, while under the oceans we have no granites?

There have been many explanations offered as to why we have oceans and continents, but the only one that appeals to me as having decided merit is that advanced by Osmond Fisher. About forty years ago he wrote a book entitled, "Physics of the Earth's Crust," which contains much material of great value. He has a chapter on the possible erosion of oceans and continents in which he discusses Darwin's idea that the moon at one time was thrown off from the earth. Darwin's discussion of the birth of the moon was more or less an academic one and he made no suggestion as to what was the condition of the earth at the time that this birth occurred, but one is led to believe by Darwin's writings that he had in mind a fluid earth. Fisher believed that there was an outer solid shell on the earth at the time that the moon was formed and that the earth lost much of the outer granite shell at that time. The places from which the crustal material was thrown off were filled with sub-crustal material, but the light granite occupied greater depth than the heavier sub-crustal material which replaced it. In consequence, the healed scars had surfaces which were lower than the surfaces of the portions of the crustal material which remained.

Darwin's hypothesis is based on the idea that the earth was rotating very rapidly and that as it slowed down to such a rate of rotation as would make the tides, caused by the attraction of the sun, synchronize with the natural period of vibration of the earth, there would be an accumulation of tidal effect which would make the earth's mass unstable. Darwin estimated that at the time of, or just before, the disruption, the major axis of the earth was about twice the length of the minor axis. This would mean that the earth's surface must have been increased by approximately fifteen millions of square miles. The solid crust, which at the time of the birth of the moon must have been thirty or forty miles in thickness, could not have stretched over this increased surface but would have been fractured and torn apart with great gaps between the crustal blocks. It may be that this distortion just prior to the birth of the moon had more to do with the scattering of the remaining crustal material over the earth's surface than the actual disruption.

It is rather interesting to look at a globe and note that the two coasts of the Atlantic are so nearly parallel that they remind one of the shores of a great river. Wegener has advanced a theory that North and South America broke away from the rest of the continental masses and moved westward during recent geological times. This is a very interesting theory which has many advocates and also many opponents. I am rather inclined to think that there are difficulties in the Wegener hypothesis which are very hard to explain away. It seems to me that the Fisher idea of the birth of the moon gives us a rather logical explanation of the creation of oceans and continents, and the strongest point of this theory is that it does no violence to isostasy.

It is certain that the earth's surface was irregular at the beginning of the sedimentary age, for without irregularities, such as we now have, the water of the oceans would have covered the whole earth's surface to a depth of approximately 9,000 feet if the amount of water was the same as now. With all of the land area covered by water, there could have been no erosion and sedimentation, such as we have had for a period of approximately one and one-half billions of years.

### KNOWN FACTS ABOUT THE EARTH

The earth should be treated like any material structure which comes under our observation for explanation or analysis. No one, of course, can give us the true explanation of how the earth came into being or state accurately what has been going on to change its surface configuration. But we have now at hand a number of facts which should enable us to arrive at some logical conclusions. We know, of course, the earth's shape and size, the portions of its surface covered by land and water, its average density, and the density of its surface material. We also know that the temperature increases with depth. We know that there are many earthquakes occurring annually and that there is no area which is entirely free from them. Most of the quakes are microscopic in their intensity, but we are reasonably certain that, with few exceptions, they result from breaking rock and, therefore, there must be forces within the earth large enough to cause such breaking.

We know that there has been a tremendous amount of erosion and sedimentation during the present era, which is called the sedimentary age of the earth. It is certain that the earth's surface was irregular at the time that sedimentary rocks began to be formed, for without an irregular surface there could have been no running water, and without running water there could have been no erosion and sedimentation. Of course, no one knows whether the amount of water that is on the earth has been constant or variable, but it is reasonably certain that land has been exposed above the waters of the ocean for about a billion and a half years. This is an estimate that is frequently used by students of the earth and it seems to be generally accepted as of the order of magnitude of the period of time that has elapsed since the formation of the first sedimentary rocks.

Geologists tell us that practically all of the exposed areas of the earth have at some time in the geological past been below sea level. These areas are now at varying distances above sea level and, hence, their change in elevation, with respect to sea level, must have been due to an actual lifting up of the land areas rather than a decrease in the amount of water of the earth. If the latter had been the cause for the changes in elevation, there would be uniformity in the elevations of exposed strata.

The isostatic investigations indicate that the solid or rigid material of the earth extends only to a depth of approximately 60 miles below sea level. Some investigators are of the opinion that the depth to which the solid rock extends is very much smaller than that. The interior of the earth acts as if it were plastic to long continued stresses. The earth has an outer shell which rests upon a plastic interior. A disturbance of the isostatic equilibrium leads to horizontal and vertical changes in the earth's surface. Some areas go down under the weight of sediments and other areas which have been undergoing erosion for long periods of time increase in elevation. There is also a rising up of material that was once below sea level and a sinking down of areas which were once standing high above sea level.

These and other known facts regarding the earth are the basis for the interpretation of the processes which have shaped its surface.

There have been many theories advanced as to why the earth has an irregular surface. Such theories may be considered as mere guesses, for no one can reproduce today the forces, resistances and temperatures which must have been involved when the earth came into being or when its surface was changed from one of fairly uniform elevation to one which has the great differences in elevation that are seen today.

Mineralogists tell us that the continents are underlaid by granite, and that granite is absent from the crust under the ocean. Granite has a smaller density than that of the basalts which underlie the oceans. Originally the earth must have had the granite or light material lying over its surface like a huge blanket of fairly uniform thickness. Why is it that now the granite is absent from such large portions of the earth's surface? There are certainly no known forces that could push the granite up into isolated masses. Gravity would have resisted such piling up and if forces had been sufficiently great to force the granite into separate masses, these masses of crushed rock would have slumped down soon after the forces had ceased to operate.

## ISOSTASY

It was a geologist, the famous C. E. Dutton of the United States Geological Survey, who coined the word *isostasy* in an address, entitled *On some of the major problems of physical geology,* at a meeting of the Philosophical Society of Washington in 1889. Dutton discussed some of the major problems of geology, including, of course, the formation of mountains and the effect of the tremendous amount of erosion and sedimentation. He came to the conclusion that the shifting of material caused stresses which could not be withstood by the strength of the earth's materials. He felt that there must be a sagging down of the earth's surface under the weight of the sediments and a rising up of the surface where erosion had carried material away. He stated that in his opinion mountains are not extra loads added to the earth's crust but that they are due to lighter than normal material in the crust below them. In effect he outlined what might be called a flotation hypothesis, that is, that the continents were floating in heavier material just as ice floats in water. A corollary of this hypothesis of Dutton's is that the irregularities of the earth's surface are due to deviations from normal densities in the outer portion of the earth.

Under the oceans the density is greater and under the continents less than normal.

At the beginning of the present century geodesists realized that isostasy was a subject of vital interest to them. Previously, for decades, they had been attempting to explain the abnormal behavior of the plumb line to which astronomical observations are referred and of the pendulum by which values of gravity are determined.

### THE FIGURE OF THE EARTH

If the earth's surface had no irregularities but conformed to a mathematical surface (an ellipsoid), then at any place on it the direction of gravity would be at right angles to a plane tangent to this ellipsoid at the point of observation. But the earth has an irregular surface and due to this irregularity the figure formed by the surfaces of the waters of the ocean and of the waters of sea level canals extended, in imagination, through the continents deviates from a true mathematical figure. This deviation is undoubtedly a maximum under the great mountain systems like the Himalayas and the Alps where the geoid, or water surface, is above the mathematical one. Conversely over the deepest parts of the ocean the geoid, or water surface, is probably depressed to the maximum amount below this spheroid. In any event, there is an angle between the water surface and the mathematical surface at any point at which astronomical observations may be made. This angle means a deviation of the direction of gravity, or the plumb line, and affects the observations for astronomical latitudes and longitudes accordingly.

### EFFECT OF TOPOGRAPHY ON GEODETIC DATA

Geodesists had noticed this condition in a number of parts of the earth where surveying and mapping operations had been undertaken, and efforts were made to apply a correction for the influence of the irregularities of the surface. It was evident to each investigator that a mountain system, such as the Himalayas, would have an attractive effect on the plumb line at stations within a reasonable distance of it. Efforts were made to compute the effect of these great masses which lie above sea level, but when such corrections were applied it was found that they were larger than were necessary to bring the theoretical and observed values into accord. The mountains, apparently, were lighter than normal but impossibly small densities would have to be assumed for the materials composing the mountains to bring the two values into exact agreement.

Pratt and Airy working on geodetic data about the middle of the last century arrived at the conclusion that the reason why mountains and continents stand above sea level is because lighter materials lie below them. While they did not, so far as I am aware, make any definite statement that the abnormal densities could only extend to a moderate depth, yet this idea was implied in their statements regarding the deficiencies in densities that must lie below mountains and continents. They advanced their ideas about seventy-five years ago but it is only within the last ten years that their ideas and those of Dutton, expressed forty-one years ago, have been accepted generally by students of the earth as a working principle in earth studies.

## VARIATIONS OF GRAVITY

Geodesists have used geodetic data in the form of triangulation, of astronomical determinations of longitude and latitude, and of values of gravity to test this flotational hypothesis. It is the only method, so far as I am aware, by which the idea can be quantitatively tested. We have a direct measure of the extent to which the plumb line deviates from the line that is at right angles to the spheroid surface, and a measure of the difference between the theoretical and observed values of gravity. The idea of isostasy can be tested by means of these data.

If the earth were a true spheroid and there were no irregularities on its surface and if the densities along each radius were normal, gravity would increase slightly as one proceeded from the equator to one of the poles. The attraction of the earth at sea level would be about 1/200 part greater at a pole than at the equator. Enough work has been done to prove conclusively that gravity does follow very definite laws. For instance, it changes on the average about one part in a million for a mile change in latitude. It changes one part in a million for about 10 feet change of elevation. These changes are perfectly normal, for the centrifugal force is a maximum at the equator and zero at the poles and, besides, the attraction at either pole is greater than it is at a point on the equator. Necessarily, too, a particle is attracted less by the mass of the earth when elevated than when it is exactly at sea level.

It is not necessary to go into details regarding the geodetic tests of isostasy, for the methods used and the results obtained have all been set forth in a number of publications of geodetic organizations. It is sufficient to state that when isostasy is taken into account in computing geodetic data, harmonious or practically harmonious results are obtained. By means of geodetic data it has been possible to determine the approximate depth below sea level to which these abnormal densities extend. The most probable depth obtained from mountain and plateau stations of the United States is about 96 kilometers, approximately 60 miles, below sea level. This depth is confirmed by determinations of Mr. A. H. Miller of the Dominion Observatory at Ottawa, Canada, who found from analysis of gravity data at mountain stations in the western part of that country a depth also of approximately sixty miles.

### COMPARISON OF PRATT AND AIRY HYPOTHESES

There has been much discussion in literature on isostasy of the question as to whether the Pratt or the Airy hypothesis is the true one. Pratt postulated that the densities vary under the different classes of topography. Under the oceans, the density would be abnormally great, and under the continents, it would be abnormally small. Airy, on the other hand, suggested that the depth of compensation is very irregular and that crustal masses under the continents extend much farther below sea level than do such masses under the oceans. Under mountain areas these protuberances would be greater than under plateaus and valleys.

We have not yet been able to prove which of the two hypotheses is the true one, since the application of either of them to gravity and deflection data gives about the same satisfactory results. However, looking at the matter from a purely physical standpoint, I am inclined to think that there are decided weaknesses in the Airy hypothesis and that the Pratt hypothesis is probably the true one. Perhaps with a greater accumulation of data we may in the future be able to show which one of these hypotheses is the better one. We should be able to derive a depth of compensation for each extensive mountain area and if the Airy hypothesis is the true one, then the higher the mountain area the greater should be the derived depth of compensation. When such mountain areas as the Andes and the Himalayas are covered by geodetic stations, it should be possible to make this test.

### ASSUMPTIONS UNDERLYING ISOSTATIC INVESTIGATIONS

Necessarily, in carrying on such investigations as have been involved in the tests of isostasy, assumptions have to be made. The assumptions made by geodesists are approximately as follows: First, that isostasy is complete or perfect for even quite limited portions of the earth's crust; second, that there is a uniform distribution with respect to depth of the compensating deficiencies of density under continents and of the excesses of densities under oceans, that is, that the compensation starts at sea level and extends uniformly approximately sixty miles to the lower limit of the crust; third, that the compensation is directly under the topographic feature and not spread out horizontally with respect to that feature; and fourth, that the density of the rock above sea level is 2.67.

These assumptions are made merely for the convenience of the investigator. It would be practically impossible for him to assume anything but very simple conditions because of the very large amount of work involved in making the computations required for the tests. We do find that when these assumptions are made and corresponding corrections computed that the theoretical and actual values for the astronomical longitudes and latitudes and for values of gravity are brought very closely into agreement. There are some outstanding differences, and these must be a measure of the degree to which one or more of the assumed conditions are not true. The depth of compensation may not be a regular surface, it may be very much deeper under some parts of the continent than under others, and it may be deeper under the continents than under the oceans. The compensating deficiency of density under a mountain system may be confined to a rather narrow zone vertically and not extend throughout the thickness of the crust. The compensation may be distributed widely in a horizontal direction from the topographic feature, and deficient densities under land masses and excessive densities under ocean areas may not be sufficient to balance the irregularities of the earth's surface in the regions studied. Finally, the density of surface rock is variable. Undoubtedly, all of these factors come in to cause the differences between the theoretical and actual values which we call anomalies, but the anomalies are so small after the isostatic principle has been applied that investigators are inclined to believe that the principle of isostasy has been amply tested and proved. Some of them, and I am one, believe that the principal cause of the anomalies is the effect of abnormally heavy or light material near the earth's surface and close to the astronomical or gravity stations. If we could find out the actual distribution of density in the earth's materials for a depth of five or ten miles below the earth's surface, I am confident that we could reduce nearly all of the anomalies.

This brings up the question as to whether or not it would be possible to discover what the geologists call *structural features* that are buried below the earth's surface. This is a matter of great importance and may have a bearing on the search for petroleum and ores. The gravity survey conducted over this country indicates certain places where there are extra heavy or extra light masses of material fairly close to the earth's surface. I do not know of any oil having been found, or drilling for oil having been undertaken, near any of our gravity stations as a result of our data, but I am sure that an intensive gravity survey would disclose structure that might be of value in the oil and mining industries.

## SOME ISOSTATIC CONCLUSIONS

The evidence seems to justify the conclusion that all mountain and plateau areas were at one time occupied by low lying portions of the earth's surface on which great beds of sediments were laid down. Then these areas were raised up to form either mountains or plateaus. If there was much distortion, mountains resulted, and if the area went up in a more or less uniform way, extensive plateaus were formed. What caused these uplifts is one of the outstanding problems of the science of geology. Many of the investigators of the past have postulated horizontal thrusts, while some, Dutton included, were inclined to favor a vertical movement as the predominant one with horizontal movements as incidental.

It is absolutely certain that the masses pushed up, whether by vertical or horizontal forces, are not extra loads added to the surface at what may be called the depth of isostatic compensation. These masses above sea level are, of course, extra loads on the sea-level surface, but they cannot possibly be extra loads added to the imaginary blocks of the earth's crust which are resting on the plastic sub-crustal material. If they were extra loads, this fact would be easily and clearly indicated by geodetic data in the form of deflections of the vertical and values of gravity. The masses that appear above sea level are compensated for by the deficiency of density in the material lying below them.

The zone within which the compensation of topographic features lies must be of limited depth. If it were otherwise, the computed effect of the compensation would be practically zero and the material above sea level would have full effect on the direction and force of gravity.

It has been concluded from a study of the deflection data for the United States that the actual deflections of the vertical are on the average not more than about 10% of what they would be if the masses above sea level and the deficiency of the mass in the oceans were not compensated by deviations from normal densities in the crust below. This is the very strongest evidence possible in favor of isostasy and, also, in favor of the theory that the outer portion of the earth is rigid and strong. This rigid material, which has been found by geodesists to extend to an average depth of approximately sixty miles, will resist for extremely long times gravitational forces which tend to make the earth's surface a true spheroid. The gravity data supplement the data derived from the deflection of the vertical in showing the existence of isostasy.

Since areas of sedimentation and erosion and all plateau and mountain regions are now in isostatic equilibrium, it seems reasonably certain that they have been in equilibrium throughout the geological era. If this is true, we must conclude that there has been an actual uplift of the surface in some places and a down warping in others. These changes in the earth's surface can occur only by vertical movements, due to changes in the density of the crustal or sub-crustal material, or to the action of horizontal forces. I am inclined to favor the former idea because it is rather difficult to see where horizontal forces of sufficient magnitude could originate. Since the sea level surface of the earth is at all places at right angles to the direction of gravity, it is difficult to see how any large horizontal component of the gravitational force could come into existence.

I believe that there has been no collapsing of the outer shell of the earth on a shrinking nucleus. The outer solid shell of the earth must be of the magnitude of sixty miles in thickness and certainly at such a depth as sixty miles there could be no voids; the outer shell, or crust, of the earth must be in intimate contact with sub-crustal material and, therefore, there is no opportunity for the crustal material to collapse on a shrinking interior. Should the interior of the earth be losing heat and contracting in consequence, and should the crust of the earth not be losing heat and, therefore, remaining constant in volume, it is probable that the crust merely thickens locally as the nucleus contracts. Any changes in the volume of the nuclear material would be so exceedingly slow that the crustal material would yield locally and the crust would continue to be in contact with the nucleus around the whole earth.

## ISOSTATIC ADJUSTMENTS AND EARTHQUAKES

If we accept the principle of isostasy, and it is a perfectly logical thing to do, then we are confronted with the problem of how to apply this principle in geological studies and investigations. It is especially important to apply the isostatic principle to the question of earthquakes.

They have been occurring for a billion years, more or less, and probably they will continue to occur as long as the earth has sunshine and rain. An earthquake is caused by the breaking of the outer portion of the earth's material. Without the break there would be no elastic shock. Where the material of the earth is hard, brittle, and elastic, it will resist deformation due to a force acting on it until the force is greater than its strength and there will be a sudden yielding in the form of a rupture. Any elastic substance necessarily has vibrations when it is struck or broken, and that is exactly what happens to the earth when we have an earthquake. The rock is snapped or broken, and the elastic waves set up by the sudden rupture travel great distances.

Records of earthquake waves are made with an apparatus called a seismograph. There are many of these instruments scattered over the earth's surface and the number of earthquakes annually recorded on them has been recently estimated as 8,000. There are many quakes of such small intensity that their shocks are not received at the existing seismological stations. It is impossible to state how many earthquakes actually occur over the earth, but if I might make a guess, I would say from 30,000 to 40,000 a year.

One of the implications from the proof of isostasy is that the outer portion of the earth is much stronger than the materials that lie somewhat farther down. In order that the irregular surface of the earth may be maintained against the tremendous weight of masses of rock above sea level, this outer portion of the earth must be strong, that is, it must have a strength sufficient to prevent the continental masses slumping down and flowing into the ocean areas to fill up the basins. This strong material extends, according to geodesists, approximately sixty miles below sea level. Below that the material must be lacking in strength and rigidity. It must yield to forces without breaking. As great masses of material are moved over the earth's surface the balance of the crust is disturbed. The extra load caused by sediments must push down the crust beneath and this must force the sub-crustal material to move sidewise and some of it to push up the crust from where the eroded material came. The earth's crust is like a sheet of ice on a pond or on the Arctic Ocean. The crust lies quietly on the interior part of the earth until something happens to disturb the equilibrium. Although the crust of the earth is composed of strong material, the strength is finite, surely not great enough to withstand the weight of the tremendous loads that have been shifted on the earth's surface. It is, however, strong enough to maintain the irregular surface of the earth just because of the floating principle.

Earthquakes have occurred probably in all parts of the earth. One cannot make an accurate estimate of the maximum size of the portion of the earth's crust in which, throughout geological time, no earthquakes have originated, but we see all about us evidences of uplift or subsidence of the earth's surface. Each continent has above sea level much sedimentary rock which must have been formed below tidal waters. These rocks in many cases are much tilted, curved, broken and crushed. It is reasonably certain that there has been an uplift of the earth's surface rather than a decrease in the amount of ocean waters to cause these exposures. The best evidence that they have been pushed up is the fact that strata laid down in salt water in horizontal positions are now tilted at various angles from the horizontal. Then again, the same strata exposed in a number of widely separated places are found at different elevations above sea level. This it seems is an indication that there has been an actual uplift of the earth's surface. Every one who has engaged in mining operations knows of the tremendous amount of faulting that has occurred in the rocks. A coal seam will be followed for a certain distance and then it gives out. Later the same seam of coal may be found at a higher or lower elevation. The many fractures that are found in mines and at the earth's surface lead one to the very definite conclusion that there has been much shifting of material in the geological past. Each one of these shifts, or changes, where a fracture has occurred, has probably caused an earthquake.

The earth may be classified as a yielding body. It should not be classed as a failing structure. A soap-bubble or a glass ball, when subjected to stresses greater than its strength, will collapse, but it is impossible for the earth to collapse. The earth is like a solid rubber ball which will yield and change its shape to forces that are exerted upon it. The earth is a globe almost spherical, approximately 8,000 miles in diameter. The number of cubic miles of material in the earth is great, but this large globe yields in a surprisingly easy manner to the forces that are acting upon it.

## OBJECTIONS TO THE CONTRACTION HYPOTHESIS

Geologists and other students of the earth have for generations sought for the forces which may have disturbed the earth. Many ideas have been advanced and some of them have had wide acceptance. One of these is that the earth's interior is losing heat rather rapidly, while the outer portion of the earth, the crust, is maintaining its temperature. In consequence, there is a shrinkage of the interior of the earth and a collapse of the crust, which causes earthquakes and elevates mountains and plateaus. This process is also held by some to be the cause of oceans and continents. It seems to me that a careful analysis of this hypothesis will lead one to the conclusion that it cannot be true. The earth has been likened to an apple or potato. Every one knows that a baked potato or a baked apple has wrinkles in its skin. The contraction hypothesis implies that the nucleus of the earth is like the interior of the apple or potato and that the crust of the earth is like the skin, but the skins of the apple and potato have practically no weight, and, therefore, during the cooking the shrinkage of the interior, due to loss of moisture, makes the skin wrinkle to fit the reduced size of the interior of the apple or potato.

The crust of the earth certainly cannot be likened to the skin of the apple or potato. In the first place, the crust is about sixty miles in thickness and is composed of heavy rock. Then, again, this material is so heavy that no wrinkles could possibly form which would have voids under them like the voids under the wrinkles of the apple and potato. There can be no such thing as a buckling or crumpling of the earth's crust on a shrinking interior. If the interior of the earth is losing heat, while the crust of the earth is maintaining its temperature, the loss of this heat must be so exceedingly slow that there can be no chance for stresses to accumulate to such an extent as to cause great horizontal forces. I believe that if in the course of geological time, measured by hundreds of millions of years, the earth's interior should cool and contract, the crust would continue to be in contact with the interior and, therefore, the crust would merely be thickened rather than buckled into ridges and troughs. Much has been written against the contraction hypothesis, notably by Mellard Reade and Alfred Wegener.

### DIASTROPHIC FORCES

There are no known forces which have their origin outside of the earth's material which can exert horizontal stresses on the crustal material of the earth of such strength as to form mountains and plateaus and cause earthquakes. It is true that the attractive forces of the sun and moon are exerted on the earth, and, since the portion of the earth that is nearest to the sun or the moon is attracted more than the material that is farther away, a stress is set up. This stress is not of sufficient magnitude, however, to rupture the material or to make it move out of its normal place, except to the extent of a slight elastic deformation called the earth tide. These tide producing forces of the sun and the moon change phase every few hours as the earth turns on its axis.

I think we can eliminate the attractive effect of the sun and the moon as being the cause of any geological phenomena involved in mountain forming, earthquakes, etc. Of course, the time of an earthquake on an island or near the continental coast may be decided by an exceptional high or low water tide in the vicinity, but it is reasonably certain that the crustal material is brought nearly to the breaking point by some other cause and that the high or low tide supplies merely the small increment required to increase the stress beyond the breaking strength of the rock. The real causes of the major features of diastrophism must lie within the earth itself.

Much has been written in recent years about the effect of the heat resulting from radioactivity of certain minerals in the outer portion of the earth. This, it seems to me, may be a factor in earth movements, but I am inclined to think it is one of minor importance. In the first place, the radioactivity is largely confined to the granitic material which is supposed to be only from fifteen to twenty miles in thickness under the continents. There is no granite under the oceans, but some of the strongest earthquakes occur there and much of the ocean bottom is quite active from a geological standpoint. Broken ground with very steep slopes is found under the oceans, and many oceanic islands are due to volcanic activity. All of this implies that movements are going on in the crust under the oceans, and these surely cannot be due alone to the radioactivity of minerals. The basalts which are supposed to underlie the granites of the continental areas and to form the bottoms of the oceans have present in them some radioactive minerals but not in such large proportions as are present in the granites.

Again, we have the problem of accounting for physical or chemical activity that probably occurs even to the depth of sixty miles below sea level. Earth students, who have been writing on radioactive minerals and their effect on geological processes, are inclined to the opinion that the deep lying materials have practically no effect on surface changes.

If we eliminate forces existing outside of the earth, forces dues to the supposed contraction of the earth's nucleus and the collapsing of the crust, and forces due to the effect of radioactive minerals as major causes of earth movements, we must search for some other force that might be effective.

We know that the temperature of the earth increases with depth. For the first two miles or less we have definite data from the determinations of temperatures in wells. There is a great variation in the rate at which the temperature increases with depth, but a fair average is 50°C. per mile. The temperature certainly continues to increase below the two mile depth, for we have many active volcanos in the world which emit cinders and lavas having temperatures of 1000°C. or more. Such temperatures would be found at a depth of approximately twenty miles if the temperature gradient were about the same throughout that depth as it is near the surface. Whether the temperature keeps on increasing with depth down to the center of the earth, we cannot tell for there is no way to discover, even approximately, what the temperature may be at great depths. A material may be at a temperature, which at the surface would be its melting point or even its boiling point, yet it probably would act like a strong solid when confined by the great pressures which must exist at considerable depths. A very hot interior of the earth, if there is little change in temperature from one period of time to another, will not exert any decided influence on the configuration of the earth's surface. Change in heat, however, whether a decrease or increase, will exert force. It will cause expansion or contraction of materials, but the heat of the interior of the earth is changing so slowly that it cannot be a major cause of surface changes. One would be most unwise to assert that the heat of the interior of the earth, without any other influences acting, could not cause changes in elevation and geographic positions of points on the earth's surface, but, if this interior heat is a primary cause of surface movements, no one, so far as I am aware, has given a very clear explanation as to how the changes are effected. I am rather inclined to think that we may eliminate the heat of the earth's interior as the major cause of geological phenomena. This heat does affect those portions of the crust which are lowered by sedimentation or raised by erosion, but it is not the primary cause of surface movements. I believe we should look for something that is closer at hand and easier of understanding.

### EROSION AND SEDIMENTATION

There is one process continuously active which is so simple that apparently its influence on surface phenomena has been ignored or even overlooked except by a few. This is the phenomenon of erosion. Vast quantities of water fall to the earth each year and presumably this has been going on continuously since the beginning of the sedimentary age of the earth, the one that we are now in. According to the best geological and geophysical evidence, the earliest sedimentary rocks were formed about a billion and a half years ago. It is absolutely impossible for sedimentary rocks to be formed without running water, and to have running water there must be sloping ground. A succession of sedimentary rocks has been formed during the past billion and a half years and for hundreds of millions of years there have been living creatures on the earth, so it seems perfectly logical to assume that rainfall must have occurred during all of that period.

The average rainfall per year over the land surface of the earth is about thirty inches. Of course, there are regions where the rainfall is one hundred inches or more, but these areas are very restricted in size, and there are other areas, such as the great deserts, where there is no rain at all or only a very few inches. A rainfall of thirty inches a year amounts to about one mile in every two thousand years, and during the whole of the sedimentary age about 750,000 miles of rain could have fallen. This, of course, means that by evaporation and precipitation the ocean waters have been used over and over again. As the water of the ocean is evaporated, the mineral content remains in the ocean. When the water runs from the continental or island areas into the oceans it carries in suspension or solution some solid material. The solids are mostly in the form of salts. The mineral content of the ocean waters that we now observe has been caused by this process of evaporation and precipitation throughout the sedimentary age.

This transfer of water from the oceans to the continents and then back into the oceans would be of no consequence from a geological standpoint if it were not for the resulting erosion of the exposed surface of the earth. Much of the water runs directly to streams and rivers and eventually reaches tidal water, except in a few desert basins where the rivers have no outlet to the sea, but these latter are very unimportant. The water that runs to the sea carries much material in suspension. The earth's surface is undergoing disintegration as the result of frost and chemical action. As soon as a particle is loosened from a rock, it is subject to transportation to some other place by wind or water. The effect of water in transporting material is believed to be far greater than that of wind. In any event tremendous amounts of material in suspension are carried by water to the streams and rivers. Another large part of the water that falls to the earth soaks into the ground and absorbs a certain amount of the mineral matter from the rocks. This water seeping through the rocks will eventually reach streams and rivers and then will flow to tidal waters carrying vast quantities of solid material with it. The combination of the material in suspension and in solution results in a large amount of continental matter that is transferred to sea areas each year.

It has been estimated that in the United States the rate of erosion is approximately 1 foot in 9,000 years. Some areas, of course, have very much more rapid rates of erosion than others, but this is the average rate at which material is carried from the area of the United States as a whole to tidal waters. The rate of erosion for the other continental areas is probably just about the same as for our country. This may not seem to be a very rapid rate, for during historic times it would amount to only about one-half a foot. The average elevation of the United States is about 2,000 feet, and so to erode all of the material lying above sea level would require something like four thousand times the total length of the historic period.

At this rate, however, something like thirty miles of erosion could have occurred during the sedimentary age. Of course, there has been no such amount of erosion as that. A particular exposed area that is undergoing erosion is worn down to sea level eventually and then erosion ceases, but it is rather remarkable that many areas which have been eroded down to sea level have in a later period been raised up again and thus other material has been subjected to erosion.

It seems probable that the average elevation of the continental areas has never been very much higher or lower than now. I believe that if there has been any change, the average elevation has been getting gradually lower. This is because the continental matter carried to tidal waters is less dense than the sub-crustal matter which moves toward the continents to restore equilibrium. The average elevation for all of the continental and island areas of the world is slightly more than 2,000 feet, less than one-half mile, but there are some parts of the earth where the elevations are three or four miles or more in height. The maximum elevation of the Himalayan Mountains is more than 29,000 feet, and there are mountain peaks in South America and Alaska which are 20,000 feet or more in elevation. There are great plateaus which stand more than two miles above sea level. But these great elevations are offset by vast areas on continents and islands which are only slightly above sea level. The ocean basins have an average depth of approximately 10,000 feet. It seems reasonably certain that some of these areas have changed their depths during the sedimentary age. Some parts of the ocean bottoms have come up, while others have gone down, but I am of the opinion that the average difference in elevation of the ocean beds and of the continents, now about two and one-half miles, has not been much less than it is now, at any time during the sedimentary period.

We can now, I believe, get an idea as to where some of the force originates which changes the configuration of the earth's surface. The water falling as rain carries off vast quantities of material in suspension and solution. It unloads certain portions of the earth's crust and overloads others. Some geologists have told us that as much as 30,000 feet, about six miles, of material have been eroded from some mountain areas. Then there are other areas on which as much as 40,000 feet, or nearly eight miles, of sediments have been placed. The earth's materials are not strong enough to resist yielding under these great negative and positive loads. There is a bending down of the crust under the sediments and a bowing up of the crust under the areas which have undergone great erosion.

The movement of material within the first five or ten miles resulting from the loading and unloading by erosion and sedimentation is not a simple one. We do not have merely a slab of material which can break or bend, but a shell approximately sixty miles in thickness completely encircling the earth. Any distortion or change in one part of this shell would have an effect on all other parts of it if the earth's crust were of tremendous strength, but such is not the case. The crust must yield under comparatively small amounts of sedimentation and erosion. If this were not true, the geodetic data would certainly enable us to detect without difficulty the extent of the masses involved. An extra load of 1,000 feet of material over the Rocky Mountain area would show up at once in the gravity data. The absence of any large differences from normal conditions leads us to believe that there is surely no excess or deficiency of material for the whole Rocky Mountain region equivalent to a blanket 1,000 feet in thickness. A blanket of even 500 feet of material is greater than can be present as an undetected excess or deficient load for an extensive area. We, therefore, may conclude, I believe, that a blanket of surface rock 500 feet in thickness over a large surface area exerts a force that is great enough to make the crust beneath yield. This yielding at times is so slow that the rocks will merely be bent and deformed, and at other times it is so rapid as to cause rocks to break.

## THERMAL CHANGES IN CRUST

Isostasy is a condition of rest. When the materials of the earth's surface are carried in great amounts from one area to another during the process of erosion and sedimentation, the isostatic balance is disturbed. It is then that gravity comes into play and causes the sub-crustal material to move horizontally to restore the balance.

We have evidence to show that as much as six or eight miles of sediments have been deposited in the areas along the shores of an inland sea or the margin of an ocean. This load of material pushed the crust down into hotter regions. Each particle of crustal material reached a position several miles below the one it formerly occupied. The geoisotherms were depressed with the crustal material. Eventually, probably millions of years after the cessation of the sedimentation, the geoisotherms returned to their normal positions. In doing so, the crustal material which had been depressed increased in temperature, perhaps as much as 400°C. in extreme cases.

This increase in temperature, of course, expanded all of the crust below the sediments. The expansion tended to be cubical, that is, in all directions, but the material involved was restrained from movement except in the upward direction; hence, the result of the expansion was an uplift of the earth's surface. The amount of movement could not have been sufficient to form great mountain masses rising two or more miles high, but is it not possible that certain chemical or physical changes, other than normal expansion took place in the crustal material and that this independent expansion gave the added height to the uplifted surface? This idea is in complete harmony with isostasy and I believe it has much merit.

When an area is undergoing erosion, it is not lowered at a rate comparable with the rate of erosion. If a thousand feet of material is eroded from a mountain area, the crust below will move upward by the influx of sub-crustal material which restores the equilibrium. The crust will presumably rise up 800 or 900 feet as a result of the 1,000 feet of material taken from the surface. If a mountain area has an average elevation of about two miles, from five to ten miles of material, or even more, will have to be eroded away, if erosion is the only acting agent, before the area is brought to a low level where erosion practically ceases. During this process every cubic yard of material in the crust below the erosion area will have been brought upward five or ten miles or more into colder regions. Eventually the geoisotherms, which have been bowed upward, will resume their normal positions and in consequence each particle of the uplifted crust will become colder by several hundred degrees Centigrade. This causes contraction and the surface becomes depressed. The depression may extend even below sea level, in which case new material in the form of sediments will be deposited in the trough or basin that is formed. There is evidence that mountain areas have been elevated and depressed several times and the explanation outlined above would seem to show how this oscillation can take place.

We have seen from the above analysis what forces are being exerted on the materials of the earth. The movement downward of the crust under the sediments causes a movement of sub-crustal material back toward the region from which the sediments were derived. The horizontal movement to restore the balance must occur below and not within the crust. What the effect is of this horizontal movement of sub-crustal material on the surface configuration of the earth between the areas of erosion and sedimentation, we do not know. Some think that perhaps much of the wrinkling of the earth's surface is due to this sub-crustal flow. I am inclined to think that the movement of sub-crustal material is so small in extent that there can be little effect of it on the surface above a crust about sixty miles in thickness. I do not think there is anything like a river of material flowing from the region below the sedimentary area to the erosion area. It is more likely that the moving material involves a large volume, and any portion moves only a very short distance. I believe that this movement of sub-crustal material, which is a part of the isostatic adjustment, exerts only a minor influence on those portions of the surface of the earth which lie between the areas of sedimentation and erosion.

From the above reasoning there appear to be four definite causes of changes in the elevation of surface areas aside from the direct effects of erosion and sedimentation: First, the depression of the crustal material under an area of sedimentation; second, the moving upward of crustal material to restore the balance under an area of erosion; third, the expansion of crustal material which has been depressed by great loads of sediments; fourth, the contraction of the earth's crust and the sinking of the surface under an area of erosion. These must be the cause of many of the earthquakes of the world, although it would not be safe to assert that these are the only causes of earthquakes and surface movements.

Many geologists do not give as much weight as I do to effects of sedimentation and erosion on changes in the configuration of the earth's surface. Prof. C. K. Leith, in his splendid book entitled, *Structural Geology,* published in 1923, tells us that isostasy and the maintenance of isostatic equilibrium are minor causes of structural changes. He expresses his views as follows:

"So far as it is possible to generalize from this vague state of knowledge, it may be said that geologists are at present inclined to give principal place to changing rate of rotation and to the shrinkage of the earth, due to heat transfer from the interior outward, whether they go back to the nebular or planetesimal hypothesis of the origin of the earth; that metamorphism and chemical changes, vulcanism, and forces tending to maintain isostatic equilibrium are regarded as subordinate or contributory causes, or perhaps as special and local expressions of the more basic causes first indicated."

Leith advises the student of the earth to be cautious in any acceptance of a simple and definite explanation as to the causes of structural changes near the earth's surface. He claims that—"The problem includes so many unmeasured and perhaps immeasurable factors that no living scientist can claim even an approximately correct perspective; all are groping for the light."

I agree with Dr. Leith that the problem involved in untangling the geological record is a very complicated one but I do not think it is wise to advise a student to avoid a simple explanation of some phenomena if other explanations are not available or if the others are so complicated as to leave one mystified and confused. I believe that the only way to attack any scientific problem is to follow a lead, no matter how simple, until evidence may show that one is not traveling in the right direction.

## CONCLUSION

Isostasy is now widely recognized as a scientific principle. Its advocates hold that there is a maintenance of the isostatic equilibrium as materials are moved from one place to another over the earth's surface. These are the physical facts which are related to the processes involved in changes in the earth's surface. They have been proven by actual physical measurements. It has been stated that there are great horizontal movements in mountain areas, but that isostasy and its maintenance call for only vertical movements. My answer to this is that I recognize the horizontal movements in mountain areas, but believe that these horizontal movements are incidental to the vertical movements which are involved in maintaining the isostatic balance and which also result from the changes in the temperature of crustal matter brought about by the maintenance of equilibrium. There is an abundance of space in a mountain area for horizontal movements to occur, and it seems to me that it is easier to explain these movements as resulting from upward or downward moving material than as resulting from a shrinking interior of the earth and a collapsing crust.

Isostasy is a geological problem. It was outlined by the great geologist, C. E. Dutton. It has been used by the geodesists merely as an effective means by which to harmonize theoretical and observed values of geodetic data. The geodesists hope that isostasy may prove of great value to geologists in their efforts to write the geological history of the earth.

## ZOOLOGY.—*New crabs from the Gulf of Mexico.*[1] MARY J. RATHBUN, United States National Museum.

During the past year two noteworthy species of crabs were discovered in the Gulf of Mexico. One, taken in deep water during explorations by the Carnegie Laboratory at Tortugas, is a second species of *Benthochascon,* a genus known previously from the Indian Ocean; the other was obtained by the Caribbean Biological Laboratories on the coast of Mississippi.

### Family PORTUNIDAE

**Benthochascon schmitti,** new species

Carapace considerably broader than long, anterior portion with an arcuate outline, the long postero-lateral margins gradually convergent; surface covered with a pavement of flat close set granules; regions fairly well indicated; hepatic region elevated, mesogastric outlined; deep thumb nail impressions either side of urogastric region and of posterior cardiac region; on the branchial region a sublongitudinal ridge through the middle and a blunt sinuous ridge following the curve of the cervical suture. Antero-lateral margin armed with three long stout equidistant spines, the first or orbital spine directed forward, the others obliquely outward; the third, at the lateral angle, the longest and most erect. Four short spines or teeth on front, sinuses U-shaped, median narrower than lateral. A small emargination and a short groove at middle of supra-orbital margin; a broad sinus and trace of a groove just within the outer spine. A long slender spine at inner angle of suborbital margin is produced about as far as front; from this spine the margin slopes backward to a small notch and groove at base of outer spine.

Buccal cavity much broader than long, anteriorly widened; merus of third maxilliped produced outward, angle arcuate. Cheliped shorter than ambulatories; a spine at inner end of ischium; two spines on merus, one distad of middle of upper margin, the other at distal third of lower margin; carpus with a long spine at inner angle, a smaller one at outer angle; a spine at distal end of upper margin of palm; palm obscurely ridged, two ridges above, two below, one through middle of outer and of inner surface. Ambulatory legs rather narrow, meri enlarged at middle; merus of swimming leg with parallel sides; propodus flattened, elongate, upper margin twice as long as height; dactylus narrow-lanceolate. Male abdomen constricted between fifth and sixth segments, the latter twice as broad as long, side margins arcuate; terminal segment broadly triangular.

*Color.*—Carapace ochraceous buff except on hinder half of middle two-thirds, which is olive buff strongly tinged with hair brown. Marginal spines basally carapace color, next whitish, distal half ochraceous buff, extreme tips

[1] Published with the permission of the Secretary of the Smithsonian Institution. Received February 3, 1931.

lighter. Antennae, antennules, rostral and suborbital spines china white, margins of orbit a sort of ochraceous buff, eye stalks ferruginous, corneae silvery black around margins. Maxillipeds white. Chelipeds china white

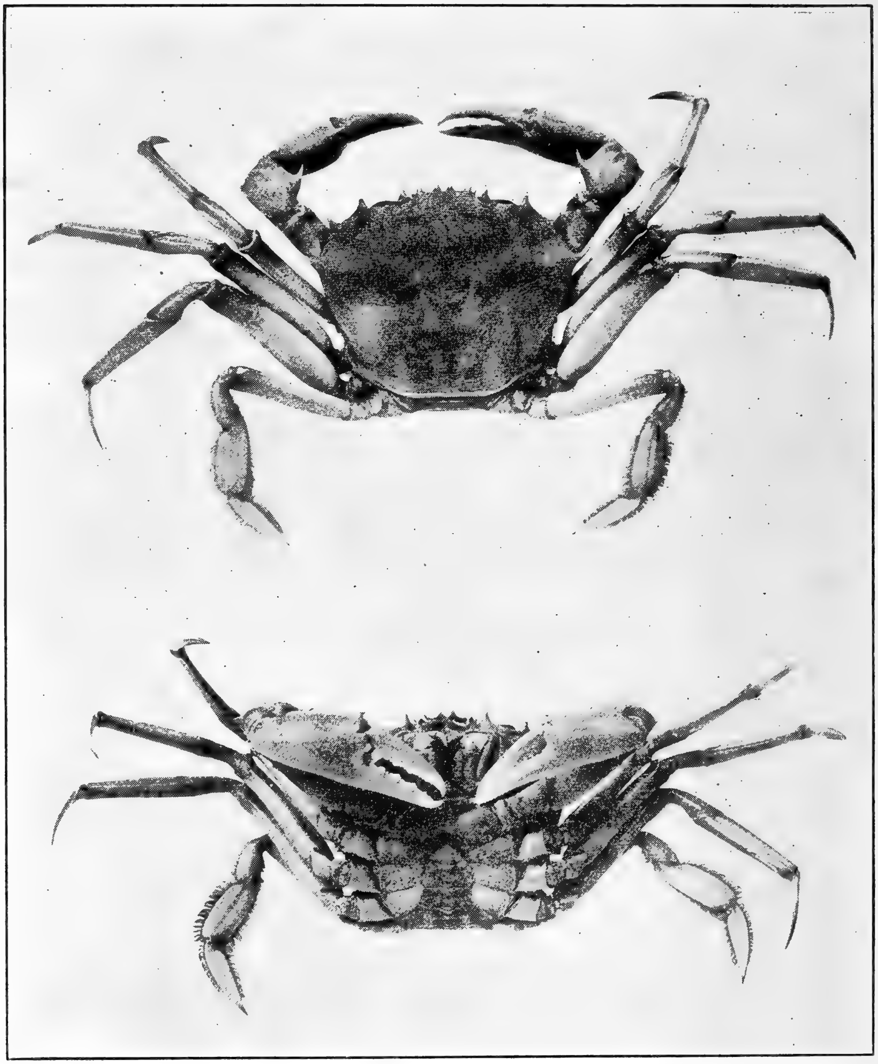

Plate 1. *Benthochascon schmitti*, ♂ holotype, carapace 67 mm. wide. Dorsal and ventral views.

except anterior third of sides and distal under edge of merus red and under side of coxae white suffused with pinkish vinaceous to peach blossom pink. Legs proximally white; running from distal half of merus in hind leg to distal fourth in front leg, the legs are bright scarlet vermilion except on inside of groove of carpus and propodus of first and second ambulatories which is

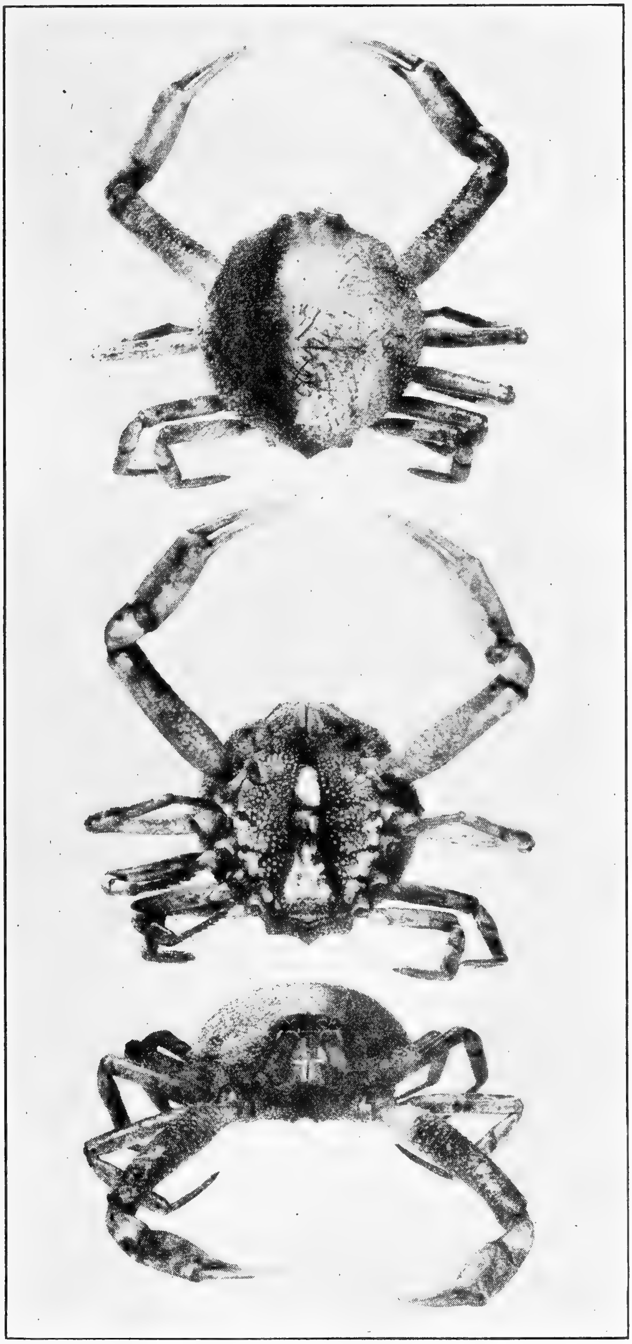

Plate 2. *Persephona crinita*, ♂ holotype, carapace 21.6 mm. wide, hair removed from right half. Dorsal, ventral, and front views.

bluish white; distal half of dactyli of ambulatories shading into wax yellow; propodus of last leg bordered above and below on anterior surface and below on posterior surface with lilac, the dactylus similarly bordered below on proximal half of anterior surface; hairs of hind leg dirty wax yellow. Under parts a fainter grayish than dorsum. (W. L. Schmitt.)

Male, median length 51, total length 53.3, extreme width 67 mm.

*Type-locality.*—22.3 miles south of Loggerhead Key, Tortugas, Florida, 180 fathoms, July 31, 1930, Station 37–30, Waldo L. Schmitt, Carnegie Institution. Three males (one is holotype), one female, Cat. No. 63738, United States National Museum.

## Family LEUCOSIIDAE

### **Persephona crinita,** new species

*Male.*—Carapace slightly longer than broad, more convex from side to side than antero-posteriorly; front little produced; hinder end with three similar, short, conical spines, the median one forming an angle not much in excess of a right angle. Dorsal surface covered with a dense coating of short, hooked hairs which conceals the small and widely separated bead granules; the granulation is denser near the lateral and posterior borders and is continued on the lower surface of the carapace where it is finer. A granular tubercle on the subhepatic protuberance and two on the lateral margin, one of which is at the widest point of the carapace and the other anterolateral; no definite marginal line. Front almost transverse, forming a very wide V, median sulcus deep.

Outer maxillipeds sparingly granulate, inner two-thirds of ischium smooth. Chelipeds narrow, less than twice as long as carapace, pubescent; merus slightly constricted near the carpus, coarsely granulate except for a smooth patch on the distal two-fifths, above and below. Carpus and manus finely granulate along outer margin; dactylus a little longer than outer margin of manus. Legs pubescent above on merus, carpus and propodus; dactylus fringed with hair on either side. Sternum coarsely granulate, interstices pubescent. Abdomen very narrow, first three segments granulate.

*Female.*—Lateral tubercles less prominent than in male, obsolescent; lateral posterior spines further apart, forming a greater angle with median spine; posterior margin more produced at middle.

Male, length 22.3, width 21.6 mm. Female, length 24, width 22.8 mm.

*Type-locality.*—Horn Island Pass, Mississippi, about 3 fathoms, Aug. 20, 1930, Caribbean Biological Laboratories Inc. Holotype male, paratype female, Cat. No. 63739, United States National Museum.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## BOTANICAL SOCIETY

### 226TH MEETING

The 226th meeting was held at the Cosmos Club May 6, 1930.

*Program:* H. B. Humphrey: *Regeneration in some conifers* (illustrated). Regeneration from stump sprouts, common in deciduous forest trees, is rare among conifers. The redwood, *Sequoia sempervirens,* is known to reëstablish itself in this way after a fire. *Pinus rigida, P. taeda,* loblolly pine; *P. serotina,* pond or marsh pine, and *P. palustris,* long-leaf, yellow or Georgia pine, are found to regenerate by means of stump shoots and from buds beneath the bark in fire-swept trees. (*Author's abstract.*)

This paper was followed by *New Woods for old,* a one reel moving picture, from the Forest Service.

E. P. KILLIP: *Across the Andes and on the Amazon for cube and other plants* (illustrated).—An abstract of this paper, appears in the Proceedings of the Biological Society, this JOURNAL **14**: 352. 1930.

### 227TH MEETING

The 227th meeting was held at the Cosmos Club October 7, 1930.

Dr. H. B. HUMPHREY presented a brief note on the influence of trees and associated undergrowth on the rate of stream discharge as observed and recorded by him in the vicinity of his home northwest of Washington.

*Program.* H. B. HUMPHREY: *The relation of weather to the development of stem rust Puccinia graminis* (address of the retiring president, illustrated).—Our modern knowledge of plant rusts dates from MICHELI who, in 1730, described and illustrated the first genus, *Puccinia.* PERSOON, in 1795, first recognized the rusts as a separate group of fungi. DEBARY's discovery of the phenomenon of heteroecism in 1865 added to our knowledge of the life history of stem rust, *Puccinia graminis.* In 1927, CRAIGIE discovered the rôle of the pycniospores in the life cycle of stem rust and sunflower rust. These steps in the life history of the stem rust require certain meteorologic conditions such as humidity, temperature, light, atmospheric movement, etc. Concert of all these factors is necessary to the development of an epiphytotic of any one of the cereal rusts.

Comparison of stem-rust epiphytotic summers with those characterized by little or almost no rust, over a long series of years, has shown that the ultimate effect on the host of an optimum of soil moisture and abundant rust is less pronounced than it is under conditions of equal rustiness accompanied by inadequate soil moisture. One of the effects of the rust attack is a marked increase in the water requirement of the afflicted host. An adequate supply of soil moisture meets this increased demand and has a tendency to sustain the photosynthetic vigor of the host. The optimum temperature for germination of teliospores of *Puccinia graminis* lies between 12° and 20°C.; that of the sporidia, between 15° and 20°C.; that of the aeciospores, between 5° and 18°C.; and that of the urediniospores, between 20° and 25°C. It is probable that spore showers falling over the spring-wheat and the hard-red-winter-wheat States in May sometimes result in early infection. If the temperature at the time be suboptimum the growth of the fungus is inhibited. These primary infections later become the foci from which urediniospores initiate secondary infection and spread of rust.

Light is one of the most important variables affecting the incidence of stem rust. It has been shown that in different varieties of wheat there are important differences in stomatal response to light and that these differences are in some varieties correlated with susceptibility to the organism. This fact is especially exemplified in such varieties of wheat as the rust-susceptible Little Club and the highly resistant Hope.

It has been proved that *Puccinia graminis* overwinters successfully in the Gulf States and in California, Oregon, and Washington. Repeated observations over many years have established the fact that with the northward march of the optimum conditions for rust development there is a corresponding northward movement of urediniospores. The origin of an epiphytotic in the spring-wheat States is not, however, to be found solely in any such south-to-north march of inoculum. We must take into the reckoning the common barberry of which there yet remain in the North-Central States uncounted thousands of bushes. Every spring these bushes discharge into the surrounding atmosphere countless billions of aeciospores which initiate local outbreaks and probably play a considerable part in furnishing initial inoculum for the general, far-flung epiphytotics that from time to time befall the spring-wheat States.

The speaker has recorded, during several crop seasons, convincing circumstantial evidence to the effect that, in addition to the spore showers precipitated by south winds which during the growing season occasionally carry urediniospores northward, there are spore showers of another kind, precipitated by rainfall from the clouds of major cyclonic storms that occasionally travel in an easterly or northeasterly direction across the North-Central States and out to the Atlantic Ocean by way of the St. Lawrence Valley. Although it yet remains definitely to be proved that these transcontinental cyclonic storms are factors in the distribution of rust spores, the theory of such distribution is sound. It may safely be assumed that aeciospores and urediniospores, set free from infected barberry bushes and from grains and grasses, rise on convection currents to great heights, to be swept later into the vortex of the approaching storm only to be precipitated by rain. We know that such spores have been collected by exposing spore traps at elevations of 10,000 feet above the Mississippi Valley. If caught by rain they cannot escape precipitation and, under conditions of humidity suitable to their prompt germination, can cause infection if light and temperature are favorable. (*Author's abstract.*)

L. H. Flint, *Recording Secretary.*

# Obituary

Howard Lincoln Hodgkins, dean and professor of mathematics at George Washington University, died on Friday, February 13, 1931, following a long illness. He was born in Elgin, Ill., but came to Washington in his youth. He graduated from George Washington University, then called Columbian University, in 1883 and later received the degrees of bachelor of arts, master of arts, doctor of philosophy and doctor of science. From 1882 to 1892 he served as special computer in the Nautical Almanac Office. He had been connected with George Washington University since 1883, holding the positions of professor of mathematics and physics, dean of the department of arts and sciences, dean of the college of engineering, and dean of the Corcoran Scientific School. He was appointed acting president in 1920 and served as president from 1921 to 1923. He was a member of the Washington Academy of Sciences, the Philosophical Society of Washington, the American Mathematical Society, the Mathematical Association of America, and the American Association for the Advancement of Science.

## OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### ANNOUNCEMENTS OF MEETINGS

| | |
|---|---|
| Friday, March 20 | The Geographic Society. |
| Saturday, March 21 | The Biological Society. |
| | The Helminthological Society. |
| Wednesday, March 25 | The Geological Society. |
| | The Medical Society. |
| Friday, March 27 | The Geographic Society. |
| Saturday, March 28 | The Philosophical Society. |
| Wednesday, April 1 | The Society of Engineers. |
| | The Medical Society. |
| Thursday, April 2 | The Entomological Society. |
| Saturday, April 4 | 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

## CONTENTS

### Original Papers



### Proceedings



This Journal is indexed in the International Index to Periodicals.

Vol. 21 April 4, 1931 No. 7



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OF THE

# WASHINGTON ACADEMY OF SCIENCES



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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.

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# JOURNAL

## OF THE

# WASHINGTON ACADEMY OF SCIENCES

Vol. 21 April 4, 1931 No. 7

GEOLOGY.—*Calvert (Miocene) tilting of the Maryland coastal plain.*[1]
A. L. Dryden, Jr., Bryn Mawr College. (Communicated by E. W. Berry.)

The coastal plain of Maryland may be taken as typical of the Atlantic Coastal Plain as a whole. It has few unusual features though it does contain a fairly complete section of the coastal plain formations. Thus, there are exposed a considerable part of the Lower Cretaceous, of the Upper Cretaceous, the Eocene, a part of the Miocene, and the series of Pleistocene terraces so common along the Atlantic Coast.

Several workers have advanced theories to account for the present position and attitude of the Pleistocene terraces. McGee, Shattuck, and Cooke are those who have probably contributed most. However, there has been a dearth of material dealing with the attitude of the older sediments of this region. The present contribution is in the nature of a general summary, with the addition of some detailed figures for the Calvert formation, and a consideration of the bearing of these results on the problem of the pre-Calvert deposits and the Pleistocene terraces.

Table I, compiled from reports of the Maryland Geological Survey, shows, in a general way, the differences in dip of the formations present.

Several things may be noted concerning Table I:

1. Those familiar with the formations enumerated know that little detailed stratigraphic work has been done on these beds in Maryland. The dips and thicknesses given, as well as the unconformities postulated, are often based on inadequate information. The dips, taken at unstated horizons in the formations, can be accepted only as approximations until detailed work is done.

[1] Published by permission of the State Geologist of Maryland. Received February 13, 1931.

2. Even after allowance is made for these deficiencies, the data show that there is a gradual, progressive decrease of dip (to the southeast) passing from older to younger deposits. Such a relation suggests continuous tilting during the whole time in question.

3. The unconformities postulated between successive formations or members make it impossible to tell whether tilting was uniform and continuous, or whether the present attitudes have been attained by

TABLE I.

| *Formation* | *Dip in feet per mile* | *Thickness in feet* |
|---|---|---|
| Talbot | 0.4 | 20 |
| Unconformity | | |
| Wicomico | 0.6 | 25 |
| Unconformity | | |
| Sunderland | 2 to 3 | 35 |
| Unconformity | | |
| Lafayette (Brandywine) | 5.5 | 50 |
| Unconformity | | |
| St. Marys | 10 | 280 (well) |
| Unconformity | | |
| Choptank | 10 (Shattuck) | 175 (well) |
| | 3 (at base, present work) | — |
| Unconformity | | |
| Calvert | 11 (Shattuck) | 310 (well) |
| | 16 to 4 (present work) | 125 |
| Unconformity | | |
| Eocene | 12.5 | 200 |
| Unconformity | | |
| Monmouth | 20 to 25 | 100 |
| Unconformity | | |
| Matawan | 25 | 70 |
| Unconformity | | |
| Magothy | 30 | 100 |
| Unconformity | | |
| Raritan | 30 to 35 | 200 |
| Unconformity | | |
| Patapsco | 40 | 260 |
| Unconformity | | |
| Arundel | 50 | 125 |
| Unconformity | | |
| Patuxent | 60 | 350 |
| Unconformity | | |
| Peneplane on basement rocks | 75 | — |

"stable" periods of sedimentation, interrupted by uplift and tilting. In other words, it is necessary, in order to answer such questions, that measurement be made of the change of dip throughout the thickness of one conformable series of beds. Detailed work on the Calvert formation seems to offer an answer to some of the problems presented. In this paper only conclusions will be presented, and proof must be reserved for a more comprehensive report.

The indurated ledge[2] just above the Eocene-Calvert contact has a dip of about 16 feet per mile (all dips are roughly southeast in direction). This ledge lies near the base of the Fairhaven diatomaceous earth (lower Calvert), which is 60 feet thick. The top of this diatomaceous bed dips about 12 feet per mile. There is, thus, a change of dip of 4 feet per mile through the 60 feet of thickness. No divisions of the Fairhaven have been drawn, so that the distribution in detail of this change of dip is not known.

At the top of the Fairhaven diatomaceous bed there is an unconformity, undescribed as yet, which probably represents a considerable part of Calvert time. Above this unconformity seven well defined beds or zones[3] can be distinguished—the Plum Point Marls of Shattuck. On a large cross-section of the Calvert Cliffs these beds are seen to have boundaries which are practically straight lines, so that their dips can be determined with some confidence. No sign of unconformity is to be seen through the thickness of about 50 feet.

The dips of these seven beds are given by the following figures. The first reading is that near the base of the lowermost bed, and the following seven readings are the dips at the tops of the seven successively younger beds. The subjacent figures show the thickness of these beds; i.e., each lower figure represents the stratigraphic thickness between the pair of dip readings above it.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dip in feet per mile............. | 10 | | 9 | | 7½ | | 6½ | | 6 | | 5 | | 4½ | | 4 |
| Stratigraphic thickness between dip readings, in feet............... | | 14 | | 10 | | 7 | | 2½ | | 6 | | 5 | | 4 | |

The total change in dip for this part of the Calvert is 6 feet per mile and the thickness 50 feet.

If we regard only the Plum Point Marls, in which the distribution of the change of dip is given by the above figures, a fact of some importance is apparent: that the rate of change of dip per foot of stratigraphic thickness is practically uniform. Tilting of the Maryland Coastal Plain during upper Calvert time kept pace with deposition, that is, it increased by about an equal angle per unit of time, if we regard the homogeneous sediments of the Calvert as having been deposited at a nearly uniform rate. From this relation certain inferences may be drawn.

First, the figures of Table I, together with the facts just enumerated, suggest the probability of such continuous tilting during pre-Calvert and post-Calvert time. Shattuck's figures for tilting of Pleistocene

[2] "Zone 2" in Md. Geol. Survey, *Miocene,* p. lxxiv. 1904.

[3] Not those recognized by Shattuck in Md. Geol. Survey, *Miocene.* 1904.

terraces have been questioned by Cooke,[4] who believes that the measurement of surface elevations of these terraces is inaccurate. Nevertheless, it seems probable that such tilting has occurred, and is still in progress, although the error of measuring the amount may be greater than the quantity itself.

Second, in seeking a "cause" for tilting, isostatic adjustment, previously invoked as an explanation, seems to be the most likely mechanism of such uniform, constant tilting, in which the land mass to the west is, and has been rising, and the sediments to the east are, and have been sinking. Under this assumption the axis of tilting lies near the fall-zone,—a postulation borne out by other facts not enumerated here.

*Summary:* The homogeneous, comformable beds of the Plum Point marls of the Calvert formation show by their regular and progressive change of dip that uniform and continuous tilting occurred during the deposition of these deposits. A suggestion is made that the same relations may be true of the Maryland pre-Calvert strata and Pleistocene terraces, and, further, that isostatic adjustment seems the most simple explanation for the phenomena presented.

BOTANY.—*Botanical notes on, and descriptions of, new and old species of Venezuelan plants.—IV.* Berberis *in Venezuela, new species of* Oxalis, Exogonium, *and others.*[1] H. PITTIER, Caracas, Venezuela.

### BERBERIS IN VENEZUELA

Up to the present, four species of *Berberis* have been reported from Venezuela, two of them, *B. discolor* and *B. truxillensis*, described by Turczaninow,[2] and two more, *B. Moritzii* and *B. vitellina*, published by Hieronymus.[3] On the other hand, we find again among our materials a fair representation of an equal number of species, three of which have tentatively been identified as *B. discolor*, *B. truxillensis* and *B. vitellina*, while the fourth seems to be new. Unfortunately however, the descriptions of the four original species are very incomplete and vague, and it is difficult to ascribe new specimens to any of them, without having the types at disposal for comparison. We find great variation in the leaves on the same bush, some of them being for instance spinulose on the margin and the others not, some pruinose and strongly glaucous beneath and others simply discolored, etc.

[4] C. Wythe Cooke, This JOURNAL, **20**: 390. 1930.

[1] Received February 9, 1931. The three first contributions on new and old species of Venezuelan plants appeared in this JOURNAL, **19**: 175–186, 351–357. 1929; and **20**: 3–12. 1930.

[2] Bull. Soc. Nat. Moscow, **27**[2]: 285, 287. 1854.

[3] Engler, Bot. Jahrb., **20**: Beibl., **49**: 15–16. 1895.

The only comparative leaf character that seems constant and that can be used to distinguish our Venezuelan species is size. The position of the leaf articulation, said by Hieronymus to be at the apex of the petiole in *B. Moritzii,* while it is placed between that and the basal sheath in the other species, would seem also to be a good distinctive character, the only one indeed, to separate *B. Moritzii* from *B. vitellina,* though the apical position assigned to it in the first species seems to me very doubtful.

Nor do the flowers furnish us with good means of distinguishing the several species; the segments of the perianth vary greatly in number in the same raceme, their size and shape are quite uniform, the new type being the only one with the flowers sensibly larger. The stamens vary also in number, but in the ovary we discovered an unexpected difference in that there are constantly 2 ovules in three of the four species studied, while in our new species the number varies from 4 to 7. Both this detail and the unusually large size of the bracts as compared with those of the other Venezuelan species, have seemed sufficient to justify the description of this type under a new name, which, however, may possibly be found to be synonymous with that of some extra-Venezuelan species.

Our five species of *Berberis,* may be distinguished by means of the following key:

Ovules 4 to 7 in each ovary; bracts up to 7 mm. long....**1. B. prolifica**
Ovules 2 in each ovary
  Inflorescence pubescent; leaves smooth and shiny on the upper face, glaucescent beneath with very revolute margin......**2. B. discolor**
  Inflorescence glabrous; leaves more distinctly reticulate
    Bracts minutely pubescent and ciliate; leaves small (up to 5 cm. long), glaucous beneath.............................**3. B. truxillensis**
    Bracts glabrous; leaves up to 8 cm. long and hardly pruinose underneath
      Leaf articulation at the petiole apex, i.e. between the petiole and the blade................ .......................**4. B. Moritzii**
      Leaf articulation at the petiole base, i.e. between the leaf sheath and the petiole......................................**5. B. vitellina**

1. **Berberis prolifica** Pittier, sp. nov.

Arbusculus ramis crassis teretibus, cortice subrimoso tectis; spinis 3-fidis basi breviter vaginatis, vagina amplia; foliis ad nodos floriferos 3–5-fasciculatis, glabris, coriaceis, basi breviter vaginatis, petiolo canaliculato supra vagina articulato; laminis ovatis oblongisve, basi cuneato-attenuatis, apice obtusis, supra saturate viridis subtus glaucescentibus, in aetate tantum pallidioribus, costa prominente, venis primariis 7–8 prominulis, demum minute reticulatis; marginibus in juveniis spinuloso-denticulatis cito denudatis; racemis simplicibus, plus minusve nutantibus, rhachi pedicellisque glabris; bracteis ovato-lanceolatis, apice longe apiculatis; sepalis 5, late ovatis plus minusve acuminatis, interdum glaucescentibus; petalis 3, late ovatis, obtusis; nectariis 6, late ovatis, basi in ungue angusto attenuatis, apice obtusis; staminibus 6; ovario ovoideo, 4–7-ovulato, glabro; bacca breviter ovoidea vel subglobosa, extus pruinosa, 1–3 sperma.

Arbuscula 1–2 m. altus. Vagina spinarum circa 2 mm. longa; spina media 6–10 mm., laterales 5–8 mm. longae. Vagina foliorum circa 5 mm. longa; petiolus 2–4 mm. longus; laminae 2–4.5 cm. longae, 1–2 cm. latae. Racemi 3–10 cm. longi; pedicelli 8–9 mm. longi. Bracteae 5–7 mm. longae. Sepala 4–6 mm. longa, 2–4 mm. lata. Petala 8 mm. longa, 6–6.5 mm. lata. Nectaria 7.5 mm. longa, 5.7 mm. lata. Bacca 6–7 mm. longa, 5 mm. diam.

MÉRIDA: Quebrada de Saisay, 3880 m., flowers and fruits April 7, 1930 (*Gehriger* 41, type); Cañada de Chachopito, 3600 m., fruits January 22, 1922 (*Pittier* 13258); both localities near San Rafael de Mucuchíes.

As stated above, this shrub differs from the other Venezuelan species in the size and shape of the leaves, the relatively long bracts, the larger flowers and the number of the ovules.

2. BERBERIS DISCOLOR Turcz. Bull. Soc. Nat. Moscou **27**$^{2}$: 287. 1854.

MÉRIDA: Sierra Nevada de Mérida, 3000 m. (*Funck & Schlim* 1124, type); páramos de Santo Domingo y Chachopo, 3200 m.; flowers Sept. 14, 1922 (*Jahn* 1120).

The specimens collected by Dr. Jahn bear a single 3-fid spine, whereas the description says *spinis . . . . palmatim 5–9-partitis*; besides, the leaves are not sessile, but for the rest the plant agrees fairly well with Turczaninow's description. In the flowers, we found 5 sepals, 3 or 4 petals and 6 or 7 nectaries.

3. BERBERIS TRUXILLENSIS Turcz. Bull. Soc. Nat. Moscou **27**$^{2}$: 285. 1854.

TRUJILLO: "In provincia Truxillo Venezuelae", 2500 m. (*Funck & Schlim* 754, type). MÉRIDA: páramo del Morro, 2500 m. (*Jahn* 1062).

This species distinguishes itself mainly by its smaller leaves, which are often quite glaucous beneath; the nectaries also are larger than the petals.

4. BERBERIS MORITZII Hieron. Engler Bot. Jahrb. **20**: Beibl. **49**: 16. 1895.

MÉRIDA: Alpine belt of the mountains above the city of Mérida; flowers in February (*Moritz* 1309, type).

Not found again and possibly identical with the following species.

5. BERBERIS VITELLINA Hieron. Engler Bot. Jahrb. **20**: Beibl. **49**: 15. 1895.

ARAGUA: Near El Pesjual de la Lagunita, on the road from Caracas to Colonia Tovar; flowers July (*Moritz* 795, type); Colonia Tovar, flowers December 1924 (*Allart* 473). MIRANDA: Upper belt of Naiguatá, forming isolated bushes; flowers May 24, 1913 (*Pittier* 6269); La Ciénega, Silla de Caracas, 2280 m.; flowers December 26–29, 1918 (*Pittier* 8303; *Röhl* 5).

## New Species of Oxalis

### **Oxalis avilensis** Pittier, sp. nov.

Fruticosa, caulibus erectis, ramis ramulisque virgatis, nodulosis, plus minusve puberulis pubescentibusve; stipulis inconspicuis, rotundatis, dense rufo-villosis; foliis parvis apice ramulorum plerumque congestis, petiolo brevi villoso, foliolis approximatis suborbicularibus ovatisve basi obtusis apice rotundatis leviter emarginatisve, supra in sicco nigrescentibus adpresse piloso-pubescentibus, subtus albo-punctulatis densiuscule cano-pubescentibus; pedunculis strictis canohirsutis foliis subaequantibus longioribusve; floribus paucis (1–4) breve pedicellatis, pedicellis hirsutis basi bracteolatis; bracteis stipulis simillimis, bracteolis minimis ovato-acutis, hirsutis; sepalis ovatis ovato-oblongisve, obtusis, duobus exterioribus dense villosis, demum parce villosis, ciliatis; petalis flavis, cuneatis, basi anguste unguiculatis, apice rotundatis leviter emarginatisve; staminibus utrinque glabris; ovario ovato-oblongo, glabro, stylis hirtellis, stigmate glabro, bilobulato.

Planta 25–35 cm. alta. Stipulae vix 1 mm. longae. Petioli 1.2–1.8 cm. longi; foliola sessilia 0.7–1.2 cm. longa, 4–10 mm. lata, lateralia minora. Pedunculi 1.5–2.5 cm. longi, pedicelli plus minusve 3 mm. longi. Sepala 5.5–6.5 mm. longa, 1.1–2.1 mm. lata. Petala 8–8.7 mm. longa, apicem versus 5 mm. lata.

Federal District: Cerros del Avila, above Caracas; flowers September 1927 (*Hermanos Cristianos* 161, type).

### **Oxalis meridensis** Pittier, sp. nov.

Herbacea, minuscula, caulibus tenuibus, repentibus, pilosulis; estipulis scariosis late obovatis, apice rotundatis, plus minusve pilosulis, longe ciliatis; foliis sparsis, petiolo filiformi pilosulo, foliolis parvis, cordatis, profunde emarginatis, lobulis rotundatis, supra minutissime puberulis, subtus plus minusve pilosulis, marginibus parce ciliatis; pedunculis unifloribus, villosis, apice bibracteolatis; bracteis lanceolatis, glabris, margine ciliatis; bracteolis linearibus, acutis, pilosiusculis; pedicello apicem pedunculi articulato, pubescente; sepalis oblongo-lanceolatis, obtusiusculis, plus minusve pilosulis ciliatisque; petalis flavis, oblongo-cuneatis, basi tenuiter unguiculatis, apice sinuatis emarginulatisque; staminibus utrinque glabris; ovario oblongo-ovoideo, stylisque glabris; stigmatibus bilobulatis; capsulis pubescentibus, loculis 4–5-spermis.

Caules 5–7 cm. longi. Stipulae 2–2.5 mm. longae. Petioli 2–3.5 cm. longi; foliola plus minusve 6 mm. longa, circa 9 mm. lata. Pedunculi 1–3 mm. longi; bracteae usque ad 4 mm. longae; bracteolae plus minusve 2 mm. longae; pedicelli 4–5 mm. longi. Sepala 7–7.5 mm. longa, 1.2–1.8 mm. lata. Petala 9–9.5 mm. longa, 2–2.5 mm. lata.

Mérida: Cañada de Chachopito, 3400 m.; flowers and fruits January 22, 1929 (*Pittier* 13343).

This may not be more than an altitudinal variety of *O. corniculata*, from which, however, it differs in the indumentation of the stems and leaves, in the uniflorous peduncles, the larger flowers, the glabrous styles and in the lesser number of seeds. The description does not agree with that of any of the varieties mentioned by Zuccarini.

**Oxalis glandulosa** (Knuth) Pittier, n. comb.
*Oxalis pubescens* var. *glandulosa* Knuth, Pflanzenr. **95**[4]**:** 108. 1930.

Herbacea, caulibus gracilibus rufo-pilosulis, erectis; stipulis conspicuis, persistentibus, scariosis, late ovatis, pilosulis; foliis parvis, petiolo tenui, rufo-villoso, foliolis cordiformibus rotundatis utrinque parce pilosulis, supra solute viridibus subtus pallidioribus costa dense villosa; pedunculis longissimis bracteatis pedicellis calycibusque rufo-villosis dense piloso-glandulosis; floribus 2–4, pedicellatis, subcymosis; bracteis ovato-lanceolatis, scariosis, villosis; bracteolis filiformibus, villosis, caducissimis; sepalis violaceis oblongo-lanceolatis, apice obtusiusculis; petalis flavis cuneatis, apice subtruncatis, basi in unguiculo angusto attenuato; staminibus utrinque glabris; ovario stylisque glabris, stigmatibus bilobulatis; capsula glabra, loculis 3–4-spermis.

Caules 8–10 cm. longi. Stipulae 4–5.5 mm. longae. Petioli 1–2.5 cm. longi; foliola 6–9 mm. longa, 4–9 mm. lata. Pedunculi 4–5 cm., pedicelli 3–5 mm. longi. Bracteae plus minusve 5 mm. longae; bracteolis 1–2 mm. Sepala 6.5 mm. longa, 1.8 mm. lata. Petala 8 mm. longa, 2–3 mm. lata. Capsula 6–6.5 mm. longa, 4.5 mm. diametro.

MÉRIDA: Near the city of Mérida, 1844 (*Moritz* 1249, type of Knuth's variety); Venta de Chachopo, 2800 m.; flowers and fruits January 16, 1929 (*Pittier* 13169, specific type).

This plant differs from *Oxalis pubescens* H. B. K. in the habit, the texture of the stems, the size and shape of the leaves, the length of the peduncles, the cymose and not umbellate inflorescence, the glands on the upper part of the latter, and also in the general dimensions as well as in the details of the flower.

**Oxalis Jahnii** Pittier, sp. nov.

Arbuscula, caulibus crassis, lignosis, ramulis nodulosis apicem versus pubescentibus; stipulis parvis, rotundatis, villosis; foliis sparsis, petiolo brevi, pubescente, foliolis ovato-oblongis obovatisve, basi subcuneatis apice rotundatis leviter emarginatisve, supra punctulatis villosisque, subtus dense villosis, terminali majori petiolulato; pedunculis subtrifloris, in axillis solitariis, foliis parum longioribus, pubescentibus; bracteis inconspicuis; bracteolis parvis, lineari-lanceolatis, villosis; floribus magnis; sepalis oblongo-lanceolatis, acutis, exterioribus violaceis, villosis; petalis flavis, cuneatis, anguste unguiculatis; staminibus glabris; ovario oblongo-fusiformi, glabro; stylis apiculatis; stigmatibus minutissime capitellatis.

Arbuscula 20–30 cm. alta. Petioli 1.5–2 cm. longi; petioluli 3–4 mm.; laminae laterales 1 cm. longae, 0.5–0.6 cm. latae; petiolulus terminalis 0.3–0.4 cm., lamina 1.5–2 cm. longa, 0.5–1 cm. lata. Pedunculi plus minusve 2.5 cm., pedicelli 4 mm. longi. Sepala 12 mm. longa, 3–4 mm. lata; petala 20–22 mm. longa. Ovarium 4 mm. longum.

MÉRIDA: Páramo de La Trampa, 1800 m.; flowers March 13, 1922 (Dr. *A. Jahn* 1002, type).

Determined first as *O. pentantha*, it was found to differ from this species in that the longer stamen filaments lack the toothlike appendage. It is more closely allied to *O. Plumieri*, from which it is distinguished by the habit, the indument and the glabrous stamens, and also by the fact that it is a high mountain type.

**Oxalis nodulosa** Pittier, sp. nov.

Frutex vel arbuscula, caulibus lignosis, ramulis virgatis, flexuosis, nodulosis, apice adpresse pubescentibus; estipulis minutis, hirsutis; foliis parvis, ad apicem ramulorum congestis, petiolis brevibus dense hirsutis, foliolis ovatis ovato-oblongisve, basi rotundatis apice obtusis retusisve, supra dense adpresso-pubescentibus in sicco nigrescentibus, subtus rufo-villosissimis; pedunculis foliis aequantibus vel superantibus, plerumque 3-floris, pedicellisque hirsutis; bracteis parvis, bracteolisque minimis linearibus villosis; sepalis lanceolatis vel ovato-lanceolatis, apice acutis obtusisve, extus villosis; petalis cuneatis, anguste unguiculatis, apice subflabellatis; filamentis minoribus glabris, majoribus dentatis, hirtellis; ovario stylisque glabris, stigmatibus bilobulatis; capsulis subglobosis, glabris, loculis monospermis.

Caules usque ad 50 cm. longi. Petioli plus minusve 1 cm. longi; foliola 0.3–1 cm. longa, 0.2–0.6 cm. lata, lateralia minores; petiolulos terminalis 2–3 mm. longus. Pedunculi 1–2 cm., pedicelli 2–3 mm. longi. Sepala 6–7 mm. longa, 1–2 mm. lata. Petala 14 mm. longa.

Federal District: Quebradita de Las Ruinas, near Caracas, on the margin of the savanna; flowers and fruits April 10, 1921 (*Pittier* 9443, type).

This species is distinguished by its bushy habit and its naked nodose ramification, the ultimate branchlets ending with a bunch of short leaves and axillary inflorescences. Provisionally we place Saer no. 296, of Cerro Gordo near Barquisimeto, Lara, with this species, with which it agrees tolerably well as to details, though it differs a little in habit. More materials are required.

### Key to the Venezuelan Species of Oxalis

Acaules, bulbosae; folia trifoliolata; pedunculi multiflori; flores umbellati; sepala apice glandulosa; petala rosea vel violacea
- Bulbi simplices; foliola sessilia, utrinque punctulata subtus pallidiora, parce pilosula; umbellae 10–15-florae; stamina minora parce, majora densius villosula............................**1. O. latifolia** H. B. K.
- Bulbi compositi
  - Foliola subtus puberula; pedunculi bifidi, ramus 3-floris **2. O. debilis** H. B. K.
  - Foliola ciliata, supra puberula, subtus pubescentia; flores apicem pedunculo umbellati........................**3. O. grandifolia** DC.

Caulescentes; radices fibrosae vel fusiformae; folia trifoliata; pedunculi simplices vel bifidi; flores solitarii, umbellati, spicati vel corymbosi
- Foliola in apice petioli omnes sessilia vel subpetiolulata; petioli filiformibus
  - Stipulae nullae; caules erecti, lignosi; foliola sessilia vel subpetiolulata, ovato-rhombea, parce adpresso-pubescentia, costa subtus hirsuta; filamenta majora hispida................**4. O. rhombifolia** Jacq.
  - Stipulae apice vel omnium liberae; plantae plus minusve pubescentes, lignosae vel herbaceae; stamina omnia glabra; petala flava
    - Caules lignosi, erecti; foliola rotundata vel ovata, subtus adpresse cano-tomentosa........................**5. O. avilensis** Pittier

Caules herbacei
Caules plus minusve decumbentes vel reptantes, ramulosi
Pedunculi plerumque biflori; foliola parce adpresse pubescentia; styli hirtelli........................ **6. O. corniculata** L.
Pedunculi plerumque uniflori; foliola subtus punctulata et tomentosa; styli glabri...............**7. O. meridensis** Pittier
Caules erecti vel suberecti
Pedunculi, pedicelli et calyx glanduliferi; foliola suborbiculares **8. O. glandulosa** (Knuth)
Pedunculi, pedicelli et calyx eglandulosi, glabri vel pubescentes; foliola plerumque ovalia vel oblonga **9. O. pubescens** H. B. K.
Foliola lateralia a terminali remota
Filamenta majora staminum edentula
Sepala ovato-oblonga, duo exteriora breviter penicillata; filamenta majora apicem versus puberula...........**10. O. Plumieri** Jacq.
Sepala oblongo-lanceolata, exteriora villosa; filamenta utrinque glabra **11. O. Jahnii** Pittier
Filamenta majora staminum denticulata
Filamenta utrinque glabra vel apice puberula..**12. O. pentantha** Jacq.
Filamenta majora plus minusve puberula vel hirtella
Flores albi, plus minusve flavescentes vel purpurascentes
Ovarii loculi monospermi; sepala lanceolata, acuta, puberula; petala alba, parva.............**13. O. borjensis** H. B. K.
Ovarii loculi 3–4-spermi; sepala ovato-lanceolata, obtusa vel subacuta, puberula vel glabrescentia; petala parva, 9.5 mm. longa..............................**14. O. Barrelieri** Jacq.
Flores flavi
Planta herbacea, annua; filamenta majora barbata **15. O. distans** St.-Hil.
Plantae fruticosae, perennae; ovarium glabrum
Petala 9 mm. longa; foliola utrinque adpresse-pubescentes **16. O. sepium** St.-Hil.
Petala 14.5–15 mm. longa; foliola utrinque villoso-tomentosa **17. O. nodulosa** Pittier

MONNINA PUBESCENS H. B. K. Nov. Gen. & Sp. **5**: 418. *pl. 505.* 1821.

This species, the type of which was collected near Caracas, varies considerably in habit according to the station. In dry places, it assumes the proportions of a real, ramose shrub, with slender branches and rather small, oblong leaves, while in shadowy groves the stems are almost simple, thick and subfistulose, with large, ovate, very broad leaves (up to 17 cm. long and 10 cm. broad in our specimens). But for the identity of the long acuminate bracts and other parts of the flowers, one may be easily induced to distinguish both forms as separate species. The plant is, with *M. phytolaccaefolia* of the same authors, the most common of the genus throughout the upper temperate belt of Venezuela.

**Grammadenia hexamera** Pittier, sp. nov. (Subg. EUGRAMMADENIA)

Arbuscula ramis ramulisque brunneis glaberrimis gracilibus, foliis parvis, sessilibus, coriaceis, ellipticis, glaberrimis, basi plus minusve cuneatis apice subacutis longiuscule mucronulatis, marginibus revolutis, supra opacis, laevibus, nervio medio angustissime impresso, subtus leviter pallidioribus parce lineatis punctatisque; inflorescentiis axillaribus, glabris vel minutissime puberulis, foliis multo brevioribus; floribus parvis hexameris, flavovirentibus, pedicellatis, bracteola parva, ovata vel triangulari-acuta, scariosa suffultis; sepalis ovatis, inaequalibus, parce lineatis ultra 1/3 connatis; petalis immaculatis, ovalibus, apice late rotundatis, basi infra 1/3 connatis; staminum filamentis coalitis tubo brevissimo efformantibus, antheris subsessilibus, brevibus, basi emarginatis, apice obtusis; ovario subgloboso, depresso, estilo brevi.

Arbuscula 3–4 m. alta. Folia 4.5–6 cm. longa, 1–2 cm. lata. Racemi 1.5–2 cm. longi; pedicelli 1.5–2 mm. Bracteolae pedicelli subaequantes. Flores 2.7 mm. longi. Calyx 2.5–4 mm. diam. Petala circa 3 mm. longa, 1.8–2.2 mm. lata. Tubus stamineus 1 mm. longus; antherae 0.7 mm. longae lataeque.

MÉRIDA: Vicinity of Tabay, 2500–3200 m.; flowers September 18, 1930 (*Gehriger* 471, type).

This species should be placed near *G. alpina* Mez, from which it differs in size, in the leaves being smaller and thinner and in the flowers being all hexamerous. It grows in forests or on semi-wooded slopes, while the former is a plant forming thick bushes in the high paramos.

**Dipladenia bella** Pittier, sp. nov.

Fruticosa, scandens, glaberrima, ramis ramulisque flexuosis, cortice griseo minute verruculoso tectis; foliis submembranaceis, discoloribus, petiolo brevi canaliculato, laminis obovatis ovatisve basi (in sicco plicata) subacutis, apice late rotundatis abrupte laeviterque acuminatulis, marginibus leviter revolutis; costa subtus prominente, venis primariis circa 12, tenuibus; racemis subterminalibus 1–3-floris, brevissime pedunculatis foliis subaequantibus; bracteis desunt; pedicellis elongatis, erectis pedunculo multo longioribus; calycis segmentis ovato-lanceolatis, acuminatis, parte angustam tubi corollae multo brevioribus, intus basi utroque latere glandula parva 2–3-loba munitis; corolla nivea, tubo usque ad 1/2 longitudinis anguste cylindrico, dein sensim ampliato, lobulis magnis, late ovatis; staminum filamentis brevibus, hirsutis, antheris lineari-lanceolatis; disci glandulis 2, compressis, oblongis, apice truncato-crenulatis, ovariis glabris apice acutatis; stylo elongato, tenui; stigma conico, basi sub-5-lobo, apice bifido; folliculi desunt.

Petioli 1–1.2 cm. longi; laminae 6.5–9 cm. longae, 3.5–4.5 cm. latae (acuminulum plus minusve 6 mm. longum). Pedunculi 0.8–1.5 cm., pedicelli 2–2.7 cm. longi. Calyx circa 5 mm. longus; segmenta 4.5 mm. longa, 2.5 mm. lata. Corolla tota 6–6.5 cm. longa; tubus 3.6–3.9 cm. longus, pars angusta 1.1–1.4 cm. longa; lobi 3.2–3.6 cm. longi, 3.6–3.8 cm. lati. Antherae 8.5–9.5 mm. longae. Stylus circa 16 mm. longus; stigma 2.5 mm. altus.

FEDERAL DISTRICT: Forests of Loma de En Medio, 1000 m., valley of Puerto La Cruz, in sunny, cool gullies; flowers September 4, 1918 (*Pittier* 8108, type). ARAGUA: Valley of Ocumare de la Costa, on humid rocks; flowers October 12, 1927 (*Pittier* 12556; *Röhl*, without date or number).

Dr. Markgraf, of the Berlin Botanical Museum, identified this plant with *Dipladenia Riedelii* Müll.-Arg. But, besides the dissimilarity of habitat, our specimens show several important discrepancies in shape of leaf, in shape and dimensions of the corolla, remarkable for its large lobes, and in the longer pedicels. Probably other differences are present in the stamens and pistil, the description of which was not given by Müller-Arg.

## On three supposedly new species of Exogonium

This genus, considered by some as a simple section of *Ipomoea*, differs from it mainly in having the stamens and style long-exserted and the corolla with a narrow tube and a more or less short, almost rotate limb. In 1897, Peter[4] attributed to the group about 15 species, but in 1925 this number was increased to 25 by N. L. Britton.[5] Of these, I have seen the descriptions of only about 12 species, only one of which seems to correspond to the materials of the four Venezuelan species collected up to the present. Our No. 8034 agrees fairly well with *E. repandum* Choisy, differing only in the size of the sepals; these, however, are accrescent, and their larger dimensions can be explained by the advanced condition of the only flower at disposal. The other species I have tentatively named and described, so that the four can be keyed as follows:

Leaves small, scarce, 3-lobed; stems thin, verrucose....**1. E. verruculosum**
Leaves large, entire; stems thick, smooth
 Stems, petioles and peduncles retro-pilose; leafblades and sepals hairy **2. E. retropilosum**
 Stems, leaves, peduncles and sepals glabrous
  Inflorescence umbellate, the peduncles shorter than the petioles **3. E. mirandinum**
  Inflorescence racemose, the peduncles usually longer than the petioles **4. E. repandum**

### **Exogonium verruculosum** Pittier, sp. nov.

Volubile, caulibus elongatis, teretibus vel infra nodos leviter sulcatis, glabris, crebre verruculosis; foliis paucis, parvis, petiolo tenui, canaliculato, glabro, laminis petiolo longioribus, basi cordatis vel late emarginatis, profunde 3-lobis, minutissime pubescentibus, lobis subintegris subrepandis, lanceolatis, acutis, exterioribus inaequilateralibus; inflorescentiis 2–4-floris, e nodos defoliatos nascentibus, pedunculo brevi, parce verruculoso suffultis; pedicellis glabris infra medium articulatis; sepalis ovalibus, glabris, imbricatis; corolla glabra, carnea, tubo elongato apicem versus sensim ampliato, limbo angusto; staminibus exsertis, basi breviter hirtis; antheris elongatis, basi cordiformibus, disco ovarioque glabris; stylo glabro, tenue, stigmate capitato, 2-lobulato; et caetera ignota.

Caules longissimi. Petioli 7–10 mm. longi; laminae circa 2.5 cm. longae, 3 cm. latae, lobulo medio 2 cm. longo, 0.7–0.8 cm. lato. Pedunculi 1.5–2 cm., pedicelli 1–2 cm. longi. Sepala circa 1 cm. longa. Corollae tubus 4.5 cm. longus; limbus circa 4 cm. diam. Staminum filamenta circa 3.7 cm. longa; antherae plus minusve 4.5 mm. longae. Stylus 4.9–5 cm. longus.

Aragua: Hacienda de Chuao, on the slopes of the dry belt, trailing and climbing; flowers March 14, 1926 (*Pittier* 12118, type).

*E. verruculosum* is closely related to *E. arenarium* Choisy, of which it differs mainly in its verruculose stems, the pubescent leaves and a much larger calyx.

[4] Pflanzenfamilien IV[1], **3a**: 27. 1897.
[5] Scientific Survey of Porto Rico, **6**: 109. 1925.

**Exogonium retropilosum** Pittier, sp. nov.

Volubile, sublignosum, caulibus vestutis crassis parce retro-pilosis, pilis canescentibus; foliis magnis, membranaceis, petiolo anguste canaliculato, parce retro-piloso, pilis mollibus, laminis cordiformibus, petiolo longioribus, basi plerumque anguste emarginatis, apice acute-acuminatis, marginibus subintegris, supra parce adpresse-pilosis, subtus pallidioribus dense adpresse-pilosis; pedunculis axillaribus, petiolis brevioribus, retro-pilosis, apice 2–3 dichotomis, vulgo 4-floris; pedicellis adpresse pilosis, inaequantes; sepalis late ovatis, acute acuminatis, accrescentibus, exterioribus basin versus dense pilosis; corolla saturate rosea, tubo recto, limbo subplano, marginibus revolutis; staminibus inaequalibus, longe exsertis, filamentis basi molliter cano-hirsutis, antheris oblongis, basi emarginatis, apice obtusis; ovario glabro; stylo glabro; stigmate capitato, bilobulato et caetera ignota.

Petioli 10–11 cm. longi; lamina foliorum 16 cm. longa, 13–15 cm. lata. Pedunculi 6–9 cm. longi, pedicelli 1–4 cm. longi. Sepala 0.8 cm. longa. Corollae tubus 4–4.5 cm. longus; limbus circa 4 cm. diam. Filamenta 4–5 cm. longa; antherae 5 mm. longae. Stylus 5–5.5 cm. longus.

MÉRIDA: Vicinity of Timotes, 2000 m., in bushes; flowers January 23, 1928 (*Pittier* 12698, type).

This species is characterized mainly by its pubescence, which seems to be lacking in the other species of the group.

**Exogonium mirandinum** Pittier, sp. nov.

Volubile et reptans, caulibus angulosis, subsulcatis, glabris; foliis magnis integris, longe petiolatis, glaberrimis, petiolo anguste canaliculato, laminis ovato-cordatis, basi late emarginatis, apice subabrupte acuminatis mucronatisque, supra obscure viridis, subtus paullo pallidioribus; pedunculis axillaribus, umbellatim 3–5-floris, petiolis brevioribus, glabris; pedicellis tenues, pedunculis multo brevioribus; sepalis ovalibus, glabris, exterioribus quam interioribus paullo longioribus; corolla rosea glabra, tubo medium ventricoso, limbo concavo marginibus revolutis; staminibus longe exsertis, infra faucem corollae insertis, filamentorum tertio inferiori villoso, antheris liberis basi anguste emarginatis; disco crasso, margine sinuato, ovario glabro obpyriformi, stylo elongato, glabro stigmate bilobulato, lobulis angustis, divaricatis; et caetera ignota.

Caules elongati, robusti. Petioli 9.5–10 cm. longi; laminae 12–14 cm. longae, circa 10 cm. latae. Pedunculi 6–8 cm., pedicelli 1.5–2.2 cm. longi. Sepala 1.5–2 cm. longa. Corollae tubus plus minusve 4 cm. longus; limbo circa 3 cm. diam. Filamenta 38–40 mm. longa; antherae 3.7 mm. longae. Stylus 4.6–4.8 cm. longus.

MIRANDA: Near Arenaza, on road from Petare to Santa Lucía, on rocky, semi-shaded slopes; flowers September 26, 1926 (*Pittier* 12217, type).

The following notes were taken on the spot: "Flowers pink; corolla limb reflected; stamens pinkish white, exserted about 1 cm.; stigma bilobulate." This species belongs near *E. repandum* Choisy, but differs in the peduncles being shorter than the leaves, in the umbellate arrangement of the pedicels, and in the larger calyx.

BOTANY.—*The Genus* Mendoncia *in Peru.*[1] E. C. LEONARD, U. S. National Museum. (Communicated by E. P. KILLIP).

Much valuable material has been added to the rapidly growing collections of South American plants in the U. S. National Herbarium by recent expeditions to Peru, especially those conducted by E. P. Killip and A. C. Smith under the auspices of the Smithsonian Institution, by J. F. Macbride and Llewelyn Williams under the Marshall Field, Jr., Fund, and by the explorations of Guillermo Klug of Iquitos, Peru. In this material are represented a large number of species of Acanthaceae, a complex and difficult group in which the writer has been interested for some time. The present paper treats of the species of *Mendoncia* indigenous to Peru, six of which are considered new to science.

The genus, named for Cardinal Mendonça, Patriarch of Lisbon, consists of twining herbaceous (sometimes suffrutescent) climbers bearing cylindric red or white axillary flowers, each subtended by a pair of conspicuous bracts. The corolla is 5-lobed; the stamens, four in number, are attached at the throat of the corolla in pairs, one pair just above the other; the anthers are relatively large, and usually have diverging bearded lobes; the calyx is a mere ring a few millimeters long, except for *M. klugii,* in which five well developed lobes are present; the fruit, drupaceous, is usually dry and compressed at the tip.

A complete historical account of this interesting genus is given by W. B. Turrill in his excellent monograph.[2]

### KEY TO THE PERUVIAN SPECIES

Calyx deeply lobed; pubescence of bracts dark brown....**1. M. klugii.**
Calyx annular or very shallowly lobed; pubescence, if sufficiently dense, drying yellowish or golden brown.
 Stem manifestly pubescent, the internodes sometimes becoming glabrous with age.
  Hairs of the stem closely appressed.
   Indument of bracts velvety-pubescent with closely appressed hairs.
    Bracts ovate.................................. **2. M. smithii.**
    Bracts oblong-lanceolate.
     Leaves thin, sparingly pubescent beneath; bracts usually less than 1 cm. wide..................**3. M. schomburgkiana.**
     Leaves firm, densely pubescent beneath; bracts usually more than 1 cm. wide.........................**4. M. aspera.**
   Indument of bracts tomentose or puberulent, the hairs spreading or ascending.
    Bracts oblong-lanceolate; hairs of the pedicels 2 to 3 mm. long. **5. M. aurea.**
    Bracts ovate; hairs of the pedicels 0.5 mm. long..**6. M. peruviana.**

[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 2, 1931.

[2] A revision of the genus Mendoncia, Kew Bull. Misc. Inf. **1919**: 407–425. 1919.

Hairs of the stem spreading.
Bracts ovate; flowers white.........................**7. M. hirsuta.**
Bracts oblong; flowers red or pink.
Apex of bracts acuminate, tipped by a mucro 2 to 3 mm. long
**8. M. lindavii.**
Apex of bracts rounded, tipped by a mucro 0.5 to 1 mm. long
**9. M. killipii.**
Stem glabrous or inconspicuously pubescent near the nodes with short-appressed hairs.
Bracts oblong; corolla about 6 cm. long..........**10. M. pedunculata.**
Bracts ovate; corolla 3.5 cm. long or less.
Stem quadrangular, the angles narrowly winged.
Bracts 1 to 1.6 cm. long........................**11. M. glabra.**
Bracts 2 to 3 cm. long....................**12. M. tarapotana.**
Stem terete or subterete.
Bracts elliptic to obovate.....................**13. M. tessmannii.**
Bracts ovate.............................. **14. M. sprucei.**

**1. Mendoncia klugii** Leonard, sp. nov.

Stem terete, densely tomentose with yellowish-brown hairs; petioles 1 to 1.5 cm. long, densely tomentose; leaf blades ovate to elliptic, 6 to 11 cm. long, 4 to 7 cm. wide, abruptly acuminate at apex and tipped by a mucro 1 to 2 mm. long, rounded or obtuse at base, both surfaces densely pilose with erect curved hairs 1.5 mm. long; flowers axillary, 2 to 4 in each axil; pedicels slender, 1 to 1.5 cm. long, densely pilose with spreading brown hairs up to 2 mm. long; bracts thin, veiny, oblong-ovate, up to 2 cm. long and 1.5 cm. wide, obtuse at apex and tipped by a mucro 1 mm. long, rounded at base, densely pilose with spreading dark-brown hairs up to 2 mm. long, glabrous within; calyx 5 mm. long, pilose with brownish hairs, deeply lobed, the lobes linear-lanceolate, 4 mm. long, 1 mm. wide at base, acuminate; corolla 3 cm. long, glabrous, "yellowish white" (Klug), the tube 2 mm. wide, the throat 5 mm. wide, the lobes orbicular, 4 mm. in diameter; filaments 1 mm. long; anthers sagittate, 12 to 13 mm. long, acute at apex and tipped by a filiform appendage 0.5 mm. long, the lobes bearing a longitudinal band of papillae, slightly unequal and puberulent at the base; ovary lepidote; style about 2 cm. long, glabrous; stigma disk-shaped, slightly 2-lobed; fruit not seen.

Type in the U. S. National Herbarium, no. 1,456,166, collected in forest near Iquitos, Mishuyacu, Department of Loreto, Peru, altitude 100 meters, March 26, 1930, by G. Klug (no. 1115). Klug's no. 581, collected in the same locality, is also of this species.

This is unique in its well developed calyx lobes. It is further marked by the dense covering of curved brown hairs, more or less spreading on the leaves, pedicels, and bracts, but matted on the stem.

**2. Mendoncia smithii** Leonard, sp. nov.

Herbaceous vine; stem terete or subquadrate, appressed-pilose; petioles 3 to 10 mm. long, appressed-pilose; leaf blades ovate to oblong-ovate, up to 7 cm. long and 4.5 cm. wide, acuminate or acute at apex, the tip itself rounded and terminating in a mucro 1 to 2 mm. long, rounded or acute at base, the upper surface somewhat scabrous and puberulent with minute ascending hairs, each arising from a raised stellate base, the midrib and nerves clothed with longer appressed hairs, the lower surface velvety-pubescent with closely appressed hairs; flowers axillary, one or two in each axil; pedicels 2 to 4 cm. long, velvety-pubescent with closely appressed hairs; bracts ovate, 25 to 28 mm. long, 14 to 15 mm. wide, obtuse at apex and tipped by a small mucro, rounded at base, softly pubescent with closely appressed hairs of a bright yellowish-brown color (when dry), the midvein prominent; calyx annular, glabrous; corolla rich pink or red, glabrous, 2.5 cm. long, 5 mm. wide near base, 9 mm. wide at middle of tube, narrowed to 7 mm. at throat, the lobes 2.5 mm. in diameter, shallowly emarginate; filaments 2 mm. long, glabrous; anthers sagittate, 9 mm. long, flat and acute at apex, the basal lobes unequal; ovary glabrous; style about 2 cm. long, glabrous, persistent; stigma 2-lobed; fruit glabrous, 17 mm. long, 7 mm. wide, 5 mm. thick, flattened and oblique at apex, dull purple when ripe.

Type in the U. S. National Herbarium, no. 1,460,767, collected in woods at Iquitos, Department of Loreto, Peru, altitude about 100 meters, August 3, 1929, by E. P. Killip and A. C. Smith (no. 26953).

*Additional specimens examined:*

DEPT. LORETO: Forests of Mishuyacu, near Iquitos, alt. 100 meters, *Klug* 2. Vicinity of Iquitos, alt. 120 meters, *Williams* 3643.

This species is characterized by glabrous fruit, velvety bright yellowish bracts, and a relatively broad corolla. It is probably nearest *M. coccinea* Vell., of eastern South America.

**3. Mendoncia schomburgkiana** Nees in DC. Prodr. **11**: 50. 1847.

Stem quadrangular, appressed-hirsute; petioles 1 to 3 cm. long, appressed-strigose; leaf blades elliptic, 5 to 11.5 cm. long, 3 to 7.5 cm. wide, abruptly acuminate at apex and terminated by an awn 2 to 4 mm. long, acute to obtuse at base and slightly decurrent on petioles, scabrous-hirsutulous above, the hairs arising from stellate bases, the lower surface sparingly strigose but not scabrous, the midrib and nerves appressed-hirsute on both surfaces, prominent beneath; flowers 1 or 2 in each axil; pedicels slender, 4 to 7 cm. long, appressed-strigose; bracts linear-oblong, subfalcate, 3 cm. long, about 8 mm. wide, abruptly acute or acuminate at apex, rounded or slightly narrowed at base, rather densely pubescent with appressed or ascending, curved, tawny hairs about 0.5 mm. long; corolla bright red, 4 cm. long, 3 mm. wide at base, gradually enlarged to 5 mm. at throat, the lobes 5 mm. long, 3 mm. wide, emarginate; ovary finely puberulent; style about 3 cm. long, finely puberulent below, glabrous above; fruit obliquely obovate, slightly compressed, about 15 mm. long, 8 mm. in diameter, narrowed at base, acute at apex, and tipped by a portion of the persistent style, sparingly puberulent.

Type collected on banks of the Pomeroon River, British Guiana, by Schomburgk (no. 1431).

RANGE: British Guiana; Venezuela; Peru; Brazil.

*Specimen examined:*

DEPT. CUZCO: Cosñipata, *Weberbauer* 6946.

A species marked by thin veiny subglabrous leaves, slender pedicels, and narrow subfalcate bracts.

**4. Mendoncia aspera** (Ruiz & Pav.) Nees in DC. Prodr. **11**: 51. 1847.
*Mendozia aspera* Ruiz & Pav. Syst. Veg. Peruv. Chil. 158. 1798.

Stem appressed-pubescent; petioles 1 to 3 cm. long, appressed-pubescent; leaf blades broadly elliptic, 5 to 12 cm. long, 3 to 6.5 cm. wide, acuminate at apex, usually tipped by a mucro 1 to 4 mm. long, rounded or narrowed at base, the upper surface pubescent with appressed hairs (about 0.5 mm. long), each arising from a stellate base, the lower surface rather densely and softly pubescent with appressed yellowish-brown hairs about 1 mm. long; flowers 1 to 3 in each axil; pedicels 2 to 6 cm. long, appressed-pubescent; bracts oblong-ovate or lanceolate, 3 to 3.5 cm. long, 1.2 to 1.5 cm. wide, often subfalcate, acute at apex and tipped by a short mucro, rounded at base, densely sericeous-hirsute with closely appressed yellowish-brown hairs; corolla bright red, 3.5 cm. long, the throat 8 mm. wide; ovary puberulent; style glabrous; fruit deep purple, 1.5 mm. long, 10 mm. in diameter, compressed, sparingly puberulent.

Type collected in Peru by Ruiz and Pavón.

RANGE: Surinam; Venezuela; Peru.

*Specimens examined:*

DEPT. LORETO: Iquitos, alt. 100 meters, *Killip & Smith* 27309. Yurimaguas, lower Río Huallaga, alt. 135 meters, *Killip & Smith* 27946, 27954; *Williams* 7842. Santa Ana, upper Río Nanay, *Williams* 1236.

DEPT. JUNÍN: In dense forest, Puerto Bermudez, alt. 375 meters, *Killip & Smith* 26412.

The distinguishing characters of this species are its large oblong-ovate silky bracts and the rather dense pubescence of yellowish-brown appressed hairs.

**5. Mendoncia aurea** Leonard, sp. nov.

Stem terete, faintly striate, densely pubescent with appressed golden-brown hairs, or becoming glabrous below; petioles 1 to 2 cm. long; leaf blades ovate to elliptic or obovate, 9 to 13 cm. long, 5 to 8 cm. wide, abruptly acuminate or obtuse at apex and tipped by a short mucro, the upper surface pubescent, the hairs 0.5 mm. long, arising from stellate bases, the nerves and midrib appressed-pilose, the lower surface rather densely pubescent with golden-brown hairs, these thickest on the nerves and midrib; flowers axillary, 1 to 3 in each axil; pedicels 3 to 4 cm. long, stout, densely tomentose with golden-brown hairs; bracts lanceolate, slightly falcate, 3.5 to 4 cm. long, 1.2 to 1.7 cm. wide, acuminate at apex, rounded at base, densely tomentose with golden-brown hairs without, glabrous within; calyx annular, 1.5 mm. long; corolla dark red, glabrous, 4.3 cm. long, 7 mm. wide at base, narrowed to 4 mm. above base, then enlarged to 8 mm. at throat, the lobes erect, obovate, 5 mm. long, 4 mm. wide, rounded and shallowly emarginate; filaments 2 mm. long, glabrous; anthers sagittate, 13 to 15 mm. long, 2 to 3 mm. wide (the upper slightly smaller than the lower), the basal lobes unequal, bearded, the tip acuminate; ovary 2 cm. long, puberulent; style 3.5 cm. long, glabrous; stigma 2-parted, the lobes disk-shaped; fruit oblong, compressed, flattened and acute at apex, puberulent.

Type in the U. S. National Herbarium, no. 1,455,671, collected at Mishuyacu, near Iquitos, Department of Loreto, Peru, altitude 100 meters, December 16, 1929, by G. Klug (no. 673).

*Additional specimens examined:*

DEPT. LORETO: Dense forest, Mishuyacu, near Iquitos, alt. 100 meters, *Killip & Smith* 29994. La Victoria, Amazon River, *Williams* 3089.

Near *M. aspera*, but differing in the thick tomentose pubescence of the bracts and pedicels.

### 6. **Mendoncia peruviana** Leonard, sp. nov.

Herbaceous vine; stem terete or subquadrangular, appressed-pilose, the hairs 0.5 to 0.75 mm. long; petioles 1 to 3 cm. long, appressed-pilose; leaf blades ovate, up to 10 cm. long, 5 cm. wide, acuminate at apex, obtuse to acute at base and decurrent on the petioles, thin, the upper surface pubescent, the hairs arising from stellate bases, the lower surface rather sparingly pubescent with appressed hairs 0.5 mm. long; flowers 1 to 2 in each axil; pedicels 2 to 2.5 cm. long, pilosulous, the hairs appressed or spreading; bracts ovate or elliptic, 2 to 2.5 cm. long, 1 to 1.5 cm. wide, rounded at apex, tipped by a short mucro, veiny, densely pubescent with fine minute hairs intermixed with larger stiffer ones, these 0.5 mm. long to 1 mm. long on the margins; calyx annular; corolla cream-white, 3 to 4 cm. long, 6 mm. wide at base, narrowed to 4 mm. about 1 cm. above base, and then enlarged to 8 mm. at throat, the lobes obovate, about 7 mm. long, 5 to 6 mm. wide, emarginate; filaments 3 mm. long, glabrous; anthers sagittate, about 10 mm. long, 1.5 mm. wide, the basal lobes unequal, bearded, acute at tip; ovary densely pilosulous; style 2.5 cm. long, pilosulous below, glabrous above; stigma 2-parted, disk-shaped; fruit not seen.

Type in the U. S. National Herbarium, no. 1,460,309, collected in thickets along river at Puerto Yessup, Department of Junín, Peru, altitude 400 meters. July 11, 1929, by E. P. Killip and A. C. Smith (no. 26357).

This species has the facies of *M. puberula* of northern and eastern South America, but differs in the closely appressed pubescence of the stems and the strongly sculptured marking at the bases of the hairs on the upper leaf surfaces.

### 7. **Mendoncia hirsuta** (Poepp. & Endl.) Nees in DC. Prodr. **11**: 52. 1847.

*Mendozia hirsuta* Poepp. & Endl. Nov. Gen. & Sp. **3**: 10. 1845.
*Mendoncia perrottetiana* Nees in DC. Prodr. **11**: 53. 1847.
*Mendoncia angustifolia* Poepp.; Nees in DC. Prodr. **11**: 52. 1847.

Stem sparingly hirsute with spreading hairs 1 to 3 mm. long; petioles 1 to 3.5 cm. long, hirsute; leaf blades elliptic, 6 to 14 cm. long, 3 to 7 cm. wide, tapering or abruptly narrowed to a slender acuminate tip, narrowed at base, membranous, rather sparsely hirsute on both surfaces; pedicels 2 to 3 cm. long, hirsute with tawny spreading hairs; bracts oblong-elliptic, rounded at base, rounded or obtuse at apex, apiculate, thin, veiny, hirsute with spreading hairs 2 to 4 mm. long; corolla white; fruit 15 to 17 mm. long, 9 to 10 mm. in diameter, compressed, the tip flat, oblique, obtuse, or rounded, glabrous.

Type collected near Yurimaguas, Peru, by Poeppig.

RANGE: French Guiana; Colombia; Surinam; Peru; Bolivia.

*Specimens examined:*

DEPT. LORETO: Lower Río Huallaga, *Williams* 4675. Yurimaguas, lower Río Huallaga, *Williams* 7871. Lower Río Nanay, *Williams* 550.

This is readily recognized by the thin veiny leaves, the long spreading pubescence, and the large, thin, oblong bracts.

**8. Mendoncia lindavii** Rusby, Mem. Torrey Club **4:** 241. 1895.

Stem angled or grooved, ferruginous-pilose with spreading hairs; petioles 0.5 to 1.5 cm. long, pilose; leaf blades ovate to broadly oval, 5 to 10 cm. long, 2 to 5.5 cm. wide, acuminate and awn-tipped at apex, rounded at base, membranous, the upper surface scabrid, sparsely pilosulous, the lower surface rather densely and somewhat velvety ferruginous-pilose; flowers 1 or 2 in each axil; pedicels stout, densely ferruginous-pilose; bracts oblong to oblong-lanceolate, 3 to 4 cm. long, 1 cm. wide, acuminate at apex and tipped by an awn 2 to 3 mm. long, subfalcate, densely ferruginous-pilose; corolla red, 4 to 5 cm. long, 6 to 7 mm. wide at throat, the lobes 4 to 5 mm. long, entire; ovary densely pilose; style about 4 cm. long; fruit oblong-obovate, strongly compressed, keeled, 2 cm. long, 1 cm. in diameter, oblique, tipped by a portion of the persistent style, densely brown-puberulent.

Type collected at Yungas, Bolivia, by M. Bang (no. 532).

RANGE: Guatemala; Costa Rica; Panama; Colombia; Peru; Bolivia.

*Specimens examined:*

DEPT. LORETO: Pinto-cocha, Río Nanay, *Williams* 791. Pebas, Amazon River, *Williams* 1785.

A species easily recognized by its dense indument of spreading ferruginous hairs. It is apparently of wide distribution.

**9. Mendoncia killipii** Leonard, sp. nov.

Herbaceous vine, sometimes woody at base; stem terete, sulcate, rather densely pilose with spreading or retrorse yellowish hairs 1 to 2 mm. long; petioles 0.5 to 1.5 cm. long, densely pilose with spreading hairs; leaf blades oblong-ovate to elliptic, up to 10 cm. long and 5.5 cm. wide, acuminate at apex and tipped by a short mucro, rounded or obtuse at base, rather firm, the upper surface bearing numerous hairs, each arising from a stellate base, the lower surface velvety pubescent with ascending hairs about 1 mm. long, these denser and more spreading on the midrib and nerves; flowers one or two in each axil; pedicels 2 to 3 cm. long, densely pilose with spreading yellowish hairs about 2 mm. long; bracts oblong-ovate, 2 to 2.8 cm. long, 1 to 1.3 cm. wide, obtuse or rounded at apex, tipped by a minute mucro 0.5 to 1 mm. long, rounded at base; calyx annular, pilose, the lobes low; corolla deep red, glabrous, cylindric, 3 cm. long, 5 mm. wide at base, slightly narrowed above and then enlarged to 7 mm. at throat, the lobes orbicular, 5 mm. in diameter; filaments 2 to 3 mm. long, glabrous; anthers sagittate, 8 to 12 mm. long, acuminate at apex, the basal lobes unequal, sparingly puberulent; ovary densely pilose with straight hairs; style 2 cm. long, sparingly pilosulous; stigma 2-parted, the lobes disk-shaped; fruit (mature?) obovoid, 2 cm. long, 1 cm. broad, 0.6 cm. thick, flattened and slightly oblique at apex, tipped by a portion of the persistent style.

Type in the U. S. National Herbarium, no. 1,358,982, collected at edge of woods on the Schunke Hacienda, above San Ramón, Department of Junín, Peru, altitude 1,400 to 1,700 meters, June 8, 1929, by E. P. Killip and A. C. Smith (no. 24622). Collected at same locality by C. Schunke (nos. 1436, 1443).

*Additional specimens examined:*

DEPT. LORETO: Woods, Yurimaguas, lower Río Huallaga, alt. 135 meters, *Killip & Smith* 28060.

DEPT. JUNÍN: Dense forests, Pichis Trail, Yapas, alt. 1,350–1,600 meters, *Killip & Smith* 25460.

Near *M. coccinea*, but easily distinguished from that species by its spreading pubescence.

### 10. **Mendoncia pedunculata** Leonard, sp. nov.

Stem terete, sulcate, the tips sparingly puberulent with appressed hairs above, glabrous below, the nodes slightly swollen; petioles 2 to 3 cm. long, glabrous; leaf blades elliptic, 10 to 16 cm. long, 6 to 10 cm. wide, abruptly acuminate at apex and tipped by a mucro 1 to 2 mm. long, obtuse at base and decurrent on petiole, both surfaces glabrous; flowers 1 to 4 on axillary peduncles 1.5 to 2.5 cm. long, the pedicels 5 to 7 mm. long, both pedicels and peduncles covered with minute appesssed hairs; bracts oblong, 4 cm. long, 1.4 to 1.8 cm. wide, rounded at apex and tipped by a short mucro, rounded at base, inconspicuously pubescent with minute appressed hairs without, glabrous within; corolla white, marked with reddish brown within, glabrous, 5 to 6 cm. long, the tube curved, 2.5 cm. long, 4 mm. wide at base, narrowed to 3 mm. near throat, 1 cm. wide at throat, the limb 3 cm. wide, the lobes oval, 1 to 1.5 cm. long, 8 to 10 mm. wide; upper pair of stamens about 8 mm. above the lower; filaments 5 to 7 mm. long, glabrous; anthers sagittate, 12 to 15 mm. long, 2 mm. wide, the basal lobes unequal and minutely bearded, acuminate at tip; ovary sparingly puberulent; style about 5 cm. long, glabrous, the lobes about 5 mm. long; fruit not seen.

Type in the U. S. National Herbarium, no. 1,455,658, collected in forest, Mishuyacu, near Iquitos, Department of Loreto, Peru, altitude 100 meters, December 13, 1929, by G. Klug (no. 659). Klug's no. 682, collected in the same region, belongs to this species.

This differs from other Peruvian members of the genus in its large glabrous leaves, large oblong bracts, showy corolla, and peduncled flowers.

### 11. **Mendoncia glabra** (Poepp. & Endl.) Nees in DC. Prodr. **11**: 52. 1847.

*Mendozia glabra* Poepp. & Endl. Nov. Gen. & Sp. **3**: 10. 1845.

Plant essentially glabrous throughout; stem subquadrangular; leaf blades elliptic-ovate, 5 to 8 cm. long, 2.5 to 4 cm. wide, acuminate at apex, rounded or acute at base; bracts ovate, 1.6 cm. long, 1.4 cm. wide; pedicels about 2.5 cm. long; corolla narrow, tubular; filaments 1 mm. long; anthers 7 mm. long.

Type collected at Tocache Mission by Poeppig; also collected in Peru by Ruiz and Pavón.

No Peruvian material has been seen by the writer.

### 12. **Mendoncia tarapotana** Lindau, Bull. Herb. Boiss. II. **4**: 313. 1904.

Plant glabrous throughout; stem quadrangular, the angles narrowly winged; petioles 2 to 3 cm. long; leaf blades elliptic or elliptic-ovate, up to 12.5 cm. long and 6.5 cm. wide, acuminate at apex, rounded at base, subcoriaceous; flowers single or paired in the axils of the leaves; pedicels about 2 cm. long; bracts oblong, 2.5 cm. long, 1 cm. wide, rounded at both ends, the apex tipped by a short mucro; corolla white, 3.5 cm. long; style 4 cm. long; fruit oblong, 1.5 to 2 cm. long, 1 cm. in diameter, deep purple.

Type collected at Tarapoto, Department of Loreto, Peru, by R. Spruce (no. 4620).

RANGE: Peru.

*Specimens examined:*

DEPT. LORETO: San Antonio, Río Itaya, alt. 110 meters, *Killip & Smith* 29473. Pebas, Amazon River, *Williams* 1769.

The larger bracts, rounded at the apex, distinguish this from its near relative *M. glabra.*

13. **Mendoncia tessmannii** Mildbr. Notizbl. Bot. Gart. Berlin **9:** 982. 1926.

Stem sparingly pilose with appressed or ascending hairs; petioles 2 to 3 cm. long, sparsely pilose or glabrous; leaf blades elliptic or ovate, 5 to 11 cm. long, 6 to 6.5 cm. wide, acuminate and apiculate at apex, rounded or obtuse at base, glabrous or bearing a few short appressed hairs; peduncles quadrangular, 3 to 4 cm. long, sparsely and minutely pilose; bracts oblong-elliptic to slightly obovate, 15 to 17 mm. long, 10 to 11 mm. wide, rounded and apiculate at tip, rounded at base, minutely and sparingly pilose; corolla white, 2.5 cm. long, the throat 7 mm. wide, the lobes about 1 cm. long and 0.8 cm. wide, shallowly emarginate; ovary glabrous; style about 17 mm. long; fruit obovate, slightly flattened, 15 mm. long, 9 to 10 mm. in diameter, glabrous.

Type collected at Boca de Yarina, Department of Loreto, Peru, by Tessmann (no. 3505). Photograph of type collection in U. S. National Herbarium.

RANGE: Colombia; Venezuela; Peru.

*Specimen examined:*

DEPT. LORETO: Wooded banks of lower Río Huallaga, alt. 130 meters, *Killip & Smith* 29252.

Distinguished by its subglabrous leaves and firm obovate bracts.

14. **Mendoncia sprucei** Lindau, Bull. Herb. Boiss. **5:** 647. 1897.

Stem subterete, striate, sparingly appressed-hirsute; petioles 1 cm. long; leaf blades elliptic, 5 to 9 cm. long, 2.5 to 4.5 cm. wide, obtuse or rounded at base, acuminate and apiculate at apex, both surfaces sparingly pubescent with scattered appressed hairs about 0.5 mm. long; flowers solitary in the axils; peduncles slender, 3 to 6 cm. long, sparingly pubescent with short appressed or ascending hairs; bracts ovate, about 20 mm. long, 10 to 12 mm. wide, rounded at base, rounded or acute at apex, sparingly covered with appressed hairs 0.5 mm. long; flowers not seen; fruit purplish black, glabrous, 17 to 20 mm. long, 10 to 11 mm. in diameter, somewhat flattened and oblique at apex, subterete below.

Type collected near Sao Gabriel de Cachoeira, on the Rio Negro, Brazil, by R. Spruce (no. 2332).

RANGE: Venezuela; Peru; Brazil.

*Specimens examined:*

DEPT. LORETO: Lower Río Huallaga, alt. 155 to 210 meters, *Williams* 4390.

DEPT. JUNÍN: Dense forest, Pichis Trail, Yapas, alt. 1,350–1,600 meters, *Killip & Smith* 25455.

The fruits of *Williams* 4390 are replaced by peculiar conical growths 4 to 5 cm. long, about 4 mm. in diameter at base and gradually narrowed to 2 mm. at tip. This growth may possibly have been caused by the sting of some gall-producing insect.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting held on January 20, 1931, elected the following officers for the ensuing year: *President:* JOHN M. COOPER, Catholic University of America; *Vice-President:* MATTHEW W. STIRLING, Bureau of American Ethnology; *Secretary:* FRANK H. H. ROBERTS, JR., Bureau of American Ethnology; *Treasurer:* HENRY B. COLLINS, JR., U. S. National Museum; *Members of the Board of Managers:* DANIEL FOLKMAR, JOHN P. HARRINGTON, J. N. B. HEWITT, H. W. KRIEGER, GEORGE S. DUNCAN.

The Secretary submitted the following report for the year.

Membership:

| | |
|---|---|
| Life members | 5 |
| Active members | 57 |
| Associate members | 9 |
| Honorary members | 27 |
| Corresponding members | 22 |
| Total | 120 |
| Deceased during year | 5 |
| Resigned | 3 |
| New active members | 2 |
| New associate members | 3 |

During the year the Society sponsored a special series of evening lectures. The subjects dealt with the evolution and cultural history of mankind. The topics and speakers were:

January 7, 1930. *The Coming of Man,* by Dr. FAY-COOPER COLE, Professor of Anthropology at the University of Chicago.

January 21, 1930. *The Differentiation of Man Into Races and His Spread Over the Earth,* by Dr. ALEŠ HRDLIČKA, Curator, Division of Physical Anthropology, U. S. National Museum.

February 4, 1930. *The Culture Area,* by Dr. CLARK WISSLER, Curator of Anthropology, American Museum of Natural History; Professor of Anthropology at Yale University.

February 18, 1930. *The Civilizations of Middle America,* by Dr. HERBERT J. SPINDEN, Curator Department of Ethnology, Brooklyn Institute of Arts and Sciences.

March 4, 1930. *Prehistoric Pueblos and Cliff Dwellings of the Southwest,* by Mr. NEIL M. JUDD, Curator of American Archeology, U. S. National Museum.

Papers presented before regular meetings of the Society were as follows:

March 18, 1930. *Some New Facts on the Creek Social Organization,* by Dr. JOHN R. SWANTON, Ethnologist, Bureau of American Ethnology.

April 15, 1930. *First Contacts of White Men, Indians and Negroes on Española,* by Dr. C. L. G. ANDERSON, retiring president of the Society.

October 21, 1930. *Current Anthropological Work in the United States,* by Mr. M. W. Stirling, Chief of Bureau of American Ethnology.

November 18, 1930. *Some Cheyenne and Arapaho Notes,* by Dr. Truman Michelson, Ethnologist, Bureau of American Ethnology.

December 16, 1930. *Pottery Making in the Province of Cocle, Panama,* by Mr. Henry B. Roberts, Carnegie Institution of Washington and Peabody Museum at Cambridge, Mass.

December 19, 1930. *Scotch Sword Dances and Other European War Dances,* by Prof. Frantisek Pospisil, Director of the Section of Ethnography of the Regional Museum of Moravia. This was a special meeting of the Society.

All of the meetings, with the exception of the five special lectures and that given by Prof. Pospisil, were held in Room 42–43 of the New National Museum. The other meetings were held in the auditorium of that building.

The Society was unfortunate in the loss by death of five of its members. Dr. J. Walter Fewkes, a past president, died on May 31, 1930. Mr. Henry W. Henshaw, also a past president, died August 1, 1930. Dr. Louis Mackall died July 27, 1930. Mr. James M. Spear died October 24, 1930. Mr. F. M. Tryon died in December 1930.

Frank H. H. Roberts Jr., *Secretary.*

## BOTANICAL SOCIETY

### 228th meeting

The 228th meeting was held at the Cosmos Club November 4, 1930.

*Program: Reports on the Botanical Congress at London:*

E. A. Auchter: *The horticultural program.*

C. L. Shear: *The fungus foray.*—The British Mycological Society, which consists of several hundred members, held its autumn Fungus Foray for 1930 at Whitby, England. Some sixty persons were present including members and guests. The party spent the week in collecting in various wooded areas in the vicinity. An abundance of material was found, especially of Agarics and other fleshy fungi. Collections made during the day were named and spread out on tables for exhibition each afternoon and evening. All the members present, many of whom were amateurs, showed a remarkable familiarity with the genera and species collected, and all participated in the work with much enthusiasm. Such gatherings of mycologists for field work are of the greatest importance in stimulating an interest in the subject and in accumulating a knowledge of the occurrence and distribution of the fungi in any region, and the example of our British colleagues might be followed with great advantage in this country. (*Author's abstract.*)

A. S. Hitchcock: *The sessions on nomenclature.*—In preparation for the sessions a "blue book," giving changes proposed from the International Rules, together with the articles to be changed, was sent out to members of the Interim Committee on Nomenclature for their vote. Upon the returns was based a "yellow book," which contained the amendments considered by the Congress. The proposal to omit the rule requiring a Latin diagnosis of new genera, species, or other groups, was lost, though names published with descriptions in other languages up to 1932 were declared valid. Later homonyms are not tenable except as conserved in the list of Nomina Conservanda. The type concept, governing the application of names, is incorporated in the Rules. A permanent International Committee on Nomenclature was appointed with power to act on proposals referred to it, such as additions to the list of conserved genera, interpretation of the rules and the typification of genera.

N. E. Stevens: *Social Aspects of the congress.*

D. B. Johnstone-Wallace: *Competition as a factor in the success of grass and clover mixtures.*—In mixtures of forage plants for hay or pasture it is not enough to consider the value of each constituent growing in pure culture but the behavior of these plants when subjected to competition must be taken into account. Italian rye-grass alone will outyield perennial rye-grass but when seeded in mixture with red clover the total yield is greatest where perennial rye-grass is used. The reason is that the ranker growth of the Italian rye-grass suppresses the red clover while the latter is able to make a good growth when competing with perennial rye-grass. Italian rye-grass is of great value in pasture mixtures where its strong early growth affords herbage which is not allowed to shade out the slower growing plants because it is constantly grazed down. The best practice in England today, therefore, is to so select the constituents of a mixture as to provide early, medium and late species or varieties which will succeed one another and will accommodate themselves to the existing competition. For this purpose some of the wild varieties of forage plants are better suited than the cultivated varieties. This is especially true of the wild white clover. It is more persistent than the cultivated white Dutch clover and has a beneficial effect on the accompanying grasses. (*Abstract by* A. J. Pieters.)

### SPECIAL MEETING

A special meeting of the Botanical Society was held at the Cosmos Club November 19, 1930. Dr. J. G. Dickson presented motion pictures illustrating his travels in Russia, especially in the region of the Caucasus and in the mountains of Armenia, where he found the wild wheat, *Triticum dicoccoides,* first discovered by Aaronson on Mount Hermon.

### 229TH MEETING

The 229th meeting was held at the Cosmos Club December 2, 1930.

*Program:* Thomas H. Kearney: *Cotton from a botanist's point of view.*—Attention was called to the obscurity surrounding the origin of cultivated cottons and the difficulty of making a satisfactory classification of them. Lantern slides illustrated the structure of the cotton plant in general and of the flower in relation to fertilization, the taxonomy and geographical distribution of the wild and cultivated species of *Gossypium,* the behavior of interspecies and intraspecies hybrids and the inheritance of particular characters. (*Author's abstract.*)

L. H. Flint, *Recording Secretary.*

## SCIENTIFIC NOTES AND NEWS

On his way to join the "China unit" of the trans-Asiatic expedition, the Rev. Father Teilhard de Chardin, paleontologist, visited Dr. Gilbert Grosvenor, president of the National Geographic Society, which is cooperating with the French explorers.

The trans-Asiatic expedition is one of the most comprehensive geographical explorations of our times, and it will employ all the aids of modern science and a diverse personnel of specialists in its study of the little-known tribes, geology, zoology, plant life and other aspects of secluded inner Asia.

A. Wetmore has been elected an Honorary Member of the Orthnithologische Gesellschaft in Bayern.

## OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### ANNOUNCEMENT OF MEETINGS

| | |
|---|---|
| Tuesday, April 7 | The Botanical Society. |
| Wednesday, April 8 | The Geological Society. |
| | The Medical Society. |
| Thursday, April 9 | The Chemical Society. |
| Saturday, April 11 | The Philosophical Society. |
| Tuesday, April 14 | The Institute of Electrical Engineers. |
| Wednesday, April 15 | The Society of Engineers. |
| | The Medical Society. |
| Thursday, April 16 | The Academy. |
| Saturday, April 18 | 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:* N. A. COBB, Bureau of Plant Industry.
*Corresponding Secretary:* PAUL E. HOWE, Bureau of Animal Industry.
*Recording Secretary:* CHARLES THOM, Bureau of Chemistry and Soils.
*Treasurer:* HENRY G. AVERS, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings



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OF THE

# WASHINGTON ACADEMY OF SCIENCES



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## 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.

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# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES

Vol. 21 April 19, 1931 No. 8

BOTANY—*New grasses from China.*[1] Y. L. Keng,[2] U. S. National Herbarium. (Communicated by A. S. Hitchcock.)

During the course of my studies in preparation of a monograph on the grasses of China, I have found two undescribed species in the Andropogoneae, and one new *Arundinella*. So little work has hitherto been done on the Chinese grasses that it is probable that as my study progresses further unknown species will be brought to light. I take pleasure in expressing my appreciation of the assistance given me by Prof. A. S. Hitchcock, Mrs. Agnes Chase, and their colleagues.

**Ischaemum lanceolatum** Keng, (Sect. *Polliniopsis*) sp. nov.

Perenne, caespitosum; culmi erecti, ad 40 cm. alti, graciles, multinodiis, nodis inferioribus confertis ramosi, iis 2 superioribus longe remotis; vaginae arctae, superiores internodiis breviores, inferiores iis longiores, equitantes, superne carinatae, glabrae vel apice pubescentes; ligula membranacea, firma, 2–3 mm. longa, saepe 2-partita, in vaginam decurrens; laminae lanceolatae, 3–8 cm. longae, 6–10 mm. latae, basi subito v. sensim angustatae, acuminatae, summa multo abbreviata v. subulata, patentissimae, rigidae, glabrae, virides v. glaucescentes, marginibus scabrae; racemi in apice culmi ramorumque 2-3-ni, 3–6 cm. longi, subgraciles, fulvi v. purpurascentes; rhacheos articuli spiculis sessilibus paulo vel dimidio breviores, leviter plano-convexi, ciliati; spiculae sessiles lanceolato-oblongae, 5–6 mm. longae, callo obtuso pilis circ. 1 mm. longis dense barbato; gluma prima chartaceo-membranacea, 4–7-nervis, medio distincte sulcata, apice integra v. bidenticulata; gluma secunda 3-nervis, primam paulo superans, acuta; lemma inferius oblongum, hyalinum, 1-nerve v. enerve; ejus palea brevior, binervis; lemma superius in $\frac{2}{3}$ superiore bifidum, inferne 3-nerve, membranaceum, e sinu aristam perfectam 8–10 mm. longam emittens; spiculae pedicellatae iis sessilibus similes v. rudimentariae, glumis primis 5–7-nervibus, secus nervos scaberulis; pedicelli articulis similes sed breviores.

Perennial; culms tufted, suberect, up to 40 cm. high, multinoded, branched

[1] Received March 17, 1931.

[2] Fellowship student of the Rockefeller Foundation, from the National Central University, Nanking, China.

below, slender and wiry above; sheaths tight, equitant at the lower nodes, keeled above, striate, glabrous or pubescent at the junction with the blades; ligule membranaceous, firm, 2–3 mm. long, usually 2-lobed, decurrent into the margins of the sheaths; blades lanceolate, 3–8 cm. long, 6–10 mm. wide, acute or acuminate, constricted at base, glabrous, rigid, glaucous, the margins scabrous, the uppermost much reduced or subulate; racemes 2–3-nate, erect, 3–6 cm. long, slender, brownish or purplish; rachis joints compressed, ciliate, subequalling or $\frac{1}{2}$ shorter than the sessile spikelets; sessile spikelets 5–6 mm. long, lanceolate-oblong, the callus obtuse, densely bearded with hairs about 1 mm. long; first glume chartaceo-membranaceous, 4–7-nerved, distinctly grooved between the median nerves, entire or bidentulate, the keels scaberulous above; second glume 3-nerved, acute, a little longer than the first; lower lemma oblong, hyaline, 1-nerved or nerveless, pilose, with a shorter 2-nerved

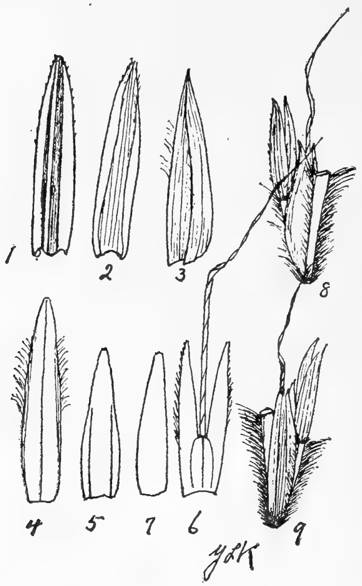


Fig. 1. *Ischaemum lanceolatum* Keng.—1–2, dorsal and ventral views of first glume, × 5; 3, side view of second glume, × 5; 4–5, lower lemma and its palea, × 5; 6–7, upper lemma and its palea, × 5; 8–9, views of a single joint and the binate spikelets, × $3\frac{1}{2}$.

palea; upper lemma 2-cleft to below the middle, the lobes acute, pilose, the portion below the insertion of the awn membranaceous, 3-nerved; awns 8–10 mm. long, geniculate about in the middle; pedicellate spikelets similar to the sessile or rudimentary, shortly awned or awnless, the first glume 5–7-nerved, the nerves scaberulous; pedicels ciliate as in the joints but usually shorter.

Type in U. S. National Herbarium, no. 1501523, collected from Yunnan, China, altitude 2800–3000 meters, by E. E. Maire (no. 7039); duplicate type in the Herbarium of the University of California, no. 388785 (ex-herb. G. Bonati).

This species is apparently an intermediate form between *Eulalia* (section *Leptatherum*) and *Ischaemum*, belonging to Hackel's section *Pollniopsis* or Stapf's *Coelischaemum* of the latter genus. It approaches the Indian species *Ischaemum petiolare*, but differs in the more slender and smaller habit, much shorter and subsessile blades, and in the fewer racemes.

**Rottboellia laevispica** Keng, (subgen. *Coelorachis*) sp. nov.

Planta annua; culmi 1 m. v. plus alti, 3 mm. crassi, striati, glabri, basi plus minusve geniculati, nodis inferioribus radicantes, ramis floriferis erectis, solitariis, simplicibus, uninodiis, lateri complanato culmi appressis; vaginae saltem inferiores laxae, superne leviter carinatae, laeves v. cum tuberculis scabrae, inferiores internodiis longiores, superiores iis breviores, apice interdum sparse barbatae; ligula rotunda, brunneo-membranacea, 0.5–1 mm. longa, ciliata; laminae lineari-lanceolatae, 15–40 cm. longae, 8–16 mm. latae, acuminatae, basi angustatae v. subrotundae, scaberulae v. inferne laeves, glabrae v. superne versus basin sparse papillato-pilosae, virides v. saepe glaucescentes, flaccidae, margine serrulato-scabrae; racemi ad 15 cm. longi, 2–3 mm. crassi, laeves, robusti, versus apicem attenuati, demum longe exserti; articuli virides v. brunnescentes, plerumque pedicellos et spiculas sessiles aequantes, fragiles, apice valde excavati; spiculae sessiles biflorae, pallide virides v. brunnescentes, callo glabro circ. 1 mm. longo e gluma prima sulco membranaceo separato 7–10 mm. longae; gluma prima lanceolato-oblonga, chartaceo-membranacea, dorso plana v. nervis elevatis striata, carina infra apicem angustissime alata et supra medium scaberula; gluma secunda primam aequans, 9–11-nervis, acuta, carina superne scaberula; lemma inferius glumam primam aequans, membranaceum, 3–5-nerve, palea rigidiori binervi, flore masculino, antheris 2–3 mm. longis; lemma superius paulo brevius, 3-nerve, palea angustiore, binervi; styli distincti, stigmata aequantes; spiculae pedicellatae plerumque ad glumam primam minutam reductae, rarissime basi racemi evolutae et fertiles, pedicellis tenuibus, planis, articulo arctissime appressis v. superne liberis.

Annual; culms 1 m. or more high, 3 mm. thick, striate, flat or channelled on one side, glabrous, more or less geniculate and rooting at the lower nodes, the floriferous branches erect, appressed to the flat or channelled side of the culm, 1-noded, solitary and simple; sheaths, at least the lower ones, loose, slightly keeled above, smooth or roughish with papillae, the lower longer, the upper shorter than the internodes, sometimes sparsely bearded at apex; ligule rounded, brownish-membranaceous, ciliate, 0.5–1 mm. long; blades linear-lanceolate, 15–40 cm. long, 8–16 mm. wide, acuminate, the base narrowed or somewhat rounded, scaberulous or smooth beneath, glabrous or sparsely papillose-pilose towards the base above, green or often glaucescent, flaccid, the margins serrulate-scabrous; racemes finally long-exserted, up to 15 cm. long, subcylindric, 2–3 mm. thick, smooth, stout, narrower with imperfect spikelets towards the apex; rachis green or brownish, fragile, the joints mostly equalling the pedicels and sessile spikelets, strongly hollow towards the base, the summit deep concave; sessile spikelets 7–10 mm. long, 2-flowered, pale-green or brownish; callus glabrous, about 1 mm. long, separated from the first glume by a membranaceous furrow; first glume lanceolate-oblong, chartaceo-membranaceous, dorsally flat or striate with slightly elevated nerves, the keels narrowly winged at apex and scaberulous above the middle; second glume as long, chartaceous, 9–11-nerved (the nerves netted above when seen under transmitted light), acute, the keel scaberulous above; lower lemma as long as the first glume, membranaceous, 3–5-nerved, with a firmer but 2-nerved palea, usually staminate; upper lemma a little shorter than the lower, 3-nerved, with a narrower 2-nerved palea; anthers 2–3 mm. long; styles distinct, as long as the stigmas; pedicellate spikelets mostly rudimentary, rarely well-developed and fertile at base of the raceme; pedicels thin, flat, broad at the base, closely appressed to the rachis joints or free above.

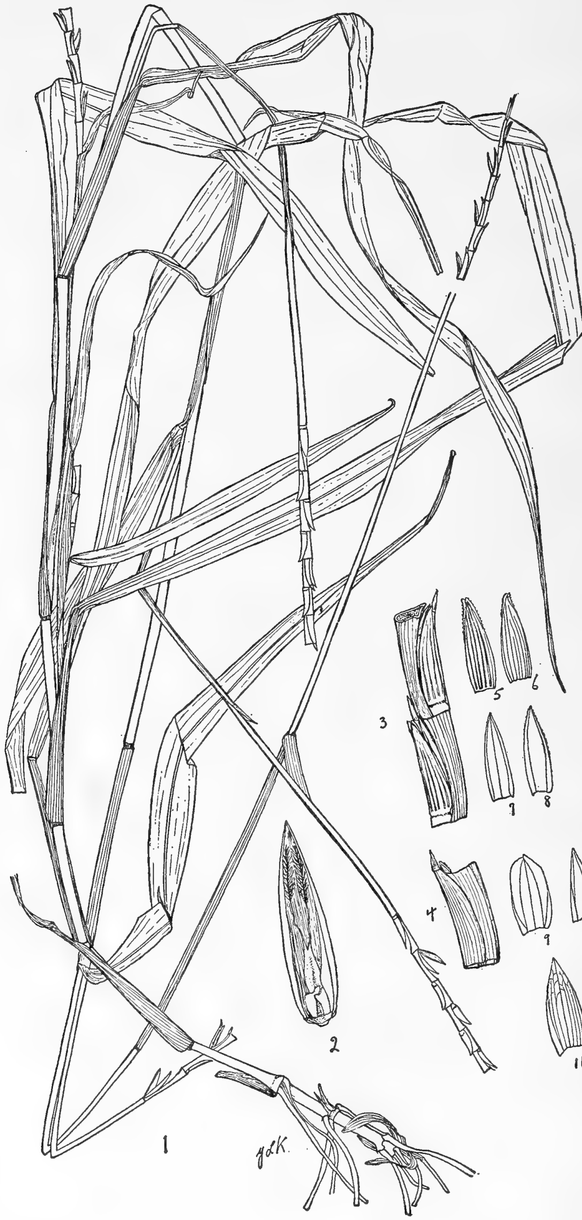


Fig. 2. *Rottboellia laevispica* Keng.— 1, plant, $\frac{2}{5}$ natural size; 2, sessile spikelet with first glume removed, showing the pistil, occasionally seen in the lower floret, $\times$ 3; 3–4, views of joints with sessile and pedicellate spikelets, $\times$ $1\frac{1}{2}$; 5–6, dorsal and ventral views of the first glume, $\times$ $1\frac{1}{2}$; 7–8, lower lemma and its palea, $\times$ $1\frac{1}{2}$; 9–10, upper lemma and its palea, $\times$ $1\frac{1}{2}$; 11, inner surface view of the second glume under transmitted light, $\times$ $1\frac{1}{2}$.

Type in U. S. National Herbarium, no. 1105524 and 1346303, collected on prairie, West of Chu-chow, Anhwei, altitude 160 meters, September 24, 1921, by J. B. Griffin and A. N. Steward (no. 996); the same species collected in shady woods, South of I-shing, Kiangsu, August 21, 1929, by Y. L. Keng (no. 2550).

A distinct species of the subgenus *Coelorachis*, probably closely related to *R. exaltata* L. f., from which it is distinguished by the smooth green or brownish racemes, lanceolate-oblong sessile spikelets, and the thinner pedicels mostly equaling the rachis joints. It differs also in the glabrous sheaths, the sheaths of *R. exaltata* being coarsely hispid.

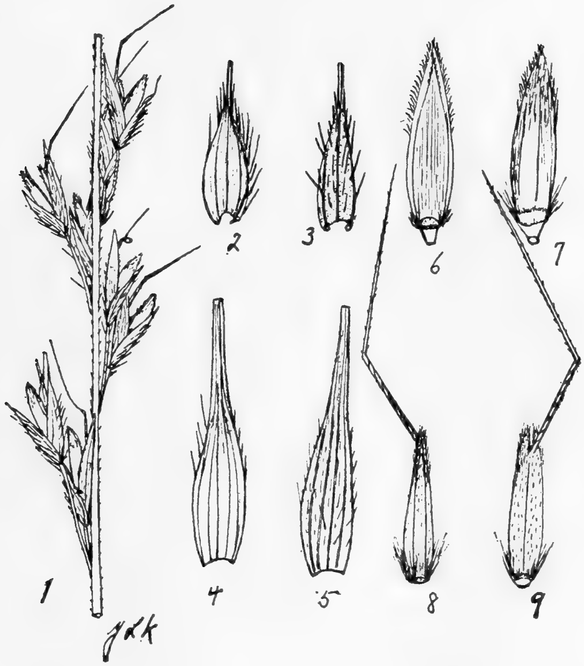

Fig. 3. *Arundinella bidentata* Keng.—1, part of raceme with 4 pairs of spikelets, $\times 2\frac{3}{5}$; 2–3, ventral and dorsal views of the first glume $\times$ 7; 4–5, ventral and dorsal views of the second glume, $\times$ 7; 6–7, ventral and dorsal views of the lower floret, $\times$ 7; 8–9, ventral and dorsal views of the upper floret, $\times$ 7.

### **Arundinella bidentata** Keng, sp. nov.

Perennis; culmi erecti, 50–70 cm. alti, glabri, 3–5-nodes, simplices v. a nodis inferioribus ramosi; vaginae laxiusculae, teretes, striatae, papillo-hispidae v. eae superioribus glabrae, nodis dense barbatis; ligulae membranaceae, 0.5–1 mm. longae, ciliatae; laminae e basi aequilata a vagina v. subrotundata lineares, subulato-acuminatae, 10–22 cm. longae, 2.5–5 mm. latae, papillo-pilosae v. inferne glabrae, firmae, saepe in sicco involutae; paniculae oblongae, 12–20 cm. longae, ramis erectis, solitariis v. iis inferioribus 2–3 nis; spiculae binatae, unilaterales, 5–6 mm. longae, pedicellis altero 1–5 mm. altero

3–10 mm. longis, scaberulis, versus apicem hispidis; gluma prima ovata, mucronata, 3–4 mm. longa, valde 3-nervis, hispida, subviolascens; gluma secunda circo 5 mm. longa, ovato-lanceolata, subulato-acuminata, 5-nervis, dorso pilosa; lemma inferius lanceolatum, tenuiter 5-nerve, superne pilosum, glumam primam subaequans, paleam acuminatum bicarinatam floremque masculam fovens; lemma superius oblongum, callo obtuso barbato 3 mm. longum, tenuiter 3–5-nerve, dorso scaberulo-punctatum, bidentatum, lobis laciniatis, dorso pilosis, e sinu aristam circo 6 mm. longam infra medium geniculatam exserens; palea lanceolata, ejus lemma aequans, marginibus inflexis, superne pilosis; antherae lineares, 1.2–1.8 mm. longae, saturate violascens; styli interdum 3, distincti, stigmatibus plumosis violascentibus breviores.

Perennial; culms, erect, 50–70 cm. high, 3–5-noded, glabrous, simple or branched at lower nodes; sheaths loose, terete, striate, papillose-hispid or the upper ones glabrous, usually shorter or the lower ones longer than the internodes, the nodes densely bearded with erect stiff hairs; ligule membranaceous, truncate or somewhat rounded, 0.5–1 mm. long, ciliate; blades linear, 10–22 cm. long, 2.5–5 mm. wide, subulate at apex, continuous with the sheaths or rounded at base, papillose-pilose or glabrous beneath, firm, usually involute when dry; panicle erect, oblong, 12–20 cm. long, the main axis angular, scaberulous, the branches solitary, simple, subsessile, or the lower ones 2–3-nate, with a few short branchlets, naked at base; rachis trigonous, scaberulous or ciliate along the angles; pedicels of the paired spikelets unequal, one 1–5 mm. the other 3–10 mm. long, erect, scaberulous, usually hispid towards the apex; spikelets binate, unilateral, 5–6 mm. long; first glume chartaceo-membranaceous, ovate, mucronate, 3–4 mm. long, strongly 3-nerved, hispid, dark purple; second glume about 5 mm. long, ovate-lanceolate, subulate-acuminate, 5-nerved, dorsally pilose; lower lemma lanceolate, membranaceous, about equaling the first glume or slightly longer, the margins hyaline, pilose above, with a narrower 2-nerved palea, staminate; upper lemma oblong, 3 mm. long, faintly 3–5-nerved, dorsally scaberulous-punctate, bidentate, the lobes laciniate, dorsally pilose; callus obtuse, bearded with hairs about 1 mm. long; awn arising between the lobes, about 6 mm. long, twisted below, geniculate about one-third above the base, scaberulous; palea equaling its lemma, lanceolate, 2-nerved, the margins inflexed, hyaline, pilose above; anthers linear, 1.2–1.8 mm. long, dark purple; styles sometimes 3, distinct, shorter than the plumose dark purple stigmas.

Type in U. S. National Herbarium, no. 1270758, collected on moist hillsides and open lands, Kuliang, Fukien, altitude about 800 meters, July 30, 1919, by J. B. Norton (no. 1154); the same species collected on Sharp Peak, mouth of Min River, Fukien, June 1924, by F. P. Metcalf and T. C. Chang (no. 60).

A distinct species, differing from all others in the upper lemma bidentate at apex, with the geniculate awn between the two laciniate pilose lobes. The species probably comes near to those of the subgenus *Miliosaccharum*, especially the common Asiatic species *A. setosa* Trin., in which, besides the awn there are two lateral setae. Except that *A. setosa* is usually glabrous, these two species resemble each other.

ANTHROPOLOGY—*The antiquity of man as indicated at Frederick, Oklahoma: A reply.*[1] HAROLD J. COOK, Cook Museum of Natural History, Agate, Nebraska. (Communicated by J. W. GIDLEY.)

In this JOURNAL, **20**: 475, 1930, Dr. O. F. Evans has contributed a criticism which brings up some points of interest in regard to the age of the deposits at Frederick, Oklahoma, wherein were found fossils and human artifacts, which we originally reported; and he has reached some conclusions which we feel do not accord with a comprehensive understanding of all the known evidence.

His description of the old stream bed in which were found the fossils and artifacts described in previous papers, is in close agreement with my original descriptions, in most respects, but he diverges widely in some of his conclusions on the age of these beds, and the value of their included fossils and artifacts as valid evidence; and in his interpretation of the time at which the stream which formed these beds, was active.

Some of the evidence which he cites as being conclusive on points which he makes, is quite as susceptible of other interpretation and so, at best, cannot be conclusive. Likewise some of his conclusions are based on inaccurate or unproven premises; and so, are either distinctly in error, or open to serious question.

To be specific. First, Dr. Evans recognizes three distinct phases of deposition in this old stream bed, (as we did, also) and says, "This (bottom) cross-bedded sandstone and conglomerate represents the early and normal period of the old stream's history." Then, "Above this old river bottom is a middle layer, ten or twelve feet thick. . . . ." Following, "Above this layer of water-deposited sands and gravels is an upper layer of several feet of material which appears to be partly water and partly wind deposited."

Anyone examining the extensive cuts in this bed at the Holloman quarries must be impressed that this division is present, and real. Yet in his conclusion Dr. Evans states: First; "It is a stream deposit," and second; "As a stream it was subject to disturbance at any time up to the time the stream left the valley." Obviously this implies that the division of the phases of the deposits he has just recognized are not determinable.

Further, he infers that, since the coarse materials in the middle bed show that an increase in velocity has occurred, it therefore follows that an uplift must have occurred to produce it. A much simpler

[1] Received March 7, 1931.

solution of the cause that would produce these effects is far more probable; namely; that a temporary climatic change occurred, with increased precipitation and increased stream run-off,—which is quite in line with well recognized habits of climatic cycles and fluctuations.

Now, let us return to the phases of stream deposit, and their portent. First, after over two years' intensive study of the large fauna found in these beds, which Dr. Hay and I recently reported upon, we found no difference in the age of the fossils from the various layers in this old stream bed. They obviously pertain to a relatively short period of time, and represent a comparatively contemporaneous fauna. Dr. Evans speaks of other gravel deposits in various other localities near the present Red River, which "contain numerous animal remains similar to those of the Holloman pit, such as tusks, thigh bones, etc., which appear, on casual examination to be what are generally referred to as of Pleistocene age." Does he mean to suggest that such *casual examination* and identification is of weight and value, comparable to the results obtained as a result of comparative studies by specialists, as a means of identifying the age of beds? I might suggest that "tusks, thigh bones, etc.," which, "on casual examination appear to be similar to those in the Holloman pit" occur in beds in stream deposits in which the writer has worked for over twenty years with Dr. W. D. Matthew, and other specialists, and date back anywhere from the early part of Pliocene times, some five or six million years ago, to well up through the Pleistocene. *Casual examinations* are of no value in comparisons of this sort; while exact comparisons, based on an extended fauna, may become rather precise in their import.

Dr. Evans suggests a Post-Pleistocene age for this stream. Without stopping to analyze all of his evidence, let us consider one point. According to all available evidence, modern races of mammals have existed back that far, showing little change in that length of time. According to the most exact comparisons Dr. Hay and I have been able to make, *not one single bone found in these deposits, which is definitely determinable, is referable to a modern species.* The closest relations and comparisons are with fossils known to have lived in the first half of the Pleistocene (to put it conservatively). So, if this were a Post-Pleistocene stream, the fossils would, of necessity, have been preserved as fossils some half million years or more before the "Frederick River" rewashed them into its bed, (as it must have done under that hypothesis). Likewise, it is safe to assume that they would have become fossilized in the first half-million years, and have been excessively fragile, even as when found now. To anyone familiar with stream deposits and with such fossils, the extreme improbability of their withstanding redeposition after fossilization, and still remaining in the condition in which we find them, is obvious, especially in the case of large and fragile specimens such as the *Glyptodon* carapace in the Oklahoma museum, which Evans cites. Instead of proving, as he evidently believes, that the lack of skeleton inside this shell proves redeposition, it actually proves the exact reverse! As any accurate field observer knows, who is familiar with the processes in life, such a dead animal would be eaten out of its shell, or the flesh would have decayed, as with modern turtles, and while yet tough and its bony segments firmly held by animal matter, it might be washed with little further damage into the muds of a stream and buried, as this specimen was found; but once there, for any length of time, it is utterly impossible that any erosion could move the specimen without scattering the parts of the shell, or losing and destroying them.

The scattering and erosion of the bones found in this bed is that common to all similar stream deposits,—in which whole skeletons are rare finds. The bones found are, so far as determinable, of mammal species known to be characteristic of the early Pleistocene, and a homogeneous assemblage.

Aside from other evidence to the contrary, if that "Frederick River" only a few thousand years ago, ran on what is now a high hill-top, then we must commend the wonderful selective wisdom it displayed in choosing for preservation in its bed *only* mammals characteristic of early Pleistocene times, and by no chance including the remains of any modern species, which surely must have lived along its course.

Dr. Evans states that reasoning from the finding of fossils and artifacts in the same bed "seems to be a case of trying to apply a line of reasoning that does not apply at all in the case of stream deposits." This statement is hardly in accord with known facts. It is true that in order to evaluate evidence found in stream channels, it is necessary to take into consideration all types of specialized evidence, including all geological and paleontological data available, with more care than in marine deposits; consequently these problems are primarily of a nature whose solution must inevitably be sought by specialists in the field concerned, and by those who do not loosely relegate all stream deposits, and all fossils casually examined, to the catagory of useless evidence.

As to the "Post-Pleistocene uplift," or disturbance, which Dr. Evans first postulates, and then uses as a basis for proof,—the existence of such an uplift is far from a settled fact. We know much of the general history of such streams, and the effects that widespread elevation and disturbances of the levels of the earth's crust have had upon them; and while some such disturbances *did* occur, there yet remains much to be worked out regarding their history and effects. There is much excellent evidence available, however, to indicate that a general uplift did occur in the whole area, and extended for hundreds of miles, but that it occurred at a much earlier date than Post-Pleistocene, namely, about mid-Pleistocene time. We expect to cite and publish some of this evidence in another place.

The statement made by Dr. Evans that the kinds of metates and arrows found in these beds are of recent age, and are as good evidence of the age of the beds as are the fossils, is based on unproven presumption, from one angle, and lack of consideration of known facts, from another, if we leave present evidence out of consideration. May I inquire the nature of the evidence that is available to the school of thought above illustrated, from which it may be stated what the people of Pleistocene times in America, (assuming they existed here) did or did not use, or what was the extent of their knowledge or lack of it? Where has such evidence been discovered, outside of deposits of this character? As previously pointed out, analogies with the cultures of Europe are interesting; speculations may lead to important discoveries; but such considerations are not proof or evidence of demonstrable fact. In view of the endless examples of both precocious and persistent primitive races among animals known to vertebrate paleontologists, we see no reason to believe that such conditions may not equally well apply to mankind. With this in mind, on present evidence, who can say that a precocious hunting race of nomadic people may not have developed, and, following the abundant game of Pleistocene times, have used the natural, obvious implements that such a life would develop,—much as did modern nomadic plains Indians—and then, satisfied with that state, have maintained it as a nearly static cultural state indefinitely, while conditions permitted? The term "metate" as applied to the type of stone artifact found in the "Frederick River" gravels is perhaps misleading. Whenever any primitive people undertook to store food, it is obvious that drying to cure and preserve meats, roots, fruits, etc., would inevitably be the first and natural method. It follows, equally well, that, after it had dried until hard, such food would be difficult to eat, and it obviously follows that such people found that by placing hard, dry food on one stone and pounding it with another, the food could be rendered more palatable. This discovery, inevitably, would lead to the use of just such primitive "metates" as we find here. This method must have originated independently many times in human history; and *by no means* can be considered conclusive proof of a modern culture.

As to the statement that calculations based on rates of erosion have no value,—this statement is, of course, absolutely arbitrary, and in excess of the facts. It is true that much is yet unknown as to the rates of erosion of this type, and the many factors which influenced it, but a good deal that is certainly significant and strongly indicative of the probable rates of erosion, is very definitely known. If such evidence is to be arbitrarily thrown out because it is incomplete,—then the same logic applied to anthropological evidence bearing on pre-basket maker races in America would leave it a rather desolate field. It seems to me that the *facts* are more likely to be arrived at, finally, if we give *all* evidence in all subjects that may bear on our problems, most careful consideration; and not attempt to rule out, arbitrarily, factors not in accord with our personal views, which, after all, may be wrong.

## CONCLUSIONS

Dr. Evans cites some interesting data on possible river piracy, that may have affected the early history of the "Frederick River" and which should be carefully worked out and studied.

His conclusions as to the unimportance of the evidence from the standpoint of fossils is certainly in error, as are also his conclusions that no reliable data can be had on the age or association of beds of this character, by the data they furnish.

The statement of his conclusion that the artifacts found are necessarily modern, is based on inference, and not on definite knowledge,—and so is indeterminate. The statement that metates and artifacts of the same type are now found on the surface of that region, has no determinable value, pro or con. It is certain that quite similar artifacts have been used into modern times. It is also true that a large part of the old "Frederick River" bed has already eroded away, and that any old artifacts that might be in such a deposit, would, in all probability be found, picked up, as erosion exposed them at the surface, and, not improbably, used by any modern Indians that found them; and so, be scattered. Therefore, the finding of such artifacts on the surface proves nothing as to the age of these deposits, either way.

Dr. Evans' conclusions on a "Post-Pleistocene uplift" in this region are certainly open to serious question, and, from evidence at hand, are believed to be in error; hence it follows that conclusions based on this supposition are highly questionable.

The implication that the fossils of this bed must have been redeposited in their present state, is out of the question as a probability, as any one with long field experience with such deposits and fossils will know.

We have seen no evidence to disprove a far greater antiquity for this deposit than the Post-Pleistocene upon which Dr. Evans insists. There is abundant evidence, (such as the complete absence of modern mammals in this deposit, and the presence of a rich and diversified mammalian fauna, of extinct races typical of early Pleistocene times, and other confirmatory data) to support a distinct Pleistocene antiquity for this stream bed and its contents.

The writer feels that until more evidence is assembled, it is premature to say dogmatically that this is an Aftonian stream deposit, (though most of the evidence is suggestive of it), just as it is premature to call it modern. However, there is so much good evidence in favor of a Pleistocene antiquity for this bed, both from the standpoint of geology and paleontology, that it deserves the most careful, comprehensive study, undertaken to find out the real facts, with due weight given to all evidence.

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# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## THE ACADEMY

### 238TH MEETING

The 238TH meeting of the ACADEMY was held at the Cosmos Club, February 20, 1931, Vice-President CURTIS presiding.

*Program.* Dr. M. A. TUVE of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington spoke on the subject, *Artificial radium-rays from high-voltage tubes.* The address was illustrated with lantern slides.

All physical objects in the universe are made up of atoms, and the different kinds of atoms are made up of different numbers of electrons surrounding a heavy kernel or core called the atomic nucleus. Fairly complete information about these external atomic electrons has been obtained from studies of spectrum-lines and from other types of investigations, but there is only scanty knowledge about the nucleus. Most of what is known about atomic nuclei has been learned from two types of investigation, (1) from studies with radium and other radioactive substances, and (2) from measurements of the masses of individual atoms in the "mass-spectrograph," which gives information as to the components in the nuclei and their energies of binding. All available evidence clearly indicates that there are two fundamental atomic "building-blocks," namely, electrons and protons, the latter being hydrogen atom-nuclei. "Quanta" of electromagnetic radiation (light-waves) should justly be included as a third elemental building-block of the universe.

Radium and other radioactive elements emit three types of rays: Alpha-rays, which are the nuclei of helium atoms shot out with high velocities; beta-rays, which are high-speed electrons; and gamma-rays, which are very penetrating X-rays. The alpha- and beta-rays from radium have energies (represented by their velocities) as great as they would acquire had they been accelerated from a state of rest by electric potentials ranging in magnitude from one hundred thousand to several million volts. The gamma-rays have energies of the same order of magnitude although they are electromagnetic waves and have velocities identical with that of light. By studies of these rays and their interaction with other atoms much information of a fundamental nature has been obtained concerning atomic nuclei. In the lecture typical experiments, including the recent ones of Pose, were described and their interpretation indicated. Since radium and other radioactive sources are available only in limited quantity and, what is more important, the energy-range of the emitted rays is distinctly limited, it has been clear for many years that the development of a controllable artificial source of such rays would greatly extend the scope of such studies.

An effort to develop such a source of artificial "radium-rays" was undertaken in the Department of Terrestrial Magetism, of the Carnegie Institution of Washington, in 1926 by Dr. Gregory Breit of the ACADEMY and the lecturer, using the potentials of several million volts produced by Tesla coils. Messrs. L. R. Hafstad and O. Dahl of the Department's staff have taken a large part in the work. The development of suitable vacuum-tubes for such high voltages was finally achieved along lines similar to those first used by Dr. W. D. Coolidge, namely, by dividing the voltage among separate vacuum-tubes connected in cascade, with an inner hole extending through all tubes. Some of the technical difficulties encountered in operating vacuum-tubes at very high voltages were described.

During the past year such tubes have been used in the laboratory of the Department with Tesla voltages up to approximately two million volts, and measurements have been made to verify the production of artificial beta-rays (high-speed electrons) and gamma-rays (very penetrating X-rays) by the tubes. The beta-rays were measured by their deflection in a calibrated magnetic field. The maximum speed of the electrons measured in this way checked the measurement by the capacity potentiometer-method of the maximum voltage applied to the tubes, thus verifying the previous voltage-measurements on the Tesla coils. The gamma-rays from the tubes were measured through one, two, and three inches of lead, using a Geiger-Müller tube-counter. With a peak-voltage of 1,300,000 volts on the tube the absorption-coefficient of the gamma-rays from the tube after filtering through one inch of lead was found to be very nearly the same as the absorption-coefficient of the gamma-rays from radium after passing through the same filter. Since most of the beta- and gamma-rays from radium have voltage-equivalents under 1,000,000 volts, and nearly all lie under 2,000,000 volts, the artificial production of beta- and gamma-rays practically covering the radium-spectrum has been achieved. The artificial production of the alpha-rays (high-speed helium nuclei) has not been attempted. Instead, experiments on high-speed protons (hydrogen nuclei) are in progress because results with them will be even more directly interpretable than similar results with helium nuclei. (*Author's abstract.*)

Charles Thom, *Recording Secretary.*

## PHILOSOPHICAL SOCIETY

### 1012th meeting

The 1012th meeting was held in the Cosmos Club Auditorium on November 22, 1930, President Lambert presiding.

*Program:* Malcolm P. Hanson: *Radio with the Byrd Antarctic Expedition.*—With the aid of about sixty lantern slides, the speaker described experiences and conditions encountered on the Byrd Antarctic Expedition during its various phases, with particular reference to radio communication and research. After pointing out the difference between the Antarctic pack ice belt, the Ross Ice Barrier or, more appropriately, the Ross Ice shelf, and the saltwater Bay ice, the speaker described the establishment of "Little America" ten miles from the water's edge, which required the transporting of five hundred tons of supplies over this distance of rough ice through months of dog sled hauling. Construction of the radio towers and other radio facilities around the camp was described, and the extensive use of radio shown to be of fourfold use to the Expedition, namely for safety, efficiency, scientific research, and morale of the personnel. The speaker showed how the long winter night was spent in thorough preparation for the spring's coming exploration activities; improved light-weight sledges were built, harnesses and clothing prepared, foodstuffs weighed out and packed, airplanes and radio facilities improved, and many other things accomplished. The peculiar radio conditions encountered during this period, such as rapid fading and multiple echoes, were studied largely by means of oscillograms. Determinations of height and condition of the Kennelly-Heaviside layer were instituted by transporting and setting up the receiving equipment and oscillograph on several trips, five to ten miles from Little America, and taking runs over at least 24 hours on special signals sent out from the base, over a wide frequency range.

The need for ski practice and a certain amount of outdoor exercise despite the darkness and temperatures which went to $-72.8°$F., caused installation of a powerful beacon light atop one of the radio towers to help guide anyone back to camp who might get lost in darkness or blizzard; a group of additional small flashing lights was in everyday use and conveniently showed the location of camp to men out walking. Ryme, fog, and even a light rain were experienced in sub-zero weather, and ice crystals in the air gave rise to many beautiful phenomena. Daily radio messages and news bulletins from various parts kept the expedition in touch with the world and radio concerts were frequently received and helped to break the monotony.

With the coming of spring, in October, the supporting party laid down depots every fifty miles for two hundred miles to the south, and with the newly-constructed portable radio equipment, deriving its transmitting power from batteries or from a little hand-operated generator, was able to maintain regular radio contact with the base. The snowmobile party, which followed in its tracks, had a breakdown 85 miles from home, and had to walk back, pulling a sledge with their sleeping bags, tent, and emergency rations behind them. The geological party made a long dog sled trip to the south, covering over eleven hundred miles in three months, while maintaining regular radio communication with their portable set.

Many airplane flights were made for exploration and aerial mapping purposes, the chief ones being the base laying flight, the south polar flight, the eastern flight to King Edward and Marie Byrd land, and the western flight over the Ross Barrier. The speaker showed the radio equipment with which the planes maintained radio communication with the base during these flights, and explained the special radio safeguards at Little America consisting of a directional radio beacon and of a radio compass, both of which would have been of great assistance in guiding the planes back in case of thick weather. Such a condition, fortunately, never arose during a flight, thanks to the expert weather predictions of our meteorologists. In addition to frequent poor visibility due to lack of shadows or horizon in overcast weather the greatest difficulties in flying operations were the uncertainty of snow surface for take-offs when away from the base, and the need for laborious heating of each engine and its oil before it could be started. The ski landing gears functioned admirably, except on a few sunny days in mid-summer when the temperature rose to near the melting point and caused the runners to stick to such an extent that a scheduled photographic flight was postponed for colder weather in order to preclude damage on landing.

The unusually heavy pack ice belt prevented the expedition vessels which had set out from New Zealand from reaching the barrier party until the end of the summer, when the City of New York managed to get through the pack and, caught in a heavy storm, was carried 400 miles off her course to the westward before reaching Little America. In passing through the pack she had observed the ice already to be freezing together again due to the late season, so in order to minimize the chance of being caught in the pack she remained at the Barrier only long enough to take aboard the men, dogs, and the most essential supplies, before heading north again. The planes, houses, and most of the supplies had to be left behind.

The scientific radio records brought back include some 1500 oscillograms and about 2000 radio log sheets, besides a great number of fading records which were taken in New Zealand. A detailed analysis of these data is now under way, and when completed should throw considerable light upon many phases of radio wave propagation. (*Author's abstract.*)

Discussed by Mr. HECK.

### 1013TH MEETING

The 1013th meeting, constituting the 60th annual meeting, was held in the Cosmos Club Auditorium, December 6, 1930, President LAMBERT presiding.

The treasurer reported expenditures of $2578.55 for the year, including the purchase of a real estate note and an item of $312.31 for printing the article on the 1000th meeting. He stated that the number of active members is 227.

The Secretaries reported that the following new members were elected during the year: Miss G. BACK, E. S. BELOTE, R. H. CANFIELD, G. W. GARDINER, L. W. HAFSTED, H. D. HARRADON, J. P. LUSHENE, R. J. SEEGER, K. L. SHERMAN, F. M. SOULE, O. W. TORRESON, C. B. WATTS.

The death of ASAPH HALL was reported.

The following officers were declared elected for the year 1931: *President,* H. L. CURTIS; *Vice Presidents,* L. B. TUCKERMAN and O. S. ADAMS; *Recording Secretary,* G. R. WAIT; *Treasurer,* N. H. HECK; *Members-at-large of the General Committee,* C. HUFF and W. D. SUTCLIFFE.

At the conclusion of the business meeting Dr. P. R. HEYL spoke on *A report on the redetermination of the constant of gravitation*—Three sets of measurements of the constant of gravitation were made, using the torsion balance in vacuum, with small masses of gold, platinum and optical glass. The results with the gold balls are open to some uncertainty because of an absorption of mercury vapor derived from the manometer in connection with the apparatus. The mean results are as follows:

| | |
|---|---|
| Gold | $6.678 \pm 0.003$ |
| Platinum | $6.664 \pm 0.002$ |
| Glass | $6.674 \pm 0.002$ |

Weighting these in the ratio 1:3:3 the final mean is $6.670 \pm 0.005$.

The difference between the values for platinum and glass is not to be ascribed to a variation of the constant of gravitation with the material. A special experiment to test this point was carried out with one platinum and one glass ball, using the method of Eötvös. No difference was found as great as one part in 10 million. (*Author's abstract.*)

Discussed by Messrs. PAWLING, LAMBERT, HAWKESWORTH, GISH, WRIGHT, and HUMPHREYS.

OSCAR S. ADAMS, *Recording Secretary.*

### 1014TH MEETING

The 1014th meeting was held in the Cosmos Club Auditorium, Saturday evening, January 3, 1931, President CURTIS presiding.

The address of the evening was given by the retiring President, W. D. LAMBERT, on *The variation of latitude.*

G. R. WAIT, *Recording Secretary.*

# ENTOMOLOGICAL SOCIETY

## 422ND MEETING

The 422nd regular meeting of the Entomological Society of Washington was held at 8 p.m., Thursday, October 2nd, in Room 43 of the U. S. National Museum, ex-president J. A. HYSLOP presiding. There were present 27 members and 20 visitors.

The first communication on the regular program was a paper by AUSTIN H. CLARK entitled *Notes on the behavior and migration of the milkweed butterfly.*—The milkweed butterfly (*Danais plexippus*), which is normally not very common in the District of Columbia and immediately adjacent region, appeared in great numbers on September 17th and 18th in the meadows west of Cabin John following a heavy rain on September 16th. The individuals were observed to devote themselves wholly to feeding, becoming increasingly sociable, for about three days. On September 20th they became restless and a few were seen high in the air passing toward Great Falls (west) before a moderate wind. Their numbers in the fields had decreased, and those that remained showed a desire to rest on trees instead of among the goldenrods and asters as they had done previously. On September 24th they appeared in Washington, becoming frequent in all parts of the city on the following day. On September 26th only about a dozen were found in the fields, and all of these had certainly been less than a week on the wing. Nothing in these observations indicates any departure from the normal life of the adult of this butterfly—about three days of intensive feeding followed by a much longer period of wandering and later of reproduction combined with wandering. At any time during the summer the insects may be observed, as individuals, flying at a great height. From this general region two migrations have been reported. In one the butterflies were flying south against the wind and in the other they were flying north with the wind. Those we saw were flying west with the wind. Most of the migrations which have been reported, however, have been southerly, especially in the central part of the continent. It was suggested that the migrations of this butterfly are in reality mere aimless wanderings having their inception in the simultaneous appearance of large numbers of individuals which happen to reach the wandering stage at the same time, and further that these migrations take their direction primarily from the prevailing meteorological conditions of the season and secondarily from geographical features, especially rivers and the sea coast. In other words, the migrations of this insect are simply the mass expression of the normal habits of the individual at all times. It was pointed out that the butterflies commonly seen in groups on muddy spots—in this region especially *Colias philodice* and *Eurema lisa* and not far away also *Catopsilia eubule* and *Eurema nicippe*—are almost exclusively fresh males, and that with the coming in of a new brood the insects appear in numbers on mud before they do in the fields. In the exceptionally dry summer of 1930 when all butterflies were scarce, no butterflies frequented the puddles at Cabin John, whereas in the previous normal year puddle butterflies had been common, even soon after a rain. It was deduced from the evidence that the butterflies about puddles are surplus males which have been driven out of the fields by persecution by older males at the time—immediately following emergence from the pupa—when they normally occupy themselves chiefly in intensive feeding, and that the appearance of puddle butterflies is therefore caused by overcrowding in the areas where the food plant is found and wherein the females more or less constantly remain. In the absence of the rivalry incited by the presence of females the young males of these pierids become gregarious. A large proportion of these males probably go back to the fields as the older males die off. But there is an unassimilible surplus, and it is probably from this unassimilible surplus, consisting of males that have been driven out into the regions devoid of females that the migrating swarms of these and related pierids are composed. These swarms fly in a more or less straight line against the wind just as single traveling males of the species concerned are often seen to do. On the Atlantic seaboard in the late summer *Catopsilia eubule* is sometimes observed migrating northward at the same season when, and in the same places where, *Danais plexippus* is migrating southward. In the fields at Cabin John where *Danais plexippus* was noticed going west with the wind toward Great Falls *Catopsilia eubule* is occasionally seen at the same season flying directly east against the wind. Unless the migrations of these pierids and the danaid are to be explained as a collective expression of the normal actions of the individuals of the species concerned, it is difficult to understand why two primarily tropical species—*Danais plexippus* and *Catopsilia eubule*—should migrate in opposite directions at the same season. (*Author's abstract.*)

This paper was discussed by Hyslop, Larrimer, Busck, Hadley, and Holland.

The second communication on the program was given by S. A. Rohwer and was entitled *Remarks on the present status of some insect pests which are subject to federal quarantine.*—By the use of lantern slides the speaker discussed outstanding events connected with regulatory and control work on the Mexican fruit worm, Gipsy moth, Satin moth, Japanese beetle, Mediterranean fruit fly, and the European corn borer. In discussing the work on the Mexican fruit worm he pointed out that no infestation of this pest was known to exist in the United States. The last incipient infestation was discovered in Brownsville on November 19, 1929 and was confined to a few trees on two residential properties. Following this discovery intensive control and cleanup work was inaugurated and spraying operations were carried on in United States until March, 1930, and are still being carried on in Matamoros in coöperation with the Mexican Government. Traps are being used as an aid in detecting presence of the fly both in the United States and in Mexico. Referring to the work on Gipsy moth, the speaker discussed briefly the infestation which was found on Long Island in November 1929, adding that this infestation was now under control and that no recent evidence of infestation had been found. He also stated that shipments made from the nurseries where infestation was known had all been traced and only one showed evidence of infestation and that was a single dead egg cluster which was located at Interlaken, New Jersey. Work done during the summer indicated that the Satin moth occurred over a considerably larger territory and that in some areas it has caused a rather intensive defoliation. A map showing localities where the Japanese beetle had been found as a result of scouting during the summer was also exhibited and explained in some detail. In discussing work on the Mediterranean fruit fly the speaker explained methods used in making intensive inspections over the State and stated that no infestation had been found since two pupae were discovered in soil under fallen fruit in a yard at St. Augustine on July 25, 1930. To show the thoroughness of the inspection work figures indicating the number of specimens which were referred for identification were given. It was pointed out that these specimens consisted largely of dipterous larvae which could not be separated from Mediterranean fruit fly larvae by any one other than a specialist. In discussing the work on the European corn borer the author used maps showing the distribution of the corn borer as determined by scouting which was done during the summer of 1930. The apparent reduction in abundance of the corn borer in the area in which it was known to occur was also briefly discussed. (*Author's abstract.*)

This paper was discussed by LARRIMER.

Remarks were made on invitation by Dr. W. J. HALL, a visitor from the British South African Company of Rhodesia, S. Africa, who expressed his pleasure at being with us and who gave us a brief resume of his work during the past four years on insect pests of citrus plants in South Africa. The major pests discussed by him were the citrus thrips, *Scirtothrips aurantii* Faure, and the Citrus aphis, *Aphis taveresia* Del. Wg.; red scale, *Aonidiella aurantii* Mask.; the cotton bollworm, *Heliothus obsoleta* Fab.; and the Mediterranean fruit fly, *Ceratitis capitata* Wied. He also made mention of some of his entomological work covering a seven-year assignment in Egypt. His itinerary included visits to Florida and California and an extensive study of our research and quarantine work on citrus pests.

Dr. MORRISON reported briefly on the recent safe arrival at the National Museum of the famous Barnes collection of Lepidoptera concerning which a more detailed discussion will be given later in the year,—probably by Mr. BUSCK.

Brief greetings also were extended to the society by two other visitors, Professor FRENCH, State Entomologist of Virginia, and Dr. M. W. BLACKMAN, formerly of Syracuse University, Syracuse, N. Y., now of the U. S. Bureau of Entomology, Washington, D. C.

Dr. J. M. ALDRICH discussed briefly the present procedure of our society in publishing its minutes in the Journal of the Washington Academy of Sciences rather than in the proceedings of the Entomological Society of Washington, and stated that he would discuss this matter more fully at a subsequent meeting.

### 423RD MEETING

The 423rd meeting of the Entomological Society of Washington was held at 8 p.m., Thursday, November 6, 1930, in Room 43 of the new building of the National Museum, President J. E. GRAF presiding. There were present 42 members and 35 visitors.

The following individuals, all connected with the Bureau of Entomology, were admitted to membership: Mrs. MARGARET C. MANSUY, Miss LOUISE M. RUSSELL, Miss IDA WECKERLY, Dr. M. W. BLACKMAN, and Mr. P. W. OMAN.

The first communication on the regular program was given by ROBERT E. SNODGRASS and was entitled *From an egg to an insect.* The paper comprised a resumé of the principal facts on record concerning the subject. A considerable number of slides were shown and explained in detail. The paper was discussed by McINDOO.

The second communication on the program was a talk by Prof. S. W. FROST of Pennsylvania State College on *Animal life on Barro Colorado Island.*—Barro Colorado is the largest island in Gatun Lake, Panama. It was set aside by the governor of the Canal Zone in 1923 as a preserve where any qualified scientist could have an opportunity to study the wild life of a typical rain-drenched tropical jungle. The island is conveniently reached by train from Panama City or Colon. Descending at the little waystation, Frijoles, where bananas are usually in evidence, the scientist is taken by launch across the canal, a distance of about three miles, to Barro Colorado Island. Here the scientist finds shelter, a comfortable bed, good food, tables and all the necessary equipment for general investigation. Knowing that all the essentials and comforts of life are abundantly provided for, he can direct his entire time and attention to the sole purpose for which he came. Botanists, ornithologists, entomologists, zoologists and many others have availed themselves of the excellent opportunities made possible through the efforts of the local custodian, Mr. James Zetek, and through the zeal of Dr. Thomas Barbour and others who have spent unlimited time in planning and developing the laboratory. In addition to the two story laboratory building, there is a guest house for visitors, and Dr. Frank Chapman has a small house of his own. At the far side of the Island, on the Drayton and Allison Armour trails, one-room shacks have been built, known as termite houses for they are a part of a project to determine the resistance of different building materials to termite injury. They also serve as shelters when one is working on this side of the island. They are stocked with provisions, provided with cots and blankets and ready to serve the scientist at any time. Here the writer was the first to sample tea after the rainy season and being very thirsty drank a cupful almost in one draught only to find that it was miserably musty. This, however, was offset by a fine fish hooked just a few feet from the steps of the shack. He did not recognize the fish and no one will ever know what species it was. The island has an area of about six square miles and is, for the most part, densely covered with vegetation. A small clearing has been made near the laboratory where bananas, pineapples and a few other plants are grown. The western half of the island is virgin forest of the finest description. The elevation at the center is only 452 feet above the level of the lake; still one finds travelling strenuous enough on some of the trails and impenetrable in places, when off the trails. There are over twenty-five miles of trails leading from the laboratory to various points on the shore line. The trails are named after scientists as "Wheeler," "Barbour," "Zetek," "Shannon," or after benefactors as "Allison Armour." They are uniquely marked every ten meters by a metal tag fastened to a tree. This makes it very easy for visiting scientists to find their way and convenient in reporting things of interest, along the trails. The large trees always attract attention. Bombacopsis sometimes attains a circumference of 190 feet at the base, including the great buttresses, and towers 150 feet above the forest floor. Here the howlers like to roost far from the danger of other animals. Adjacent to the laboratory a magnificant group of trees rise 100 feet from the edge of the lake. The American Museum of Natural History features a habitat group which does justice to these trees with their twining lianas and abundant bird life. It was here that the writer had his first glimpse of Barro Colorado Island. Great clumps of epiphytes, aroids, bromeliads and orchids frequently adorn the bare limbs of trees. From the laboratory we could see a limb supporting a world of life itself. Individual plants, some perhaps new to science, could be distinguished with field glasses, but the tree was too tall and too remote in the jungle to be conveniently reached by man. The plants of special interest to the writer were the hosts of leaf-mining insects. They ranged from the low growing weeds to the tallest trees. Nearly three hundred specimens were brought back and twenty-five new plant records added to the flora of the island. Animals and birds were abundant and, as hunting was prohibited, they were unusually tame. From the laboratory alone, two or three species of monkeys were frequently seen. The coati often came to feed at the garbage pile or climbed the papaya to steal fruits. The puma was heard not far distant from the laboratory on several successive nights and finally took its own picture by flash light for Dr. Chapman. The birds were too numerous and interesting to pass with a few words. Some made indelible impressions on our minds that will last forever. The familiar sound of the dropping of heavy dew from the trees at dawn or the notes of the goat sucker will always recall mornings when we awoke refreshed for our work. The muffled notes of the owls greeted us as Dr. Chapman remarks, "bidding the day 'Good night'." Along the trails the noisy toucans and guans frequently startled us. The wrens and the oropendulas provided us with more pleasant music. Towards the close of day the parrots and parakeets amused us as they flew from tree to tree getting ready to settle down for the night. He who travels cautiously on the trails is sure to see and hear many animals and birds even though he be an entomologist with his whole nervous system fastened on a tiny insect just ready to take flight. The coati was seen more frequently than any of the other animals. One day in making a turn on Fairchilds trail the writer came upon three coati feeding upon the inner fleshy pulp that surrounds the seeds of the monkey comb (*Apeiba aspera*). Some other animals, possibly parrots, had been feeding there before and had split open many of the pods. The seeds missed by the parrots and avoided by the coatis, yielded a new species of Bruchid for the entomologist. The collared peccary was seen on many different occasions. One day the writer watched about twenty-five file across the trail fifteen feet ahead of him. As the last animal passed, the writer raised his insect net, the animal paused for a moment then slowly walked away. At the next bend in the trail he came upon the same herd of peccaries. They were travelling nearly in a straight line while the writer was following the crooked trail. Again he waited for them to pass and at the same time took a few motion pictures. The larger animals as the puma, the tapir and the deer are seldom seen. Dr. Frank Chapman has the distinction of being the only one that has seen a puma on the Island. He has however taken many excellent pictures of pumas, ocelots and tapirs in the low wet places on the Island. Whoever spends a little time on the Island soon becomes acquainted with the monkeys. The howlers take to the tree tops and are more frequently heard than seen. The passing airplanes disturb their peace and they set up a terrific roar. The white faced monkeys are encountered more often. They are inquisitive little fellows and are as anxious to see their peculiar relatives as we are to view them. By remaining quiet they would play about the branches for a long time, peer down at us and even descend to a lower level in hopes of getting a better view. A little noise or motion disturbs them and they go scampering over the tree tops with more agility than man walks on the ground. Along the shores of the island the basalisks and iguana were seen frequently. The basalisks were especially numerous. They were difficult to locate for they had the habit of remaining perfectly quiet for a long period of time and blended well in color with their background. When disturbed they skipped over the water with tremendous speed. With a little care one could paddle a cayuca within eight or ten feet of them. There is no doubt that one can see more tropical life on Barro Colorado Island than by penetrating the average jungle, for the trails are used by animals as well as man and further permit man to travel noiselessly and easily to remote parts of the island. It is remarkable to think of such a comparatively small bit of land housing such a large fauna and flora. All visiting scientists have found its climate enticing and its resources unlimited.

Several reels of motion pictures were shown covering various phases of animal and plant life on the Island.

### 424TH MEETING

The 424th regular meeting of the Entomological Society of Washington was held at 8 p.m., Thursday, December 4, in Room 43 of the new building of the

National Museum, President J. E. GRAF presiding. There were present 31 members and 11 visitors. Mr. W. D. REED, of the U. S. Entomological Laboratory at Danville, Va., was elected to membership on recommendation of the Executive Committee.

A motion was offered by Dr. J. M. ALDRICH as follows: Moved, that the Executive Committee be instructed to arrange for the publication of the minutes of our meetings in our own Proceedings hereafter, beginning with the January meeting. In commenting on the motion, Doctor ALDRICH stated that the minutes of the society for several years past have been published in the Journal of the Washington Academy of Sciences and that such procedure appeared inconsistent with the fact that our only publication was entitled "Proceedings." He read some comparative figures regarding space requirements and publication costs, and indicated that he for one would be willing to aid pro rata in whatever increased cost of publication the adoption of this motion might entail. After comments by EWING, HYSLOP, and ROHWER, the latter speaking against the motion, the society voted 12 to 11 in favor of the motion.

The following were elected officers of the society for 1931: *President:* A. C. BAKER; *First Vice-President:* F. C. BISHOPP; *Second Vice-President:* C. T. GREENE; *Recording Secretary:* J. S. WADE; *Editor:* W. R. WALTON; *Corresponding Secretary-Treasurer:* S. A. ROHWER; *Representative of the Washington Academy of Sciences:* H. MORRISON; *Executive Committee:* The officers and T. E. SNYDER, A. N. CAUDELL, W. H. LARRIMER.

During intervals in the election of officers, a note was presented by Dr. W. D. PIERCE on *The mango weevils.*—A number of species of weevils breed in the seed of mango in the Orient, and as they have not all been listed in their proper genus it is well to publish the following notes on the synonymy of the genus *Sternochetus* to which four of the mango weevils belong.

Genus *Sternochetus* (Kolbe) Hubenthal (1915)

*Sternochetus* (Kolbe) Hubenthal (1915) Ent. Mitt., **4**: 128, type *mangiferae* Fabricius. Below is cited the synonymy of the mango weevils which may be assigned to this genus:

*Sternochetus mangiferae* (Fabricius) Hubenthal

*Curculio mangiferae* Fabricius (1792) Ent. Syst., **1**$^2$: 432, No. 161.

*Rhynchaenus mangiferae* Fabricius (1801) Syst. Eleuth., **2**: 473, No. 173.

*Cryptorhynchus mangiferae* Schönherr (1826) Curc. Disp. Meth., p. 282; Boheman (1837) Schönherr's Gen. et Sp. Curc., **4**: 91.

*Sternochetus mangiferae* Hubenthal (1915) Ent. Mitt., **4**, No. 4–6, pp. 128, 129; Pierce (1917) Manual of Dangerous Insects, p. 144, fig. 72.

Originally described from seeds of mango in India orientalis. Recorded by Boheman from India orientalis, Bengalia, Java, He-de-France, Madagascar. According to Lefroy is confined to Southern India and Ceylon.

This is the species most commonly known as the Mango Weevil. It has ben written about by many authors and its habits are pretty well known. It breeds in the seed of the mango.

*Sternochetus gravis* (Fabricius) Pierce

*Curculio gravis* Fabricius (1792) Ent. Syst., **1**$^2$: 435, no. 172. Cape of Good Hope.

*Rhynchoenus gravis* Fabricius (1801) Syst. Eleuth., **2**: 481, no. 203.

*Cryptorhynchus gravis* Stebbing (1914) Indian Forest Insects, p. 436, fig. 289.

*Sternochetus gravis* Pierce (1917) Manual of Dangerous Insects, pp. 143, 144, fig. 71.

Stebbing calls this the Northern Mango Weevil of India. The larvae first feed in the pulp and then enter the seed.

*Habitat:* United Provinces, Bengal, Assam.

*Sternochetus frigidus* (Fabricius) Pierce

*Curculio frigidus* Fabricius (1787) Mant. Ins. App., p. 381.

*Curculio chinensis* Olivier (1790) Encyc. Meth., Ins., **5**: 507, no. 166.

*Rhynchaenus frigidus* (chinensis) Fabricius (1801) Syst. Eleuth., **2**: 470, 471, no. 158.

*Rhynchaenus chinensis* Olivier (1807) Entomologie, **5**, no. 83, p. 175; tab. 8, fig. 97. The plate is referred to by Olivier (1790) and Fabricius (1801).

*Cryptorhynchus frigidus* Rosenschoeld (1837) Schönherr's Gen. et Sp. Curc., **4**: 115.

*Cryptorhynchus frigidus* Faust (1894) Ann. Mus. Genova, ser. 2, **14** (**34**): 287.

Fabricius records from Amboina; Rosenschoeld from India orientalis, Bengal, Java, Madagascar, New Holland; Faust from Burma.

Faust records it as bred from fruit of mango.

*Sternochetus olivieri* (Faust) Pierce

*Cryptorhynchus olivieri* Faust (1893) Ann. Soc. Ent. Fr., **61**: 518, 519.

*Cryptorhynchus olivieri* Faust (1894) Ann. Mus. Genova, ser. 2, **14** (**34**): 287.

Faust (1893) recorded it from Saigon and (1894) from Schwegoo (Burma). It attacks mango in Java, material having been received from Buitenzorg, collected by Paul Vandergoot.

*Sternochetus poricollis* (Faust) Pierce

*Cryptorhynchus poricollis* Faust (1894) Ann. Mus. Genova, ser. 2, **14** (**34**): 287, 288.

Recorded from Burma. I have no definite host record on this species. (*Author's abstract.*)

Doctor ALDRICH mentioned receiving a letter from one of his acquaintances in the British Museum in London, advising that the entomological section recently has moved into new quarters on the ground floor, in which twice as much room is now available for entomological work. This was commented on by HYSLOP.

J. G. SANDERS, of Philadelphia, and E. A. RICHMOND, of Brockton, Mass., both visitors, on invitation greeted the society and expressed pleasure at being with us.

Mr. GRAF referred to the recent publication of a book by Doctor HOWARD, entitled *A history of applied entomology,* and this was discussed very briefly by LARRIMER and EWING.

AUSTIN H. CLARK commented briefly on some recent work performed by him in making photographs of butterfly wings and showed several specimens of his work. Comments were made on his remarks by GRAF, MORRISON, ROHWER, PIERCE, and HYSLOP.

The first communication on the regular program was given by Dr. H. E. EWING and was entitled *The distribution and host relationships of ectoparasites, with special reference to chiggers.*—The distribution of fleas in North America was discussed and a map presented showing the localities in the United States from which specimens of the human flea, *Pulex irritans* Linnaeus, have been taken. This flea occurs generally throughout the more humid parts of the Mississippi Valley, along the Pacific slope and in a restricted area in the Middle Atlantic States. The probable reasons for its absence from more than half the area of our country were discussed. Preliminary results of an ectoparasite survey of amphibians, reptiles, birds and mammals, of the South Atlantic Slope of the United States, were presented. This showed amphibians to be the most heavily parasitized of the four classes with chiggers, the per cent being 23.8. Mammals, on the other hand, had the highest percentage of infestation with all ectoparasites (57.1 per cent). The degree of infestation with ectoparasites for the four classes of vertebrates considered was shown also by plotted curves. Recent advances made by others concerning the distribution and host relationships of parasites were mentioned and discussed. Live specimens of some of the more important natural hosts of our common chigger, *Trombicula irritans* (Riley), were exhibited. (*Author's abstract.*)

A considerable number of slides and specimens of various animal forms were shown. The paper was discussed by HYSLOP, WADLEY, BISHOPP, ALDRICH, and PIERCE.

J. S. WADE, *Recording Secretary.*

(*Editor's Note.*—In accordance with action taken at the 424th meeting, further proceedings of the Entomological Society will be published in the Proceedings of the Entomological Society of Washington.)

## GEOLOGICAL SOCIETY

### 471ST MEETING

The 471st meeting was held at the Cosmos Club January 14, 1931, President MEINZER presiding.

*Program:* Symposium on drought of 1930.

A. H. HORTON: *The Potomac River and the drought of 1930.*—The Potomac River is one of the larger streams in the United States which drain into the Atlantic Ocean. Its drainage area is larger than that of the Connecticut, Hudson, Delaware, James, or Savannah Rivers and about half as large as that of the Susquehanna River. The drainage area of the Potomac River at Great Falls is about 11,500 square miles—about 10 per cent less than the combined area of Massachusetts and Connecticut. The altitude of the basin ranges from sea level at Washington to about 3,000 feet at the divide on the south and west. The North Branch is considered the main stem of the river even though the drainage area of the South Branch is somewhat larger.

The average or normal annual precipitation of the basin is about 40 inches. The maximum annual precipitation of about 47 inches occurred in 1891. The minimum previous to 1930 was about 31 inches in 1895.

Records of the flow of the river at Great Falls or at Point of Rocks are available since 1896. During this period of about 33 years there were five large floods ranging from 175,000 second-feet to 265,000 second-feet, the largest of these being the flood of May, 1924. The maximum known flood, however, was that of June, 1889, which was caused by a rainfall on the basin of 5.3 inches in three days. The maximum discharge of this flood was about 390,000 second-feet at Great Falls, roughly 50 per cent larger than the flood of May, 1924. Storms with much greater rainfall have occurred along the Atlantic Coast, but fortunately they have missed the Potomac basin.

The rainfall on the Potomac River basin in 1930 was approximately 22 inches, about 55 per cent of the normal and about 35 per cent less than in the driest year previous to 1930. The mean daily flow at Great Falls for the lowest 7-day period in 1930 was 821 second-feet in August, 25 per cent less than the previous record, and the mean daily flow for the lowest month in 1930 was 870 second-feet in October, about 45 per cent less than the previous record. During the 33 years of record from 1897 to 1929, the flow at Great Falls was less than 1,000 second-feet for only 38 days, while in 1930 the flow was less than 1,000 second-feet for 83 days during the period August to October. This flow was almost wholly from underground sources for there was but little surface runoff, as the small amount of precipitation during these months was mostly absorbed by vegetation.

The supply of ground water has probably been seriously depleted and unless precipitation occurs this year under conditions favorable for replenishing the ground-water supply, the flow of the Potomac River during the low-water period of 1931 will probably be less than for 1930. In this connection, it should be noted that the flow for the minimum week of 821 second-feet was at least five times the amount needed for the city of Washington. (*Author's abstract.*)

Miss M. D. FOSTER: *The effect of the drought upon the quality of the water of the Potomac River.*—Two charts compare the fluctuations of discharge, turbidity and total hardness of the water of the Potomac River for a normal year (October, 1928–September, 1929) and for the period October, 1929 to December, 1930. In a normal year (as shown in the first chart) the discharge is relatively low in the fall, rises in the winter, with several high stages in the spring, decreases in June and July, and is again low in the late summer and fall. The turbidity, which is relatively proportional to the material in suspension, follows in a general way the discharge; any disagreements may be attributed to local rains which erode parts of the drainage basin more or less than an average amount. The hardness, plotted to indicate changes in quality, varies inversely with the discharge—being relatively high in the fall, low in the spring and increasing again in the late summer and early fall.

The second chart shows that the whole period—October, 1929 to December, 1930—was abnormal; high stages of the river in the fall, lower peaks than normal in the spring (a maximum of about 35,000 second feet in 1930 as compared with a maximum of 173,000 second feet in 1929), and after the middle of July a uniformly low discharge of 800–900 second feet until the last of December. With the earlier decrease in discharge the hardness of the water began to increase at an earlier date than usual and continued high longer, reaching a maximum of 136 parts per million, as compared with a maximum of 111 parts per million in the fall of 1929. The drought continued until the 27th day of December, when the hardness was 134 parts per million. On December 28, the hardness dropped to 31 parts per million, simultaneously with a rise in discharge greater than since April and with a great increase in turbidity. The increase in hardness with decrease in discharge may be attributed to the greater proportion of spring water present. (*Author's abstract.*)

Discussed by FERGUSON, E. S. HOPKINS, and DAVID WHITE.

CARL J. LAUTER: *Effect of the drought on filtration processes for the Washington water supply.* Discussed by HESS and BRADLEY.

W. N. WHITE: *Effects of the drought on wells and springs.*

Discussed by MEINZER, RUBEY, LAUTER, MCQUEEN, and THOMPSON.

H. B. HUMPHREY: *Influence of vegetation on stream flow during the drought.*—During the period September 1 to October 12, inclusive, daily observations on the rate of stream discharge were carried on by the author at his home in

Cabin John, Md. The stream, fed by springs, lies in a deep ravine and discharges into a small reservoir. In this ravine there were growing and drawing upon the water supply, at the time the readings were made, 32 trees of various species and sizes plus a fairly dense undergrowth of shrubs and annuals. It was observed that between 2:30 p.m. and 7:30 p.m. no water was discharging from the stream. Beginning at about 7:30 p.m. there was a mere trickle and the rate of discharge increased hourly until between 5:00 and 7:00 a.m. when it attained a maximum of 4.78 quarts per minute. This maximum flow was maintained until about 9:30 a.m. when it began to decline, ceasing altogether at 2:30 p.m. It was subsequently shown that this diurnal variation in stream discharge was directly related to the transpiration carried on by the dependent trees and associated plant growth. Factors, such as light and temperature, affected the water intake of the vegetation and registered their effect on the rate of stream discharge. Later, when the leaves fell from the trees and transpiration processes had ceased, the stream discharge rose to 6 quarts per minute and this rate has prevailed with occasional fluctuations due to rains. (*Author's abstract.*)

Discussed by MEINZER, SPENCER, HECKMER, MISER, and W. N. WHITE.

M. I. GOLDMAN: *Some biologic effects of the drought in tributaries of Chesapeake Bay.*—The paper was based on a report by Truitt and Algire, to the State Conservation Department of Maryland, on an unusual mortality of fishes in the Severn and Magothy Rivers. This report was very generously placed at the disposal of the speaker by Doctor Truitt.

The object of the paper was to bring out the fact that events like the drought of 1930 which, from the geological point of view, may be regarded as inherent factors in an environment rather than as catastrophic events, may account for sudden high mortalities of organisms such as might result in stratification surfaces covered with the remains of fishes or other organisms. The drought resulted in an upstream shift of salinity in Chesapeake Bay and its tributaries which, in the Susquehanna River amounted to about 30 miles, in the Potomac to about 16 miles. In small tributaries with small watersheds like the Severn and Magothy rivers the effect was even more pronounced. The mortality occurred between the 5th and 19th of November, 1930. The investigation by Truitt and Algire showed an increase of the salinity of these waters, (as indicated by the specific gravity) to about eight times normal, equivalent to a salinity about half that of normal sea water. Turbidity, pH, and other chemical and physical factors appeared normal. Seine hauls in areas in which fresh water fishes ordinarily abounded yielded only marine fishes which appeared perfectly healthy. The fishes affected were all fresh water forms. Parasitic marine isopods were found attached to the gills of most of the dead or dying fishes. There appears to be little doubt that, directly or indirectly, abnormal salinity, resulting from the drought, was responsible for the death of the fishes. (*Author's abstract.*)

Discussed by HECKMER, TRUITT, HOPKINS, and THOMPSON.

## 472ND MEETING

The 472nd meeting was held at the Cosmos Club on January 28, 1931, President MEINZER presiding.

*Informal communications:* W. H. BRADLEY compared certain fine-grained non-calcareous laminated marine sediments with recent laminated sediments of lacustrine origin, followed Rubey in interpreting the laminations in the marine sediments as probably varves resulting from a maximum summer pulse in the production of planktonic organisms, and pointed out that according to this interpretation the laminations form a basis for estimating rates of sedimentation and intervals of geologic time.

M. I. GOLDMAN called attention to two outstanding sets of joints which control the course of the Potomac River near Great Falls, this effect of jointing being disclosed by a stereo-photograph compiled from airplane views.

*Program:* C. S. ROSS: *The Valles Mountain volcanic crater, New Mexico.* Discussed by CROSS and MERTIE.

ADOLPH KNOPF: *The Engels copper district, California.*

Discussed by SHORT, LOUGHLIN, R. C. WELLS, and GREIG.

## 473RD MEETING

The 473rd meeting was held at the Cosmos Club on February 11, 1931, President MEINZER presiding.

*Informal communications:* W. C. ALDEN described large ripple marks occurring on the upstream end of a silt bar at the confluence of the Flathead River and one channel of the Stillwater River, 3 miles southeast of Kalispell, Montana. These marks were 5 to 15 feet from crest to crest by 8 to 12 inches deep, and were likened to forms described by Kindle as current ripples or mammoth ripples.

Discussed by MATTHES.

G. R. MANSFIELD showed a polished specimen of *Tempskya knowltoni*, a fern, from the Wayan formation of Cretaceous age in the Lanes Creek quadrangle, southeastern Idaho. The common fossil form consists of hundreds of stems entwined in a dense root net, the whole resembling fossilized wood.

Discussed by HESS.

*Program:* F. C. KRACEK: *Recent studies of alkali silicate systems.*

Discussed by GILLULY.

P. J. SHENON: *The Flathead mine, Montana, an unusual silver deposit.*—The Flathead mine is located 10 miles west of Flathead lake in Flathead County, Montana. It has produced over a million ounces of silver and considerable lead, and development work indicates even a greater future production. The region is underlain principally by flat lying Belt rocks of Algonkian age. Ten isolated patches of volcanic rocks, principally latite and trachyte tuffs and flows, rest upon the Belt rocks and two small exposures apparently represent outcrops of intrusive rocks. The latter are porphyrytic latites and enclose the ore at the mine. The most unusual feature of the intrusive rock is the size of its orthoclase phenocrysts, many of which are more than three inches long. In the ore many of the feldspar phenocrysts have been removed and are now represented by empty casts or casts which are partly filled with barite, silica, and in lesser amounts, a clay mineral and limonite. The ore occurs as an irregular body, 150 feet wide by 400 feet in length at its greatest dimensions. On the upper levels the ore body is roughly elliptical in horizontal plane. Vertical cross-sections show that the ore body somewhat resembles a molar tooth with one or more roots pointing downward. Inclusions of Belt rocks and irregular patches of brown nontronite mud occur through the ore.

The hypogene ore minerals include galena and a complex sulphide of silver, antimony, and bismuth, as well as pyrite and a little enargite. Argentite, covellite, and marcasite occur as supergene sulphides. Barite, quartz, clay, and alunite constitute the principal gangue minerals. More than one period of mineralization is evident. Quartz and pyrite first formed in the wall rock. Fractures were then developed which were healed principally by fine grained quartz, barite, and sulphides, in order of deposition. The evidence shows that the deposit formed at a depth of less than 400 feet and probably nearer 200 feet below the land surface and that the outline of the cellular ore approximates the outline of the hypogene mineralization. Secondary enrichment has been a very important process in the formation of the commercial ore. (*Author's abstract.*)

Discussed by Tunell, Hewett, Loughlin, and Nolan.

E. O. Ulrich: *Highlights of the past season's work in early Paleozoic stratigraphy.*

C. H. Dane, Arthur M. Piper, *Secretaries*

## SCIENTIFIC NOTES AND NEWS

The twelfth annual meeting of the American Geophysical Union and of its Sections will be held April 30 and May 1, 1931 at the headquarters of the National Academy of Sciences, Washington, D. C. A seventh Section, known as the Section of Hydrology, has been formed in the past year and will hold its first meeting under the chairmanship of O. E. Meinzer.

The American Geographical Society, Carnegie Institution of Washington, Norwegian Geophysical Institution, Wood's Hole Oceanographic Institution and the Cleveland Museum of Natural History are cooperating in the preparations for scientific work to be undertaken by the Wilkins-Ellsworth Trans-Arctic Submarine Expedition.

Dr. J. Bartels, Professor of Physics at the Forstlicher Hochschule of Eberswalde, Germany, who has been appointed a research associate of the Carnegie Institution of Washington for one year, will arrive in Washington, April 8. Dr. Bartels will undertake a study in the Department of Terrestrial Magnetism of the interpretation of terrestrial-magnetic and electric data and laboratory methods.

S. L. Seaton, former observer and radio operator on the Carnegie, expects to leave during the summer for the Huancayo Magnetic Observatory, Peru, to install equipment for an experimental radio station for which an appropriation has now been made by the Carnegie Institution of Washington.

## Obituary

Capt. Henry Martyn Paul, U.S.N., retired, died on Sunday, March 15, following a long illness. Born at Dedham, Mass., in 1851, he graduated from Dartmouth College in 1873 and from Thayer School of Civil Engineering in 1875. He served as assistant astronomer at the Naval Observatory from 1875 to 1880 and again from 1883 to 1899. In the interim he was professor of astronomy in the Imperial University, Tokyo, Japan. It is believed that he was the first to introduce the study of astronomy into a Japanese University. In 1899 he was assigned to duty in the Bureau of Yards and Docks and in 1905 he was ordered to the Naval Academy, where he taught mathematics until shortly before his retirement in 1913.

Capt. Paul was a fellow of the American Association for the Advancement of Science and a member of the Washington Academy of Sciences and of the Philosophical Society of Washington.

## OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcement of Meetings

| | |
|---|---|
| Tuesday, April 21 | The Anthropological Society |
| | The Historical Society |
| Wednesday, April 22 | The Geological Society |
| | The Medical Society |
| Saturday, April 25 | The Philosophical Society |
| Wednesday, April 29 | The Medical Society |
| Saturday, May 2 | 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.

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*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
*Treasurer:* Henry G. Avers, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings



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## 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.

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# JOURNAL

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Vol. 21 MAY 4, 1931 No. 9

PHYSICAL CHEMISTRY.—*The influence of pressure on the solubility of sodium chloride in water. A new method for the measurement of the solubilities of electrolytes under pressure.*[1] L. H. Adams and R. E. Hall, Geophysical Laboratory, Carnegie Institution of Washington.

In this paper is described a method for the determination of the solubility of a salt or other electrolyte under pressure. The method involves (1) a means for measuring the concentration of a solution in a place inaccessible to direct observation, as in a pressure apparatus, without disturbing the equilibrium between solid and liquid, and (2) a simple arrangement for obtaining saturation in a vessel that can not be shaken and is not provided with a mechanical stirrer. The concentration is determined by measuring with sufficient precision the electrical resistance of the solution, and saturation is attained by using a cell in which convection-currents readily produce complete equilibrium between solid and liquid. This method has been applied to the study of the system, $NaCl$-$H_2O$, under pressure, and some measurements on the effect of pressure on the solubility of sodium chloride have been made.

*Apparatus.* The conductivity cell, shown in Fig. 1, was constructed of Kavalier glass with platinum electrodes sealed through the sides of the narrow part of the cell, which was about 5 mm. inside diameter and about 4 cm. between electrodes. In order to obtain with saturated salt solutions a resistance that was not inconveniently low, especially in a cell small enough to go into the pressure apparatus, small ring-shaped electrodes were used. These were made by bending platinum wire of 0.4 mm. diameter into circular loops about 3 mm. outside diameter and then closing the loop by soldering with gold. The electrodes were

[1] Received March 25, 1931.

coated with platinum black in accordance with the usual procedure[2] for conductivity measurements. Outside the cell the platinum wires were fused on to gold wires in order to have the resistance of the leads as low as possible. Near the top and at the bottom of the cell, as shown in the diagram, were placed several crystals of the salt under investigation, the remainder of the space inside the cell, up to within 1.5 cm. of the top, being filled with saturated solution. The enlarged portion at the lower end of the cell was fitted with a ground joint to facilitate the placing of crystals at the bottom. It was expected that convection currents in the cell would operate in such a way as to keep the solution always saturated. Thus, if at any time the concentration were less than the equilibrium value, solid would tend to dissolve, and the more concentrated, denser, solution would sink toward the bottom of the cell. This action would continue until the solution became completely saturated. On the other hand, if for any reason the solution became supersaturated, salt would crystallize out, and the less concentrated, lighter, solution produced at the bottom of the cell would rise toward the top, until as before equilibrium was attained. Furthermore, it was expected that the attainment of equilibrium in a cell of the size and shape shown in the diagram would be sufficiently rapid to make the method a convenient one. How well this supposition was justified will be evident from some preliminary experiments, which will be described below.

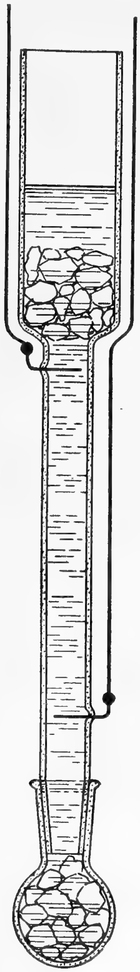

Fig. 1.—Conductivity cell for obtaining saturated solution under pressure, (about natural size).

In order to use the electrical conductivity for determining the solubility of an electrolyte[3] at various pressures it is necessary to know the conductivity over a range of concentrations in the vicinity of saturation and also over the range of pressures at which it is

[2] KOHLRAUSCH and HOLBORN. Das Leitvermögen der Elektrolyte, p. 9 (Leipzig, 1898).

[3] The application of conductivity to the analysis of solutions has been discussed in detail by KOHLRAUSCH and HOLBORN (*op. cit.*). Conductivity methods have been used to determine the progress of chemical reactions at atmospheric pressure by WALKER and KAY (J. Chem. Soc. **71**: 489. 1889) and by WALKER (Proc. Roy. Soc. **78 A**: 157. 1908), and at higher pressures by COHEN and KAISER (Zeit. phys. Chem. **89**: 338. 1915).

desired to work. Some measurements have already been made by previous investigators on the effect of pressure on the conductivity of solutions of various salts including sodium chloride, but the pressure-range was not large enough, and sufficient attention was not given to the nearly saturated solutions. Even at atmospheric pressure, although the conductivity of dilute solutions has been thoroughly investigated, the available data for concentrated solutions are so meager that they are practically valueless for measuring concentrations.

Additional measurements were therefore required. The detailed results of the investigation on the conductivity of sodium chloride solutions under pressures up to 4000 bars (metric atmospheres) and the complete description of the apparatus will be published in another paper. The conductivity-cell, surrounded by sulphur-free oil, was subjected to pressure in a steel bomb, which was placed in a thermostat, with kerosene as the liquid. The temperature was maintained at 30°, because of the inconvenience of running the thermostat at a lower temperature during the summer months. The maximum variation in temperature of the thermostat was 1 or 2 thousandths of a degree. Pressure was generated by means of a hand-pump and pressure-intensifier, and was measured with a resistance-gauge. The cell was connected to insulated leads at the top of the bomb and thence to a slide-wire bridge, which was supplied with alternating current at 1000 cycles per second. A telephone receiver served to determine the balance-point of the bridge. On account of the tendency to heating-effects in the type of cell that was used, the maximum current that could safely be passed through the cell was about 0.5 milliampere. When the limiting current is so small, sufficient sensitivity can not be obtained with the telephone alone; but by connecting a two-stage electron-tube amplifier between the bridge and the telephone[4] there is no difficulty in making the bridge-setting to within one-tenth of a division, which corresponds to a precision of 1 part in 50,000 in the resistance-measurement. This precision is quite satisfactory for electrolytic solutions, although, of course, much greater refinement is possible in the measurement of metallic resistances, with which direct current can be used.

*Test of saturation in the convection-cell.* Prior to the determination of solubility under pressure, a preliminary experiment was made to find out how well saturation would take place in the chosen type of cell. For this purpose it was sufficient to alter the conditions so that the solubility of a particular salt would be increased or decreased and to

[4] HALL and ADAMS. Journ. Am. Chem. Soc. **41**: 1515–1525. 1919.

observe the course of the conductivity with time. The simplest way to alter the solubility is by changing the temperature, and for convenience a salt with a large temperature-coefficient of solubility should be chosen. Accordingly the saturation-test was conducted as follows: The cell was nearly filled with saturated $CuSO_4$ solution, crystals of the salt being at the top and bottom, as shown in Fig. 1. It was then placed in the bomb just as it was for the measurements under pressure, and the thermostat adjusted to a temperature around 30°. After equilibrium was attained, as shown by the resistance of the cell reaching a constant value, the temperature was changed somewhat (usually one-half to one degree) and the resistance of the cell again measured at suitable intervals of time. This procedure was repeated at several temperatures so that equilibrium would be approached from both above and below and at two different temperatures. The first and large effect observed after each change of temperature was that due to the temperature-coefficient of resistance, but since the temperature had probably become quite uniform as well as constant in one-half hour or less, the subsequent drift in resistance was due to the change in concentration of the solution. Apparently this change takes place approximately according to a simple exponential relation with respect to time, so that saturation, following a rise in temperature, proceeds about half way to equilibrium in 2 hours, and is sensibly complete in 24 hours. On the other hand, after a drop in temperature about 5 hours is required for the change in concentration to reach one-half the final amount, and about 2 days to be completed. This difference in behavior in the two cases is probably connected with the way in which equilibrium is attained within the convection-cell. When the solution is unsaturated, as for example immediately after a rise in temperature, the solution proceeds to saturate itself by dissolving salt at the top, but, when it is supersaturated, salt crystallizes out at the lower end. Probably the rate at which salt will dissolve at the top is considerably greater than that at which it will crystallize at the bottom.

In Table I are summarized the results of the preliminary test of the convection-cell. The first column gives the equilibrium temperature; the second, the change in temperature immediately preceding the maintenance of constant temperature; and the third, the final value for the resistance. Each of the 8 series of measurements was continued for 2 to 8 days in order to make sure that the resistance had become constant. The average of the 4 equilibrium values at 30.05° is 247.700 ohms, and of the 4 at 30.95° is 242.240. From the fourth column of

Table I, which shows the deviation in resistance from the corresponding average, it is evident that equilibrium was attained to a very satisfactory extent. The average deviation (without regard to sign) is 0.010 ohm, and the uncertainty in the equilibrium value is therefore only about twice the uncertainty in the resistance measurements themselves.

It is important to determine what this degree of precision means in terms of the concentration of salt in the solution. From conductivity data[5] it may be calculated that at 30° with a saturated solution of $CuSO_4$ (19.6 per cent) a decrease in salt content of 1 per cent—i.e., from 19.6 to 18.6 per cent—will cause a fractional increase in resistivity of 0.023, which with a cell of 240 ohms resistance gives 5.5 ohms change for 1 per cent change in concentration. From this it follows that an uncertainty of 0.010 ohm in resistance corresponds to 0.002 per cent $CuSO_4$, and that on the average the cell came to within 0.002 per cent of the equilibrium concentration of the salt.[6] Even with the maximum discrepancy (0.020 ohm) the uncertainty is only twice as large.

TABLE I.—SUMMARY OF RESULTS OF SATURATION TEST

| Temperature (°C.) | Previous temperature change | Resistance at equil. (ohms) | Deviation of resist. from av. |
|---|---|---|---|
| 30.05 | −0.90 | 247.683 | −0.017 |
| " | +0.49 | 247.711 | + 11 |
| " | −0.90 | 247.695 | − 5 |
| " | +0.35 | 247.710 | + 10 |
| 30.95 | −0.60 | 242.235 | − 5 |
| " | +0.90 | 242.230 | − 10 |
| " | +0.90 | 242.260 | + 20 |
| " | −0.57 | 242.236 | − 4 |

These results showed quite definitely that it was feasible to obtain complete equilibrium between salt and solution in the convection-cell, and they indicated that the cell could be used with confidence in determining the solubility of a salt under pressure, because, in whatever

[5] KOHLRAUSCH and HOLBORN. *op. cit.*, p. 151.

[6] It is interesting to note the relative effects of increased temperature and increased concentration on the resistance of a cell containing a saturated solution. At 30° an increase in temperature of 1° increases the solubility of $CuSO_4$ 0.25 per cent; the cell resistance would therefore decrease 0.25 x 5.5 or 1.4 ohm due to the solubility change. Since the temperature coefficient of the resistivity of a 19.6 per cent $CuSO_4$ solution at 30° is −0.019, the decrease in resistance due to temperature change alone is 0.019 x 240 or 4.6 ohms, which is over three times the change due to increased solubility. This illustrates the importance of maintaining the temperature constant to about 0.001°.

way the solubility were altered, by pressure as well as by changes in temperature, the cell would maintain saturated solution between the electrodes.

*Experimental results with NaCl under pressure.* As mentioned above, the first step was to determine the effect of pressure on the conductivity of sodium chloride solutions at constant composition. An extensive series of measurements at pressures up to 4000 bars, at various concentrations, and at a temperature of 30°, was made with the same cell as was used in the solubility experiments, except, of course, that no solid salt was placed in the cell. The method and results for the effect of pressure on conductivity will be published in detail elsewhere.

TABLE II.—RESULTS FOR THE EFFECT OF PRESSURE ON THE SOLUBILITY OF NaCl AT 29.93°

| Pressure in bars | $R_s$, resist. of soln. satd. under pressure | $R_p$, resist. of 26.48 per cent soln. under pressure | $-\Delta R$ $(= R_p - R_s)$ | $-\frac{\Delta R}{\Delta C}$ | Increase of sol., per cent | Group Averages | |
|---|---|---|---|---|---|---|---|
| | | | | | | $P$ | $\Delta C$ |
| 1 | $58.19_0$ | $(58.18_6)$ | $(-0.00_4)$ | 0.41 | 0.00 | 1 | 0.00 |
| 293 | 58.40 | 58.49 | 0.09 | .36 | .26 | 300 | .26 |
| 307 | 58.42 | 58.51 | .09 | .36 | .26 | | |
| 412 | 58.52 | 58.63 | .11 | .35 | .32 | 412 | .32 |
| 812 | 59.03 | 59.17 | .14 | .28 | .51 | 845 | .52 |
| 877 | 59.13 | 59.27 | .14 | .27 | .53 | | |
| 1258 | 59.76 | 59.90 | .14 | .21 | .68 | | |
| 1266 | 59.77 | 59.91 | .14 | .21 | .68 | 1259 | .66 |
| 1218 | 59.70 | 59.83 | .13 | .22 | .60 | | |
| 1293 | 59.82 | 59.96 | .14 | .21 | .68 | | |
| 1437 | 60.08 | 60.22 | .14 | .19 | .75 | | |
| 1429 | 60.07 | 60.21 | .14 | .19 | .75 | 1428 | .75 |
| 1419 | 60.05 | 60.19 | .14 | .19 | .75 | | |
| 1911 | 61.05 | 61.18 | .13 | .13 | 1.01 | 1911 | 1.01 |
| 1 | $58.18_7$ | — | — | — | — | | |
| 3649 | 65.77 | 65.58 | −.19 | — | — | | |
| 3637 | 65.75 | 65.55 | −.20 | — | — | | |

Next, the cell was filled with a saturated solution of NaCl, crystals of NaCl placed at the top and bottom, and the cell put in position in the bomb which was then supported in the thermostat at (or near) 30°. Pressure was then applied and held constant while readings of the cell resistance were made at suitable intervals of time until equilibrium was attained, as shown by resistance becoming constant, after which the pressure was increased and the same procedure followed. Usually, less than 24 hours was required for the attainment of equilibrium; the time required obviously depends on the preceding increment of pressure, which ordinarily was not large. The results are presented in Table II, the second column of which shows the equilibrium resistance,

$R_s$ (in ohms), of the solution when saturated at the pressures indicated in Column 1. By interpolation from the results of the previous investigation on the conductivity of NaCl solution under pressure, the resistance, $R_p$, of a 26.48 per cent solution in the same cell at the various pressures was determined, as shown by the values in the third column. The difference, $\Delta R$, is the change in resistance caused by the change in solubility of NaCl at the given pressure.

These changes of resistance were evaluated in terms of concentration by using the values of the resistance-concentration gradient at the various pressures, as calculated from the results of the preceding investigation. For this purpose the resistances at three concentrations were determined at even values of pressure by interpolation. These values are shown in Table III and Fig. 2. For each pressure the values of $R$ and $C$ (concentration in weight per cent) were fitted to an

TABLE III.—THE EFFECT OF PRESSURE ON THE RESISTANCE OF CONCENTRATED SOLUTIONS OF NaCl AT 29.93°

| Pressure in bars | Resistance, $R$, of a cell with solution of concentration $C$ (wt. per cent) | | | $\frac{dR}{dC}$ from eqn. (at $C$ = 26.48) |
|---|---|---|---|---|
| | $C$ = 20.26 | $C$ = 23.92 | $C$ = 26.48 | |
| 1 | 64.31 | 59.85 | 58.19 | −0.41 |
| 1000 | 64.54 | 60.70 | 59.46 | −0.25 |
| 2000 | 65.74 | 62.29 | 61.38 | $-0.11_4$ |
| 3000 | 67.66 | 64.43 | 63.77 | 0.00 |
| 4000 | 70.16 | 67.08 | 66.60 | 0.1(?) |

equation, and the resistance-concentration gradient, $dR/dC$, was then determined by differentiating the equation. This operation involved much greater difficulties than had been anticipated, principally because $R$ as a function of $C$ departs so much from linearity, especially at high pressures, that it is not easy to decide what type of equation to use. Measurements at a larger number of concentrations in the region near saturation should have been made, but this fact was not fully appreciated until after the apparatus had been dismantled. The last column of Table III shows the values of $dR/dC$ (at saturation) obtained by fitting the results to the parabolic equation

$$R = a + bC + cC^2$$

in which $a$, $b$, and $c$ are constants. It may be seen that the equation demands that $R$ pass through a minimum and that at the higher pressures this minimum occurs at a concentration less than saturated. Hence, for pressures above 3000 bars, and in concentrated solutions, the resistance may actually increase with increasing concentration of

NaCl. This seemed rather surprising until it was noted that even at atmospheric pressure the resistivity of many salt solutions (e.g. $CaCl_2$) passes through a minimum at high concentrations.

Several other types of equation also were tried. The hyperbola, $R = aC + b + c/C$, gave results not very different from those obtained with the parabola, and, like it, gives a minimum in $R$ at a finite concentration. But it seems probable that the simple parabola gives the

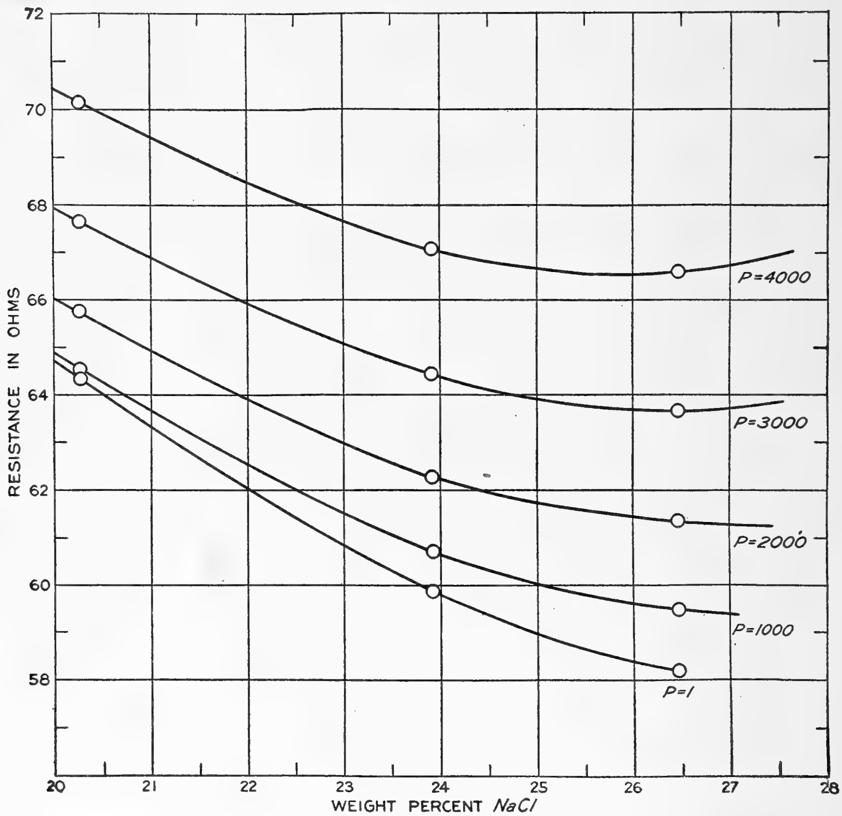


Fig. 2.—Resistance of the cell as a function of concentration at various pressures. At high pressures and in nearly saturated solutions the resistance *increases* with concentration.

best representation of the data, and, since it is somewhat more convenient to use, this type of equation was adopted. Two other three-constant equations, the hyperbola, $RC = a + bC + cR$, and the exponential, $R = a + be^{-cC}$, were tried and rejected when it was realized that this would require the values of $R$ to be asymptotic to the $C$ axis, and that this would be an arbitrary and unreasonable restraint.

The resistance-concentration gradients shown in the last column of Table III were plotted against pressure, and the values of this gradient for the various pressures, as read from the graph, are given in the fifth column of Table II. With sufficient accuracy for the present purpose the gradient at a given pressure can be considered constant throughout the small range of concentrations encountered with NaCl solutions under pressure. Therefore, from the values of $\Delta R$ and $\Delta R/\Delta C$ the change of solubility is readily obtained by simple division.

The solubility of NaCl in water at 30.00° and *atmospheric pressure* was measured by shaking a mixture of solution and salt in a mechanical shaker operating within a thermostat, withdrawing a sample of the saturated solution and analyzing it by evaporation and careful drying. The average of 4 determinations, in which equilibrium was approached in both directions, was 26.470 per cent, the maximum deviation from the average being 0.007 and the average deviation being 0.004. Hence, the solubility will be taken as 26.47 per cent, and since the change for 1° temperature increase is only 0.01, 26.47 is the solubility also at 29.93°. The most concentrated solution used in the measurements on the pressure-coefficient of resistivity was, therefore, very slighty supersaturated (by 0.01 per cent). Moreover, its concentration, 26.48 per cent, was the reference point for the values of $\Delta R$. Therefore, in order to determine the change of solubility from the values of $\Delta R$ in Table II, it is necessary to divide by $\Delta R/\Delta C$ and to add 0.01. The results of this operation are given in Column 6 and are the respective amounts by which the stated pressure has increased the solubility above the initial 26.47 per cent.

In the last two columns of Table II the values of $P$ and $\Delta C$ for those pressures which are nearly the same have been averaged together to give a single pair of values for each group. These averages are plotted in Fig. 3, which shows graphically the effect of pressure on the solubility of NaCl in water at 30°. It may be observed that although a resistance measurement of the saturated solution was made at 3600 bars this result was not evaluated in terms of solubility-change. This was because of the uncertainty connected with the value of the resistance-concentration gradient $(\partial R/\partial C)_P$ for the nearly saturated solutions at the higher pressures. With increasing pressure the gradient decreases rapidly and changes sign at about 3000 bars. This unexpected circumstance makes it difficult to obtain an entirely satisfactory set of values of $(\partial R/\partial C)_P$ from the present data. Measurements of $R$ should have been made at much smaller intervals at $C$ close to the saturation-concentration, but the full importance of this was not appreciated until after the apparatus had been dismantled. It is interesting to note, however, that the value of $\Delta R$, 0.20, at 3600 bars, as given in Table II, is consistent with other measurements. The solubility change $\Delta C$ at 3600 bars is known to be 1.2 (see below). Hence $\Delta R/\Delta C$ is $0.1_6$, which is not inconsistent with the values of this coefficient as determined directly from the conductivity measurements and as shown in the last column of Table III.

The system $NaCl$–$H_2O$ turns out to be a peculiarly unfavorable system by which to try out the method here described for determining the change of solubility under pressure. This is on account of the

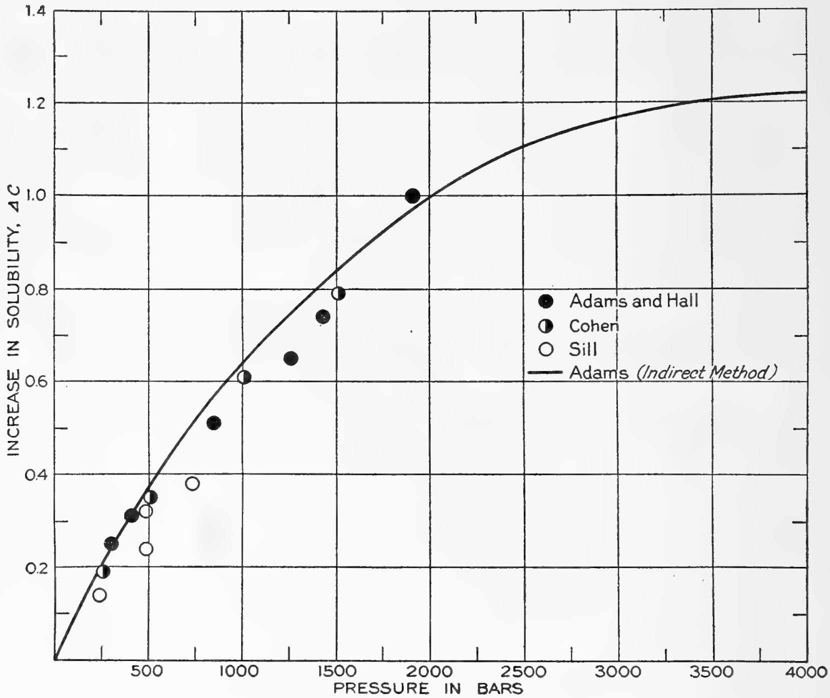


Fig. 3.—The change of solubility of NaCl with pressure. Some results of other investigators are included for comparison.

above-mentioned inversion in $(\partial R/\partial C)_P$ and also on account of the small change in solubility. Nevertheless, the results with this system are believed to be useful, and they quite justify the value and convenience of the method.

*Comparison with previous determinations.* In Fig. 3 there are also plotted the results obtained by Cohen *et al.*[7] and by Sill.[8] Cohen

[7] COHEN and SINNIGE. Zeit. phys. Chem. **67**: 432. 1909; COHEN, INOUYE, and EUWEN. *Ibid.* **75**: 257. 1911.

[8] SILL. Journ. Am. Chem. Soc. **38**: 2632. 1916.

and his collaborators used an electromagnetic stirrer within the pressure bomb. After equilibrium beween solid and solution had been attained, the bomb was quickly opened and a sample of the solution withdrawn for analysis. Sill, on the other hand, had an arrangement for shaking the bomb, which was connected to the remainder of the pressure-apparatus by means of a piece of flexible copper tubing. A sample of the saturated solution was obtained by opening a valve while the contents of the bomb were still under pressure. The methods and results of other earlier investigators[9] on solubility under pressure are of little value for comparison here, because of an inadequate pressure-range, and insufficient precision in the measurements. The curve in Fig. 3 represents the unpublished determinations (by one of the present authors) of the change in solubility of NaCl under pressure at 25° by an indirect thermodynamic method. This indirect method involves the use of the compressibility and certain other properties of NaCl solutions and solid NaCl, and will be described fully in a forthcoming paper.

The various results shown in Fig. 3 are not strictly comparable, since the present results were obtained at 29.93°, those of Cohen *et al.* at 24.05°, and those of Sill at 25.0°. On the other hand, there are good reasons for believing that in this system a few degrees change in temperature will not have much effect on the *increase in solubility* caused by a given increment of pressure. Probably the correspondence of the three sets of results would not be altered noticeably by correcting them to the same temperature.

From the diagram it may be seen that on the whole the agreement between the various determinations is satisfactory. The average discrepancy of the results by the present method is probably not as much as 0.05 gram of NaCl per 100 grams of solution. Since the principal uncertainty is in the resistance-concentration gradient, more complete measurements on the electrical conductivity of nearly saturated solutions would make worth while the recording of one more digit due to change of solubility, and would therefore considerably increase the accuracy of the results. Furthermore, with a number of other electrolytes it should be possible to obtain easily an accuracy of better than 0.005 gram per 100 grams of solution.

*Summary.* A method has been developed for determining the effect of pressure on the solubility of salts and other substances without the

[9] e.g., Favre. Compt. rend. **51**: 827, 1027. 1860; Moeller. Ann. Phys. **117**: 386. 1862; Sorby. Proc. Roy. Soc., **12**: 538. 1863, Phil. Mag. **27**: 145. 1864; Brown. Ann. Phys. **30**: 250. 1887. Zeit. phys. Chem. **1**: 258. 1887; von Stachelberg. Zeit. phys. Chem. **20**: 337. 1896.

use of a mechanical stirrer or shaking device. Essentially the method consists in measuring the electrical resistivity of the saturated solution in a special type of conductivity-cell in which a small amount of the solid is placed at the top and at the bottom and in which saturation takes place merely by convection.

Preliminary experiments at atmospheric pressure having shown that with solubility-changes induced by changes of temperature, equilibrium in the cell was attained within a reasonable time, measurements at pressures up to about 4000 bars (metric atmospheres) were made on the system, NaCl-$H_2O$, at 30°. The choice of this system turned out not to be a very happy one, because the resistance-concentration gradient (at constant pressure) in the saturated solution decreases rapidly with pressure and changes sign at 3000 bars; but although the data for the highest pressures could not be completely evaluated, the final results for the solubility-change agree satisfactorily with previous determinations by other means, and indicate that the present method is convenient and accurate.

BOTANY.—*The eastern short-stemmed leatherflowers.*[1] EDGAR T. WHERRY, University of Pennsylvania.

In current botanical manuals two species of short-stemmed broad-leaved leatherflowers are listed as present in the eastern United States, *Clematis ochroleuca* Aiton and *C. ovata* Pursh. Field studies of this group of plants in the Appalachian shale-barrens[2] and elsewhere have indicated that their relationships and ranges have been to some extent misinterpreted, as the data here recorded may serve to show.

The principal diagnostic features of the plants in question are presented in the accompanying key. Certain characters often regarded as significant have proved to be inconstant and variable, and have accordingly been omitted from consideration. For instance, leaf-terminations range from obtusish to acutish or even acuminate from one branch to another on a single plant. Again, the violet tinge on the outside of the sepals may be intense on one individual and almost lacking on another growing beside it, with intermediates elsewhere in the vicinity. Finally, dimensions of sepals and of achenes vary by 25% within any large clump, depending on the degree of maturity attained by the particular branch on which they are borne.

[1] Contribution from the Botanical Laboratory of the University of Pennsylvania. Received March 2, 1931.

[2] This JOURNAL 20: 46. 1930.

KEY TO THE EASTERN SHORT-STEMMED LEATHERFLOWERS (*Clematis* spp.)

Plant sparingly branched and small leaves relatively few; head of fruit tending to be spherical, about 6 cm. in diameter; achenes nearly symmetrical.
Under side of leaves glabrate to moderately pubescent; hairs of achene-appendages deep, or exceptionally pale, yellow; range chiefly at altitudes below 1000 feet, mostly in Piedmont.... **C. ochroleuca ovata**
Under side of leaves moderately to densely pubescent; hairs of achene-appendages pale, or exceptionally deep, yellow; range chiefly at altitudes above 1000 feet, mostly in Blue Ridge.... **C. ochroleuca sericea**
Plant copiously branched and small leaves relatively numerous; leaves glabrate.
Head of fruit nearly spherical, about 5 cm. in diameter; achenes fairly symmetrical, their appendage-hairs brown.............. **C. viticaulis**
Head of fruit spheroidal, about 4 cm. high and 6 cm. broad; achenes rather unsymmetrical, their appendage-hairs whitish.... **C. albicoma**

*Clematis ochroleuca* Aiton.—This plant varies in a number of respects from one clump to another, but the only features in which such variation shows any recognizable geographical relationships are those enumerated in the key. Two extreme variants with respect to degree of leaf-pubescence have received specific names, but in view of the complete gradation between them only varietal distinction seems justified. It is accordingly here proposed to divide this species into two varieties, as follows:

**Clematis ochroleuca ovata** (Pursh) Wherry, status novus[3]

*C. ovata* Pursh, not of current manuals
*C. integrifolia α ochroleuca* Kuntze.

The specimen on which Pursh based his specific name is preserved in the Sherard Herbarium at Oxford University, having been collected by Catesby and labelled by him with a citation from Plukenet, followed by the words "negroes head." The latter has been regarded as a locality,[4] but as Catesby did not in general add place-names to his labels, and as "nigger-head"—in allusion to the globular mass of kinky plumes—is the term universally applied to the leatherflowers by laymen in the south, it is believed to represent a common name instead.

In his work on the Natural History of Carolina, etc., Catesby did not mention this plant. Pursh[5] supposed it to have been obtained in South Carolina, Small[6] in that state or Georgia. It could equally well have come from Virginia, which was also visited by Catesby, as shown by the following quotation:[7]

"In the Year 1714 I travelled from the lower Part of St. *James's* River in *Virginia* to that Part of the *Apalatchian* Mountains where the Sources of that

[3] "*Status novus*" is believed to express the situation more accurately than the more frequently used "*combinatio nova*."
[4] Britton, Mem. Torr. Bot. Club **2**: 28, footnote. 1890; Small, Flora Southeastern U. S. 439. 1903.
[5] Pursh, Flora Amer. Sept. **2**: 736. 1814.
[6] Small, loc. cit.
[7] Catesby, Nat. Hist. Carolina, etc. **1**: v. 1731.

River rise, . . . At the Distance of twelve Miles from the Mountains we left the River, and directed our Course to the nearest of them."

The specimen in question was examined by Asa Gray, who stated[8] that it "appears to be *C. ochroleuca*, Ait." It was later compared by Messrs. Vines and Druce with material from a West Virginia shale-barren sent to England for the purpose by Dr. N. L. Britton,[9] and was concluded by them to be identical with this. Their interpretation has been adopted in current manuals, but as there is no evidence that Catesby ever reached the shale-barren region, its reconsideration seemed desirable. Accordingly, at my suggestion, Dr. and Mrs. Francis W. Pennell kindly obtained data on the specimen in October 1930, and their description of it indicates clearly that it does not represent the shale-barren plant after all. In lacking small-leaved branches, and having relatively large leaves and a spherical head of achenes with pale yellow appendage hairs, it corresponds exactly to the plant of the Virginia and Carolina Piedmont.

The range of this variety is indicated by the following county records:[10]

GEORGIA.

DeKalb: Stone Mt., *Ashe*, not dated (N)

SOUTH CAROLINA.

Abbeville: Abbeville, *Porcher*, Aug. 1898 (U)

NORTH CAROLINA.

Alamance: Graham, *Biltmore*, May 26, 1902 (U)
Caldwell: Lenoir, *Biltmore*, May 17, 1902 (U)
Davie: Farmington, *Biltmore*, Aug. 27, 1895 (U)
Guilford: High Point, *Canby*, June 1868 (N)
Halifax: Weldon, *Williamson*, April 16, 1897 (N, P)
Iredell: Statesville, *Hyams*, June 1898 (N, U)
Polk: Lynn, *Peattie*, April 19, 1919
Randolph:———, *Ashe*, June 1895 (N)
Rowan: Salisbury, many collectors and dates (N, P, U).

VIRGINIA.

Arlington: many localities north of Alexandria (G, N, P, U)
Dinwiddie: Petersburg, *Tuomey*, not dated (P)
Fairfax: many localities south of Alexandria (G, N, P, U)
Fauquier: Buckland, *Meredith*, May 25, 1922 (P, U)
Greensville: Belfield (now Emporia), *Heller*, June 19, 1893 (G, N, P, U)
Henrico: Richmond, *Burk*, July 25, 1887 (P)[11]
Spotsylvania: Fredericksburg. *Ward*, May 3, 1872 (U).

[8] Gray, Curtis's Bot. Mag. [3] **37**: pl. 6594. 1881.

[9] Britton, loc. cit.

[10] The following abbreviations are used for names of herbaria: G, Gray Herbarium; N, New York Botanical Garden; P, Academy of Natural Sciences of Philadelphia; U, U. S. National Herbarium.

[11] This specimen is especially similar in leaf outline and pubescence to the type of *C. ovata;* as Catesby would have started his 1714 trip in the vicinity of what is now Richmond, it is quite possible that they came from the same station.

PENNSYLVANIA.

Chester: London Grove (old record; no specimens seen).

NEW YORK.

Queens: Brooklyn, CAREY, May, 1841 (G, N)
Richmond: many localities on Staten Island (G, N, P, U).

**Clematis ochroleuca sericea** (Michaux) Wherry, status novus.

*C. sericea* Michaux.

*C. ochroleuca* β Torrey and Gray.

*C. integrifolia* α *ochroleuca* 2 *tomentosa* Kuntze.

Fig. 1. *Clematis albicoma* Wherry
West of Covington, Virginia, June 10, 1930.

This is the variety of *C. ochroleuca* which occurs at the higher elevations. It is characterized by its tendency toward tomentose pubescence on the leaves and pale hairs on the achene appendages. The most extreme material seen is that from Botetourt county, Virginia; the remaining records here cited are of specimens more or less transitional to the other variety.

GEORGIA.

Stevens: 5 miles west of Toccoa, *Wherry*, April 7, 1930 (P).

NORTH CAROLINA.

Forsyth: Salem, *Schweinitz*, not dated (P).

VIRGINIA.

Botetourt: Eagle Rock, *Lewis*, April 27, 1929 (P, Va. State Herbarium).
Roanoke: Roanoke, *E. G. Britton* and *Vail*, May 16–27, 1892 (G, N, P, U).

**Clematis viticaulis** Steele[12]

This species is known thus far only from the type locality, where it occurs on shale slopes along the railroad west of the tunnel. The characters listed in the key amply differentiate it.

VIRGINIA.

Bath: West of Millboro, *Steele*, Sept. 3, 1906 (N, U); *Wherry*, June 11, 1930 (P).

**Clematis albicoma** Wherry, nomen novum

*C. ovata* of current manuals, not Pursh

So far as recorded this plant was first collected on Kates Mountain by Gustav Guttenberg in 1877. The way it came to be identified with Pursh's *C. ovata* has been discussed above. It differs from that, however, in the respects enumerated in the key, and accordingly requires a new name, which is appropriately derived from its most unique character, the whitish hairs on the achene-appendages. It occurs on various shale-barrens, and has been collected from the following:

VIRGINIA.

Allegheny: $1\frac{1}{2}$ miles west of Covington, *Wherry*, June 10, 1930 (N, P).
Bath: Hot Springs, *Hunnewell*, May 11 to July 3, 1911 (G)
Southwest of Hot Springs, *Wherry*, June 10, 1930 (P).

WEST VIRGINIA.

Greenbrier: Kates Mountain, many collectors and dates (G, N, P, U).

This is to be taken as the type locality of the species, and as type specimen should be designated:

*Guttenberg*, July 31, 1877 (U).

ZOOLOGY.—*A report on some amphibians and reptiles from New York and New Jersey.*[1] CHARLES E. BURT,[2] Trinity University. (Communicated by DORIS M. COCHRAN.)

During the academic year of 1929–1930, while I was a member of the herpetological staff of the American Museum of Natural History, I took the opportunity to make occasional studies of the local amphibians and reptiles, both in New York and New Jersey; and, as a consequence of this, the following locality data and ecological annotations have been gathered.

With future continuation of the phenomenal constructive activity at present in progress in the New York City region, it is evident that

[12] Steele, Contr. U. S. Nat. Herb. **13**: 364. 1911.

[1] Received March 13, 1931.

[2] Professor of Biology, Trinity University, Waxahachie, Texas.

great ecological pressure will be brought to bear on the local fauna and that progressive extermination or succession of animal communities at many points must inevitably follow. In view of this, concise locality data on the local fauna, as opposed to generalized records, are especially needed. Noble (1927) in his "Distributional List of the Reptiles and Amphibians of the New York City Region," which presents only a preliminary statement of the general range of each of the local species, called attention to this need by writing that "Exact locality records of practically all our species are greatly desired. It is only when they are brought together that a clear picture of the distribution of our local species can be obtained."

## Salamanders

*Triturus viridescens viridescens* (Rafinesque).—On April 12 a small red eft, the land form of the common newt, was obtained 4 miles north of Alpine, Bergen County, New Jersey, among soggy, dead leaves near a semi-stagnant streamlet, which was found to contain developing egg masses of the wood frog, *Rana sylvatica.* On April 19 another example was secured near this point in the water of a stagnant, leaf-filled roadside ditch; and on this same date two others were taken 3 miles north of Engelwood, Bergen County, New Jersey, in a swampy area where they were sheltered by crevices in the rocks.

*Plethodon cinereus* (Green).—This salamander was commonly found in woods under stones and in or under rotting logs or other objects when sufficient moisture was available. It appears that in the spring there is often too much moisture for *cinereus* in the valleys, but too little on the more exposed hilltops. At this time the maximum abundance is found on the hillsides where moisture and protection are more nearly at the optimum. Later, if the summer brings drying, a migration into the valleys or a disappearance into subterranean retreats probably takes place.

In New Jersey, both dark and red-backed phases were common. On April 7 and April 12 small series were secured 4 miles north of Alpine, Bergen County, from under stones and from rotted wood on a timbered hillside above a small stream, but on April 19 a total of 114 specimens was secured here within a period of about two hours. On the latter date *cinereus* was found to occur 3 miles north of Engelwood, Bergen County. On October 12–13 specimens were collected 1 mile north of Island Heights and at Lakehurst, in Ocean County. At the last locality individuals were found in damp situations under pieces of tin, cardboard and cloth, as well as under damp bark and leaves.

In New York, a small individual secured at West Haverstraw, Rockland County, on April 12, was found to have a perfectly developed red-backed color pattern. It measured 15 mm. from snout to anus, and the tail was 10.5 mm. long (total length, 25.5 mm.). In the laboratory this small creature showed a tendency to get a running start before making the characteristic jump of the species, demonstrating this method several times. The jumps were only about an inch in length. Additional New York representatives of this salamander were obtained 1 mile south of Harriman, Orange County; 12 miles southwest of the St. George Ferry, Staten Island, Richmond County; 2 miles north of Rockland Lake, Rockland County; and at Grassy Sprain Reservoir, Westchester County. The last place was visited on June 11 and specimens were found to be scarce because of a drying of the woods.

*Plethodon glutinosus* (Green).—Several specimens of this form were removed from under flat rocks on a wooded hillside 4 miles north of Alpine, Bergen County, New Jersey, on April 12 and April 19. In this vicinity *glutinosus* apparently occupies the same general situations as the much more abundant *cinereus*.

*Pseudotriton ruber ruber* (Sonnini).—On April 7 the red salamander was found 4 miles north of Alpine, Bergen County, New Jersey; and on April 19 it was taken 3 miles south of Piermont, in the same county. At both places the species was dislodged from under flat rocks near the edge of shallow, clear, cold bodies of running water, and in each instance individuals attempted to escape by diving downward toward crevices among the rocks at the bed of the stream.

*Eurycea bislineata bislineata* (Green).—On April 7 two-lined salamanders were discovered under rocks at the border of a small stream 4 miles north of Alpine, Bergen County, New Jersey, and on April 19 others were found in a similar situation 3 miles south of Piermont (Bergen County, New Jersey). These attempted to escape by lodging under rocks in the water below. On April 12, examples were secured among soaked leaves in the pathway of seepage from a spring near a small stream 1 mile south of Harriman, Orange County, New York, and on April 16 specimens were taken in a similar habitat at Grassy Sprain Reservoir, Westchester County, New York.

*Desmognathus fuscus fuscus* (Rafinesque).—The dusky salamander was found in very moist situations under rocks or leaves near streams or pools and, upon being disturbed, it usually tried to escape by rushing toward the water. In Bergen County, New Jersey, the species was procured on April 7 near a streamlet 4 miles north of Alpine, and on April 19, near a larger flow of water 3 miles south of Piermont. The New York specimens of *fuscus* were all collected on April 12. They were found 1 mile north of Lake Tiorati, near the "Seven Lakes Drive," and 1 mile south of Harriman, both localities being in Orange County; and under rocks near a small stream on the north slope of Dunderburg Mountain, in Rockland County.

### TOADS

*Bufo americanus* Holbrook.—On April 19 this toad was taken 1 mile north of Leonia, Bergen County, New Jersey. On this cold evening many individuals were calling from an extensive fresh-water swamp in the vicinity, but only a few clasping pairs were located. The female of one such pair was laying eggs and females transferred to the laboratory deposited eggs during the night.

An examination of a series of these toads revealed some with distinct black spots below and others without such markings; but most of them had at least a few faint black spots or slaty patches on the upper chest.

*Bufo fowleri* Garman.—*Bufo fowleri* GARMAN, Bull. Essex Inst., **16**: 42. 1884 (type locality, Massachusetts).—*Bufo terrestris* BURT and BURT (not of Bonnaterre), Amer. Mus. Novitates, no. 381, 1929, p. 2 (reports from Louisiana, Texas, and Arkansas).—Through the courtesy of Mr. J. T. Nichols I had the opportunity to hear the call of *Bufo fowleri* at Garden City, Nassau County, New York, in June 1930. I recognized it at once as the same "goat-like" cry that I had heard in the Mississippi Valley the year before. The latter toads were doubtfully reported by Burt and Burt (1929) as *Bufo terrestris* on structural characters alone, but I am now convinced that they are *B. fowleri*—vocally at least! To this latter category the report of *B. woodhousii* Burt and Burt (1929) from 6 miles south of Vinton, Calcasieu County, Louisiana, which are based on young specimens, should probably also be placed.

## Frogs

*Acris gryllus* (Le Conte).—A cricket-frog was captured on October 13 at the edge of a shallow pond, 12 miles southwest of the St. George Ferry, Staten Island, Richmond County, New York.

*Hyla crucifera* Wied.—*Hyla crucifer* WIED, Reise Nord-Amer., **1**[5]: 275. 1838 (type locality, Catonment Leavenworth, "Kansas").—*Hyla crucifera* MYERS, Proc. Indiana Acad. Sci. for 1926, **36**: 338. 1927.—Spring-peepers were singing in Bergen County, New Jersey, on April 7, 19, and 28. They were abundant 1 mile north of Leonia, 1 mile north of Oradell, and at Harrington, particularly in flooded meadows where they clung to grass stems. Several specimens from the last locality had broken or incomplete crosses on their backs. In New York, *crucifera* was secured at the edge of a shallow pond 12 miles southwest of the St. George Ferry, Staten Island, Richmond County.

*Hyla triseriata* Wied.—*Hyla triseriata* WIED, Reise Nord-Amer., **1**[4]: 249. 1838 (type locality, Mt. Vernon, Ohio River, Indiana).—*Pseudacris triseriata* STEJNEGER and BARBOUR, Check List N. Amer. Amph. Reptil., ed. 2, 1923, p. 29.—In an area of flooded grass-land 1 mile north of Oradell, Bergen County, New Jersey, it was found that frogs of this species were much more wary and harder to secure than those of *Hyla crucifera* (April 19).

*Rana catesbeiana* Shaw.—On April 28 a bullfrog was found sitting in the water of a pond 1 mile north of Leonia, Bergen County, New Jersey, but the song of the species was not heard at this time.

*Rana clamitans* Latreille.—Green-frogs are common in the vicinity of the larger of the small streams at the localities given below, as well as about small lakes and ponds. On April 20 they were very hard to secure at Garfield, Bergen County, New Jersey, where they often escaped by diving. Specimens were taken in the daytime from under flat stones near streams at Queensboro Lake and 1 mile north of Lake Tiorati, in Orange County, New York, on

April 12, and on October 13 several examples, including a tadpole, were collected 12 miles southwest of the St. George Ferry, on Staten Island, Richmond County, New York.

*Rana halecina* Linnaeus.—*Rana halecina* LINNAEUS, Syst. Nat., ed. 12, pt. 1, 1766, p. 356 (first latinized binomial name for Kalm's *sillhoppetosser*, type locality, New Jersey).—BOULENGER, Proc. Amer. Acad. Arts and Sciences, **55**: 433. 1920.—BURT, Proc. Biol. Soc. Wash., **44**: 13. 1931.—*Rana pipiens* SCHREBER, Der Naturforscher, **18**: 182, pl. 4. 1782 (type locality, Pennsylvania).—Leopard frogs were calling in Bergen County, New Jersey, on April 19, where they were secured at Garfield and 1 mile north of Leonia.

*Rana sylvatica* Le Conte. On April 7 woodfrogs were not in full song at Harrington, Bergen County, New Jersey, but their notes were occasionally heard. Large egg masses were seen in a flooded meadow in this vicinity, and this indicated that the height of the mating season had passed. Examination of clusters revealed living embryos in various stages of development.

On June 11 adult woodfrogs were obtained in Donald Park, Westchester County, New York, where they sought concealment by hopping into masses of green vegetation. A pond near here sheltered *Rana clamitans*, as attested by the characteristic "zoom" which came from that quarter.

## Lizards

*Sceloporus undulatus undulatus* (Latreille).—On the sunny afternoon of October 12 pine lizards were very abundant about logs 1 mile west of Lakehurst, Ocean County, New Jersey.

*Leiolopisma laterale* (Say).—One of these little skinks was taken near a pile of brush 1 mile west of Lakehurst, Ocean County, New Jersey, in the same general habitat as *Sceloporus undulatus undulatus*.

## Snakes

*Lampropeltis triangulum triangulum* (Lacépède).—On June 11, 1930, a young specimen of this king-snake, probably of the 1929 brood, was found in the open road in Donald Park, Westchester County, New York, where a stone pile at the side of the highway probably served as its home.

*Natrix sipedon sipedon* (Linnaeus).—This water snake was captured near a stream in the vicinity of the railroad station at Tappan, Rockland County, New York, on April 15.

*Thamnophis sirtalis sirtalis* (Linnaeus).—On the sunny afternoon of October 13, one of these snakes wandered into the road from its abode at the margin of a salt marsh 1 mile west of Matawan, Monmouth County, New Jersey; and here it was easily captured.

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## ETHNOLOGY.—*The Caddo social organization and its possible historical significance.*[1] John R. Swanton, Bureau of American Ethnology.

A large number of Indian tribes, as is well known, were divided internally into social groups called *clans*, *gentes*, or *sibs*. These usually, though not invariably, bore the name of some animal, plant, or natural feature, and where this was not the case they often maintained special relations with such organisms or objects. Associations of this kind constitute what we know as totemism and have been the occasion of endless discussion.

A striking characteristic of these tribal subdivisions is the fact that they were usually perpetuated either in the male line or the female line exclusively, and the terms above mentioned have been given technical definitions accordingly, a *clan* referring to a social group perpetuated in the female line, a *gens* to one perpetuated in the male line, while *sib* is employed when one wishes to indicate either indifferently. Often the sibs in any given tribe form larger groupings for which the terms *phratry* and *moiety* are used, the latter mainly restricted to the very common condition where there are but two major classes such as are represented among the Iroquois, Choctaw, and Haida.

Divergencies from the standard are numerous, and it is always interesting to discover one of these since atypical forms usually throw more light upon the origin of the institution than those which fall into the classic categories.

When the writer was among the Caddo Indians near Anadarko, Oklahoma, about twenty years ago, he elicited some interesting information of this sort, but it has lain in manuscript because he was not then able to follow up the matter or check it. While he has not been able to verify this since, it seems worth while to make it a matter of record as there is no reason to doubt its substantial accuracy, and it suggests some important conclusions.

The living Caddo consist of remnants of two considerable con-

[1] Received March 25, 1931.

federations of five or six tribes each and two or three unattached tribes, which together occupied a large territory in parts of Louisiana, Texas, and Arkansas, where the three states meet. The speech of the two main groups differed only in a few words and some easily recognized sound shifts. The tongue, or tongues, of the isolated tribes were, on the other hand, widely divergent, but they have been long extinct and do not here concern us.

Some years before the writer's visit, Mr. James Mooney, also of the Bureau of American Ethnology, spent a short time with the Caddo and he obtained a few notes regarding their clan divisions—for descent was usually reckoned by them in the female line—which were incorporated into the article on the Kadohadacho or Caddo proper, in the Handbook of American Indians. He learned the names of ten clans, as follows: Sun, Thunder, Eagle, Panther, Raccoon, Beaver, Crow, Bear, Wolf, and Bison. Caddo Jake, the oldest Indian of the tribe living in 1912 when the writer visited them, stated that this list was correct so far as it went, but he thought it was not sufficiently extensive. At an earlier period he believed there had been still other clans.

However, particular interest attaches to information obtained from a second Caddo named White Bead whose age was almost equal to that of the man just mentioned. According to him there were but five clans, arranged in something of a caste system, with the animal esteemed most powerful at one end and the weakest at the other. In order of "strength" these clans were: Bison, Bear, Panther, Wolf, Beaver. Another irregularity was the fact that a man could marry a woman of his own clan, and vice versa, but this was evidently necessary if the facts regarding clan intermarriage were as reported. Thus, it was said that in case of marriage between a woman of a "stronger" clan and a man of a "weaker one," all of the children belonged to the former, while in case of marriage between a man of a strong clan and a woman of a weak one, the boys were allocated with their father's people and the girls with their mother's. If marriages between clans had been frequent, it is evident that the stronger ones would have gained constantly on the weaker ones to the probable extinction of some of the latter.

White Bead added that, when inter-clan marriages of this kind took place, the near relatives on each side could make fun of, and play pranks upon, each other. Nothing was thought of it if persons connected in this way used the most outrageous expressions. If a man saw another bearing this relation to him mounted on a good horse, he could order him to dismount and ride away on it himself, leaving his victim to get even at some future time as best he could.

Anciently each clan had its particular story, and all of these were supposed to fit together so as to make one narrative.

The disagreement between White Bead's information and that of Caddo Jake is not as important as might at first appear because White Bead belonged to one of the tribes of the western Caddo, the old Hasinai confederation, while Caddo Jake came from the Natchitoches tribe, from the easternmost part of the former Caddo country. These were separated sufficiently to have had quite diverse social systems.

It is also to be remembered that the Natchitoches, who seem to have preserved the stricter clan system, were not far removed from tribes similarly organized, such as the Creeks and Chickasaw. In historic

TABLE I

| | *Caddo* | *Creek* | *Chickasaw* |
|---|---|---|---|
| Bison | *tanaha* (N)[2] | *yanasa* | *yannash* |
| | *tāna'* (H) | | |
| Bear | *namtsi* (N) | *nokosi* | *nita* |
| | *nawotsi* (H) | | |
| Panther | *kĭshĭ'* | *katca* | *koi* |
| Wolf | *tāsha* | *yaha* | *nashoba* |
| Beaver | *tc!aōk* (N) | *itcha'swa* | *kinta* |
| | *t!aox* (H) | | |
| Eagle | *ĭmĭ* (N) | *lamhi* | *oñssi* |
| | *ĭwĭ* (H) | | |
| Raccoon | *ōt* | *wotko* | *shaui* |

times the latter were less remote geographically but there is reason to think that they had borrowed their own organization from the Creeks. Under such circumstances it is particularly interesting to find certain striking resemblances between the Creek and Caddo names for those animals which both employed as designations of clans. To appreciate the force of this comparison the two are placed side by side in the subjoined table along with the Chickasaw, and it is to be remembered that, when all three tribes were first known to Europeans, the Caddo and Creeks were entirely separated from each other by the Chickasaw and Choctaw (the Choctaw language being almost identical with Chickasaw). Where the Natchitoches and Hasinai languages employed different terms for the animals in question, both have been inserted and distinguished by the letters N and H.

The first of the above comparisons may be left out of consideration because one word for "bison," with slight variations, is used throughout

[2] In these words, accents and most diacritical marks have been omitted, *tc* is employed for English *ch*, *x* for German *ch*; *ñ* indicates that the preceding vowel is nasalized, and *!* that the preceding consonant has an explosive sound.

the Gulf area in languages wholly unrelated. Of the remaining six there is only one, the term for "wolf," in which the Chickasaw form seems to be somewhat nearer that employed in Caddo. The remaining terms speak for themselves. Further indication of a former more westerly location of the Creeks is furnished by the Tunica language, spoken by a small tribe between the Chickasaw and Caddo, in which the word for "bear" is identical with that of the Creeks, and still another is supplied by the Creek migration legend which refers their origin to some point west of the Mississippi. The Caddo migration legend strengthens this by assigning Caddo origins to the region about Hot Springs, Arkansas, or the territory immediately southwest of it. What we know of the ceremonial mound system of the Creeks seems also to fall in line with the theory since it was of a type found along the lower Mississippi.

But if the clan system, as exemplified particularly by the eastern Caddo, suggests Creek contact, the caste features of the Hasinai recall the old Natchez system and may indicate that the western Caddo were once on Red River south of their kindred.

### CONCLUSIONS

There are indications that the clan systems of the eastern and western Caddo differed, and that they grew up in contact with the clan system of the Creeks, probably in the territory now embraced in the State of Arkansas, but certain features of the western Caddo system suggest contact with tribes of the Natchez group, probably in what is now Louisiana. This last point is left in considerable doubt by lack of confirmation of the writer's data regarding western Caddo social organization, but that does not affect the rest of the argument. It may be found to have a bearing on the origin of the higher forms of culture on the lower Mississippi associated with the peoples loosely called "Mound Builders."

## SCIENTIFIC NOTES AND NEWS

Resignation of John E. Graf as assistant chief of the Bureau of Entomology of the Department of Agriculture, to become associate director of the National Museum was announced recently. S. A. Rohwer, assistant chief of the plant quarantine and control administration, was appointed to fill the vacancy caused by the resignation of Mr. Graf.

The Hillebrand prize of the Chemical Society of Washington has been awarded to Dr. Claude S. Hudson, professor of chemistry at the National Institute of Health of the Public Health Service, for his work on the ring structure of sugars.

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## CONTENTS

### Original Papers



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# JOURNAL

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Vol. 21 May 19, 1931 No. 10

ZOOLOGY.—*On a collection of Copepoda made in El Salvador by Samuel F. Hildebrand and Fred J. Foster of the U. S. Bureau of Fisheries.*[1] C. Dwight Marsh.

This collection consisted of 15 bottles which were collected by Mr. Hildebrand and Mr. Foster in January and February, 1924. They were taken from the following lakes: Ahuachapan, Chalchuapa, Chamico, Coatepeque, Guija, Ilopango, and Olomega. Ilopango, Coatepeque, Chamico, and Chalchuapa may be classed as deep lakes; Olomega and Ahuachapan as shallow. Hildebrand, 1925, (3),[2] found a depth of 83 meters in L. Coatepeque; he states that Chalchuapa and Chamico are quite deep, that Ahuachapan is shallow, and that Olomega has an average depth of 2 meters. He took a deep water temperature in Lake Guija at a depth of 16 meters; this may have been the maximum depth.

Juday, 1915, (4), gave descriptions and sketch maps of lakes Ilopango and Coatepeque. He found a maximum depth of 215 meters in Ilopango. In Coatepeque he found a maximum depth of 110 meters.

All the collections were made from surface waters. Following is a list of the species found.

| | |
|---|---|
| Lake Ahuachapan | *Cyclops tenuis* Marsh: *Diaptomus marshi* Juday |
| Lake Chalchuapa | *Cyclops tenuis* Marsh; *Diaptomus marshi* Juday |
| Lake Chamico | *Diaptomus siciloides* Lilljeborg |
| Lake Coatepeque | *Cyclops leuckarti* Claus; *Cyclops tenuis* Marsh |
| Lake Guija | *Cyclops albidus* Jurine; *Cyclops tenuis* Marsh; *Diaptomus* sp. all immature. |

[1] Received April 1, 1931.

[2] Numbers in parenthesis refer to papers cited in the bibliography.

| | |
|---|---|
| Lake Ilopango | *Diaptomus siciloides* Lilljeborg |
| Lake Olomega | *Cyclops leuckarti* Claus; *Diaptomus marshi* Juday. |

It will be noticed that very few species were found, but it must be remembered that the collections were made within a short period of time and can be considered as representative of only the January and February fauna. The fact that the collections were all made at the surface must also be considered, for under certain conditions most of the mature copepods are found beneath the surface. This is shown in Juday's (1915, p. 247) report of Lake Atitlan, in which no mature forms were found in the 0—5 meter collection, while large numbers appeared between 5 and 30 meters.

The special interest of these collections is in the addition to our knowledge of the distribution of these species. Juday's paper, 1915, is the only preceding paper dealing with the Copepoda of El Salvador.

### Notes in Regard to the Species

No importance attaches to the presence of *Cyclops albidus* and *Cyclops leuckarti*. Both species are cosmopolitan, and may appear in any collections.

### Cyclops tenuis Marsh

This is the first record of *C. tenuis* in El Salvador. The species was described from material collected at Calabasas, Arizona. It is closely related to *C. leuckarti* from which it is distinguished by being smaller and more slender, with few (generally four) ova in each egg sac, lack of armature of the terminal segments of the female antennae, and the form of the *receptaculum seminis*. It was found in many localities in the Panama Canal Zone, Marsh 1913, (5), Dodds, 1926, (2), and was considered one of the most characteristic species of that region. It was found in Lakes Ahuachapan, Chalchuapa, Coatepeque, and Guija. It is to be presumed that eventually it will be found in other localities in Central America and Mexico.

### Diaptomus siciloides Lilljeborg

Juday, 1915, has already reported *D. siciloides* from Lake Ilopango and Lake Coatepeque. In the Hildebrand and Foster collections it was found not only in these lakes but also in Lake Chamico. As shown by Marsh, 1929, (7), it is very widely distributed in the central and western United States. Since that publication it has been reported by Bajkov, 1930, (1), in Lake Winnepegosis, and has been found by Wright in Lake Erie. El Salvador is the most southern location and it has not been reported between that region and Texas.

In the United States, *D. siciloides* is found generally in small bodies of water. Possibly it may be somewhat significant that in El Salvador, it has, so far, appeared only in deep lakes.

### Diaptomus marshi Juday

Juday, 1915, reported *D. marshi* from Puerto Barrios and Los Amates, Guatemala, and wrote his description from material collected at those localities. Marsh, 1913, (5), reported it in the Panama Canal Zone and in 1919 (6), from Honduras. In the El Salvador collections it was found in Lakes Chalchuapa, Olomega, and Ahuachapan, and Pearse, 1915, (8), found it in Colombia. *Diaptomus columbiensis* Thiebaud 1914, (9), also collected in Colombia, is a synonym of *D. marshi*. So far as our present knowledge is concerned, it has a somewhat limited distribution, being confined to Guatemala on the north and Colombia on the south. While not found in all localities, it is not a rare species and in Lake Ahuachapan occurred in large numbers. Its preferred habitat is in shallow water or pools, while *D. siciloides*, as stated above, is found, in El Salvador, in deep bodies of water.

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## ZOOLOGY.—*Three new pumas.*[1] E. W. Nelson and E. A. Goldman, Biological Survey, U. S. Department of Agriculture.

Further study of the large American cats assigned to *Felis concolor* Linné has resulted in the segregation of three geographic races which, in addition to those recently characterized by the authors (Journ. Mamm., **10**: 345–350, November 11, 1929), seem worthy of distinctive names.

### **Felis concolor kaibabensis**, subsp. nov.

Kaibab Mountain Lion

*Type.*—From Powell Plateau, Grand Canyon National Park, Arizona (altitude 8,700 feet). No. 171186, ♂ adult, U. S. National Museum (Biological Survey collection), collected by J. T. Owens, April 15, 1911. X number 8432.

[1] Received April 15, 1931.

*General characters.*—A large, long-haired, pallid subspecies, with dark median dorsal area comparatively ill defined, the general tone, merging with less contrast than usual into that of sides of back, owing in part to a reduction of the overlying black wash present in most forms of the group; skull large, narrow, and elongated. Most closely allied to *F. c. hippolestes,* but generally paler, the dark median dorsal area less clearly defined; skull narrower. Larger than *F. c. azteca,* and differing otherwise in about the same characters as from *hippolestes.* Differing from *F. c. californica* in larger size, paler color, and relatively narrower skull. Closely resembling *F. c. browni* in color, but larger and cranial characters distinctive.

*Color.*—*Type:* Top of head, neck, and rather poorly defined median dorsal area to base of tail light tawny, very thinly and inconspicuously overlaid with black, the tawny element deepest along lower part of back and rump, paling gradually through cinnamon buff on sides of neck, shoulders, along flanks and on outer surfaces of limbs to pale pinkish buff on feet; lips, lower part of cheeks, chin, throat, chest, and inguinal region white; under surface of neck suffused with pinkish buff; belly overlaid on sides with pale pinkish buff, becoming whitish along median line; inner sides of limbs dull white, the drab basal color showing through; face in general buffy gray, with large whitish, supraorbital spots; blackish areas at base of vibrissae on sides of muzzle rather inconspicuous; ears blackish externally, broadly edged with gray extending also in a band across middle, thinly clad internally with white hairs; hairs around pads on feet brownish black; tail above light tawny, becoming dull pinkish buffy below to tip which is black, the black extending forward about three inches on upper side.

*Skull.*—Very similar to that of *F. c. hippolestes,* but narrower and relatively more elongated, less rounded in general outline as viewed from above; zygomata less widely spreading; interpterygoid fossa narrower; dentition about the same. Similar in general to that of *F. c. azteca,* but larger and differing otherwise in the same proportions as from *hippolestes.* Larger and more elongated than that of *F. c. californica,* with flatter frontal region and relatively less widely spreading zygomata. Approaching that of *F. c. browni* in narrowness, but decidedly larger, with heavier dentition.

*Measurements.*—*Skull of type* (no reliable measurements of body available): Greatest length, 216.8 mm.; zygomatic breadth, 141.6; interorbital breadth, 43.4; least width between outer walls of interpterygoid fossa, 29; alveolar length of upper canine-premolar series, 62.4; crown length of upper carnassial, 22.5.

*Remarks.*—The mountain lions of the Kaibab plateau north of the Grand Canyon of the Colorado River in northwestern Arizona, southwestern Utah and central and eastern Nevada, assigned to this subspecies, are closely allied to *F. c. hippolestes* which has an extended range from north to south in the Rocky Mountain region. While the differential characters are comparatively slight they are exhibited so consistently by the material examined that separate recognition by name seems necessary in order to clarify the relationships of neighboring forms.

### **Felis concolor anthonyi,** subsp. nov.

Venezuelan Puma

*Type.*—From Playa del Rio Base, Monte Duida, Territorio de Amazonas, southern Venezuela. No. 76935, ♂ adult, American Museum of Natural History, collected by Olalla Brothers, November 22, 1928.

*General characters.*—A large, short-haired, rusty reddish subspecies, with a massive skull. Similar in size to *F. c. wavula,* but type somewhat darker in general tone than specimens referred to that form, and skull differing in important details. Differing from *F. c. bangsi* and *F. c. söderstromi* in more rufescent coloration and cranial features.

*Color.—Type:* Upper surface of neck and median dorsal area to base of tail near ferruginous or hazel, moderately mixed with black especially on the rump, becoming light tawny on sides of neck, shoulders, along flanks and outer sides of limbs, paling to near light pinkish cinnamon on feet; lips, except near base of vibrissae, chin and throat white; under surface of neck suffused with light pinkish cinnamon; chest, inner sides of limbs, inguinal region, and median line of abdomen dull white; sides of abdomen invaded by irregular light tawny spots; top of head ferruginous mixed with black; face in general buffy brownish; a conspicuous black area at base of vibrissae; ears black externally, thinly clothed internally with whitish hairs; hairs around pads on feet blackish; tail above buffy brownish, with a blackish median line, below dull buffy becoming black all around at tip which is tufted.

*Skull.*—Size large and structure massive. Similar in general to that of *F. c. bangsi,* but much larger; interpterygoid fossa much broader; auditory bullae larger; dentition similar, but heavier. Not very unlike that of *F. c. söderstromi,* but larger; ascending branches of premaxillae ending on maxillonasal suture (premaxillary endings slightly deflected outward and incising maxillae in *söderstromi*); jugal reaching farther posteriorly, well into plane of glenoid fossa; auditory bullae larger; dentition similar but heavier. Compared with that of *F. c. wavula* the skull is broader; frontal region much broader; nasals more highly arched, less flattened anteriorly; ascending branches of maxillae less compressed, or "pinched in" laterally; interpterygoid fossa much broader; auditory bullae large as in *wavula*; dentition similar, but upper carnassial with internal cusp less prominent.

*Measurements.—Type:* Total length, 1720 mm.; tail vertebrae, 725; hind foot, 245. *Skull* (type): Greatest length, 205; zygomatic breadth, 143.5; interorbital breadth, 41.2; least width between outer walls of interpterygoid fossa, 33.3; alveolar length of upper canine-premolar series, 62.5; crown length of upper carnassial, 23.5.

*Remarks.*—Although based on a single specimen, a fine adult male, the characters presented by the type of *F. c. anthonyi* seem clearly beyond the range of individual variation in any of the forms described. From the Monte Duida region, near the upper Orinoco River, it may range into much of the upper Amazon Valley. The width of the interpterygoid fossa is remarkable and equalled in the known forms of the group only in *F. c. pearsoni* and *F. c. puma* which are widely different in other respects. This new puma is named for Mr. H. E. Anthony, Curator of Mammals, American Museum of Natural History, in recognition of his extensive explorations and research on the mammals of South America, and to whom we are indebted for the privilege of describing it.

**Felis concolor greeni,** subsp. nov.

East Brazilian Puma

*Type.*—From Curraes Novos, Rio Grande do Norte, Brazil. No. 249896, ♂ adult, U. S. National Museum (Biological Survey collection), collected by Edward C. Green, November, 1930.

*General characters.*—A small, short-haired, rich rusty reddish subspecies, with small but robust skull and remarkably small teeth. Apparently not very closely allied to any known form. Similar in general to *Felis concolor concolor*, but much smaller, and cranial characters distinctive. Not very unlike *F. c. wavula* and *F. c. osgoodi* in color, but much smaller and skull quite different.

*Color.*—*Type:* Top of head, neck, and median dorsal area to base of tail rich cinnamon rufous, very thinly mixed with black, the general rufescent tone most intense along lower part of back and rump, becoming light tawny on sides of neck, shoulders, along flanks and on outer surfaces of limbs, paling gradually to near light pinkish cinnamon on feet; lips, except near base of vibrissae, chin and throat white; chest, inner sides of limbs, and inguinal region dull whitish; abdomen whitish, the sides with irregular but rather distinct light tawny spots; face in general buffy brownish; ears blackish externally, thinly clothed internally with whitish hairs; hairs around pads on feet brownish black; tail above ochraceous tawny rather heavily mixed with black along the median line, below ochraceous buffy, the tip tapering and lacking a distinct black terminal tuft.

*Skull.*—Skull small, short, rounded and rather heavy. Similar in general to that of *F. c. concolor*, but much smaller; frontal region actually as well as relatively broader and flatter; nasals relatively narrower, more pointed posteriorly, less decurved along median line anteriorly; interpterygoid fossa relatively narower; auditory bullae relatively much smaller, more flattened, less inflated in front of meatus; jugal extending posteriorly to plane of glenoid fossa about as in *concolor;* dentition similar but much lighter, the individual teeth much smaller, except vestigial premolars and molars which are rather large. Compared with that of *F. c. wavula* the skull is smaller; frontal region broader; ascending branches of maxillae not compressed or "pinched in" laterally as in *wavula;* interpterygoid fossa narrower; auditory bullae smaller, less inflated anteriorly; dentition much lighter; upper carnassial with internal cusp less developed. In general form the skull somewhat resembles that of *F. c. osgoodi*, but is much smaller and differs in detail, the rostrum being less compressed laterally, the auditory bullae relatively smaller and dentition much lighter.

*Measurements.*—*Skull of type* (no measurements of body available): Greatest length, 189 mm.; zygomatic breadth, 132.6; interorbital breadth, 43.1; least width between outer walls of interpterygoid fossa, 26.6; alveolar length of upper canine-premolar series, 52.8; crown length of upper carnassial, 20.

*Remarks.*—*Felis c. greeni* from extreme eastern South America requires no very close comparison with any known form. In essential characters, however, it agrees so closely with the other subspecies that the use of a trinomial name seems fully warranted. It is readily distinguished by small size and remarkably small teeth. The canines are especially short and weak. The new form is named for the collector of the type, Mr. Edward C. Green, a collaborator of the Biological Survey for many years.

ENTOMOLOGY.—*On certain hymenopterous parasites of stored-grain insects.*[1] A. B. GAHAN, Bureau of Entomology. (Communicated by HAROLD MORRISON.)

The recent untimely death of my good friend and colleague, Dr. James Waterston of the British Museum, brought to an end a correspondence and in later years a warm personal friendship covering a period of more than ten years, during which time Dr. Waterston's whole-hearted and efficient cooperation was a source of very great helpfulness and pleasure to me. Shortly before his death in April, 1930, we became mutually interested in solving the identity of certain parasites of stored-grain insects and had made considerable progress when the project was interrupted. Fortunately the assistance of Dr. Ch. Ferriere, of the Imperial Bureau of Entomology, has made it possible to complete the investigation, in part at least, and the results which deal with certain species of Bethylidae are deemed worthy of publication at this time.

## BETHYLIDAE

### **Plastanoxus westwoodi** (Kieffer)

Figs. 1, 2, and 3.

*Cephalonomia formiciformis* var. Westwood, Trans. Ent. Soc. London, 1881, p. 127, pl. 6, fig. 4; male, female.

*Cephalonomia westwoodi* Kieffer, Das Tierreich, Bethylidae, 41 Lieferung, 1914, p. 248.

The species *Cephalonomia formiciformis,* which is type of the genus *Cephalonomia,* was described by Westwood in 1833[2] from specimens reared from a fungus growing in the neighbourhood of London. In 1833, Westwood republished the description and figured both sexes of the species. In his remarks he stated that he had received specimens of both sexes collected in Indian corn from Africa. In addition to figuring the winged and wingless forms of the female as well as the male of typical *formiciformis,* he published without further comment figures of the head, antenna, and wing of a male obtained from Indian corn. Apparently on the basis of Westwood's figures, Kieffer recognized the form from Indian corn as different from typical *formiciformis* and gave to it the name *Cephalonomia westwoodi* Kieffer.

Both the British Museum and the United States National Museum had accumulated a considerable number of specimens of Bethylidae reared from various lots of grain infested by beetles and some of this material obviously belonged to the genus *Cephalonomia.* Waterston found what he believed to be two species of this genus among his material and I discovered what I believed to be the same two forms in the material of the United States

[1] Received March 24, 1931.

[2] Mag. Nat. Hist., **6**: 421, fig. 55. 1833; female.

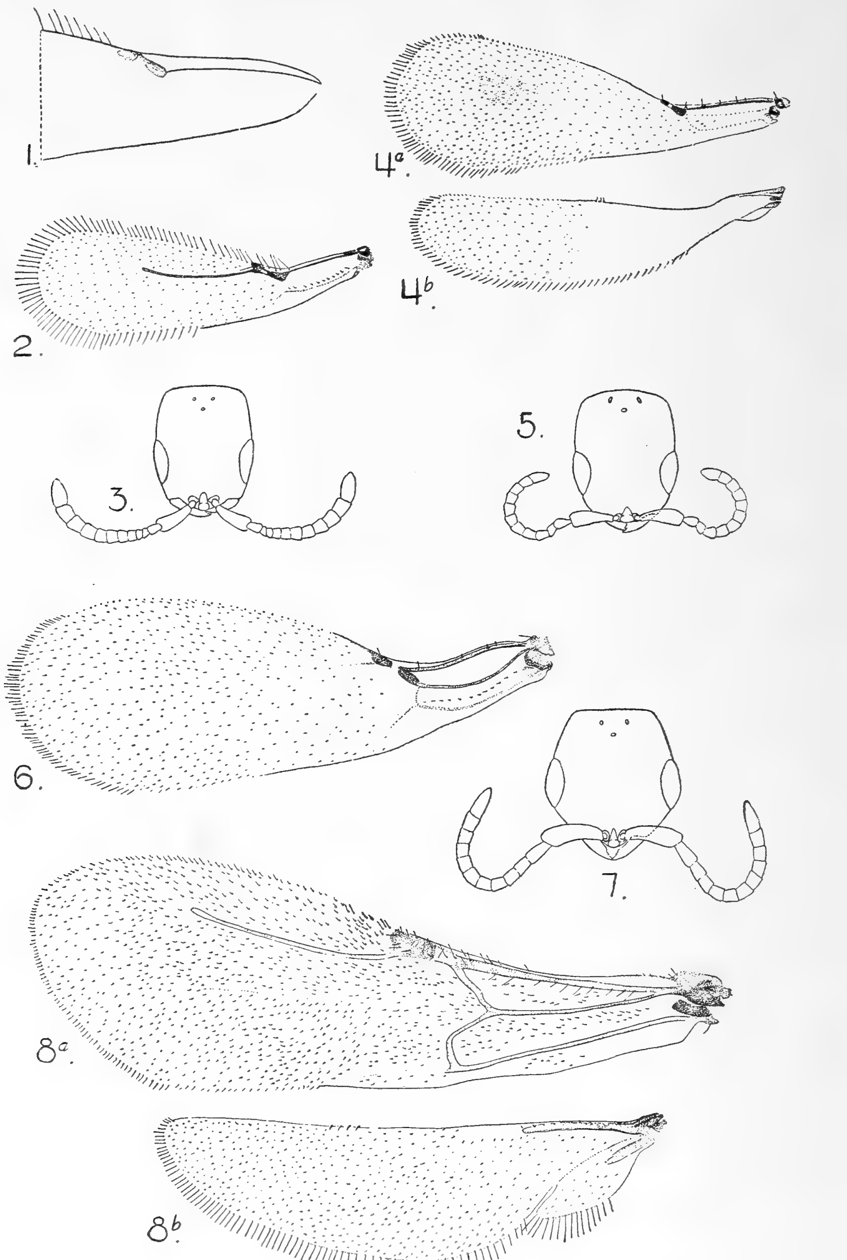


Fig. 1. Copy of Westwood's original figure of the wing of *Cephalonomia formiciformis*, variety from Indian corn, later named *Plastanoxus westwoodi* by J. J. Kieffer.

Fig. 2. *Plastanoxus westwoodi* (Kieffer). Forewing as it actually is.

Fig. 3. *Plastanoxus westwoodi* (Kieffer). Head of female.

National Museum. One of these species we recognized as being *C. tarsalis* (Ashmead). The other seemed to agree rather closely with Westwood's figures and Kieffer's description of *C. westwoodi* Kieffer. In order to settle the identity of this species the writer suggested to Waterston that he endeavor to see the type of *C. westwoodi*, which was believed to be in the Hope Museum at Oxford. Through the cooperation of Prof. E. B. Poulton of Oxford the desired specimens were located and turned over to Waterston for study. The types, which were easily identified by the labels, consisted of two females and a single male mounted on cards. After a preliminary examination of these types Waterston wrote me in January, 1930, as follows: "I have struck rather a snag regarding *Cephalonomia*. There appears to be some slight difference between the antennae of the African type specimens and the examples which you and I have gathered. I am quite convinced, however, that our gatherings contain the same forms, and I shall send you my collection whenever I have come to a definite conclusion on the matter". In February he again wrote me, saying, "I have obtained permission from Prof. Poulton to send you one of the original examples of *Cephalonomia* first described by Westwood as a variety of the common British form and later described by Kieffer. I do not think that this Westwood material is identical with our gatherings but I should like you to see the insect and form your own opinion. I am also sending you my own grain-pest material of the genus which is quite comparable with the material you have been collecting. It may interest you to see what I have". This material arrived later in good shape and proved very interesting.

At first examination the Westwood specimen, a female, appeared to be a *Cephalonomia* but did not seem to agree with either of the two species of that genus represented in the grain-pest material before me. The specimen was glued to the card in such a way that the wing venation was only partly visible. By moistening one wing very slightly it was found possible to raise it from the card without detaching it from the specimen. When examined in its original position on the card, the venation appeared almost exactly as figured by Westwood, but when raised from the card it immediately became evident that this specimen at least had a long radial vein which was entirely lacking in the figure. Since the radial vein is lacking in typical *Cephalonomia* this specimen was run through Kieffer's key to the genera of Bethylidae and found to run directly to *Plastanoxus* Kieffer, the genotype of which is *P. chittendeni* (Ashmead).

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Fig. 4. *Cephalonomia waterstoni* Gahan. a, forewing: b, hind wing.
Fig. 5. *Cephalonomia waterstoni* Gahan. Head of female.
Fig. 6. *Cephalonomia tarsalis* (Ashmead). Forewing.
Fig. 7. *Cephalonomia tarsalis* (Ashmead). Head of female.
Fig. 8. *Rhabdepyris zeae* Waterston. a, forewing: b, hind wing.
All figures greatly enlarged. Drawings were made by ELEANOR A. CARLIN, artist of the Bureau of Entomology.

When compared with the types of *chittendeni*, which are in the United States National Museum collection, the specimen proved to be congeneric but a different species.

However, a review of Westwood's original remarks revealed the specific statement that his figures of the insect from grain were drawn from the male. The question then presented itself whether the male figured by Westwood (and therefore the holotype of the species) and the female examined by me were in reality the same species. Not having seen the male type I was in no position to answer this question. In the meantime Waterston's fatal illness developed and he passed away.

Fortunately Mr. Ch. Ferriere located the male specimen in question among other material on Waterston's desk, and he has recently informed me that he has compared this specimen with the female and found them to be specifically identical in venation as well as otherwise.

It is certain therefore that the figures by Westwood of the insect from Indian corn are incomplete (see Figs. 1 and 2) and that the so-called *Cephalonomia westwoodi* Kieffer is not a *Cephalonomia* but belongs in the genus *Plastanoxus*. The species is very similar to *Plastanoxus chittendeni* but may be easily distinguished. The following key will suffice to distinguish the three known species of the genus *Plastanoxus* Kieffer. Only *P. westwoodi* is known to be a parasite of stored-grain pests.[3]

### Key to the Known Species of *Plastanoxus* Kieffer

1. Forewing with median and submedian cells complete and distinct. Propodeum with a very distinct and complete median longitudinal carina. Radial vein extending fully two-thirds of the distance to wing-apex. **P. laevis** (Ashmead)

   Forewing with median and submedian cells effaced. Propodeum without longitudinal carina. Radial vein reaching less than two-thirds of distance to apex of wing.

2. Radial vein extending a little more than half the distance from its origin to the apex of wing; head of the female viewed from in front fully one and one-half times as long as broad, about 18:11, its sides nearly parallel; female antennae short, none of the flagellar joints except the apical one longer than broad, the first and second flagellar joints distinctly broader than long, apical joint ovate and nearly twice as long as broad; male head 13:12; male antennae longer than in the female, the flagellar joints except the first and second all slightly longer than broad, first and second nearly quadrate, apical joint twice as long as broad. Eyes in both sexes situated much nearer to the mouth than to the vertex. Pronotum distinctly more than twice as long as mesoscutum; propodeum twice as long as scutellum.............. **P. westwoodi** (Kieffer)

   Radial vein extending distinctly less than half the distance from its origin to apex of wing. (Female unknown.) Head of male scarcely longer than broad, about 15:14, its sides rounded; antennae longer, all

[3] The species *Bethylus musculus* Say which is referred to *Plastanoxus* by Kieffer is known only from the original description. It may or may not belong here. It apparently differs from all of those included in the key by having the "feet honey-yellow."

flagellar joints distinctly a little longer than broad, the first and second not or scarcely shorter than the others, apical joint more than twice as long as broad. Eyes not or very little nearer mouth than vertex. Pronotum not twice as long as mesoscutum; propodeum not quite twice as long as scutellum............**P. chittendeni** (Ashmead)

*Plastanoxus kiefferi* is a slender species, 1 to 1.25 mm. in length, wholly black except the tarsi which are yellowish; head wholly smooth, impunctate, and shining; pronotum, mesoscutum, and scutellum also polished, parapsidal grooves absent; propodeum longer than broad, finely and distinctly punctate

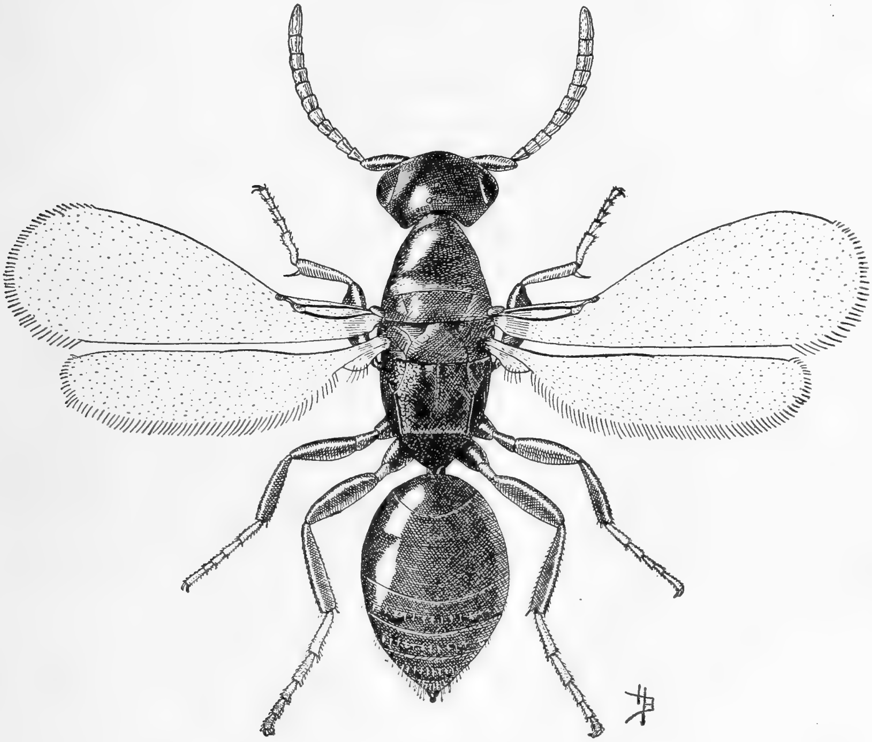

Fig. 9.—Adult female of *Cephalonomia tarsalis* Ashmead. (Greatly enlarged.) Drawing by H. Bradford.

basally, the dorsal apex mostly polished; abdomen practically smooth, the tergites beyond the first very faintly reticulated.

In addition to the type female already mentioned, the writer has seen the following material: Fourteen specimens (2 males and 12 females) in the United Station National Museum, reared at Washington, D. C., from the pupal cell of *Laemophloeus* (*Cryptolestes*) *pusillus* Schönherr, by R. T. Cotton March 16, 1925; one male in the British Museum tentatively identified by Waterston as *Cephalonomia* sp. in Reports of the Grain-Pests (War) Committee, No. 9, and shown in that report (see page 51, No. 324) to have been collected at Plymouth, England, from a shipment of grain from Sydney, Australia, which was infested by several different species of beetles, one of which was the species above named; one previously unidentified specimen, also in the British Museum, bearing the number 381, which number undoubtedly refers to the shipment of grain mentioned in the above-named report (see page 48, No. 381) as having been received at Sunderland, England, from Freemantle, Western Australia, and which was likewise infested by several species of beetles of which *L. pusillus* was one.

Apparently then *P. westwoodi* is a widely distributed species, probably occurring in Africa, Australia, and North America, and parasitic upon *Laemophloeus pusillus.*

### **Cephalonomia tarsalis** (Ashmead)

Figs. 6, 7 and 9.

*Ateleopterus tarsalis* Ashmead, Bul. U. S. Nat. Mus., **45**: 45. 1893.

*Neoscleroderma tarsale* Kieffer, in Wytsman's Gen. Ins., **76**: 41. 1908.

*Neoscleroderma tarsale* Kieffer, Das Tierreich, **41**: 270. 1914.

*Neoscleroderma tarsalis* Brues, Conn. Geol. Nat. Hist. Surv. Bul. 22, Hymenoptera, 1917, p. 610.

*Neoscleroderma tarsalis* Washburn, 17th Rept. Sta. Ent. Minn., 1918, p. 205.

*Cephalonomia kiefferi* Fouts, Proc. Ent. Soc. Wash., **22**: 71. 1920.

*Ateleopterus tarsalis* Back and Cotton, Jour. Agr. Res., **33**: 449. 1926.

? *Cephalonomia* sp. Myers, Bul. Ent. Res., **20**: 428. 1929.

*Cephalonomia tarsalis* Gahan, Proc. U. S. Nat. Mus., **77**: 11, art. 8. 1930.

This species, although closely resembling the following new species, is easily distinguished from it by the presence of a complete and distinct median cell in the forewing (Pl. I, Fig. 6). It is also slightly larger, the head is not parallel-sided but distinctly broader at middle than at either vertex or mouth, the eyes are situated at or very near the middle of head, the antennae of female longer with at least the 10th and 11th joints slightly longer than broad and the 12th about two and one-half times as long as broad.

*Female.*—Length 1.7 to 2 mm. Shining black, the antennal scape black, flagellum brown to brownish black, all tarsi and usually the anterior tibiae reddish yellow; wings hyaline, the venation brownish.

Head pronotum, mesoscutum, and scutellum with fine shallow reticulate-punctate sculpture; propodeum dorsally very distinctly and nearly uniformly reticulate-punctate and with a very distinct and usually complete median longitudinal carina; abdomen as long as thorax, ovate, smooth, the third, fourth, and fifth tergites each with an arcuate depression before the apex, this depressed area defined anteriorly by more or less of a ridge which is more prominent laterally than at middle.

*Male.*—Similar in every way to the female except that the antennae are entirely black, more slender than in female, joints 3 to 11 each twice or nearly twice as long as broad, joint 12 three times as long as broad; abdomen shorter than the thorax, ovate.

Redescribed from the types and 40 additional specimens in the United States National Museum.

*Cephalonomia tarsalis* was originally described from specimens reared from *Oryzaephilus surinamensis* (Linnaeus) collected at Lafayette, Indiana, and Washington, D. C. The above cited references by Kieffer, Brues, and Washburn are for the most part merely repetitions of this original record. Back and Cotton record the species from Washington, D. C., reared from the same host and also from Texas from an unidentified host. The types of *C. kiefferi* Fouts, which species was synonymized with *tarsalis* by Gahan in 1930, were reared from *Sitophilus oryzae* (Linnaeus) at Wellington, Kansas. The national collection contains specimens reared from *O. surinamensis* at Vienna, Virginia, by R. A. Cushman, and from Columbus, Ohio, by O. E. Gahm. Other specimens without definite host records are from Fresno, California, collected by J. C. Hamlin, Sept. 24, 1924, and W. D. Reed, Sept. 7, 1925; Saticoy, California, S. E. Flanders; Bozeman, Montana, R. A. Cooley; and Agricultural College, Michigan, D. B. Whelan. I have also seen numerous specimens, now in the British Museum, collected from shipments of infested grain during the World War and listed in Reports of the Grain Pests (War) Committee, No. 9, 1921, pp. 50–52, under the name *Cephalonomia* sp. and comprising lots numbers 201, 206, 222, 324 (in part), 358, 371, 378, 382, and 387 as there enumerated. All of these shipments of grain seem to have originated in Australia and in practically every instance either *Oryzaephilus surinamensis* or *Sitophilus oryzae* were found to be present in the shipment. In most instances both of these species were present along with other species of Coleoptera which infest stored grain.

It appears certain from the above records that *C. tarsalis* occurs in both Australia and North America and it seems highly probable that it will be found to be practically cosmopolitan. The records show only *Oryzaephilus surinamensis* and *Sitophilus oryzae* definitely established as hosts of the species but it is not improbable that other related grain-infesting beetles may be attacked.

The interesting account by J. G. Myers of *Cephalonomia* sp. attacking *Silvanus* in Australia, cited above, very probably involves this species and may also involve the following species. Myers states that Waterston recognized the species as identical with the species collected by the Grain Pests (War) Committee. Waterston, I believe, was not aware at that time that this material included two species and it is impossible to tell from Myers's account which species he had under observation.

### **Cephalonomia waterstoni,** new species

Figs. 4 and 5

Readily distinguished from *C. tarsalis* by the absence of a complete median cell in the forewing, the more nearly parallel-sided head, and the fact that the eyes are situated below the middle of the head.

*Female.*—Length 1.6 mm. Black and shining; mandibles, pedicel, and first flagellar joint more or less, and all tarsi yellowish; antennal flagellum and the tibiae brownish black; wings hyaline or with a very faint discal cloud. Head viewed from in front longer than broad (20:16), the sides nearly parallel or very slightly convex; eyes situated much nearer to mouth than to vertex, about their own length below vertex; ocelli distinct, in an equilateral triangle; whole head finely reticulate-punctate. Antennae inserted at clypeus, 12-jointed; scape two and one-half to three times as long as broad, pedicel about one and one-half times as long as broad, joints 3 to 11 subquadrate, joint 12 about twice as long as broad. Thorax flattened dorsally and with reticulate-punctate sculpture like the head; pronotum about three times the length of mesoscutum, much narrower anteriorly than posteriorly; mesoscutum without longitudinal grooves; scutellum distinctly longer than mesoscutum, with a short groove or pit on either side of base; propodeum flat, in the same plane as scutellum, as long as pronotum, distinctly narrower at apex than at base, sculptured like the thorax, finely margined laterally and at apex of dorsum, a very delicate median longitudinal carina present or absent, the lateral and posterior faces sculptured like the dorsum. Wings (see Pl. I, Fig. 5) well-developed, the prostigma and pterostigma very small, other veins except the submarginal effaced, the forewing without basal cells. Legs normal, the femora moderately swollen, the hind tarsi longer than their tibiae. Abdomen ovate, a little broader than the thorax and subequal to it in length, smooth and polished, the third tergite with a barely perceptible suggestion of a depression on each side of the middle.

*Male.*—Unknown.

*Type-locality.*—Australia.

*Type.*—Cat. No. 43361, U. S. N. M.

Described from 11 female specimens taken at quarantine in Washington, D. C., by E. A. Back from a shipment of grain the original source of which was said to be Australia; also four females collected from stored corn at Baton Rouge, Louisiana, November 12, 1928, by C. O. Hopkins, and bearing Louisiana Agricultural Experiment Station No. 1511; also one female taken at Urbana, Illinois, January 26, 1927, by W. V. Balduf.

I have likewise seen numerous specimens now in the British Museum, the same being those listed in the Royal Society's 9th Report of the Grain Pests (War) Committee, 1921, listed under the name *Cephalonomia* sp. (p. 50) and comprising the lots numbered 247, 262, 266, 347, 348, 349, 370, 384, 386, 389, and 390 of that report. According to that report one or more of the following species of Coleoptera were present in each of these shipments of grain: [*Calandra*] *Sitophilus oryzae* (Linnaeus), [*Calandra*] *Sitophilus granaria* (Linnaeus), *Tribolium castaneum* (Herbst), *T. confusum* Duval, *Rhizopertha dominica* (Fabricius), [*Silvanus*] *Oryzaephilus surinamensis* (Linnaeus), *Laemophloeus pusillus* (Schönherr), *Anthicus floralis* (Linnaeus), *Carpophilus dimidiatus* (Fabricius), *Tenebroides mauritanicus* (Linnaeus), and [*Cathartus*] *Ahasverus advena* (Waltl).

The species has not been associated with any definite host but is in all probability parasitic upon one or more of the Coleoptera which infest stored grain. It is apparently established in Australia and North America and probably occurs elsewhere.

As pointed out in discussion of *C. tarsalis*, the account by J. G. Myers of *Cephalonomia* sp. in Australia may possibly involve this species.

### **Cephalonomia meridionalis** Brèthes

*Cephalonomia meridionalis* Brèthes, An. Mus. Nac. Hist. Nat. Buenos Aires, **24:** 87. 1913.

This species is unknown to the writer. It is said to be parasitic upon [*Silvanus*] *Oryzaephilus surinamensis* (Linnaeus) in Argentina.

It apparently differs from both of the foregoing species by having the coxae testaceous.

### **Cephalonomia** sp.

Cephalonomia sp. Grandi, Bol. Lab. Ent. R. Ist. Super. Agr. Bologna, **2:** 301–314, figs. 1–9. 1929.

Grandi describes and figures a species reared from *Sitodrepa panicea* Linnaeus in Italy as *Cephalonomia* sp. He was unable to identify this insect specifically.

This species is evidently different from either *C. tarsalis* or *C. waterstoni*. The head resembles that of *waterstoni*, but the venation is more reduced, the prostigma and pterostigma apparently effaced in the alate male, while the female is wingless.

### **Rhabdepyris zeae** Waterston

*Rhabdepyris zeae* Waterston, 9th Rept. Grain Pests (War) Committee, Roy. Soc. Lond., 1921, p. 27, figs, 14 and 15; Gahan, Proc. U. S. Nat. Mus., **77:** 12, art. 8. 1930.

Originally described from a specimen taken at Liverpool, England, in a shipment of grain from Africa. The writer has recently recorded its occurrence in stored grain at Lafayette, Indiana, and Baton Rouge, Louisiana, as a probable parasite of *Tribolium confusum*. Five specimens more recently received were reared from stored grain at Brownwood, Texas, by J. L. Gardiner.

The wings of this species are figured for comparison with the other species (see Pl. I Fig. 8).

### **Parepyris sylvanidis** Brèthes

*Parepyris meridionalis* Brèthes, An. Mus. Nac. Nat. Hist. Buenos Aires, **24:** 87. 1913.

This species is unknown to me. It is said to be parasitic upon [*Silvanus*] *Oryzaephilus surinamensis* in Argentina.

*Parepyris* is characterized by Brèthes as a new and monobasic genus. At about the same time Kieffer (Boll. Lab. Zool. Portici, **7:** 108. 1913) proposed *Parepyris* as a new genus with *Epyris interruptus* Kieffer as the genotype. *Parepyris* Kieffer and *Parepyris* Brèthes are apparently different genera but the writer is unable at present to determine which has priority, as the exact date of publication of Kieffer's paper is not clear.

ENTOMOLOGY.—*Notes on* Gypona octolineata (*Say*).[1] J. W. SCRIVENER, Bureau of Entomology, U. S. Department of Agriculture. (Communicated by J. S. WADE.)

In connection with the investigations of leafhoppers that are being carried on by the Bureau of Entomology at Arlington Experiment Farm (post office, Rosslyn, Virginia), some seedling apple trees grown on the experiment farm and apparently infested with some species of leafhoppers were brought into the greenhouse January 10, 1930. By

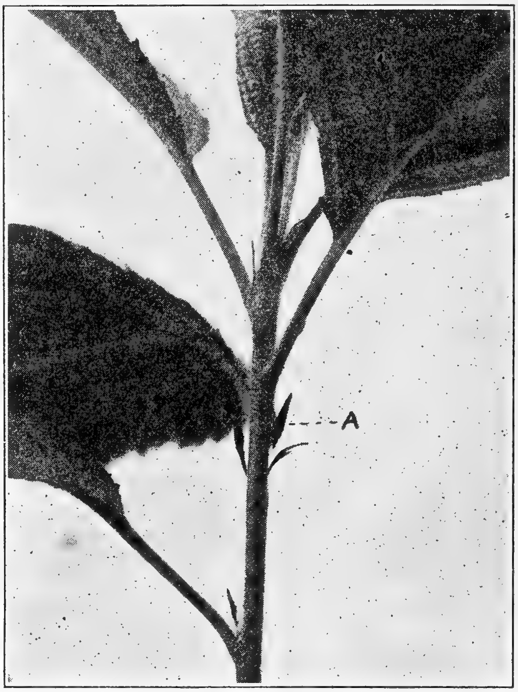


Fig. 1.—Nymph of *Gypona octolineata* on apple stem at A. When this nymph was photographed it had not settled down to feeding, so the head is not in contact with the stem; neither is the abdomen curved outward from the stem in the usual manner, in which position the mimicry of the stipules is most pronounced.

January 28 a number of nymphs of *Gypona octolineata*[2] had hatched out on them. These were kept upon seedling apple plants in celluloid cages in order that their development might be studied. The entire nymphal development of a single individual of this species was observed. It covered 38 days—from February 26 to April 5. The

[1] Received March 27, 1931.

[2] Adults of this material were kindly identified as *Gypona octolineata* Say, var. *striata* Burm., by Dr. Herbert Osborn.

temperatures in the greenhouse during this period ranged from 75° to 85°F. As stated, the leafhopper was confined upon the host plant in a small celluloid cage, but in order that it might have reasonably good host material, it was moved to a fresh leaf every four or five days. The duration of the five nymphal stages, increasing in length with each instar, were 1, 4, 5, 10, and 18 days, respectively.

The main purpose of this brief article is to record the apparent protective mimicry which is enjoyed by the nymphs of this species when they follow their normal feeding habits. When placed upon the plants many of them soon found their way to the base of the petioles of the leaves and at this point they so closely resembled the stipules (Figure 1, **A**) that anyone unaccustomed to looking for them would have had considerable difficulty in finding them. They moved about very little after they had settled down for feeding on the stem. In one instance an individual was known to have fed for three weeks in the same position. This was determined from microscopic sections of the plant material to which this individual was exposed during the period. Feeding on the stem takes place with the head downward and with the abdomen pointing upward and curving outward from the stem. In this position the leafhopper is very similar in appearance to the stipules of the plant, which are of the same green color as the nymphs.

ENTOMOLOGY.—*A revisional study of the genus* Pseudopityophthorus *Sw. in North America.*[1] M. W. BLACKMAN, Bureau of Entomology, U. S. Department of Agriculture. (Communicated by HAROLD MORRISON.)

In a former paper on the genus *Pityophthorus* Eichh. and its allies in North America the writer (1928) treated in detail the taxonomy of the genera *Myeloborus* Blackm., *Pityophthorus* Eichh., *Pityoborus* Blackm., and *Pityophilus* Blackm., gave keys to the genera of the Pityophthori (which includes *Conophthorus* Hopk., *Pseudopityophthorus* Sw., and *Gnathotrichus* Eichh. in addition to those just mentioned), and discussed in a general way the relationships of these various genera. The present paper should be considered as a continuation of the larger paper and deals with the genera *Pseudopityophthorus* Sw., while another paper on *Gnathotrichus* Eichh. will follow immediately.

This paper is based upon a study of the Scolytid material in the National Museum and in the writer's own collection.

[1] Received April 16, 1931.

## The Genus *Pseudopityophthorus* Swaine

The genus *Pseudopityophthorus* was described by Swaine (1918) as follows: "The antennal club with strongly arcuate sutures, the distal segments much wider than the first; the tibia coarsely serrate; the elytra not striate, irregularly finely punctulate; the intercoxal process of the prosternum elongate; the *male* with the front clothed with long arcuate yellow hairs. Allied to *Pityophthorus* Eichh., in which it has been included."

This description applies with exactness to the type species which is designated as *P. minutissimus* Zimmermann (1868) and applies reasonably well to all of the species in Division AA of the key on a succeeding page of the present paper. However, it does not apply in its entirety to the species in Division A, only one of which (*P. asperulus* Lec.) was known at the time Swaine's genus was erected. The members of this division differ in being usually smaller, with a more slender body, with the elytral punctures sparser and either in regular or nearly regular strial rows, with the declivity less strongly impressed, and with the septa of the antennal club subtransverse.

Before the erection of the genus *Pseudopityophthorus* by Swaine (1918) several species had been described and had been assigned to various genera by different authors.

*P. pubipennis* was first described by LeConte (1860) under the name of *Bostrichus pubipennis* from San Jose, Calif. Later LeConte (1868) referred it to the genus *Cryphalus* Er. and still later (1876) to *Pityophthorus* Eichh.

*P. minutissimus* Zimm. was described in 1868 as of the genus *Crypturgus* Er. LeConte (1868) transferred it to *Cryphalus* Er. and later (1876) to *Pityophthorus.*

*P. asperulus* Lec. was described by LeConte (1868) under the name of *Cryphalus asperulus.* Later the same author (1876) transferred it to *Pityophthorus.* Eichhoff (1878) retained it in *Pityophthorus* and placed it close to the other forms now included in *Pseudopityophthorus.* Schwarz (1886) referred to this species as *Gnathotrichus asperulus* and later writers, including Swaine (1909, 1918), have followed him. *Pseudopityophthorus gracilus* Blackm. described by the writer in 1921 should be regarded as a synonym of *asperulus* Lec.

*P. pruinosus* was described by Eichhoff (1878) from "Carolina" as of the genus *Pityophthorus. Pityophthorus querciperda* described by Schwarz (1888) is identical, as has been pointed out by Eichhoff and Schwarz (1896).

*Pityophthorus tomentosus* was described by Eichhoff (1878) from "America borealis." This species has never been recognized with certainty since, and to the present writer it seems probable that it was based on an aberrant specimen of *P. pruinosus*.

The form described as *Cryphalus pilosus* (*pilosulus*) by LeConte (1868) was by him later (1876) transferred to *Pityophthorus*, in which it was retained by Eichhoff (1878) and Swaine (1909). In 1918 Swaine placed it among the species in his genus *Pseudopityophthorus*. An examination of the type of this species indicates that it belongs to neither *Pityophthorus* nor *Pseudopityophthorus*.

Harris (1837) described *Tomicus pusillus*. LeConte (1868) suggested that this species may be identical with *minutissimus* Zimm., and Eichhoff (1878) placed the latter name as a synonym of *Pityophthorus pusillus* Har. The species described by Harris can not be recognized at the present time. The description is rather general and might equally well be applied to several small Scolytids occurring in the Northeastern States and in fact has been used by various authors for species in several genera of bark beetles. The single specimen from which the description was prepared never formed a part of Harris's own collection and has apparently long since been lost.

### Key to the Species of Pseudopityopthorus Sw.

A. Body more slender, more than 2.9 times as long as wide; elytra moderately to narrowly rounded behind, the punctures sparse to moderately numerous, in regular or nearly regular rows; declivity with second interspace weakly flattened; antennal club with septa of sutures 1 and 2 subtransverse.

- B. Front of head in male narrow, flattened, not fringed with long hairs; that of female with a frontal elevation; antenna with club nearly twice as long as funicle; pronotum more than 1.2 times as long as wide; smaller, less than 1.25 mm. long.................... **asperulus** Lec.
- BB. Front of head in male fringed with long hairs; antennal club less than 1.7 times as long as funicle; pronotum less than 1.15 times as long as wide; larger, more than 1.3 mm. long.
  - C. Elytra narrowly rounded behind; sides of pronotum not strongly constricted before the middle; antennal club with segments 2 and 3 subequal in width.
    - D. Smaller, less than 1.4 mm. long; pronotal summit not markedly lighter in color; elytral hairs nearly uniform, fine, short, semi-erect; Southeastern States........................ **fagi,** *n. sp.*
    - DD. Larger, more than 1.7 mm. long; pronotal summit notably lighter in color; elytral hairs more abundant, those from the interspaces coarser, longer, and more erect.
      - E. Pronotum with disc moderately shining, distinctly pubescent; elytra with hairs from the interspaces very long; declivity without granules; Southeastern States...... **pubescens,** *n. sp.*
      - EE. Pronotal disc brightly shining, subglabrous; elytra with interspacial hairs moderately long; declivity with interspaces finely granulate; Southwestern States............ **granulatus,** *n. sp.*

CC. Elytra moderately rounded behind; sides of pronotum arcuate behind, strongly constricted before the middle; antennal club widest through third segment........................**agrifoliae,** *n. sp.*

AA. Body stouter, less than 2.8 times as long as wide; elytra moderately to broadly rounded behind, the punctures irregular, very fine and close; declivity distinctly, often strongly impressed at each side of suture; antennal club with septa of sutures 1 and 2 strongly arcuate except in *minutissimus.*

B. Smaller, less than 1.85 mm. long; elytra moderately rounded behind; pubescence very fine, short, appressed; antennal club with segments 2 and 3 subequal in width.

C. Elytral pubescence uniform, not notably different on declivity; declivity faintly impressed at each side of suture; front of head broadly plano-concave; antennal club with septa of sutures 1 and 2 weakly arcuate; Eastern States............**minutissimus** Zimm.

CC. Elytral pubescence broader and more scalelike on the declivity; declivity distinctly impressed at each side of suture; front of head broadly plano-convex; antennal club with septa of sutures 1 and 2 moderately arcuate; Southwestern States..........**pulvereus,** *n. sp.*

BB. Larger, more than 1.85 mm. long; elytra broadly rounded behind, pubescence coarser and longer, with longer hairs on certain discal interspaces and on the declivity; antennal club widest through the third segment, with septa of sutures 1 and 2 strongly arcuate.

C. Front of head in male with an impunctate, shining, median callus; pronotum with sides feebly constricted before the middle, anterior margin very broadly rounded, disc moderately to brightly shining, more deeply, less closely punctured.

D. Elytral pubescence dense, rather short and stout, that on the declivity longer on the first and third interspaces; smaller; Eastern States............................**pruinosus** Eichh.

DD. Elytral pubescence less dense, longer and more slender, the longer hairs on the declivity slender, long, and conspicuous, but often abraded; usually much larger; Western States.

E. Disc of pronotum brightly shining, more sparsely punctured, devoid of pubescence; elytra less densely punctured, pubescence sparser; declivital hairs longer, finer, and more abundant; female frons with faint longitudinal carinal line **yavapaii,** *n. sp.*

EE. Disc of pronotum moderately shining, rather closely punctured, with very short hairs; elytra densely punctured and pubescent; declivital hairs shorter, coarser, and less abundant; female frons with small impunctate area above epistomal margin **pubipennis** Lec.

CC. Male frons without median callus; pronotum with sides strongly constricted before the middle, anterior margin narrower, the disc opaque, more closely and deeply punctured; elytra with the longer hairs of declivity rather stout................**opacicollis,** *n. sp.*

### **Pseudopityophthorus asperulus** Lec.

Figs. 1 and 2.

*Description of the adult male.*—Dark brown to black with the summit of the pronotum reddish-brown; 1.14 to 1.4 mm. long, slightly more than three times as long as wide.

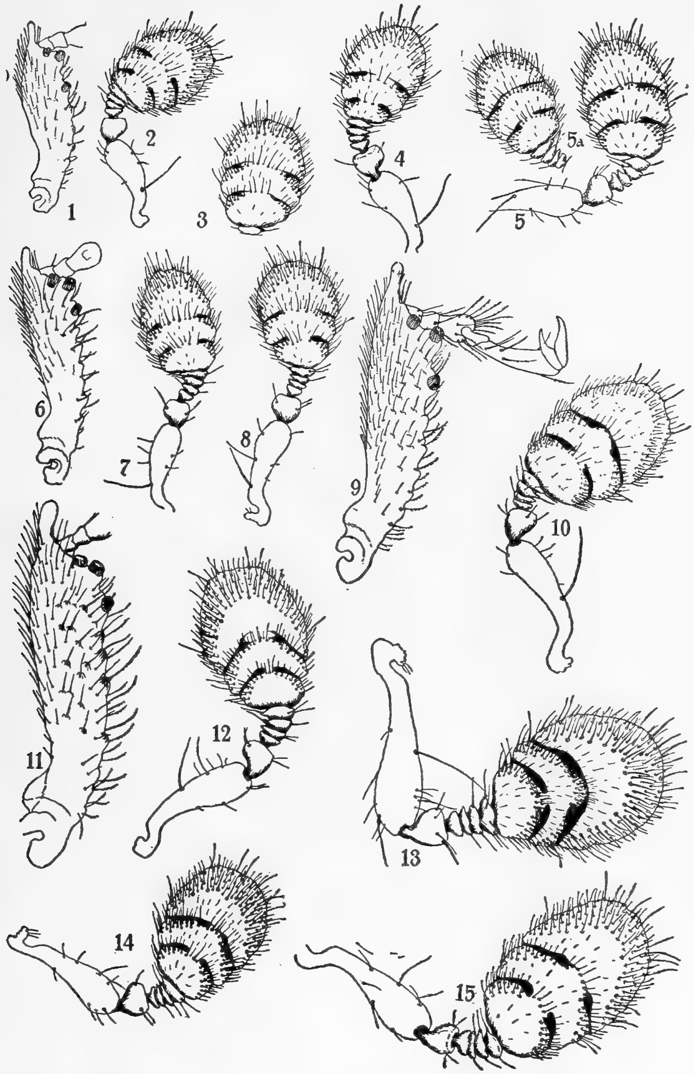


Fig. 1. Fore tibia of *Pseudopityophthorus asperulus* Lec.—Fig. 2. Antenna of *P. asperulus* Lec.—Fig. 3. Antenna of *P. fagi* n. sp.—Fig. 4. Antenna of *P. pubescens* n. sp.—Fig. 5. Antenna of *P. granulatus* n. sp. male, 5a female.—Fig. 6. Fore tibia of *P. minutissimus* Zimm.—Fig. 7. Antenna of *P. minutissimus* Zimm.—Fig. 8. Antenna of *P. agrifoliae* n. sp.—Fig. 9. Fore tibia of *P. pulvereus* n. sp.—Fig. 10. Antenna of *P. pulvereus* n. sp.— Fig. 11. Fore tibia of *P. yavapaii* n. sp.—Fig. 12. Antenna of *P. yavapaii* n. sp.—Fig. 13. Antenna of *P. pruinosus* Eichh.—Fig. 14. Antenna of *P. pubipennis* Lec.—Fig. 15. Antenna of *P. opacicollis* n. sp.

All figures were made by the writer from preparations mounted in balsam, using a compound microscope and a camera lucida. All are magnified about 112 diameters.

*Front* of head flattened on a semicircular area, shining, finely, not closely punctured, with fine, sparse, rather short, cinereous pubescence. *Eye* finely granulate, rather broadly and deeply emarginate. *Antenna* lighter in color; the club 1.9 times as long as funicle, 1.32 times as long as wide, segments 2 and 3 subequal in width, septa of sutures 1 and 2 feebly arcuate, subtransverse.

*Pronotum* one-fourth longer than wide, widest on the posterior half, with the sides weakly arcuate posteriorly, very faintly constricted before the middle, moderately narrowly rounded in front, with the anterior portion extending well beyond the front of the head; anterior margin rather strongly, regularly serrate; anterior area strongly asperate; summit moderate, much lighter in color, anterior to the middle, with a moderately well-developed, transverse impression posterior to it; posterior area moderately shining, finely, sparsely punctulate, median longitudinal line rather broad, feebly elevated.

*Elytra* subequal to pronotum in width, 1.8 as long as wide; the sides subparallel, rather narrowly rounded behind; surface shining; strial punctures minute, in fairly definite rows, each bearing an extremely minute hair (not usually visible); interspaces scarcely punctured on the disc, but on sides and declivity moderately punctured, with very fine erect hairs of moderate length. *Declivity* convex, the second interspace very feebly flattened.

The *female* is similar, but the front of the head is more roughly punctured, has a median elevation, and the hairs are smaller.

*Pseudopityophthorus gracilus* Blkm., described by the writer from Mississippi, is on the average slightly more slender and more finely punctured than the average *P. asperulus* Lec. but apparently falls within the range of variation of this species. The specific name should bé submerged.

The writer has studied specimens of this species from Maine, Massachusetts, Connecticut, New York, Pennsylvania, District of Columbia, West Virginia, North Carolina, Florida, Mississippi, Louisiana, and Texas. The various species of *Quercus* occurring in this wide territory most commonly serve as hosts, but specimens have also been studied from *Castanea dentata* and *Betula populifolia*.

### **Pseudopityophthorus fagi,** new species

Fig. 3.

*Description of the adult male.*—Dark reddish-brown; 1.37 mm. long, 3.0 times as long as wide.

*Front* of the head rather narrow, convex, slightly flattened below, the median area shining, impunctate or nearly so, densely punctured above and at the sides, and ornamented with rather long yellowish hairs which are strongly incurved and directed toward the center. *Eye* finely granulate, the inner line strongly emarginate. *Antenna* considerably lighter in color, club more than one-half longer than funicle, about one-third longer than wide, second and third segments subequal in width, septa sub-transverse.

*Pronotum* 1.15 as long as wide, the sides subparallel, faintly constricted in front of the middle, broadly rounded in front; anterior margin slightly extended, with numerous, subequal, regular serrations; anterior area finely asperate; summit moderately elevated, with the transverse impression posterior to it feebly developed; posterior area feebly shining, finely but rather deeply punctured, median longitudinal line scarcely elevated.

*Elytra* about equal in width to pronotum, 1.8 times as long as wide; the sides subparallel as far as the origin of the declivity, rather narrowly rounded behind; surface moderately shining, finely rugulose; strial punctures very fine, in slightly irregular rows; interspaces rugulose, very finely punctured. *Declivity* convex, very faintly flattened, interspaces 1 to 3 very minutely granulate-punctate. Elytral pubescence only slightly better developed on the declivity, more abundant than in *asperulus*, the hairs from the interspaces slightly longer, coarser and more erect, especially on the declivity.

The *female* is similar in size and proportions, with the front of the head wider, convex, shining, and impunctate in the median area, closely and finely punctured at the sides and above, with a few inconspicuous hairs; declivital granules absent.

*Type.*—Cat. No. 43423, U. S. N. M.

Type, allotype, and four paratypes bear the labels—"Hopk. W. Va. 7142 a a; A. D. Hopkins, Collector; Midland Farm, Morgantown, W. Va.; Nov. 26, '96; Fagus."

The type series of six specimens are all that have been seen by the writer.

**Pseudopityophthorus pubescens,** new species

Fig. 4.

*Description of the adult male.*—Dark reddish-brown, almost black, except the summit of the pronotum which is light reddish-brown; 1.8 mm. long; 2.9 times as long as wide.

*Front* of head plano-concave on an approximate circle extending from eye to eye, surface moderately shining, finely punctured, granulate-rugulose, more strongly and closely punctured at the periphery, and ornamented with a fringe of long, coarse, yellow hairs directed meso-ventrally and masking the frons. *Eye* rather finely granulate, moderately broadly and deeply emarginate on the inner line. *Antenna* much lighter in color, the club 1.65 longer than funicle, 1.32 longer than wide, third segment slightly wider than second and much wider than first; septa of sutures 1 and 2 subtransverse, weakly arcuate.

*Pronotum* 1.13 times as long as wide, the sides on the posterior half weakly arcuate, feebly constricted in front of the middle, rather broadly rounded in front; anterior margin with numerous, very broad, low serrations; anterior area with approximately concentric rows of broad, low asperities; summit reddish-brown, moderately low, central in position, with a moderately strong, transverse impression posterior to it; posterior area moderately shining, with very fine, moderately close punctures; median longitudinal line not elevated; sides and anterior area with rather long upright hairs, those on the disc less conspicuous, sparser, shorter, and finer.

*Elytra* subequal in width, one and three-fourth times as long as wide, the sides subparallel, moderately narrowly rounded behind; surface feebly shining, rugulose; the strial punctures very fine, in fairly definite rows, with short, reclinate, cinereous hairs; punctures of interspaces still more minute, more numerous, irregular in arrangement, giving origin to much longer, erect, fine hairs. *Declivity* convex, faintly impressed at each side of suture; strial hairs broad and more scalelike, the longer hairs shorter and thicker than on the disc and sides.

The *female* is similar, but the front of the head is not so strongly and broadly flattened, the punctures and pubescence are more evenly distributed, and the hairs are shorter and much finer.

*Type.*—Cat. No. 43424, U. S. N. M.

Type and one paratype bear the labels—"Hopk. U. S., 3040; Tryon, N. C.;

Castanea dentata; W. F. Fiske, Collector;" allotype and two paratypes—"Hopk. U. S. 2546-b; W. F. Fiske, Coll.; Tryon, N. C.; Dec. 16, '03; Quercus rubra;" six paratypes—"Hopk. U. S., 575; Carter Bridge, Va., White oak."

### **Pseudopityophthorus granulatus,** new species

Figs. 5 and 5a.

*Description of the adult male.*—Very dark brown to black, with the summit of the pronotum light reddish-brown; 1.8 mm. long, 3.1 times as long as wide.

*Front* of the head broadly flattened, feebly concave at the center, finely, moderately sparsely punctured, with a few, fine, moderately long, cinereous hairs, the frons more or less masked by a wisp of coarser, longer, bright yellow hairs originating from the top of the head and extending downward. *Eye* finely granulate, the inner line rather deeply emarginate. *Antenna* lighter in color, the club 1.6 times as long as the funicle, 1.4 times as long as wide, the second and third segments subequal in width, the septa subtransverse.

*Pronotum* 1.1 times as long as wide, widest on the posterior half, the sides subparallel behind, scarcely at all constricted before the middle, moderately broadly rounded in front; the anterior margin with numerous subequal, fine, regular serrations; anterior area finely asperate; summit low, with scarcely any transverse depression posterior to it, bright reddish brown, contrasting sharply with the very dark brown to black of the rest of pronotum and elytra; posterior area brightly shining, moderately finely punctured, median impunctate line slightly elevated.

*Elytra* about equal in width to pronotum, 1.9 times as long as wide; the sides subparallel as far back as the declivity, rather narrowly rounded behind; the surface moderately shining, finely rugulose; the strial punctures very minute, in regular rows, each bearing a short, semierect hair; the interspaces with the punctures more sparse, still more minute, the hairs longer, more erect, and coarser. *Declivity* convex, the suture scarcely elevated, with a sparse row of fine but distinct granules; second interspace slightly flattened, for the most part smooth, but with from two to four small granules in each; third interspace with four to six granules; the interstrial hairs only slightly longer on the declivity.

*Type.*—Cat. No. 43425, U. S. N. M.

Type allotype, and 54 paratypes bear the labels—"Prescott, N. F., Ariz., VI-10-30; M. W. Blackman collector; Hopk. U. S. 20404 R,; Quercus:" one paratype—"S. Rita Mts., 13-6, Ar.; coll. Hubbard and Schwarz."

The type series of more than 50 specimens does not show the usual secondary sexual differences. The *frons* in all of the specimens is flattened and ornamented as described above, with but little differences in the sculpture and pubescence. It would seem nearly certain, however, that both sexes are represented, as all but one specimen were taken by the writer from recently started burrows in oak twigs. Certain specimens are, however, slightly smaller, show slightly finer sculpture, have a smaller antennal club and slightly sparser frontal pubescence, and these are believed to be females.

### **Pseudopityophthorus agrifoliae,** new species

Fig. 8.

*Description of the adult male.*—Dark reddish-brown; 1.97 mm. long, 2.95 times as long as wide.

*Front* of the head convex, slightly flattened below; with moderately fine, deep punctures, with long, incurved, yellow, frontal hairs arising principally from the peripheral area at the sides and above. *Eye* finely granulate, moderately emarginate. *Antenna* much lighter in color, club 1.69 times as long as funicle, 1.3 times as long as wide; widest through the third segment, the second and first progressively narrower; septa subtransverse.

*Pronotum* 1.06 times as long as wide, widest behind the middle, the sides decidedly arcuate, distinctly constricted in front of the middle, moderately broadly rounded in front; anterior margin with numerous, regular, low serrations, those at the sides at least as coarse as those near the middle; anterior area with numerous asperities in slightly irregular concentric rows, becoming much smaller toward the summit; summit slightly higher than in *minutissimus*, with the transverse impression stronger; posterior area moderately shining, closely, very finely punctured, and finely rugulose; median line rather feebly elevated.

*Elytra* as wide as pronotum, 1.8 times as long as wide, with the sides subparallel as far back as the declivity, moderately rounded behind; surface moderately shining, finely rugulose; minutely and subregularly punctured, with indications of strial rows on the disc and sides, the pubescence cinereous, fine, short, often abraded. *Declivity* convex, suture feebly elevated; second interspace flattened, devoid of pubescence in the middle third, pubescence on declivity slightly longer.

*Type.*—Cat. No. 43426, U. S. N. M.

Type and two paratypes bear the labels—"Hopk. U. S., 11[a]; A. D. Hopkins, coll.; Golden Gate Park, Cal.; Apr. 20, 1899; Quercus agrifolia."

**Pseudopityophthorus minutissimus** Zimm.

Figs. 6 and 7.

*Description of the adult male.*—Dark reddish-brown; about 1.5 to 1.86 mm. long, 2.77 times as long as wide.

*Front* of head very broadly plano-concave on a subcircular area extending from eye to eye, surface very finely and densely reticulate, the central portion impunctate, punctured peripherally, and ornamented with rather coarse, long, incurved yellow hairs; epistomal margin broadly emarginate. *Eye* finely granulate, inner line emarginate. *Antenna* somewhat lighter in color, club 1.75 times as long as funicle, 1.4 times as long as wide, segments 2 and 3 subequal in width, the first much narrower, septa of sutures 1 and 2 subtransverse.

*Pronotum* slightly longer than wide, the sides behind subparallel, feebly arcuate, feebly constricted before the middle, rather broadly rounded in front; anterior margin with numerous sharp, regular serrations; anterior area strongly asperate, summit rather low, usually concolorous, with the transverse impression weak; posterior area subopaque to moderately shining, surface finely reticulate, very finely punctured, median longitudinal line feebly elevated.

*Elytra* as wide as pronotum, 1.68 times as long as wide, the sides subparallel, moderately rounded behind; surface feebly shining, finely rugulose; irregularly, minutely punctured, with little evidence of arrangement in strial rows, each puncture bearing a fine, short, reclining, cinereous hair, often abraded. *Declivity* convex, the suture narrow and feebly elevated, faintly flattened at each side; pubescence not notably longer or coarser.

The *female* is of about the same size and proportions, with the frontal serrations and asperities slightly finer; front of head not so widely or strongly flattened, finely and densely punctured and ornamented with very fine cinereous pubescence of moderate length, which is shorter and sparser in the median epistomal area.

This species is widely distributed and varies considerably in various localities and hosts but a long series from one locality will often show nearly the entire range of variation. As a usual thing specimens from a colder climate seem to be larger as shown by a series from West Point, New York, and another from Ute Pass, Colorado. At West Point the maximum size of 1.86 mm. is attained and the average of the series of 24 specimens is well above 1.7 mm. In series from farther south only occasional specimens exceed 1.6 mm. in length.

The writer has studied many hundreds of specimens from Massachusetts, Connecticut, New Jersey, Pennsylvania, Colorado, Maryland, District of Columbia, West Virginia, Virginia, Tennessee, Mississippi, North Carolina, and Georgia. This bark beetle breeds most commonly in the various species of *Quercus,* but specimens have also been studied from *Castanea, Betula, Fagus, Carpinus, Ostrya, Hicoria, Cornus, Hammamelis, Amelanchier,* and *Pinus* (?).

### **Pseudopityophthorus pulvereus,** new species

Figs. 9 and 10.

*Description of the adult male.*—Dark reddish-brown; 1.67 mm. long, 2.76 times as long as wide.

*Front* of the head broadly plano-convex, weakly, transversely impressed above the epistomal margin, with a median shining callus, finely and closely punctured at the sides and above, and ornamented with long, rather coarse, yellow hairs masking the frons. *Eye* finely granulate, the inner line strongly emarginate. *Antenna* somewhat lighter in color, the club twice as long as wide, the second and third segments subequal in width, the septa moderately arcuate.

*Pronotum* 1.1 times as long as wide, the sides subparallel on the posterior half, feebly constricted before the middle, broadly rounded in front; anterior margin with numerous, rather broad, low serrations; anterior area moderately asperate; summit low and the posterior transverse impression very weak; posterior area shining, very finely, rather sparsely punctulate, the median longitudinal line feebly elevated.

*Elytra* about as wide as pronotum, 1.68 times as long as wide, the sides subparallel, moderately rounded behind; surface subopaque to feebly shining, finely rugulose, closely, irregularly, minutely punctured, with no evidence of strial rows; each puncture on the disc and sides bearing a fine, short, reclining hair. *Declivity* convex, the suture slightly elevated, the region of the second interspace distinctly impressed; pubescence flattened and more scalelike.

The *female* is similar in size and proportions, but with the front of the head less strongly flattened, without a shining callus, finely, moderately closely punctured and ornamented with very fine, moderately long, cinereous hairs of nearly uniform length.

*Type.*—Cat. No. 43427, U.S.N.M.

The type and three paratypes bear the labels—"Hopk. U. S. 5580; Nov. 11, '07; J. L. Webb coll.; Chiracahua Reserve, Ariz.; Quercus:" allotype—"S. Rita Mts., 26.5, Ar.; coll. Hubbard and Schwarz."

### **Pseudopityophthorus pruinosus** Eichh.
### (**Pityophthorus querciperda** Sz.)

Figs. 13 and 14.

*Description of the adult male.*—Reddish-brown; 1.93 mm. long, 2.79 times as long as wide.

*Front* of head broadly flattened, the median area elevated, shining, impunctate, densely punctured at sides and above, and ornamented with a dense fringe of long, moderately coarse, yellow, converging hairs which mask the frons. *Eye* finely granulate, narrowly emarginate. *Antenna* considerably lighter in color, the club 1.75 times as long as funicle, 1.37 times as long as wide, the third segment wider than second and nearly twice as wide as first, the septa strongly arcuate.

*Pronotum* 1.1 times as long as wide, the sides subparallel, faintly arcuate behind, slightly constricted anterior to the middle; moderately broadly rounded in front; the anterior margin with numerous fine serrations; anterior area finely asperate, the asperities finer and reddish toward the summit, which is low; posterior area rather sparsely, finely punctured, moderately shining, nearly glabrous.

*Elytra* scarcely wider than pronotum, the sides subparallel, broadly rounded behind, surface finely, irregularly, rather densely punctured, with the abundant pubescence short and stout, less abundant near suture and more slender toward the sides of the disc. *Declivity* convex, distinctly impressed at each side of the suture, the pubescence longer and more erect on all the interspaces except the second.

The *female* is similar in size, proportions, and general appearance, but with the front of the head more convex, finely, closely punctured, and ornamented with very slender, rather short, cinerous hairs.

The above description is based partly upon a specimen from Eichhoff's type series of *P. pruinosus* and partly upon the type series of *P. querciperda* Schwarz. In connection with these the author has studied hundreds of specimens in the United States National Museum collection and in his private collection.

This species is widely distributed over the eastern portion of the country from Michigan and New York to Texas and Florida. The writer has studied specimens from Michigan, New York, New Jersey, Pennsylvania, District of Columbia, West Virginia, Tennessee, North Carolina, South Carolina, Georgia, Mississippi, Louisiana, Texas, and Florida. The various species of *Quercus* most commonly serve as the hosts, but specimens from *Castanea, Fagus, Hicoria, Carpinus, Ostrya, Acer,* and *Pinus* (?) have been examined, and all come within the limits of the species.

Probably *Pityophthorus tomentosus* Eichh. should also be considered as a synonym of *P. pruinosus* Eichh. from which it was said by Eichoff to differ especially in the pronotum being sub-inflated posteriorly. Such variations are not uncommon in long series of *pruinosus.*

### **Pseudopityophthorus yavapaii,** new species

Figs. 11 and 12.

*Description of the adult male.*—Dark reddish-brown with the disc of pronotum and often that of elytra lighter in color; 2.23 mm. long, 2.69 times as long as wide.

*Front* of the head broadly flattened from eye to eye, transversely impressed above the epistomal margin, with a median, shining, impunctate callus; the peripheral portion finely, closely punctured, and bearing hairs, those toward the center cinereous, rather fine, and of medium length, those from the outside, bright yellow, coarser, much longer, and converging over the frons so as to mask it. *Eye* finely granulate, the inner line deeply and broadly emarginate. *Antenna* much lighter in color; the club 1.75 times as long as funicle, 1.38 times as long as wide; widest through the third segment, with the second and first progressively narrower; septa strongly arcuate.

*Pronotum* slightly longer than wide, the sides subparallel, weakly arcuate behind, feebly constricted before the middle, broadly rounded in front; anterior margin with very low serrations (weaker than in *pubipennis*); anterior area with the numerous asperities very broad and low, summit low, and transverse impression weak; posterior area brightly shining, the punctures fine, more sparse than in *pubipennis,* the disc glabrous, the pubescence on the sides and in the asperate area short and much sparser than in *pubipennis*; median longitudinal line broad, not elevated.

*Elytra* nearly equal to pronotum in width, 1.68 times as long as wide; the sides subparallel, broadly rounded behind; surface shining; finely, moderately closely, irregularly punctured (more coarsely and less densely than in *pubipennis*); the pubescence similar to that of *pubipennis* but sparser. *Declivity* similar to *pubipennis,* but with the erect hairs longer, finer, and more numerous; the suture scarcely elevated, with a sparse row of minute granules.

The *females* average slightly smaller than the males, are similar in general proportions and sculpture, but have the long hairs on the declivity not so well-developed; the front of the head is less broadly flattened, devoid of the median impunctate callus, but with faint indications of a median, longitudinal carina; the hairs are finer, shorter, and evenly distributed.

*Type.*—Cat. No. 43428, U.S.N.M.

Type, allotype, and 112 paratypes bear the labels—"Prescott, N. F., Ariz. VI–10–30; M. W. Blackman, collector; Hopkins U. S. 20404-Q; Quercus:" 19 paratypes—"Hopk. U. S. 5580; J. L. Webb, collector; Chiricahua Reserve, Ariz.; Live oak:" two paratypes—"Hopk. U. S. 7189; M. Chrisman, collector; Bred, 8–9–08:" three paratypes—"Hopk. U. S. 7706; M. Chrisman, collector; Sta. Catalina Mts., Ariz.; Black Jack:" two paratypes—"S. Rita Mts., Ariz., 6–6; coll. Hubbard and Schwarz:" one paratype—"Chiric. Mts., Ariz. 19–6; coll. Hubbard and Schwarz:" one paratype—"Arizona, Morrison; coll. Hubbard and Schwarz."

### **Pseudopityophthorus pubipennis** Lec.

Fig. 14.

*Description of the adult male.*—Reddish-brown to nearly black; 2.1 to 2.3 mm. long, 2.75 times as long as wide.

*Front* of head broadly flattened, with a median, shining, smooth callus, the periphery finely, densely punctured and ornamented with a dense fringe of long, rather coarse, yellow hairs which extend downward and converge, masking the frons. *Eye* finely granulate, the inner line deeply and widely emarginate. *Antenna* somewhat lighter in color, the club about twice as long as funicle, about one-third longer than wide, widest through the third segment, with the second and first progressively narrower; the septa arcuate.

*Pronotum* slightly longer than wide, the sides rather weakly arcuate posteriorly, faintly constricted well before the middle, broadly rounded in front; anterior margin with numerous rather broad low serrations; anterior area with numerous broad low asperities; summit low with only a weak transverse impression posterior to it; summit and disc much lighter in color; posterior area moderately shining, finely, moderately closely punctured with a few very short hairs (often abraded on the disc), the sides with longer hairs; median longitudinal line broad, scarcely elevated.

*Elytra* about equal in width, 1.66 times as long as wide, the sides subparallel, broadly rounded behind; surface feebly shining, irregularly, very finely and densely punctured, rather densely clothed with cinereous recumbent hairs, with a few, longer, more erect ones, becoming more numerous and longer on the declivity. *Declivity* convex, moderately abrupt, slightly depressed at each side of the suture.

The *female* is similar in general proportions, but with the frons not so broadly flattened, and ornamented with rather fine cinereous hairs of moderate length, evenly distributed except on a small, shining, impunctate area just above the epistomal region.

The foregoing description was prepared from specimens compared with LeConte's type series.

This species is western in its distribution, the type series having been collected in California. The writer has examined several hundreds of specimens from California, Oregon, and Washington. All are from the various western species of *Quercus*.

**Pseudopityophthorus opacicollis,** new species

Fig. 15.

*Description of adult male.*—Dark brown; 2.18 mm. long, 2.7 times as long as wide.

*Front* of the head flattened from eye to eye, without median callus but with a median, impunctate, shining area just above the epistomal margin, the rest of the frons punctured and bearing hairs, those at outside much longer, coarse, and yellow, converging over and masking the frons. *Eye* finely granulate, rather deeply and widely emarginate. *Antenna* lighter in color, club more than twice as long as funicle, 1.5 times as long as wide; the third segment slightly wider than second, the first much narrower; septa strongly arcuate.

*Pronotum* scarcely longer than wide, widest behind the middle, with the sides subparallel on the posterior half; strongly constricted before the middle, moderately rounded in front; anterior margin with numerous rather broad, low serrations; anterior area with approximately concentric rows of rather coarse asperities, which are gradually reduced to concentric rugae on the rather low summit; posterior area subopaque, closely, finely, and deeply punctured, slightly more coarsely and sparsely on the sides; median longitudinal line scarcely elevated behind, more strongly anteriorly in the broad, shallow, transverse impression; pubescence on anterior area and sides moderately short, that on the disc shorter and finer.

*Elytra* similar in width to pronotum, 1.7 times as long as wide; the sides subparallel, moderately rounded behind; surface subopaque or feebly shining, rugulose; the punctures fine, rather dense, iregular, with no indications of strial lines on the disc; pubescence short, rather stout, reclining, with a very few, longer, more erect hairs on the suture and region of third interspace. *Declivity* convex, impressed at each side of the slightly elevated suture; suture and third interspace bearing longer, coarser, more erect hairs.

The *female* is of similar proportions, but the front of the head is not so strongly flattened, the median area just above the epistomal margin shining and impunctate, rather closely and finely punctured, and ornamented with fine hairs of moderate length at the sides and above.

This species is rather closely allied to both *pubipennis* Lec. and *yavapaii*, new species, but is readily distinguished by the shape and sculpture of the pronotum, the character of the longer elytral hairs, and by other differences brought out in the descriptions.

*Type.*—Cat. No. 43429, U.S.N.M.

Type, allotype, and four paratypes bear the labels—"Hopk. U. S. 5644; reared Sept. 1, 08; J. L. Webb, colr.; Sta. Catalina Mts. Ariz.;Quercus:" five paratypes—"Hopk. U. S. 7199h, 4–15–08; M. Chrisman, colr.; Sta. Catalina Mts., Ariz.; Quercus:" 23 paratypes—"Hopk. U. S. 10366-b; reared Sept. 25, 13; M. Chrisman, colr.; Sta. Catalina Mts., Ariz.; Quercus emoryi:" three paratypes—"Hopk. U. S. 10387; M. Chrisman colr.: Sta. Catalina Mts., Ariz.; Sept. 18–13, Quercus emoryi:" seven paratypes—"Hopk. U. S. 10519a; reared July 28, '13; M. Chrisman, colr.; Sta. Catalina Mts., Ariz.; Black jack and Buck acorn."

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# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## ANTHROPOLOGICAL SOCIETY

### 630TH MEETING

The 630th meeting of the Anthropological Society of Washington was held on February 17, 1931, in room 42-43 of the U. S. National Museum, President COOPER, presiding.

*Program:* HENRY B. COLLINS, JR., assistant curator of Ethnology, U. S. National Museum: *Archaeological explorations on St. Lawrence Island, Alaska.*—From June 20th to October 20th excavations were carried on at the sites of five abandoned Eskimo villages within a mile of Gambell, at the northwestern extremity of St. Lawrence Island, Bering Sea. The villages are situated on a gravel spit which extends westward from Cape Chibukak (Sevuokok). A series of old beach lines shows the manner in which the spit was built up, and the positions of the several old villages in relation to these former beach lines and the present sea affords preliminary evidence of their respective antiquity. The oldest site was not known to the present Eskimos. It was on the lower slope of the mountain and was completely covered over with sod, moss, and rocks. It proved to be a site of pure Old Bering Sea Culture, a very old Eskimo culture previously known only from a relatively few elaborately decorated objects of ivory that had been found at various places in northern Alaska and northeastern Siberia. Situated on the gravel spit immediately below this old village and within the three earliest beach lines, was the next oldest site, known to the Eskimos as Miyowaghameet. The lower strata of the midden yielded only Old Bering Sea material, but above it were found objects decorated in the Punuk style, which in 1928 and 1929 had been recognized as an intermediate stage between the Old Bering Sea art and the modern. The next oldest villages, Ievoghiyogameet and Seklowaghyoget had only Punuk art; there was likewise evidence of a progressive simplification in harpoon heads. At the latest site, which was not entirely abandoned until about 40 years ago, simplification of harpoon types continued, resulting finally in the modern form; art was also of the modern type. Ten houses were excavated, one or more at each old village, showing that three types of houses had been in use on St. Lawrence Island in prehistoric times. Additional evidence of the relation of the Thule and Old Bering Sea cultures was afforded by the finding of Thule harpoon heads only at the three latest villages. (*Author's Abstract.*)

FRANK H. H. ROBERTS JR., *Secretary.*

# SCIENTIFIC NOTES AND NEWS

A. WETMORE has been elected an honorary member of the Societé Orthologique et Mammalogique de France.

The Langley Gold Medal for Aerodromics has been presented by the Regents of the Smithsonian Institution to Admiral EVELYN BYRD.

Through a cooperative arrangement between the Physikalische-Technische Reichsanstalt and the National Bureau of Standards, an exchange of personnel has been arranged for the purpose of promoting work on fundamental standards. Dr. F. Henning of the Physikalische-Technische Reichsanstalt is studying at the Bureau of Standards the proposal of the Bureau that the emission from a black body at the freezing point of platinum be adopted as the primary standard of light. Dr. Henning will take part in measurements of the emission of a black body at the freezing point of platinum and also at the freezing point of iridium, if such an extension is found desirable.

Dr. G. W. Vinal of the staff of the Bureau of Standards is proceeding to the Reichsanstalt to engage in intercomparisons of the national standards of electromotive force and in work on the improvement of standard cells.

There have just been published the first three volumes of the series *The Physics of the Earth* as bulletins of the National Research Council by the Division of Physical Sciences with the cooperation of the Division of Geology and Geography and the American Geophysical Union. The volumes already published include *Volcanology*, *The Figure of the Earth*, and *Meteorology*. There is also in press a fourth volume of the series on *The Age of the Earth*, which will be issued about the middle of April.

The submarine Nautilus, formerly the U. S. S. O–12, was christened by Lady Wilkins at the Brooklyn Navy Yard on March 24, 1931, there being about 800 guests present to witness the ceremony. It will be recalled that this vessel is to be used by the Wilkins-Ellsworth Trans-Arctic Submarine Expedition during the coming summer.

With the cooperation of the Mountain States Telephone and Telegraph Company and the American Telephone and Telegraph Company, there is being installed at the Tucson Magnetic Observatory by the U. S. Coast and Geodetic Survey and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington recording apparatus for measuring earth-currents. W. J. Rooney of the Department of Terrestrial Magnetism is installing the apparatus at the Observatory. The two lines involved extend northward from Tucson approximately 35 miles in an air-line to Mammoth and eastward approximately 56 miles in an airline to Wilcox.

The American Physical Society held meetings April 30 and May 1, 1931, at the Bureau of Standards, Washington, D. C., and May 2 in the National Academy-Research Council Building, Washington, D. C.

The American Section of the International Scientific Radio Union held a meeting in the National Academy-Research Council Building, Washington, D. C., on May 1, 1931.

## OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcement of Meetings

| | |
|---|---|
| Wednesday, May 20 | The Medical Society |
| Thursday, May 21 | The Academy |
| Saturday, May 23 | The Philosophical Society |
| Wednesday, May 27 | The Geological Society |
| | The Medical Society |
| Saturday, May 30 | The Biological Society |
| Thursday, June 4 | 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:* N. A. Cobb, Bureau of Plant Industry.
*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
*Treasurer:* Henry G. Avers, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings




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# WASHINGTON ACADEMY OF SCIENCES



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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.

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* 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. 21 June 4, 1931 No. 11

GEOPHYSICS.—*Tidal phenomena in Long Island Sound.*[1] Embert A. LeLacheur, U. S. Coast and Geodetic Survey. (Communicated by W. D. Sutcliffe.)

The earliest tide observations on record in Long Island Sound were made in 1835. Tidal currents were first observed in this waterway in 1845. A study of the observational data from 150 tide stations and over 300 current stations in this region has resulted in information concerning the tidal phenomena in this waterway which should prove to be of considerable value to the navigator, the scientist and the engineer.

The tide in Long Island Sound is derived from that of the North Atlantic Ocean and, as inferred from the results of observations mentioned above, consists primarily of a stationary wave. According to the stationary-wave theory of tides, advanced by R. A. Harris, regional oscillatory areas are located in various portions of the oceans as the origin of the dominant tides, these oscillations being set up and maintained by the periodic tidal forces of the sun and moon. Therefore, the tides of any region are caused by the stationary-wave oscillation of that particular region and the tides of areas not capable of sustaining a stationary wave are caused by a progressive wave from an oscillating system of the open ocean.[2]

For a body of water to support a stationary tidal wave its period of oscillation should be nearly the same as that of the tide, or approximately 12 hours. If the period of oscillation for Long Island Sound be

[1] Received April 25, 1931. Presented before the Philosophical Society of Washington, April 11, 1931.

[2] G. T. Rude, The figure of the earth. Bull. Nat. Research Council **78**: 5. 1931.

derived from the stationary-wave formula, $T = \frac{4L}{\sqrt{gh}}$, in which $L$ = length of body of water or approximately 82 nautical miles (498,560 feet), $g$ = acceleration of gravity or 32.2 feet per second, and $h$ = average (mean tide level) depth of water or 71 feet, a value of 41,720 seconds, or 11.6 hours, is obtained. This approximates to the period of oscillation of the tide, and the body of water will, therefore, support a stationary wave.

From the formula for a progressive tide wave, $r = \sqrt{gh}$, in which $r$ = rate of tide progression, $g$ = acceleration of gravity or 32.2 feet per second, and $h$ = average (mean tide level) depth of water or 71 feet, a value of 47.8 feet per second is obtained for the rate of progress of the tide wave. As the distance between the two extremities of the waterway is approximately 82 nautical miles, or 498,560 feet, the time that it should take for the tide wave to be propagated from Little Gull Island Light to Throgs Neck should be approximately 10,430 seconds, or 2.9 hours. As determined from the Greenwich lunitidal intervals derived from observations at these tide stations, the actual times of propagation of high and low water, respectively, throughout Long Island Sound are $1\frac{3}{4}$ hours and $2\frac{1}{4}$ hours.

From the above considerations it will be noted that the tide in Long Island Sound is produced by a combination of the stationary and progressive types of tide wave, the former predominating. According to Harris, this progression is not due to a shoaling at the mouth or entrance to the waterway, such as obtains in the Gulf of Maine and Bay of Fundy, but rather to a contraction. In addition to this contraction there are obstacles to the progression of the tide wave such as Fishers, Little Gull, Great Gull, and Plum Islands and numerous rocky shoals and reefs.

There is an earliness in the time of occurrence of high and low water along the north shore of Long Island Sound as compared with such phenomena along the south shore. From the vicinity of Eaton Point, L. I., westward, however, there is practically no difference in time of tide or range of tide along either shore of the sound. Likewise, there is an earliness in the time of occurrence of the tidal current along the north shore of the sound. The acceleration in the time of current, however, is due to the fact that the current generally occurs earlier in shoaler waters than in midchannel and the waters along the Connecticut shore are relatively considerably shoaler than those along the north coast of Long Island, especially in Eastern Long Island Sound.

The tide produced by a stationary wave should exhibit considerable increase in range throughout the waterway. This is true in Long Island Sound, the range increasing from approximately $2\frac{1}{2}$ feet at Little Gull Island Light to about $7\frac{1}{4}$ feet at the western end of the sound. From Eaton Point, L. I., westward, however, there is practically no difference in the range of tide.

As is true in the Bay of Fundy, Delaware Bay, and other waterways, there is an increase in the range of tide on the right bank, or shore, of Long Island Sound with respect to the propagation of the tide wave. From the latter standpoint the northern shore of Long Island Sound is the right bank, or shore. The theoretical amount (in feet) by which the ranges on the two banks of a tidal stream differ $= \frac{3\,vd \sin\phi}{g}$ approximately, in which $v$ = velocity of water in knots, $d$ = width of waterway in nautical miles, $\phi$ = latitude, and $g$ = acceleration of gravity. At three cross-sections in Long Island Sound the following differences in range of tide were found: between Rocky Point, L. I., and Lynde Point, Conn., a theoretical difference of 0.3 foot and an actual difference of 0.2 foot; between Roanoke Point, L. I., and Sachem Head, Conn., a theoretical difference of 0.65 foot and an actual difference of 0.6 foot; between Matinicock Point, L. I., and Parsonage Point, N. Y., a theoretical difference of 0.1 foot and an actual difference of 0.1 foot.

The tide in the Connecticut and Housatonic Rivers is primarily of the progressive-wave type. Theoretically, it should require about 4.0 hours for the propagation of the tide wave from Saybrook Breakwater to Hartford, Conn., and 1.0 hour for the same phenomenon in the Housatonic River from Stratford to Shelton. By actual tidal observations, the times of propagation in these rivers between the localities mentioned above are, respectively, approximately $4\frac{3}{4}$ hours, and 0.95 hour.

The progression of the tidal current is rapid over the 48-mile (nautical) stretch of Eastern Long Island Sound owing to the wide expanse and good depths of the waterway. From Stratford Shoal to Execution Rocks in Western Long Island Sound, a distance of 30 nautical miles, about an hour is required for the progression of the current. In this stretch of the waterway the time of current is retarded considerably by the funnel shape of the waterway which narrows rapidly from a width of about 12 nautical miles, off Bridgeport, Conn., to about $2\frac{1}{2}$ nautical miles off Execution Rocks. At the same time the waterway rapidly shoals from depths of about 20 fathoms off Stratford Shoal to about 7 fathoms northeast of Execution Rocks. Over the $2\frac{1}{2}$-mile stretch from Execution Rocks to Hart Island Light the progression of the current is exceedingly slow, requiring nearly two hours.

Although the tidal current, or horizontal movement of the water, accompanies the tide, or vertical rise and fall of the water, and is part of the same phenomenon, the results from observations show that there is considerable difference in time of occurrence of strength of flood current and high water at most localities in this waterway. In fact, at the entrances to the bays and harbors along the northern and southern shores of the sound the maximum flood current occurs about the time of local mean-tide level, or approximately three hours before local high water. For example, at the entrances to Huntington Bay, Oyster Bay, Hempstead Bay and Coscob Harbor, strength of flood current occurs earlier than local high water by 2.3 hours, 2.8 hours, 2.9 hours, and 3.1 hours, respectively.

Owing to the presence of a stationary tide wave in Long Island Sound we should expect a large range of tide and a small current velocity at the head of the waterway or western end of the sound and a small range of tide and considerable current velocities in The Race and Plum Gut at the eastern entrance to the sound. Such conditions actually obtain, a range of tide of $7\frac{1}{4}$ feet and current strength of about $\frac{3}{4}$ knot occurring off Execution Rocks while in Plum Gut and The Race current velocities of $3\frac{1}{2}$ to 4 knots accompany a tide range of about $2\frac{1}{2}$ feet.

The average (mean-tide level) depth of Long Island Sound is approximately 12 fathoms and this depth would be sufficient to support a stationary tide wave of about 365 nautical miles in length. Measured from the western end of Long Island Sound a north-and-south line one-fourth of this wave length from the head of the sound would lie about 10 miles east of Little Gull Island Light, or immediately east of Montauk Point, Long Island. Such a condition accounts primarily for the small tidal ranges and increased current velocities in The Race, Plum Gut, and the southern entrance to Block Island Sound off Montauk Point.

GEOLOGY.—*The heat of solution of some potash minerals.*[1] L. T. RICHARDSON and R. C. WELLS, U. S. Geological Survey.

The purpose of this paper is twofold—to consider whether measurements of the heat of solution may afford a rapid method of detecting potash minerals or estimating their percentage in gangue material, and to discuss whether the heat of solution may affect the geothermal gradient of such a region as the area of potash deposits in Texas and New Mexico.

Some years ago while visiting the plant of the American Trona Corporation, now the American Potash and Chemical Corporation, at Searles Lake, California, one of the writers was informed that the heat of solution was used in the plant as a control method for certain KCl-NaCl mixtures. Except for single salts few figures are given in the literature for the heat of solution of potash minerals. It accordingly seemed worth while to obtain some figures for these minerals. For this purpose measurements were first made with a few salts over a range of concentrations to find the most favorable conditions for a rapid method.

A 5-gram portion of a ground sample of each salt was placed in a large test tube, surrounded by an air jacket, and its temperature was observed with a thermometer. A portion of water was brought to the same temperature, then poured on the sample, and the mixture stirred with the thermometer. The heat effect usually attained its maximum in $\frac{1}{2}$ to $1\frac{1}{2}$ minutes. Correction was made if necessary for the drift of the temperature caused by exchange of heat with the environment during this interval. Table 1 shows the results. In those experiments in which there was not enough water to dissolve all the salt, the heat of solution was calculated for the gram molecule from the known solubility of the salt.

It is seen from Table 1 that the temperature change is largely independent of the quantity of water as long as the salt is in excess. But on account of ease of stirring and uniformity of conditions, 25 grams of water, 5 grams of salt, and a short piece of a 35 mm. test tube were selected as the best combination for further work.

When mixed salts are used, the heat effect obtained with a little water and a low percentage of KCl resembles that obtained with more water and a high percentage of KCl, and it is greater than that obtained with the same mixture of salts dissolved in more water. Both NaCl and KCl lower the temperature on dissolving in water.

[1] Received April 11, 1931. Published by permission of the Director of the U. S. Geological Survey.

The results obtained with the minerals and some mixtures of minerals and salts are given in Table 2. Owing to incomplete solution in

TABLE 1. HEAT OF SOLUTION OF SOME SALTS (5-GRAM SAMPLE)

| *Salt* | *Diameter of tube (mm)* | *$H_2O$ (grams)* | *Time (min.)* | *Final temperature (°C.)* | *Change in temperature (°C.)* | *Mols $H_2O$ per mol of dissolved salt* | *Molecular heat of solution (cal.)* |
|---|---|---|---|---|---|---|---|
| NaCl | 23 | 5 | ½ | 22.7 | −1.8 | 10 | −500 |
| " | " | 10 | " | 21.2 | −1.8 | " | −510 |
| " | 35 | 25 | 1 | 23.3 | −1.7 | 16 | −590 |
| KCl | 13 | 5 | ½[a] | — | −9.1 | — | — |
| " | 16 | " | "[a] | — | −12.1 | — | — |
| " | 20 | " | 1[a] | — | −10.6 | — | — |
| " | 23 | " | ½ | 10.2 | −11.4 | 12 | −3820 |
| " | " | " | 1 | 12.8 | −10.5 | " | −3520 |
| " | " | " | 1½ | 13.0 | −10.4 | " | −3490 |
| " | 50 ml.[b] | " | " | — | −9.7 | — | — |
| " | 23 | 10 | 1 | 10.8 | −12.9 | 12 | −3740 |
| " | " | " | 1 | 11.1 | −12.6 | " | −3650 |
| " | " | 15 | 1½ | 10.4 | −11.7 | " | −3220 |
| " | " | 20 | 2 | 12.4 | −10.3 | 16 | −3800 |
| " | " | " | 2½ | 13.9 | −10.4 | " | −3830 |
| " | " | 25 | ½ | 14.4 | −9.6 | 21 | −3940 |
| " | " | " | " | 14.0 | −8.6 | " | −3530 |
| " | 35 | " | " | 16.0 | −9.0 | " | −3800 |
| " | " | " | 1½ | 16.2 | −8.6 | " | −3630 |
| $K_2SO_4$ | 23 | 5 | ½ | 22.1 | −2.7 | 87 | −6320 |
| " | 35 | 25 | 2 | 21.5 | −3.5 | " | −6600 |
| $MgCl_2 \cdot 6H_2O$ | 23 | 5 | 1 | 26.3 | +3.5 | 16 | +914 |
| 2.5 NaCl, 2.5 KCl | " | " | ½ | 16.3 | −5.7 | — | — |
| " " " " | " | 10 | 1 | 14.0 | −7.5 | — | — |
| " " " " | " | " | 1½ | 14.5 | −7.0 | — | — |
| " " " " | 35 | 25 | 1 | 20.8 | −4.9 | 18 | −1900 |
| 1.0 " 4.0 " | " | " | ½ | 16.2 | −7.5 | 20 | −3070 |
| 2.0 " 3.0 " | " | " | 1½ | 19.1 | −5.9 | 19 | −2330 |
| 3.0 " 2.0 " | " | " | ½ | 19.7 | −3.5 | 18 | −1320 |
| 4.0 " 1.0 " | " | " | " | 22.6 | −2.7 | 17 | −950 |
| 4.5 " 0.5 " | " | " | " | 21.1 | −2.1 | " | −720 |
| 4.0 " 1.0 " | 23 | 10 | 1½ | 18.5 | −4.5 | " | — |

[a] Stirring difficult.
[b] Beaker.

some cases, as well as to lack of information in regard to the specific heat of the solutions, the figures for the molecular heat of solution must be considered as somewhat preliminary, but they indicate the direction of the heat effect. The molecular heat of the salt-anhydrite mixtures refers to the soluble salt only.

From Table 2 it appears that polyhalite ($2CaSO_4 \cdot MgSO_4 \cdot K_2SO_4 \cdot 2H_2O$), langbeinite ($2MgSO_4 \cdot K_2SO_4$) and kainite ($MgSO_4 \cdot KCl \cdot 3H_2O$) evolve heat when mixed with water. Polyhalite is rather slowly decomposed, but the heat effect follows that of $MgSO_4$ rather than that of $K_2SO_4$. With carnallite ($KCl \cdot MgCl_2 \cdot 6H_2O$) the fall of temperature caused by the KCl outweighs the rise due to $MgCl_2 \cdot 6H_2O$, and a net cooling effect results. Although anhydrite alone shows no appreciable heat effect under these conditions a mixture of anhydrite

TABLE 2.—HEAT OF SOLUTION OF SOME POTASH MINERALS (5-GRAM SAMPLE)

| *Mineral* | *Diameter of tube (mm.)* | *$H_2O$ (grams)* | *Time (min.)* | *Final temperature (°C.)* | *Change in temperature (°C.)* | *Mols $H_2O$ per mol of dissolved salt* | *Molecular heat of solution (cal.)* |
|---|---|---|---|---|---|---|---|
| Polyhalite | 23 | 5 | ½ | 26.0 | +0.9 | 35 | (+834) |
| Langbeinite | 35 | " | " | 22.9 | +2.4 | 24 | +5,600 |
| " | " | 25 | " | 24.0 | +1.2 | 39 | +2,900 |
| Kainite | " | " | " | 25.0 | +1.0 | 35 | +1,520 |
| Carnallite | 23 | 5 | " | 16.8 | −5.9 | 8 | −2,900 |
| " | 35 | 25 | " | 21.5 | −2.0 | 39 | −3,300 |
| Anhydrite | " | " | " | — | −0.0 | — | — |
| 2.5 " 2.5 KCl | " | 10 | 1½ | 13.8 | −9.1 | 17 | −3,600 |
| " " " " | " | 25 | ½ | 20.7 | −4.8 | 42 | −4,200 |
| 4.0 " 1.0 " | 23 | 10 | 1 | 18.8 | −4.1 | 41 | −5,200 |
| " " " " | 35 | 25 | ½ | 22.7 | −2.2 | 100 | −4,900 |
| 2.0 " 0.5 " 2.5 NaCl | " | " | " | 21.6 | −2.0 | 27 | −1,200 |

and sylvite (KCl) seems to give a proportionately greater cooling effect than sylvite alone. This may be caused by the low specific heat of anhydrite (0.1753) or it may indicate a metathetical reaction.

In view of the opposite directions of some of the heat effects, as well as variations caused by the proportions and kinds of minerals, it is obvious that the heat effect with an unknown mixture of potash minerals will not bear any simple relation to the $K_2O$ content. Some samples might have a positive heat of solution, some a negative, and some none. On the other hand, in specific mixtures the heat of solution might give definite information—for example, in a mixture consisting only of sylvite and halite.

In Table 3 some figures are given for two sections of core, mainly sylvite in halite, from Blanchard well No. 3 of the United States Potash Co., in Sec. 10, T.21 S., R.29 E., Eddy County, New Mexico. Ground samples of 3-inch portions were prepared, and the tests were made with 25 grams of water as given for langbeinite in Table 2. One section shows a fairly uniform change in the heat effect from top to bottom; the other shows extreme irregularity. Without more detailed information about each sample, calculations of the $K_2O$ content are practically impossible.

The whole section from 791′ to 795′ averaged 3.58 per cent $K_2O$, with increasing proportions of clay toward the bottom. For the sample at 794′6″ the insoluble matter was 16.03 per cent; the $H_2O$ at 110°, 2.62 per cent. For the sample at 794′9″ the insoluble matter was 9.26 per cent; the $H_2O$ at 110°, 1.73 per cent.

TABLE 3.—FALL IN TEMPERATURE RESULTING FROM SOLUTION OF SAMPLES OBTAINED FROM SUCCESSIVE 3-INCH PORTIONS OF TWO SECTIONS OF CORE FROM BLANCHARD WELL NO. 3

| *Depth* | *Fall in temperature* (°C.) | *Depth* | *Fall in temperature* (°C.) |
|---|---|---|---|
| 791′0″—791′3″ | 3.7 | 794′9″—795′0″ | 1.1 |
| 791′3″—791′6″ | 2.9 | | |
| 791′6″—791′9″ | 2.0 | 834′6″—834′9″ | 1.6 |
| 791′9″—792′0″ | 1.6 | 834′9″—835′0″ | 1.9 |
| 792′0″—792′3″ | 2.0 | 835′0″—835′3″ | 2.3 |
| 792′3″—792′6″ | 1.2 | 835′3″—835′6″ | 2.1 |
| 792′6″—792′9″ | 1.8 | 835′6″—835′9″ | 1.7 |
| 792′9″—793′0″ | 1.4 | 835′9″—836′0″ | 2.5 |
| 793′0″—793′3″ | 1.7 | 836′0″—836′3″ | 2.0 |
| 793′3″—793′6″ | 1.6 | 836′3″—836′6″ | 2.4 |
| 793′6″—793′9″ | 1.1 | 836′6″—836′9″ | 1.6 |
| 793′9″—794′0″ | 1.3 | 836′9″—837′0″ | 2.3 |
| 794′0″—794′3″ | 1.2 | 837′0″—837′3″ | 2.7 |
| 794′3″—794′6″ | 1.1 | 837′3″—837′6″ | 1.9 |
| 794′6″—794′9″ | 1.1 | 837′6″—837′9″ | 2.0 |

The section from 834′6″ to 837′9″ averaged 9.55 per cent $K_2O$. As each tenth of a degree change in temperature corresponds to nearly 3 per cent of KCl the variation in the material is very evident, but calculation of the total potash content of the section by addition of the 13 separate results, taking 1.6° fall as representing zero per cent of KCl gives far too little total KCl, so that some factor has evidently not been given due consideration, though what this factor is has not yet been determined.

The field of usefulness of the calorimetric method of analysis of potash minerals is therefore limited to certain special combinations, and even these will require careful standardization to give quantitative results.

The second question of interest is the geologic application of the heat of solution. Lang[2] has discussed the low geothermal gradients in the area of western Texas and southeastern New Mexico known to be underlain by salt and anhydrite. Although he concludes that the thermal conductivities of the rocks are too poorly known to warrant any definite discussion of the problem, it may be of interest to consider further some of the factors that have been mentioned as responsible for the gradients. Radioactivity of the potassium minerals cannot be a major factor, or at least the heat effect thus produced is in the wrong direction Are water-soluble salts dissolving in ground water or deep solutions at a rate that would cause sufficient cooling to explain the low gradients? In the absence of any simple direct answer to this question it is proposed to make certain assumptions that appear to be too liberal and show that even so the corresponding effects would be insufficient to explain the gradients observed.

For example, let us assume that soluble material is being dissolved at a depth at the same rate at which it is carried off in the surface run-off. This would mean that there would have to be some channel ways or permeable strata for the accession of fresh water and the escape of mineralized water, as simple calculation shows that mere diffusion of the salts from a depth of around 2000 feet would be insufficient to supply the soluble material in the run-off, even if there were enough pore space to insure a continuous aqueous medium.[3]

The quantity of dissolved matter removed annually by the Pecos, Brazos, and Colorado rivers,[4] which drain a part of the area underlain by salt, is of the following order:

| | |
|---|---|
| Pecos River near Comstock, Texas................ | 2,400,000 tons |
| Brazos River at Waco, Texas.................... | 2,070,000 tons |
| Colorado River at Austin, Texas.................. | 580,000 tons |
| | 5,050,000 tons |

Unfortunately the proportion of potash in all of this material is

[2] W. B. Lang. *Note on temperature gradients in the Permian basin.* This Journal **20**: 121. 1930.

[3] Such solution as might occur owing to the lowering of the water-table in the earth on account of erosion at the surface or emergence of the area as a whole from sea level would not yield a significant heat effect.

[4] Computed from data given in U. S. Geol. Survey water-supply papers.

not known, so that it is necessary to pursue the inquiry in terms of sodium chloride and calcium sulphate, which are the principal constituents. The substitution of sodium chloride for potassium chloride does not alter the essential conclusions, in spite of the fact that the solution of potassium chloride gives several times the cooling effect of that of the same weight of sodium chloride. It is estimated from analyses of the water that the total annual runoff includes at least 1,300,000 tons of calcium sulphate and 2,800,000 tons of sodium chloride. Assuming that the calcium sulphate comes from the hydration and solution of anhydrite, rather than from gypsum, we have as corresponding heat effects with a large excess of water the evolution of $38 \times 10^{12}$ calories for the solution of the anhydrite and an absorption of $100 \times 10^{12}$ calories for the solution of the sodium chloride, leaving a net absorption of about $62 \times 10^{12}$ calories. Here again, then, we encounter heat effects that are in opposite directions. Such compensating effects make it more difficult but still not impossible to reach definite conclusions.

As the area involved covers about 90,000 square miles, the net heat effect last mentioned reduces to an average of 0.027 calories per square centimeter, or, if concentrated in a single layer 1 cm. in thickness to 0.027 calorie per cubic centimeter. But under a geothermal gradient of 0.000117° C. per cm.,[5] and with rock having the conductivity of anhydrite (0.0123), there would be annually a flow of 45 calories of heat per square centimeter normally escaping from the earth. It is obvious that the heat effect calculated for the solution of anhydrite and sodium chloride would be negligible as explaining the present geothermal gradients. Even if the assumed area of action were contracted to 1,000 square miles the heat of solution would be scarcely significant, amounting to less than 3 calories a year. Expressed differently, to produce the present gradients sodium chloride would have to be dissolved at depth at the rate of a layer nearly a centimeter thick each year, a rate that is incompatible with the known geologic age of the deposits.

In other words, the figures indicate that the quantity of heat normally flowing through the rocks of the earth's crust is large in comparison with the heat of any chemical changes that are likely to take place under nearly static conditions due to such transformations as hydration, solution, carbonation, silicification, and replacement.

[5] Equivalent to 1°F. in 159 feet. This gradient is based on the average for eight wells in the area under discussion, reported in *Earth temperatures in oil fields*, American Petroleum Institute Bull. 205; computed by C. E. Van Orstrand, of the U. S. Geological Survey.

# MAMMALOGY.—*Two new desert foxes.*[1] E. A. GOLDMAN, Biological Survey, U. S. Department of Agriculture.

The accession of specimens in recent years has materially extended the known range of the desert foxes of the *Vulpes macrotis* group. Forms of this section of the genus occur in suitable areas from the Pacific coast east to the basin of Great Salt Lake, Utah, and the Rio Grande Valley in New Mexico and western Texas, and from the Snake River Valley, Idaho, south to southern Lower California, Sonora, and Chihuahua. Two hitherto unrecognized geographic races are described below.

## **Vulpes macrotis arizonensis,** subsp. nov.

Arizona Long-eared Desert Fox

*Type.*—From two miles south of Tule Tanks (near Mexican Boundary), Yuma County, Arizona. No. 202959, ♂ adult, U. S. National Museum (Biological Survey collection), collected by E. A. Goldman, December 9, 1913. Original number 22357.

*Distribution.*—Desert region of southwestern Arizona and adjoining parts of Sonora.

*General characters.*—A small, light buffy subspecies with short pelage lacking much of the silver white usual in the group. Skull slender and delicate. Closely allied to *Vulpes macrotis arsipus,* but usually smaller, the winter pelage shorter, brush smaller, and dorsum less heavily overlaid with silvery white; skull differing in detail. Similar in general to *V. m. neomexicana,* but decidedly smaller and dentition much lighter.

*Color.—Type:* Upper parts in general buffy brownish, purest on head, less pronounced along median line, paling to light ochraceous buff along flanks, the dorsum rather thinly overlaid with silvery white producing a somewhat grizzled effect; dorsal pelage with narrow subterminal white bands, and black tips so short and inconspicuous the general tone is scarcely affected; middle of face buffy grayish; chin, throat, median line of abdomen, inguinal region and inner sides of limbs nearly pure white; sides of neck, a narrow band across lower part of neck, anal region, sides of abdomen, and areas conspicuously invading upper parts behind shoulders light ochraceous buff; outer sides of forearms and hind legs, and external base of ears rich ochraceous tawny; feet whitish, the hind feet becoming light ochraceous buff on soles; sides of muzzle and lips, except anteriorly, dusky; outer sides of ears buffy-brownish, inner sides thinly clothed with white hairs; tail grayish, becoming light ochraceous buffy on basal half below, the tip black all around.

*Skull.*—Closely resembling skulls of small individuals of *arsipus,* but sides of brain-case converging in more nearly straight lines (tending more distinctly to bulge outward anteriorly in *arsipus*); interpterygoid fossa narrower; anterior processes of frontals broader, more prolonged, meeting ascending branches of premaxillae (frontal processes separated from ascending branches of premaxillae by a distinct gap along maxillo-nasal suture in *arsipus*); auditory bullae small and dentition light much as in *arsipus.* Similar

[1] Received April 7, 1931.

to that of *neomexicana*, but decidedly smaller, slenderer and more delicate; dentition relatively lighter.

*Measurements.—Type:* Total length, 784 mm.; tail vertebrae, 315; hind foot (c.u.), 120. An adult male from Vicksburg, Arizona: 765; 300; 116. An adult female topotype: 735; 270; 115. An adult female from Yuma, Arizona: 712; 270; 117.5. *Skull* (type): Greatest length, 111.5; condylobasal length, 108.4; width of braincase, 42.5; zygomatic width, 56.4; least width of rostrum, 15.4; interorbital width, 21; maxillary toothrow (front of canine to back of last molar), 52.5; upper carnassial, crown length of outer side, 10, crown width anteriorly, 4.3.

*Remarks.—V. m. arizonensis* is closely allied to *V. m. arsipus* from whose range it appears to be separated by the barrier of the Colorado River. It appears to intergrade with *V. m. neomexicana* in southeastern Arizona. The reduction of the white over the dorsum in the winter pelage seems to be a differential external character worthy of note.

*Specimens examined.*—Total number, 6, from Arizona as follows: Tacna, 1; Tule Tanks (type locality), 2; Yuma, 2; Vicksburg, 1.

### **Vulpes macrotis nevadensis** subsp. nov.

Nevada Long-eared Desert Fox

*Type.*—From Willow Creek Ranch, near Jungo, Humboldt County, Nevada. No. 213103, ♂ adult, U. S. National Museum (Biological Survey collection), collected by Mike Gill, December 14, 1915. X catalogue number 13255.

*Distribution.*—Desert regions from the Humboldt and Snake River valleys of northern Nevada and southwestern Idaho east to the basin of Great Salt Lake, Utah.

*General characters.*—A subspecies of medium size with long, full, and comparatively dark pelage. Skull with large, fully inflated braincase. Closely allied to *V. m. arsipus*, but less silvery white, the black tips of hairs more in evidence over dorsum, and cranial characters distinctive. Similar to *V. m. neomexicana*, but somewhat darker and skull different.

*Color.—Type:* Upper parts in general a coarsely grizzled mixture, the dorsal pelage light brown below, the individual hairs with rather broad subterminal white bands and only moderately conspicuous black tips, becoming light ochraceous buff along flanks; middle of face grayish; chin, throat, median line of abdomen, inguinal region and inner sides of limbs nearly pure white; sides of neck, a narrow band across lower part of neck, anal region and sides of abdomen light ochraceous buff; light areas behind shoulders ochraceous buffy, but rather inconspicuous; outer sides of forearms and hind legs and external base of ears rich ochraceous tawny; feet whitish, the hind feet becoming ochraceous buffy on soles; sides of muzzle and lips, except anteriorly, dusky; outer sides of ears buffy brownish, inner sides thinly clothed with white hairs; tail grayish, heavily overlaid with dusky along median line near base above, washed with light ochraceous buff below, a black tip doubtless present in life, broken off.

*Skull.*—Similar to that of *arsipus*, but broader, more robust; braincase larger, more fully inflated; nasals usually broader, more abruptly tapering posteriorly; dentition similar; auditory bullae small as in *arsipus*. Compared with that of *neomexicana* the skull is somewhat smaller, but relatively broader; braincase broader, more fully inflated; auditory bullae smaller; dentition similar.

*Measurements* (no body measurements available).—*Skull* (type): Greatest length, 113.7; condylobasal length, 110; width of braincase, 45.6; zygomatic width, 62.8; least width of rostrum, 17; interorbital width, 22.5; maxillary toothrow (front of canine to back of last molar), 52.8; upper carnassial, crown length of outer side, 9.7, crown width anteriorly, 4.6.

*Remarks.*—The range of *V. m. nevadensis* marks the northern limit of the *V. macrotis* group. This subspecies is most closely allied to *V. m. arsipus* but is somewhat darker, less silvery whitish in color of upper parts and the skull is distinguished by the larger, more fully inflated braincase.

*Specimens examined.*—Total number, 14, as follows:

Idaho: Grandview (20 miles south), 1 (skull only).

Nevada: Adelaide (near Golconda), 3 (skins only); Carson Sink (10 miles east of Fallon), 1 (skull only); Fallon (between Old River and Soda Lake), 1 (skin only); Jungo (type locality), 5 (4 skins only); Sodaville, 1 (skin only); Sulphur Cow Creek, Humboldt County, 1 (skin only).

Utah: Low, 2.

## MAMMALOGY.—*Bats from the Bahamas.*[1] H. HAROLD SHAMEL, U. S. National Museum. (Communicated by JOHN B. REESIDE, JR.)

An interesting collection of bats was made during the summer of 1930 in the Bahama Islands by Dr. Paul Bartsch, Curator of the Division of Mollusks in the U. S. National Museum. These specimens, 98 in number, are from islands hitherto unrepresented by any mammals in the national collection.

### ARTIBEUS JAMAICENSIS PARVIPES (Rehn)

1902. *Artibeus parvipes* Rehn, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, p. 639. December 8, 1902.

Twenty-four specimens were taken on Great Inagua Island and four specimens at Abrahams Hill, Mariguana Island. This bat has hitherto been known only from the island of Cuba. Its capture in the Bahama Islands bears out, in part, a belief of Andersen,[2] the recent reviser of this genus, who said he believed that it would be found throughout the Bahamas and as far north as southern Florida.

### MACROTUS WATERHOUSII COMPRESSUS (Rehn)

1904. *Macrotus waterhousii compressus* Rehn, Proc. Acad. Nat. Sci. Philadelphia, vol. 56, p. 434. June 30, 1904.

Three specimens collected at Salt Point, Jamaica Bay, Acklin Island. The specimens are perfectly typical of, and match in every detail those from the Island of New Providence, the type locality, and from Nassau Island, the only two known localities for this bat.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received April 23, 1931.

[2] K. ANDERSEN. *A monograph of the Cheiroptera genera* Uroderma, Enchisthenes, *and* Artibeus. Proc. Zool. Soc. London, p. 262, 1908.

**Macrotus waterhousii heberfolium** subsp. nov.

*Type.*—Adult male in alcohol, No. 255651, U. S. National Museum, collected by Dr. Paul Bartsch at Kingston, Providencialis Island, July 23, 1930.

*Diagnosis.*—Larger than true *M. waterhousii*, with darker, distinctly tricolor fur.

*Color.*—The fur and membranes are dark; fur smoky-gray at base; this area followed by a narrower band of whitish gray; the tips a rich coppery brown, but rather sparse; the gray shows through to such an extent that it is nearly the predominant color.

*Character.*—One outstanding external character is the broad, bluntly rounded nose leaf. In all other specimens of *Macrotus* examined the nose leaf is rather slender and more acutely pointed.

*Skull.*—The skull is like that of the typical form, except that there is no ridge on the occiput. This ridge is well developed in true *M. waterhousii* as a downward continuation of the occipital crest. The zygomatic breadth, interorbital breadth, greatest length of mandible, and breadth of braincase are slightly greater than these same measurements in skulls from Hispaniola.

*Measurements.*—(Measurements in parentheses are the extremes of 5 specimens of *Macrotus waterhousii waterhousii* from Hispaniola.) *Type:* Head and body, 68.0; tail, 33.8 (24.2–32.5); tibia 24.0 (21.0–23.0); foot, 14.2 (11.0–12.6); forearm, 57.4 (54.0–55.2); thumb, 8.6; third metacarpal, 44.8 (42.0–43.3); fifth metacarpal, 47.2 (42.6–45.6); ear from meatus, 29.6 (26.2–28.6); ear from crown, 24.6 (21.2–23.2); width of ear, 18.5 (16.2–17.5); total length of skull, 26.6; zygomatic breadth at base of zygoma, 13.2 (11.8–12.4); interorbital constriction, 4.6 (4.2–4.5); breadth of braincase, 10.0 (9.2–9.6); greatest length of mandible, 18.4 (16.8–18.0); maxillary toothrow, 9.8.

Only one specimen of this bat was secured in a cave on the island. I am informed by Doctor Bartsch that it was the only occupant of this cave.

Its nearest relative is *Macrotus waterhousii waterhousii* from Hispaniola, as one would expect from the geographical position of its habitat. There are so many differences in its external measurements, and the color is so unlike that in any known *Macrotus* from the West Indies that there can be little doubt that it represents a new form. The fur on the back in other West Indian forms is bicolor, whitish basally with much paler brownish tips.

**Erophylla planifrons mariguanensis** subsp. nov.

*Type.*—Adult male in alcohol, No. 255593, U. S. National Museum, collected by Dr. Paul Bartsch at Abrahams Hill on Mariguana Island, July 20, 1930.

*Diagnosis.*—A larger, darker form with smaller teeth than true *Erophylla planifrons.*

*Color.*—Fur at base gray, individual hairs tipped with auburn (Ridgway, 1912). Ventral side drab-buff. The hairs at the base in *E. planifrons planifrons* are whitish when compared with the gray of specimens from Mariguana Island, and the tips of the hairs are much lighter.

*Skull.*—The skull is like that of typical *Erophylla planifrons* except for the smaller teeth and average greater length.

After comparing eight skulls of this bat with the same number of true *E. planifrons* I find the following: maxillary toothrow, 8.2–8.8 as against 7.6–8.2; total length of skull, 24.8–26.4 as against 24.2–25.5; condylobasal length, 22.2–23.2 as against 20.8–22.2.

*Measurements.—Type:* Head and body, 65.8; tail, 13.4; tibia 22.4; foot, 15.0; forearm, 49.4; thumb, 12.0; third metacarpal, 41.5; fifth metacarpal, 41.6; ear from meatus, 20.6; ear from crown, 16.0; width of ear, 12.2; total length of skull, 26.4; condylobasal length, 23.2; zygomatic breadth, 10.6; interorbital breadth, 4.8; breadth of braincase, 10.2; occipital depth, 8.8; greatest length of mandible, 17.4; maxillary toothrow, 8.8; breadth of rostrum at $m^2$, 7.0; mandibular toothrow, 9.2.

There were no dry skins, but eight specimens which had been in alcohol since July were dried, and compared with 18 skins of *Erophylla planifrons planifrons* from Nassau and New Providence. This comparison shows that the southern form is considerably darker. There were three skins from Nassau and New Providence which approached those from Mariguana and East Caicos in color, but such resemblance may be expected in forms so closely related. However, the two forms were distinct when laid out in nearby series.

From among eight skulls of each of the two races all except three could be separated by the differences in the size of the teeth.

Fifty specimens were examined from Abrahams Hill, Mariguana Island, and 16 specimens from Stubbs Guano Cave, East Caicos.

## SCIENTIFIC NOTES AND NEWS

Because of the generally adverse economic conditions throughout the world, the organization committee of the Sixteenth International Geological Congress has decided to postpone until June, 1933, the meeting of the Congress which had been scheduled for Washington in June, 1932.

The Smithsonian Institution has received from the estate of the late JAMES ARTHUR somewhat more than $50,000 to establish a yearly lecture about the sun. The remainder of the income from this fund is to be devoted to researches relating to the sun.

At the annual meeting of the National Academy of Sciences, which met in Washington on April 27, 28, and 29, the following officers were elected:

*President,* WILLIAM WALLACE CAMPBELL, director emeritus of Lick Observatory.
*Vice-President,* DAVID WHITE, U. S. Geological Survey.
*Home Secretary,* FRED E. WRIGHT, Geophysical Laboratory of the Carnegie Institution of Washington.
*Members of the Council,* W. B. CANNON, Harvard Medical School, and ROGER ADAMS, University of Illinois.

E. O. ULRICH, geologist of the U. S. Geological Survey, has been awarded the Mary Clark Thompson medal "for the most important services to geology and paleontology." The presentation was made by RUDOLPH RUEDEMANN, state geologist of New York, at the annual dinner of the National Academy of Sciences.

Adolf Knopf, professor of geology at Yale University, a member of the Academy and a geologist of the Geological Survey, has been elected to membership in the National Academy of Sciences.

Prof. W. H. Twenhofel of the University of Wisconsin has been elected chairman of the Division of Geology and Geography of the National Research Council, succeeding Arthur Keith. He will take office July 1.

The Alaskan Branch of the U. S. Geological Survey is to make an intensive study of the mineral resources of the Alaskan Railroad this season, and will employ temporarily several additional geologists. R. W. Richards of the Fuel Section and C. P. Ross, F. G. Wells, J. C. Reed, and C. F. Park of the Section of Metalliferous Deposits of the Geologic Branch have been transferred to the Alaskan Branch for this purpose. J. M. Hill and G. A. Waring, former members of the geologic staff of the Survey, and J. C. Ray and Ralph Tuck have been appointed geologists for the Alaskan Railroad work. Perry A. Davison, also, has been appointed junior geologist on the Alaskan Branch.

Sir James H. Jeans, former secretary of the Royal Society of London and research associate of the Carnegie Institution of Washington, spoke on the subject *Out in the depths of space* at the National Museum on May 18, under the auspices of the Carnegie Institution of Washington.

Paul H. Oehser, for the past six years a member of the editorial staff of the Bureau of Biological Survey, succeeds Dr. Marcus Benjamin, retired, as editor of the National Museum.

Rollin E. Stevens has been appointed assistant chemist in the Geological Survey and has taken up the study of the chemistry relating to the origin of certain ore deposits.

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**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

## CONTENTS

### Original Papers



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CRYSTALLOGRAPHY.—*The spinel structure: An example of variate atom equipoints.*[1] TOM. F. W. BARTH and E. POSNJAK, Geophysical Laboratory, Carnegie Institution of Washington.

The commonly accepted interpretation of the spinel structure is in some respects not in harmony with the general results of crystal analysis. For instance, it shows a distinct discrepancy with the assumption, which is well based on Goldschmidt's[2] extensive work, that the structure of a crystal is largely determined by the ratio of sizes of its constituent atoms (or ions). A few examples will readily show that in the spinel structure, with the general chemical formula $XY_2O_4$, the radius ratio $R_X:R_Y$ does not seem to be the important factor in determining the structure. For example, in $MgAl_2O_4$ we have $R_{Mg}:R_{Al} = 1.37$, in $CdFe_2O_4$, $R_{Cd}:R_{Fe} = 1.54$; in $K_2Cd(CN)_4$, $R_{Cd}:R_K = 0.78$, and in $Mg_2TiO_4$, $R_{Ti}:R_{Mg} = 0.82$. Phenacite, $Be_2SiO_4$, has a ratio $R_{Si}:R_{Be} = 1.15$ which lies well between the aforementioned values, nevertheless this mineral crystallizes with trigonal symmetry, and not as a spinel.

Another, and very disturbing feature of the spinel structure is that the law of constant atomic radii seems to be violated. For example, in the common spinel Mg has an apparent radius of 0.42 Å, whereas it is supposed to have the value of 0.78 Å—an enormous difference. In this connection one might think of the possibility of the spinel structure forming an atom lattice instead of an ion lattice. However, the comparison of the *differences* of the spacings of various spinels which have one metal common (like $MgAl_2O_4-MgFe_2O_4$; $MgFe_2O_4-CdFe_2O_4$) shows definitely that we are dealing here with an ion lattice.

Examinations of the X-ray data show conclusively that the only possible arrangements of the ions within the unit cell are (8f), (16c), and

[1] Received May 16, 1931.

[2] *Cf.* V. M. GOLDSCHMIDT. Geochem. Verteilungsgesetze VII, Vid. Akad. Oslo 1926, No. 2.

(32b). The parameter,[3] $u$, of the oxygen ions had been determined and found to have a value close to $\frac{3}{8}$. By choosing another value for the parameter it appeared possible to get interatomic distances that lead to more reasonable radii for the cations. However, re-calculations of the intensities show that it is hardly possible to move the positions of the oxygen atoms. In the case of $MgAl_2O_4$, for instance, the value for $u$ appears to be good to less than $\pm$ 0.01.

The only assumption which leads to reasonable distances between oxygen and metal and at the same time is consistent with the observed intensity data is that *the 16 equivalent positions in the unit cell are not occupied by chemically equivalent ions.* Instead of having Mg in (8f) and Al in (16c) the spinel has 8 Al-ions in (8f) and 8 Al-ions + 8 Mg-ions in (16c).[4] (This arrangement will be expressed further on by writing $AlMgAlO_4$ instead of $MgAl_2O_4$.)

It was possible to test this assumption on spinels in which the two kinds of cations show a sufficient difference in their scattering power for X-rays. As such magnesium ferrite and magnesium galliate were selected. The results of the intensity calculations are given in Table 1 and prove that magnesium galliate and magnesium ferrite must have the structures $GaMgGaO_4$ and $FeMgFeO_4$; all the decisive data are in good agreement with this assumption, whereas they are quite incompatible with the formerly accepted spinel structure.

It seems to us that the demonstration of this new spinel structure is of more than ordinary interest. It brings forward a new principle in crystal analysis, or rather it causes us to give up the old idea that structurally equivalent positions have to be occupied by chemically equivalent atoms. While in the case of mixed crystals it has long been known that chemically different atoms may enter into structurally equivalent positions, no extension of this idea to pure compounds had previously been considered necessary.[5] Our study of the structure of spinels thus

[3] Determined on spinel and magnetite by W. H. BRAGG (Phil. Mag. **30**, 305, 1915), and S. Nishikawa (Proc. Math. Phys. Soc. Tokyo **8**, 199, 1915), A. Claasen (Proc. Phys. Soc. London **38**, 482, 1926); on silver molybdate by R. W. G. Wyckoff and on various complex cyanides by R. G. Dickinson (Journ. Am. Chem. Soc. **44**, 1922, pp. 1994 and 774 respectively).

[4] If one assumes that $u$ = 0.378, the apparent radius of the Al-ions in (8f) is 0.46 Å, while $Al^{+++}$ in coördination number 4 should have a value of from 0.44 to 0.47 Å. The average radius of the Mg + Al-ions in (16c) is 0.67 Å, while the radius $\frac{Mg + Al}{2}$ in coördination number 6 should be 0.675 Å.

[5] A somewhat similar idea has been proposed by A. F. Westgren and G. Phragmén (Faraday Society, *Crystal structure and chemical constitution*, p. 382, 1929) to explain the structure of intermetallic compounds.

establishes a more fundamental application of this principle. A unit cell which contains different atoms at structurally equivalent points

TABLE 1.[a] INTENSITY DATA FROM MAGNESIUM GALLIATE AND MAGNESIUM FERRITE

| Indices | Magnesium galliate | | | Magnesium ferrite | | |
|---|---|---|---|---|---|---|
| | Calculated | | Observed | Calculated | | Observed |
| | $MgGa_2O_4$ | $Ga(MgGa)O_4$ | | $MgFe_2O_4$ | $Fe(MgFe)O_4$ | |
| (111) | 7 | 0.1 | 0.5− | 6 | 0.2 | 0.5 |
| (113) | 10 | 10 | 10 | 10 | 10 | 10 |
| (133) | 3 | 0 | 0 | 3 | 0 | 0 |
| (333) (115) | 6 | 6 | 7 | 6 | 6 | 7 |
| (135) | 4 | 0 | 0 | 3 | 0 | 0 |
| (335) | 3 | 3 | 2 | 3 | 3 | 2 |
| (155) (117) | 2 | 0 | 0 | 2 | 0 | 0 |
| (355) (137) | 6 | 6 | 4 | 6 | 6 | 4 |
| (555) (157) | 3 | 3 | 2 | 3 | 3 | 3 |
| (357) | 1 | 0 | 0 | 1 | 0 | 0 |
| (159) (377) | 3 | 3 | 1 | 3 | 3 | 1 |

[a] The intensities were calculated according to the formula $I = \frac{j \cdot \sqrt{A^2+B^2}}{h^2+k^2+l^2}$ disregarding the variation of scattering with the angle. The scattering power of the atoms has been taken directly proportional to the number of electrons, i.e. the atomic number minus the valence. Only faces with all indices odd are shown in the table; for such faces the expression for $\sqrt{A^2+B^2}$ becomes $4\sqrt{2}\cdot X + 8\cdot Y$ if one or all three of the indices is 3 (mod. 8) and $4\sqrt{2}\cdot X - 8\cdot Y$ if one or all three indices is 1 (mod. 8). (X and Y stand for the atoms in (8f) and (16c) respectively, and the parameter, $u$, of the oxygen atoms is taken as 0.375.) All other faces give approximately the same intensities for either arrangement, so it seemed unnecessary to incorporate them in this table.

may be referred to as a cell with variate atoms in equivalent positions; or, to give it a short name, a cell with variate atom equipoints. The introduction of this conception falls in line with, and extends Machatschki's[6] ideas of the structures of silicates.

The importance of this principle for crystal analysis may, e.g., be seen from Raaz's paper[7] on the structure of gehlenite. In working out this structure he used the formula $Ca_2Al_2SiO_7$, whereas its relation to åkermanite, $Ca_2MgSi_2O_7$, would suggest that its structure possesses variate atom equipoints: $Ca_2Al(AlSi)O_7$; in this latter case the 4*e* positions of $D^3_{2d}$ would be alternately occupied by Al and Si-ions. All chemical evidence is in agreement with this arrangement and the only reason for Raaz's unwillingness to accept it was the fact that this assumption would be contrary to the traditional application of the theory of crystal analysis.

## SUMMARY

Comparisons of the observed and calculated intensities on the spinels, magnesium ferrite and magnesium galliate, show that instead of having Mg in (8f) and Al in (16c), 8 Al-ions occupy positions in (8f) and 8 Al-ions + 8 Mg-ions are in (16c). The possibility that different atoms partly replace one another in structurally equivalent positions of a crystal is in all likelihood not confined to spinels, but very likely is a more general phenomenon. It is proposed to call unit cells of such crystals, cells with variate atom equipoints.

[6] Cf. F. Machatschki. Zeitschr. f. Krist. **71**, 219. 1929; Centralblatt f. Min. Abt. A, 1930, 279.

[7] F. Raaz. Sitzungsberichte Akad. Wiss. Wien, Abt. 1, **139**, 645. 1930.

ZOOLOGY.—*Resistance of rats to superinfections with a nematode,* Nippostrongylus muris, *and an apparently similar resistance of horses to superinfection with nematodes.*[1] BENJAMIN SCHWARTZ, JOSEPH E. ALICATA and JOHN T. LUCKER, Bureau of Animal Industry, U. S. Department of Agriculture.

For the past twenty-five years parasitologists have been seeking evidence in regard to immunity in parasitic infections. By means of the known immunological technic developed in connection with the study of bacterial and related diseases, it has been possible to demonstrate more or less specific antibodies in certain diseases caused by metazoan parasites, particularly in schistosomiasis, hydatid disease, trichinosis, filariasis, and some of the worm infestations of the gastro-intestinal tract of various mammals. While the evidence obtained in the course of these investigations is of interest and of value, and shows that certain substances eliminated by the parasites involved are probably absorbed by the host with the resultant elaboration of antibodies, it falls short of explaining how the host actually copes with the parasites themselves, particularly in cases of superinfections. More recently a number of parasitologists have presented data, based on laboratory investigations, which appear to indicate that following the successive administration of infective nematode larvae to susceptible host animals, the latter ultimately become entirely refractory, or nearly so, to an infection with the particular parasites involved. The evidence presented in connection with the latter investigations has been in the main indirect, and has been based, for the most part, on information derived from quantitative studies in the form of counts, made at regular intervals of the number of worm eggs in definite amounts of the feces of experimentally infected animals, the rise and fall in the intensity of the parasitic infestations being judged by the relative number of parasite eggs present in definite quantities of feces. In the opinion of the present writers, however, evidence of this sort has definite usefulness and value, and also definite limitations. It fails to give an accurate index to the total number of worms harbored by a host, since the evidence of egg counts takes cognizance only of female worms which have attained fertile maturity, and gives no direct or positive information in regard to males, immature worms, or senile females, which might be present in the host in considerable numbers. This limitation has been pointed out from time to time in the past, but even yet is not always taken into consideration or kept in mind. The significance

[1] Received May 20, 1931.

of the possible presence of agamic parasites in a state of arrested development has been entirely overlooked in the past.

The writers' investigations on the life history of *Nippostrongylus muris,* a nematode parasitic in the small intestine of rats, and more or less closely related to pathogenic trichostrongyles occurring in domestic meat-food animals, have already brought to light facts which show rather conclusively that following the recovery from a single infection with this nematode, under rigorous experimental conditions which have precluded extraneous infections with this and with other parasites, the rat host is already in a state of relative resistance to superinfection. If exposed to a second infection or to subsequent infections, the development of the parasites is considerably retarded, but agamic worms commonly remain in the host and may ultimately come to fertile maturity, apparently a few at a time.

As first shown by Yokagawa in 1925, the infective larvae of *Nippostrongylus muris* may enter the host through the skin and be carried by the circulation to the lungs. In these organs the larvae develop for a time and then migrate to the small intestine in a manner similar to that of various species of human and carnivore hookworms, species of ascarids, and other intestinal parasites which undergo part of their development in the lungs. In about six to seven days after experimental infection with *N. muris,* the worm eggs appear in the feces of infested rats. The writers' investigations have shown that once the the eggs have appeared in the feces, their production, as followed by microscopic examination of the feces, rises rather rapidly at first, then declines gradually, and finally the eggs disappear from the feces altogether. Experimentally infected rats, killed from 13 to 16 days following infection, and about 7 to 10 days after the first appearance of eggs in the feces, contained fully grown, sexually mature worms, the females being, as a rule, at the peak of egg production, but sometimes already on the decline in production. Occasionally a few larvae, usually from three to five, have been discovered in the lungs of such rats. These larvae are worms which, for one reason or another, have failed to get into the intestine and have, therefore, been unable to develop beyond the stage which these parasites can attain in the lungs.

In experimental rats killed from 13 to 16 days following the first superinfection, subsequent to the disappearance from the feces of eggs resulting from the previous infection, the parasite picture discovered at necropsy was quite different from that noted at the corresponding stage in the course of the first infection. In some rats many of the worms from the second infection, in some cases 50 per cent or more, were still in the lungs as third-stage larvae; the worms recovered from the intestine were, for the most part, not fully grown and many of the females had not yet attained the egg-laying stage. Before being killed, the rats in question showed an insignificant number of eggs in the feces as compared to the large number of eggs present at a corresponding stage of development in the first infection. At necropsy, the egg-producing females from the second infection were found to contain relatively few eggs in the uterus.

While direct evidence based on the finding of worms post-mortem, about two weeks after a second or a third superinfection of rats, is as yet unavailable, indirect evidence, based on the period required for eggs to appear in the feces following such successive infections, indicates that the prepatent period increases directly with the number of times that these host animals are exposed to re-infection. This is interpreted as indicating that with successive infections the host builds up an increasing resistance of a sort resulting in retardation of the growth and the development of these nematodes, possibly by elaborating, either throughout the body or, what is, perhaps, more probable, in the tissues and organs with which these worms come in contact, a specific growth-inhibiting substance or substances which retard the development of the parasites. So far as the writers are aware, this is the first experimental demonstration of what appears to be the development by the host of a growth-inhibiting mechanism for keeping in check the development and propagation of a parasitic nematode.

In connection with an investigation on the prevalence in horses of species of *Habronema,* heteroxeneous nematodes which are transmitted by flies, it was discovered that despite the absence of flies during the the winter months in the vicinity of the District of Columbia, agamic forms of *Habronema* species, in many cases no further advanced in development than that attained in their intermediate fly hosts, were present in the stomachs of horses during the months of December, 1930, to March, 1931 inclusive.[2] In the light of the experimental results obtained with *N. muris,* the writers interpret these findings in horses as probably falling within the same category of resistance as that discovered in connection with the superinfection experiments with the rat trichostrongyle discussed in this paper. It is not improbable that in cases of superinfections with other species of nematodes a growth-retarding mechanism, similar to that discovered in rats infected with *Nippostrongylus muris,* will be found.

[2] These data were collected by Mr. Allan McIntosh, Assistant Zoologist, Bureau of Animal Industry.

ZOOLOGY.—*A new species of Pinnotherid crab from Costa Rica.*[1]
MARY J. RATHBUN, United States National Museum.

In a collection of Costa Rican crabs recently sent to the United States National Museum by Prof. Manuel Valerio of San José, there is a *Pinnixa* different from any previously obtained.

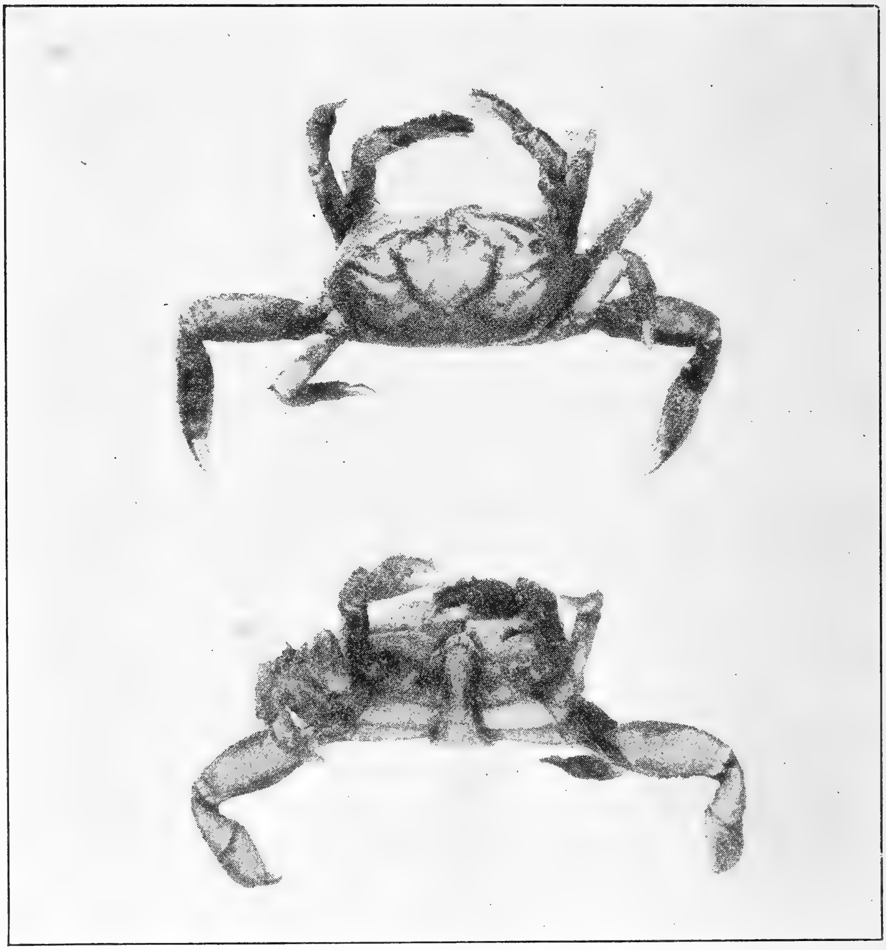


Fig. 1. *Pinnixa valerii* ♂ holotype, carapace 9.8 mm. wide, dorsal and ventral views.

**Pinnixa valerii,** new species

Figures 1 and 2

Carapace and appendages covered with a short close pile. Carapace nearly twice as wide as long; anterior and anterolateral margins together forming a strongly convex arch, reaching to the line of the widest part of the cardiac

[1] Published with the permission of the Secretary of the Smithsonian Institution.
Received May 4, 1931.

region and meeting posterior margin at almost a right angle; posterior margin transverse at its middle for less than $\frac{1}{3}$ of carapace width. Gastric and cardiac regions strongly delimited, the former the wider; three longitudinal, narrow gastric furrows, one median, short, reaching only half way back; branchial region crossed by five obliquely transverse furrows, the hinder one deep and parallel to posterior margin. A short dorsal hepatic furrow is directed inward and forward. Eyes minute. Fronto-orbital width less than $\frac{1}{4}$ width of carapace; below the level of the orbit the carapace is vertical; the antero-lateral margin is a smooth blunt ridge, separated from the sharp pterygostomian ridge by a broad depression.

Chelipeds small, about as long as first leg, and fringed with long hair on upper margin and along middle of inner surface of carpus and manus. Chelae

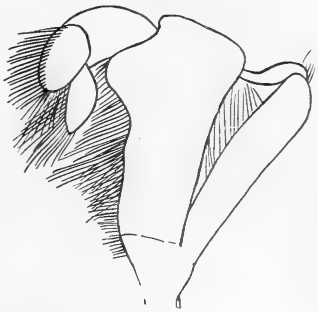


Fig. 2. Left outer maxilliped of *Pinnixa valerii* ♂ holotype, enlarged.

thin, sharp-edged; palm nearly as high as long; fingers narrow, longitudinal, acuminate, gaping in proximal two-thirds. Legs stout, first pair with remarkably short dactyl; third pair much stouter than the others, $1\frac{1}{4}$ times as long as second pair; merus widest at middle, narrowing toward either end. Male abdomen very long and narrow, overlapping buccal cavity; third, fourth and fifth segments regularly tapering, fourth and fifth equally long, sixth long and narrow, with parallel sides, seventh suboblong. Female abdomen, second to sixth segments subcircular, sixth rapidly tapering, seventh short with arcuate tip.

Male, length of carapace 5.3, width of same 9.8, width of front and orbits 2.3, of transverse posterior margin 2.8 mm.

*Type-locality.*—Isla San Lucas, west coast of Costa Rica; Jan. 15, 1930; 1 male holotype, 1 female, Cat No. 63854, United States National Museum.

ENTOMOLOGY.—*A revisional study of the genus* Gnathotrichus *Eichhoff in North America.*[1] M. W. BLACKMAN, Bureau of Entomology, U. S. Department of Agriculture. (Communicated by HAROLD MORRISON.)

This is the third of a series of revisional studies of *Pityophthorus* Eichh. and its allies in North America. The one remaining genus of the group, *Conophthorus* Hopk., will perhaps serve as the subject of a future study.

*Gnathotrichus materiarius* Fitch was described by Fitch in 1858 under the name *Tomicus materiarius*. In 1868 Zimmerman referred *materiarius* Fitch to the genus *Crypturgus* Er. and in the appendix to this same paper LeConte (1868) placed it in the genus *Cryphalus* Er. along with *retusus, sulcatus,* and *asperulus* described as new, and various other species now included in *Pityophthorus* Eichh., *Pseudopityophthorus* Sw., etc.

Eichhoff in 1868 erected the monobasic genus *Gnathotrichus* to include *G. corthyloides* described by him as new. In a footnote, however, he expressed his belief that this species might be identical with *Tomicus materiarius* Fitch.

LeConte (1876) placed *corthyloides* Eichh. as a synonym of *materiarius* Fitch, which he included, along with the other North American forms described by him, as one division of the genus *Pityophthorus* Eichh.

Eichhoff (1878) in his "Ratio Tomicinorum" placed *corthyloides* as a synonym of *materiarius* Fitch, the type of the genus thus becoming *Gnathotrichus* [*corthyloides*] *materiarius* Fitch. In this same great work Eichhoff described three additional species, *G. longipennis, G. consobrinus,* and *G. nanus,* all from Chile, and included a full redescription of the genus.

Blandford (1895) redescribed the genus and added the two new species, *G. consentaneus* and *G. bituberculatus* from Central America.

Hopkins (1902) referred to his manuscript species, *occidentalis,* which apparently has never been described, and in 1905 described *G. nitidifrons* Hopk. from Mexico.

Thus the species listed by Hagedorn (1910) are 11 in number, but *occidentalis* MS Hopk. has never been described, and *asperulus* Lec. was correctly placed by Eichhoff (1879) in the section of the genus *Pityophthorus* Eichh. which was later removed by Swaine (1918) to form the new genus *Pseudopityophthorus* Sw.

[1] Received April 16, 1931.

Swaine (1918) included in the North American members of the genus *Gnathotrichus* not only *materiarius* Fitch, *retusus* Lec., and *sulcatus* Lec., but also *asperulus* Lec., which should have been placed under *Pseudopityophthorus* Sw.

### REVISED DESCRIPTION OF THE GENUS GNATHOTRICHUS EICHHOFF

Body form cylindrical, elongate, more than three times as long as wide; the surface very smooth, finely reticulate, varying from subopaque to brightly shining with the punctures varying from fine to minute.

*Head* with the front convex, either punctured, with the median area elevated, or convergently aciculate, with a few moderate hairs; the antenna with the club more than one and a half times as long as the five-jointed funicle, with segments 2 and 3 subequal in width, and sutures 1 and 2 septate, the females with long curved hairs on the outer border of both club and funicle; the mouth parts with slender hairs; the pregula either normal or protuberant.

*Pronotum* with the sides not constricted before the middle; the anterior area with numerous very broad and low asperities; the summit anterior to the middle and marked by a sharply elevated, tranverse carina; the basal border without a well-developed, beaded margin, although traces of this are to be found in some specimens of all of the North American species.

*Elytra* finely rugulose, with the strial punctures fine to minute and in definite rows, glabrous or subglabrous except on the posterior third; declivity weakly to strongly sulcate.

The *legs* more slender than in its allies; the tibia rather narrow and gradually widened toward the distal end, which is ornamented with two socketed teeth and in one of the sub-groups by an additional tooth on the outer edge as in other Pityophthori; the tarsi longer and more slender than in *Pityophthorus*.

The members of this genus occurring in the United States are readily recognized owing to their great similarity in general appearance. However, when studied carefully the group readily divides itself into two sub-groups separated by differences nearly as great as those separating other genera of the Pityophthori. These differences have to do with such structures as the front of the head, the pregula, the tarsi, and the tibia of the fore leg.

In *sulcatus* Lec. and *aciculatus*, new species, the front of the head in both sexes is strongly, convergently aciculate over a greater portion of its surface; while in the other group which includes *materiarius* Fitch, *denticulatus*, new species, *retusus* Lec., and *alni*, new species, the frons is punctured, with an impunctate, elevated area in the median line with either very faint or no aciculations. In *sulcatus* and *aciculatus* the pregula is normal, similar in general to the pregula of *Pityophthorus* and most of its allies. In the other group, however, the pregula is swollen and protrudes anteroventrally.

The two groups of species also differ as regards the structure of the fore legs. The general shape of the tibia is rather similar in all of the species but in the *sulcatus-aciculatus* group the submarginal teeth are confined to the distal end and are only two in number, while in the group containing *materiarius, denticulatus, retusus,* and *alni* these submarginal teeth are three in number as in all of the other Pityophthori, the third tooth being placed on the outer edge of the tibia. Other differences are to be seen in the degree of development of the serrations on the outer edge of the tibia, the modification at the tarsal joint of the tibia in *sulcatus* and *aciculatus* to form a rudimentary subapical tooth, and in the greater length of the first tarsal joint in this same group.

These differences might be considered great enough to warrant the separation of *sulcatus* and *aciculatus* to form a new genus but the writer does not consider them of more than subgeneric value and believes the true relationship can best be expressed by dividing the genus *Gnathotrichus* into the subgenus *Gnathotrichoides*, new subgenus, including *sulcatus* and *aciculatus*, and the subgenus *Gnathotrichus*, containing the other North American species.

*G. nitidifrons* Hopk., described from Mexico, belongs to the true *Gnathotrichus*, with the frons not aciculate, the pregula protuberent, and the fore tibia tridentate. The position of the other described species can not be determined with certainty, as the descriptions, while excellent in other respects, do not take cognizance of the structures which the present writer considers of greatest subgeneric value. However, on the basis of frontal characters *G. consentaneus* Bldfd. seems to fall into the subgenus *Gnathotrichoides* while *G. longipennis* Eichh., *G. consobrinus* Eichh., *G. nanus* Eichh., and *G. bituberculatus* Bldfd. seem to belong to the true *Gnathotrichus*.

*Added note.*—Since this paper was written in its final form, the article by K. Schedl (1931) on the *Morphology of the bark-beetles of the genus* Gnathotrichus *Eich.* (Smithsonian Misc. Coll. Vol. 82, No. 10, Publication 3068; 88 pp., 40 figs.) has appeared. The author has worked out the comparative morphology of the three species known to him in accordance with a very admirable plan, and has added considerably to our knowledge of this group of Scolytidae. In most cases he has also constructed keys to the three species, based on the characters of each set of structures studied. For the most part his findings agree with those of the present writer, but in regard to the structure of the fore-leg he is certainly in error when he says on page 45,—"They (the legs) do not vary strikingly from species to species, neither in form nor in sculpture." He therefore made all of his drawings and apparently all of the descriptions from *G. materiarius*. On page 48 he says regarding the tibia,—"The sinestral margin bears four to six low serrations, and three marginal teeth which are imbedded in sockets." This is true of *materiarius* Fitch and *retusus* Lec. and also of the new species *denticulatus* and *alni*, described in the present paper, but is certainly not true of *sulcatus* Lec. and *aciculatus*, new species. These latter two species have but two "marginal" (really submarginal), socketed teeth on the fore tibia and this character serves as one of the principal differences in the subdivision of the genus as proposed by the present writer. There are also other differences in leg structure, as for instance in the greater relative length of the first tarsal segment and in a greater tendency toward the development of a subapical tibial tooth in the *sulcatus* group. But these differences are not tangible enough to lend themselves readily to use in a key.

### KEY TO THE GENUS GNATHOTRICHUS EICHHOFF

*A*. Front of head punctured at sides, the median area elevated; antennal club with septa of sutures 1 and 2 subtransverse or weakly arcuate; the pregula protruding antero-ventrally; fore tibia with three submarginal teeth.

Subgenus *Gnathotrichus* n. sub-gen.

*B*. Median elevated area of frons smooth; pronotum with posterior area feebly shining, finely, sparsely punctured; elytra more narrowly rounded behind, declivity weakly or moderately sulcate, the sides feebly or moderately retuse; smaller species, less than 3.4 mm. long.

*C*. Antennal club with septa of sutures 1 and 2 subtransverse; pronotum more narrowly rounded in front, flattened on a triangular area just posterior to summit, posterior area sparsely, very minutely punctured; the declivity feebly sulcate, the sides not distinctly retuse, with the granules nearly obsolete; eastern species **materiarius** Fitch.

*CC*. Antennal club with septa weakly arcuate; pronotum moderately rounded in front; the region posterior to summit not usually flattened, the punctures moderately fine and sparse; declivity distinctly sulcate, the sides moderately retuse and distinctly denticulate; western species............................**denticulatus,** n. sp.

*BB*. Median elevated area of the frons feebly aciculate in the males; posterior area of pronotum at least moderately shining, the punctures moderately fine and sparse; elytra moderately rounded behind, declivity strongly sulcate, the sides strongly retuse; larger species, more than 3.5 mm. long; western species.

*C*. Slightly smaller, less than 3.8 mm. long; pronotum with carina marking summit shorter, moderately arcuate, and slightly in front of middle; elytra with the declivital sulcus narrower, the sides less strongly retuse, and the granules finer; the posterior margin moderately extended; living in western coniferous trees......**retusus** Lec.

*CC*. Larger, usually about 4.0 mm. long; pronotum with carina longer, feebly arcuate, and more anterior in position; elytra with the declivital sulcus wider, the sides more strongly retuse, and the granules coarser; the posterior margin more strongly extended; living in western alder...........................**alni,** n. sp.

*AA*. Front of the head distinctly convergently aciculate; antennal club with septa of sutures 1 and 2 moderately to strongly arcuate; the pregula not protruding; fore tibia with only two submarginal teeth.

Subgenus *Gnathotrichoides* n. sub-gen.

*B*. Antennal club with septa of sutures 1 and 2 moderately arcuate; front of head more coarsely aciculate, the punctures coarser and more evident; pronotum with the carina marking the summit moderately elevated and weakly arcuate, posterior area brightly shining, the punctures moderately fine; elytral declivity more abrupt, moderately strongly retuse, the granules coarser......**aciculatus,** n. sp.

*BB*. Antennal club with septa strongly arcuate; front of head distinctly but finely aciculate, the punctures fine; pronotum with carina weakly elevated, straight and short; posterior area feebly shining, the punctures minute; elytral declivity more sloping, less strongly retuse, the granules minute....................................**sulcatus** Lec.

### **Gnathotrichus materiarius** Fitch

Figs. 1, 1a, 2, and 3

*Description of the adult female.*—Dark reddish brown; 3.03 mm. long, 3.29 times as long as wide.

*Front* of the head plano-convex, rather coarsely, strongly, moderately sparsely punctured at sides and above, with moderately fine, short hairs, median area slightly elevated, impunctate, smooth or very faintly aciculate. *Eye* moderately granulate, the inner line broadly and deeply emarginate. *Antenna* considerably lighter in color, club 1.5 times as long as funicle, 1.29 times as long as wide, widest through the second segment, the septa sub-transverse; with a few very long hairs on the outer margin of the club and funicle. *Pregula* protruding antero-ventrally.

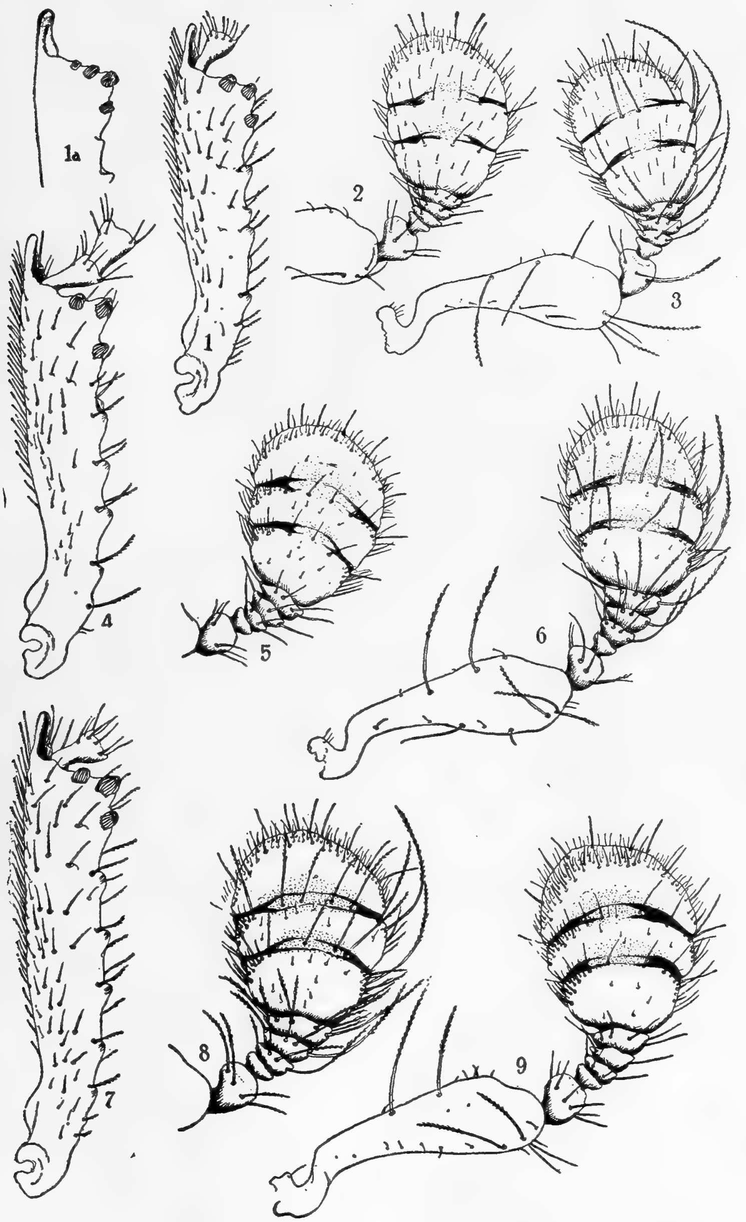
*Pronotum* 1.29 times as long as wide, widest near the posterior margin, the sides subparallel on the posterior half, then regularly curved to the rather narrowly rounded, slightly extended front margin, which is armed with rather low and broad serrations; anterior area with subconcentric rows of numerous, rather broad and low asperities; the summit modified to form a distinct, well-developed, arcuate, transverse carina, anterior to the middle; the surface posterior to it depressed to form a shallow, median, triangular impression which tapers posteriorly and is lost about half way between summit and posterior margin; posterior area feebly shining, the surface very finely reticulate, minutely, rather sparsely punctulate, glabrous; the beaded marginal line feebly developed.

*Elytra* nearly exactly twice as long as wide, the sides subparallel, narrowly rounded behind, with the posterior margin extended; surface moderately shining, rugulose; the strial punctures very fine, in fairly regular rows, interstrial punctures still more minute, very sparse on the disc, which is nearly glabrous, more numerous, and bearing stiff erect hairs of moderate length on the declivity. *Declivity* convex, weakly sulcate in the sutural region, the suture flat, lateral elevations weak, with a few small, nearly obsolete granules.

The *male* is similar in size, proportions, and sculpture, but with the pronotum more broadly rounded in front, and the anterior margin not extended; it is readily distinguished by the absence of the longer hairs on the outer margin of the antennal funicle and club.

The foregoing description of the female was prepared, with the exceptions of the measurements of the antenna, from a specimen now in the National Museum but obtained from the Fitch Collection and bearing the label "*Tomicus materiarius*, Fitch" in Fitch's own hand-writing. It is believed that this specimen served as the type for Fitch's original description.

This species is widely distributed over eastern Canada and the eastern part of the United States. The writer has examined several hundred specimens from the following States: Ontario, Canada, Maine, Vermont, Massachusetts, New York, Pennsylvania, Michigan, Wisconsin, Minnesota, Nebraska, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Mississippi, Louisiana, Arkansas, and Texas. The hosts are the various species of *Pinus, Picea, Larix, Abies,* and *Tsuga* occurring in its range. Other conifers used in plantations or as ornamentals are also subject to attack.




FIGURES.—1. Fore tibia of *Gnathotrichus materiarius* Fitch;—1a. fore tibia of same showing extra tooth on distal end.—2. Antenna of male *G. materiarius*.—3. Antenna of female *G. materiarius*.—4. Fore tibia of *G. denticulatus* n. sp.—5. Antenna of male *G. denticulatus* n. sp.—6. Antenna of female *G. denticulatus* n. sp.—7. Fore tibia of *G. retusus* Lec.—8. Antenna of female *G. retusus*.—9. Antenna of male *G. retusus*.

All figures were made by the writer from preparations mounted in balsam, using a compound microscope and a camera lucida. All are magnified about 112 diameters.

**Gnathotrichus denticulatus,** new species

Figs. 4, 5, and 6

*Description of the adult female.*—Reddish brown; 3.28 mm. long, 3.25 times as long as wide.

*Front* of the head convex, similar to that of *G. retusus* but considerably more finely sculptured, with the median impunctate area wider and less elevated below; pubescence scanty and inconspicuous. *Eye* short oval, broadly and deeply emarginate, rather finely granulate. *Antenna* considerably lighter in color, club 1.6 times as long as funicle, 1.32 times as long as wide, the second segment slightly wider than the third, the septa of sutures 1 and 2 weekly arcuate, with longer hairs on the outer margin of club and funicle. *Pregula* protruding antero-ventrally.

*Pronotum* 1.19 times as long as wide; widest just behind the middle, the sides slightly arcuate, feebly narrowed in front of the middle, moderately rounded in front; the anterior margin extended and armed with broad, low serrations; the asperities low and broad; summit anterior to the middle and marked by a sharply elevated, transverse, arcuate carina; the region posterior to it impunctate, not flattened or impressed; posterior area with surface subopaque or feebly shining, finely reticulate, the punctures moderately sparse, shallow, much finer than in *retusus;* the posterior margin with little evidence of a beaded line.

*Elytra* about equal to pronotum in width, slightly more than twice as long as wide; the sides subparallel; rather narrowly rounded behind, with the posterior margin extended; surface shining, rugulose; the strial punctures fine but distinct, in fairly regular rows; interspaces nearly devoid of punctures on the disc but sparsely punctured on sides and declivity and ornamented with stiff, suberect hairs of moderate length. *Declivity* convex, abrupt; the sutural region moderately sulcate (much less so than in *retusus*), the lateral elevations moderate, with a row of denticles in the third interspace.

The *male* is slightly smaller, with the pronotum not extended, broadly rounded in front and the serrations and asperities coarser; the front of the head is more coarsely and roughly punctured, and the antennae lack the long hairs on the outer margin.

*Type.*—Cat. No. 43430, U. S. N. M.

Type, allotype, and two paratypes bear the labels, "Hopk, U. S. 3984f; W. F. Fiske, Colr.; Cloudcroft, N. M.; *Pinus ponderosa:*" 10 paratypes collected from *Pinus ponderosa* at Cloudcroft, N. M. by W. F. Fiske: four paratypes, "Hopk. U. S. 3899; Davis Mts., Tex., W. F. Fiske, Colr.; *Pinus edulis:*" 18 paratypes collected by Hopkins and Webb at Flagstaff, Ariz., from yellow pine: 18 paratypes collected from *Pinus ponderosa* and *Abies concolor,* Sta. Catalina Mts., Ariz., by J. L. Webb: 11 paratypes collected from *P. ponderosa, P. strobiformis,* and *P. chichuahuana* by J. L. Webb, Chiricahua Mts., Ariz.

**Gnathotrichus retusus** Lec.

Figs. 7, 8, and 9

*Description of the adult female.*—Dark reddish-brown, with the anterior part of pronotum and of elytra slightly lighter in color; 3.5 to 3.8 mm. long, 3.25 times as long as wide.

*Front* of the head convex, moderately punctured, with a triangular callus above, one angle of which is extended as a strongly elevated smooth ridge on the vertex; below, with an impunctate, shining, median, broad elevation ending in a small, acute epistomal process; pubescence rather scanty. *Eye* short-oval, moderately granulate, the inner line widely, rather deeply emarginate. *Antenna* somewhat lighter in color, the club 1.54 times as long as funicle, 1.23 times as long as wide; second and third segments subequal in width, the septa of sutures 1 and 2 rather weakly arcuate; with longer hairs on the outer margin of the club and funicle. *Pregula* protruding antero-ventrally.

*Pronotum* 1.29 times as long as wide; the sides subparallel, feebly arcuate, moderately rounded in front, with the anterior margin slightly extended and armed with rather low, wide serrations; the asperities of the anterior area low and broad; summit anterior to middle and marked by an arcuate, rather strongly elevated, transverse, rather short carina, the surface posterior to it slightly flattened on a triangular area narrowing to a point about midway between summit and posterior margin; posterior area glabrous, with the surface finely reticulate, shining, the punctures moderately sparse, deep, and moderately fine; beaded marginal line feebly developed.

*Elytra* very slightly narrower than pronotum, twice as long as wide, the sides subparallel, feebly converging, moderately rounded behind, with the posterior margin extended; surface shining, rugulose; the strial punctures fine but distinct and rather deep, in regular strial rows; interspaces nearly devoid of punctures on the disc, but on the sides and declivity with a few punctures similar in size to those of the striae and bearing stiff, suberect hairs of moderate length. *Declivity* rather abrupt, convex, strongly sulcate in the sutural area, with the sides strongly retuse and armed with a row of denticles.

The *male* is similar, but with the median carinal area of the frons finely, weakly aciculate, the antenna with the longer hairs of the outer margin absent; the pronotum more broadly rounded and strongly serrate in front, and the sculpture in general slightly coarser.

Specimens of this species examined by the writer were from British Columbia, Washington, Oregon, California, Nevada, Idaho, and South Dakota. The hosts are *Pinus ponderosa*, *P. jeffreyi*, *P. radiata*, *P. lambertiana*, *Pseudotsuga taxifolia*, *Abies magnifica*, and *Tsuga heterophylla*.

*G. occidentalis* Hopk. MS., mentioned by Hopkins (1902) but not described, appears to be identical with *G. retusus* Lec.

### **Gnathotrichus alni**, new species

Figs. 10, 11, and 12

*Description of the adult female.*—Dark reddish-brown; 4.04 mm. long, 3.4 times as long as wide.

*Front* of the head convex, with a triangular callus above, moderately punctured below, except on the elevated, median, carinal space which ends in a small sharp epistomal process, pubescence rather scanty and inconspicuous. *Eye* short-oval, moderately granulate, the inner line broadly, moderately deeply emarginate. *Antenna* lighter in color, the club 1.8 times as long as funicle, 1.3 times as long as wide, second and third segments subequal in width, the septa of sutures 1 and 2 rather weakly arcuate; with a few longer hairs on the outer margin of club and funicle. *Pregula* lighter in color, except on the anterior margin, strongly protruding antero-ventrally.

*Pronotum* 1.26 times as long as wide, widest near the posterior border, the sides subparallel, feebly converging anteriorly; moderately rounded in front; with the anterior margin extended and armed with very broad, low serrations, asperities very low and broad; summit anterior to the middle, marked by an arcuate, rather strongly elevated carina, longer than in *retusus*, the surface posterior to it slightly flattened on a triangular area which narrows to a point about half way to the posterior border; posterior area glabrous, with the surface finely reticulate, moderately shining, the punctures moderately fine, rather deep, moderately sparse.

*Elytra* slightly narrower than pronotum, 2.18 times as long as wide, the sides straight and feebly converging, moderately narrowly rounded behind, more narrowly than in *retusus*, with the posterior margin extended; surface brightly shining, rugulose, the strial punctures fine, rather deep, in regular strial rows; interspaces nearly devoid of punctures and nearly glabrous on the disc, more numerous on the sides and declivity, similar in size to those of the striae and bearing stiff, suberect hairs of moderate length. *Declivity* moderately abrupt, less so than in *retusus*, convex, strongly sulcate in the sutural area, more widely than in *retusus*, with the sides strongly retuse and armed with a row of denticles.

The *male* is similar but has the carinal area of the frons weakly and finely aciculate; the antennae lack the longer hairs on the outer margin; the pronotum is more broadly rounded and strongly serrate in front, with the anterior margin not so much extended, and in general the sculpture is slightly coarser.

*Type.*—Cat. No. 43431, U. S. N. M.

Type, allotype, and three paratypes bear the labels—"Hopk. U. S. 1868a; Burke, Colr., Hoquiam, Wn.; *Alnus*;" one paratype—"Hopk. U. S. 2020; Burke, Colr., Satspo, Wn.; *Alnus oregona*;" one paratype—"Hopk. U. S. 2369a, Hopkins, colr., Hoquiam, Wn.;" one paratype—"Hopk. U. S. 4007a; Burke, Colr., Hoquiam, Wn.; *Alnus oregona*;" one paratype—"Hopk. U. S 4217b; Burke, Colr., Miller Lg., Wn.; *Alnus oregona*:" one paratype—"Webb 116e; Sequim, Wash.; *Alnus*; J. L. Webb, Colr."

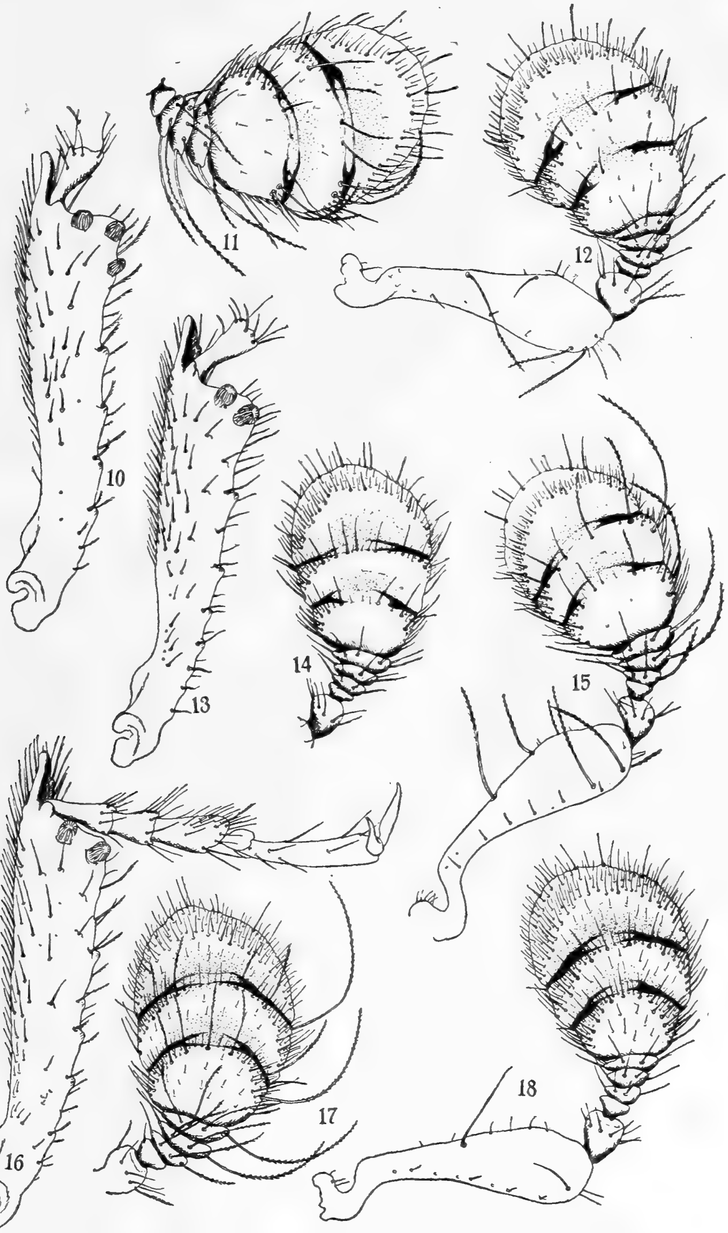
### **Gnathotrichus aciculatus,** new species

Figs. 13, 14, and 15

*Description of the adult female.*—Dark reddish-brown; 3.54 mm. long, 3.24 times as long as wide.

*Front* of head similar to that of *G. sulcatus* Lec. but with the aciculations coarser, more coarsely and evidently punctured, and not so deep. *Eye* broad oval, moderately coarsely granulate, the inner line broadly and deeply emarginate. *Antenna* somewhat lighter in color; the club 1.79 times as long as funicle, 1.3 times as long as wide, the second and third segments subequal in width, the septa moderately arcuate, with the usual development of long hairs on the outer margin of club and funicle. *Pregula* normal.

*Pronotum* 1.28 times as long as wide, the sides subparallel, very feebly arcuate, the front margin distinctly extended, rather narrowly rounded, and armed with moderately broad low serrations, more numerous and sharper than in *sulcatus*; anterior area with the asperities low and broad but much stronger than in *sulcatus*; the transverse carina marking the summit moderately elevated, moderately short, weakly arcuate; the surface posterior to it not modified; posterior area glabrous, with the surface very finely reticulate,




FIGURES.—10. Fore tibia of *Gnathotrichus alni* n. sp.—11. Antenna of female *G. alni* n. sp.—12 Antenna of male *G. alni* n. sp.—13. Fore tibia of *G. aciculatus* n. sp.—14 Antenna of male *G. aciculatus* n. sp.—15. Antenna of female *G. aciculatus* n. sp.—16. Fore tibia of *G. sulcatus* Lec.—17. Antenna of female *G. sulcatus*.—18. Antenna of male *G. sulcatus*.

See note to figures 1–9.

shining, the punctures rather sparse, rather deep, moderately fine; beaded marginal line feebly developed or lacking.

*Elytra* slightly less than twice as long as wide, the sides subparallel, moderately narrowly rounded behind, with the posterior margin extended; surface brightly shining, densely rugulose; the strial punctures moderately fine, in nearly regular rows; interspaces nearly devoid of punctures on the disc; on the sides and declivity with a few punctures coarser than those of the striae and bearing moderately long stiff hairs more numerous than in *sulcatus.* In the fifth interspace a sparse row extends forward nearly to the middle of the elytra. *Declivity* convex, more abrupt than in *sulcatus* and with the sulcus deeper, the retusions higher and armed with coarser, more numerous granules.

The *male* is slightly smaller and the anterior margin of the pronotum more broadly rounded, not extended, the sculptures slightly coarser, and the antennae show the usual sexual differences.

*Type.*—Cat. No. 43432, U. S. N. M.

Type and one paratype bear the labels—"Hopk. U. S. 3986b, Cloudcroft, N. M.; *Pinus ponderosa:*" allotype— "Hopk. U. S. 3988, W. F. Fiske, Colr.; Cloudcroft, N. M.; *Pseudotsuga taxifolia;*" one paratype—"Hopk. U. S. 3981b; Cloudcroft, N. M.; *Pseudotsuga taxifolia:*" two paratypes—"Hopk. U. S. 3984f; Cloudcroft, N. M.; *Pinus ponderosa:*" one paratype—"Hopk. U. S. 5708b; J. L. Webb, colr.: Sta. Catalina Mts., Ariz.:" a series of 14 paratypes bearing various lot numbers collected by J. L. Webb, Sta. Catalina Mts., Ariz., from *Pinus ponderosa, Abies concolor,* and *Pseudotsuga taxifolia:* a series of 16 paratypes collected by J. L. Webb, Chiricahua Mts., Ariz. from *Abies concolor, Pinus ponderosa, P. strobiformis,* and *Pseudotsuga taxifolia:* three paratypes—"Hopk. U. S. 7160 & 7164, Rincon Mts., Ariz.; *Pinus ponderosa:*" 54 paratypes collected by J. L. Webb, Black Hills, S. D. from *Pinus ponderosa* under various lot numbers: one paratype—"Hopk. U. S. 12436q; W. D. Edmonston, Colr.; Waldo Canon, Colo.; *Pinus scopulorum.*"

### Gnathotrichus sulcatus Lec.

Figs. 16, 17, and 18

*Description of the adult female.*—Dark reddish-brown 3.48 mm. long, 3.3 times as long as wide.

*Front* of the head convex, strongly convergently aciculate, the median area broadly, indistinctly elevated below, weakly flattened at each side with fine punctures among the aciculations; above smooth, shining, with coarser, sparse punctures and with a distinct median carina on the vertex; ornamented with a few moderate hairs, directed downward. *Eye* broad oval, moderately coarsely granulate, the inner line broadly, moderately deeply emarginate. *Antenna* lighter in color, club 1.78 times as long as funicle, 1.33 times as long as wide; the second and third segments subequal in width, the septa strongly arcuate; with a few much longer hairs on the outer margin of the club and funicle. *Pregula* normal.

*Pronotum* 1.27 times as long as wide, the sides subparallel, faintly arcuate, the front margin moderately broadly rounded, distinctly extended, and armed with very broad and very low serrations;. anterior area with the subconcentric rows of asperities very low and very broad, the summit anterior to the middle and marked with a short, straight, feebly elevated, transverse carina, the surface posterior to it not flattened or impressed except occasionally and then very weakly; posterior area subopaque or feebly shining, the surface very finely reticulate, glabrous, with the punctures shallow, very minute, almost obsolete, and moderately sparse, the beaded marginal line feebly developed, sometimes not to be distinguished.

*Elytra* twice as long as wide, the sides subparallel, very narrowly rounded behind with the posterior margin distinctly extended; surface feebly shining, densely, minutely rugulose; the strial punctures minute, in fairly regular rows; interspaces nearly devoid of punctures on disc, very minute, more numerous, and bearing stiff erect hairs of moderate length on the declivity. *Declivity* convex, the sutural region moderately sulcate, more strongly than in *materiarius* Fitch, much less strongly than in *retusus* Lec., the suture not elevated, lateral elevations moderate, with a row of minute granules in line with the third interspace.

The *male* is similar in general proportions, but with the pronotum more broadly rounded in front and the anterior margin not extended. It is also readily distinguished by the absence of the long hairs on the antennal club and funicle.

Examples of this species have been studied from British Columbia, Washington, Oregon, California, Arizona, New Mexico, and Mexico. It probably breeds in all of the coniferous trees within its range but specimens from the following hosts have been examined by the writer: *Pinus ponderosa, Picea engelmanni, P. sitchensis, Tsuga heterophylla, T. mertensiana, Pseudotsuga taxifolia, Abies concolor, A. grandis, Sequioia sempervirens, S. washingtoniana,* and *Thuja plicata.*

The above description was prepared from material compared with LeConte's types and found to be identical.

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# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## PHILOSOPHICAL SOCIETY

### 1015TH MEETING

The 1015th meeting was held in the Cosmos Club Auditorium, Saturday evening, January 17, 1931. The meeting was called to order at 8:15 P.M. by President CURTIS.

*Program:* E. O. HULBURT: *The zodiacal light* (illustrated).—Variations in the zodiacal light, from the observations of Jones in 1853–1855 and of more recent observers, are shown to occur during magnetic storms. This indicates that the commonly accepted planet-dust theory of the zodiacal light is untenable and opens the way to an atmospheric theory which is developed quantitatively. Neutral atoms and molecules sprayed out in all directions from the earth's atmosphere are ionized at 50,000 to 70,000-kilometer levels by the ultra-violet light of the sun. Because of the wobble of the earth's magnetic field with the rotation of the earth, ions near the equatorial plane stay for some time at these high levels to form a ring around the earth, and ions at high latitudes fall quickly back to the earth to give aurorae. The gravitational magnetic drift of the ions forces the ion ring into a long oval stretching out away from the sun to $10^6$ kilometers. The pressure of the sunlight warps the oval into the plane of the ecliptic and makes the ions stream out like a comet's tail. The ions are fluorescent; they absorb the sun's ultra-violet light and emit a part of the absorbed energy as visible light. The oval ring is the zodiacal light; the comet-tail ion stream is the gegenschein. The zodiacal cones in December are somewhat to the south of the cones in June; the evening cone is south and north of the morning cone in March and September, respectively. These theoretical inferences are in accord with observation. (*Author's abstract.*)

Discussed by Messrs. WHITE, GISH, and CURTIS.

H. T. WENSEL: *The Waidner-Burgess standard of light and the freezing point of platinum* (illustrated).—The unit of light is at present maintained by carbon filament lamps deposited in the various national laboratories. The unit of light is therefore subject to any drift that may occur in the brightness of these standard lamps.

Various sources, more or less reproducible from specifications, have been studied from time to time, but none has been found reproducible enough for use as a standard. The carbon lamps were adopted in 1909 primarily because it was felt that their drift with time would be sufficiently small so that it would be many years before the uncertainty in the unit would reach the magnitude of the uncertainties in the unit as represented by those sources, "reproducible" from specifications, which were then available. It was recognized, however, that in time the carbon lamps would have to be superseded by some reproducible standard.

In 1908 Waidner and Burgess suggested the use of a black body immersed in a bath of freezing platinum as a standard of candlepower. This suggestion has been experimentally carried out. The platinum was contained in crucibles of fused thorium oxide and heated in a high-frequency induction furnace. The immersed black body was made of fused thorium oxide. The source as set up was found, by comparison with standard carbon filament lamps, to be reproducible within the limits detected photometrically.

The brightness of the immersed black body was found to be 58.84 candles per $cm.^2$ during the freezing of the platinum. Measurements of the temperature with an optical pyrometer yielded 1773.5°C. From these results the least mechanical equivalent of light may be computed as 0.001603 watt per lumen. (*Author's abstract.*)

Discussed by Mr. WHITE.

## 1016TH MEETING

The 1016th meeting was held in the Cosmos Club Auditorium, Saturday evening, January 31, 1931. The meeting was called to order at 8:15 P.M. by President CURTIS.

*Program:* V. L. CHRISLER and W. F. SNYDER: *The measurement of sound absorption* (illustrated).—The common interest of the acoustical laboratory, the architect, and the manufacturer of sound-absorption materials demands a measurement of the sound-absorbing qualities of the various materials. The term, *coefficient of absorption,* is used as a basis for comparison and is simply the fractional part of the sound energy absorbed at each reflection.

There are two general methods of making sound-absorption measurements, —the tube and the reverberation method—each of which has several modifications. The tube method is now practically obsolete because of inherent characteristics which fail to bring it into agreement with the more accepted reverberation method.

Although Wallace Sabine of Harvard University had made many experimental determinations by the reverberation method it was not until 1911 that Jaeger developed a satisfactory mathematical analysis of the problem.

The usual method of making these measurements has been by the ear—listening for the sound to decay from some definite intensity level to the threshold of audibility. To calibrate a room it is necessary to change the intensity of the sound and Sabine used one, two, three, and four organ pipes to make this change. Recent developments in loud speakers and amplifiers make it possible to work through a range of intensity shifts of several thousand; consequently the time differences are larger and the accuracy is increased. When using the ear it is necessary to make about 1000 stop-watch observations to determine the coefficient of absorption of a material at six frequencies. This is a rather laborious and time-consuming procedure.

The general equation can be put into a form that will yield an absorption value by measurement of the rate of decay of the sound in the room. Picking up the decaying sound with a microphone and recording it on an oscillograph has met with some success but it is also a time-consuming process. At present a purely instrumental method is being used at the Bureau of Standards. The initial intensity of sound and an arbitrary setting of the recording instrument determines two sound levels whose time difference is recorded by an electric clock that is automatically started and stopped. Very rapid observations can be made and therefore a statistical method is possible. This is desirable in sound measurements. (*Author's abstract*).

Discussed by Messrs. HEYL, HUMPHREYS, TUCKERMAN, and CURTIS.

R. H. CANFIELD: *Internal friction in metals* (illustrated).—This paper is a resumé of the author's experiments and an account of his experimental methods.

The property known as *internal friction* or *elastic hysteresis* is due to an imperfection in the elastic properties of materials, such that the stress is higher when the strain is increasing than it is when the strain is decreasing. Thus the stress-strain diagram of a specimen carried through a cycle of stress, varying from zero to $+f$ to zero to $-f$ to zero, is a loop instead of a straight line as it would be if Hooke's law were precisely true. It is difficult to determine the form of this loop by static tests and extensometer measurements. On the other hand it is easy to measure the *area* of the loop, since this is the portion of energy dissipated as heat during the stress-cycle. It has ordinarily been the custom to make this measurement by measuring the rate of decay of vibrations of an elastically controlled pendulum. The disadvantage of this method is that during the course of the experiment the stress-amplitude changes by a considerable amount, so that the value of the dissipation constant is an average over a range of stresses and not a unique value for a single stress. This is undesirable because, as the author's experiments show, the internal friction undergoes rather abrupt changes at certain stress-amplitudes.

The author's method, without entering into details, uses the phenomenon of forced vibrations at constant amplitudes. Under these conditions the elastic pendulum is supplied with a fixed amount of energy at each vibration, this energy being exactly equal to the work dissipated by internal friction during one cycle. This energy is actually supplied by magnetic forces, and the principal experimental problem is to determine what the work done by these forces actually is. The present method of driving involves the use of a subsidiary pendulum loosely coupled to the main one and carrying contacts which control the admission of current into the magnet windings through a vacuum-tube valve circuit. Adjustable oil cups act on damping vanes attached to the subsidiary pendulum so as to permit the exact adjustment of the phase relation between the two vibrations necessary for maximum amplitude. The forces due to the magnetic field are determined once for all by static measurements.

The experimental results cannot be described in actual detail here. They show that it is possible to duplicate results with different pieces of apparatus and different-sized specimens of the same material. They also bring to light very interesting relations between the internal friction and the mechanical history. Such treatments as cold working, fatigue, and precipitation hardening, reveal themselves by marked changes in the internal-friction "diagram."

The internal-friction diagram, just referred to, is considered by the author to be the most advantageous way of displaying his experimental results. The ordinate of a point on this curve, called the *elastic stress*, is the stress-amplitude of the cycle. The abscissa is the *friction stress*, defined as the half-width of the elastic hysteresis loop, considered to be a parallelogram such that its area is equal to the loss of energy for the stress-cycle in question. The diagram is often approximately linear. In such cases the cotangent of the slope angle is the ratio of internal-friction stress to elastic stress, and can be termed the *coefficient of internal friction* in complete analogy to the common definition of the coefficient of surface friction. (*Author's abstract.*)

Discussed by Messrs. CURTIS, BROMBACHER, and BRICKWEDDE.

### 1017TH MEETING

The 1017th meeting was held in the Cosmos Club Auditorium, Saturday evening, February 14, 1931. The meeting was called to order at 8:17 P.M. by President CURTIS.

*Program:* F. L. MOHLER and C. BOECKNER: *The radiation from metal surfaces under low-speed electron bombardment* (illustrated).—A small probe surface in the highly ionized region of a discharge may draw an electron current of several amperes per cm.$^2$ at any positive potential relative to the surrounding space. Under such conditions the metal probe surface emits a continuous spectrum radiation. This has been observed in helium, potassium, and caesium discharges and studied quantitatively in the last case. The spectrum of copper radiation at 7 volts shows an approximately equal energy distribution with an absolute value at 3700 AU of $3 \times 10^{-14}$ ergs per cm.$^2$ per sec per unit frequency range for a current density of 1.4 amperes per cm.$^2$. The intensity distribution remains nearly the same between 5 and 20 volts but below 4 volts has a frequency limit in the ultra-violet. This threshold frequency $\nu_0$ depends on the voltage V by the relation

$$h\nu_0 = e\,(V + W)$$

where W (presumably the work function of the caesiated metal) has values of 1.95 volts for copper, 2.1 volts for silver, and 1.45 volts for tungsten. The intensity-voltage curves increase rapidly up to 7 volts and very slowly beyond. The radiation can be considered as analogous to the continuous X-ray spectrum. The general equation for X-ray intensity as a function of voltage predicts an intensity for Cu at 7 volts and 3700 AU of $1.85 \times 10^{-14}$ ergs in satisfactory agreement with the observed value of $3 \times 10^{-14}$. A theoretical relation between the photoelectric effect and the converse process also leads to an agreement in order of magnitude with the observed intensities. (*Author's abstract.*)

Discussed by BRICKWEDDE.

F. E. WRIGHT: *Optical methods for reducing the effects of photographic-plate grain* (illustrated).—The image on a photographic plate consists of clumps and aggregates of minute particles of silver scattered through the gelatine film. At points where the silver particles are closely packed, the plate is dark. In making measurements on photographic images, the accuracy of the setting depends on a number of factors, of which one of the most disturbing is the presence of a large grain or clump of silver particles. A more exact measurement could be made if this effect of prominent grains were suppressed, even if only partially.

In the case of spectral lines which are straight and parallel different optical methods can be used for suppressing or fusing the prominent grains: (1) The image itself can be made to vibrate rapidly parallel with the spectral lines (method of Linnik). (2) Each object point can be drawn out into an image line parallel with the spectral lines by means of a cylindrical lens (method of Anderson). (3) Each object point can be elongated into a short image line by inserting a tilted glass plate between the objective of the observing microscope and the photographic plate. (4) Each object point can be elongated into a short line in the image by use of a single or multiple narrow slit-diaphragm above the objective. (5) Two images of each spectral line are produced and the one is superimposed on the second, but slightly shifted along the spectral line (Wollaston prism method). (6) The plate is viewed under dark-ground illumination. Each silver grain or clump becomes a luminous image point on which it is easy to make an accurate setting.

The fusing of grains that mark the position of the image of a star can be effected by reducing the resolving power of the imaging microscope objective either by the use of an iris diaphragm in the rear focal plane of the objective or by first forming a minified image of the plate and then observing this image under suitable magnification. In each case the resolving power of the optical system is so much reduced that silver particles separated by a short distance no longer appear as separate points in the image. Another method of fusion is to cause the image to vibrate in rapid circulatory motion; the diameter of the small vibration circle should be about equal to the average distance between the silver particles in a star's image. This movement is most readily accomplished by use of a weak lens mounted in an iron ring suspended by three elastic wires in front of the objective. The iron ring is set in motion by two electromagnets set 90° apart and actuated by alternating currents, the phase of the two currents differing by 90°. The 60-cycle alternating current causes the ring to oscillate so rapidly that the image appears stationary and fused.

These methods for decreasing graininess in special parts of a photographic plate enhance the accuracy of measurement several fold and at the same time decrease eye-strain to an appreciable extent. (*Author's abstract.*)

Discussed by Mr. HUMPHREYS.

Two short informal communications were given by Messrs. TUCKERMAN and DRYDEN, and a report made by HUMPHREYS.

## 1018TH MEETING

The 1018th meeting was held in the Cosmos Club Auditorium, Saturday evening, February 28, 1931. The meeting was called to order at 8:20 P.M. by President CURTIS.

*Program:* F. T. DAVIES: *Aurora australis observed on the Byrd Antarctic Expedition* (illustrated).—Observations of both aurora borealis and australis indicate an auroral zone in either hemisphere and a belt within each of the zones in which auroral displays are most frequent. In the north, this maximum-frequency belt is situated at about 23° from the point in which the axis of the earth's uniform magnetic field meets the surface. This point is not the magnetic pole, however.

Analysis of the auroral records of antarctic expeditions shows that a similar distribution of auroral frequency occurs in the southern hemisphere centered approximately on the opposite projection of the earth's magnetic axis.

In the northern hemisphere, observations have been made of aurora for a very long time and in many localities both north and south of the maximum-frequency belt. In the south, on the contrary, observations have been taken largely south of the maximum-frequency belt and these over a total period of some thirty years. Although the aurora australis has been seen occasionally in the countries of the southern hemisphere, these countries are separated from the antarctic by wide stretches of ocean, little traversed by ships, so that only exceptionally widely spread auroras are observed north of the antarctic maximum-frequency belt. Thus in the study of the aurora borealis, the observations of polar expeditions are supplemented by considerable observational data in temperate latitudes, while our knowledge of the aurora australis is derived chiefly from the records of the few expeditions that have wintered on the antarctic continent.

The following expeditions made regular systematic auroral observations: The Borchgrevink Expedition, 1899, Cape Adare; the Scott Expeditions, 1902–03 and 1911–12, McMurdo Sound and Cape Adare; the German Expedition under Drygalski, 1902, Kaiser-Wilhelm Land; Shackleton Expedition, 1908, McMurdo Sound; the Mawson Expedition, 1912–13, Addie Land and Macquarie Island; and the Byrd Expedition, 1929, Bay of Whales. All of these bases with the exception of Macquarie Island were within the belt of maximum frequency.

The aurora australis exhibits similar phenomena to the aurora borealis so that the terminology is the same for both. The fact that McMurdo Sound, the base for three of the above expeditions, is a considerable distance from the maximum belt, has given the impression that the aurora australis is much less brilliant than the aurora borealis. Mawson's bases, the German base, and our own were also well within this zone but the Cape Adare observations show that the aurora australis as seen from that position is much brighter, more colored, and more active than as seen from any of the other positions.

At Little America the aurora australis was first seen on the night of March 16–17, 1929. A regular 24-hour watch was instituted on April 3 and kept up for the remainder of the year. The observations taken at half-hourly intervals between April 3 and September 26 at which date an aurora was last seen, form the basis of analysis. A single observation included mention of time (165° meridian east of Greenwich); intensity of display on a scale 0–4, "0" meaning not seen and "4" brilliant; form, that is, glow, arch, curtain, rays and streamers, or corona; direction; altitude; and color. The amount of cloud and the intensity of moonlight were also noted.

It was found that of all clear or only partly cloudy nights an aurora was seen on over 90 per cent of the time. A better estimate of occurrence, however, is the proportion of half-hourly observations when an aurora was seen (1412 times) to the number when conditions of cloud and light were such as would allow it to be seen. This proportion was 48 per cent. The comparable figures were: For the Scott Expedition, 1911, 36 per cent; for the Mawson Expedition, 1912–13, 52 per cent; and the second group of the Scott Expedition at Cape Adare, 1911, 64 per cent. Even though 1929 was a year near the maximum of the sunspot cycle the proportion is considerably below the Cape Adare proportion for a year near sunspot minimum.

A marked feature of the observations of Little America was the progressive change throughout the period of observation of the following phenomena: (a) The average intensity of a display was greatest in April, least in September, and decreased during the period between; (b) the ratio of the number of displays seen to the number that could possibly have been seen (cloud and light permitting) was greatest in April and decreased throughout the period to September; (c) the proportion of displays at a high altitude was least in April and greatest in September, the proportion increasing slightly through the period; (d) although the majority of displays were seen in the eastern sky, the proportion of those seen in the west increased during the period from April to September; (e) the proportion of displays exhibiting ray-structure, although less than half the total from April to August, increased in September to more than half.

Of the 1412 half-hourly observations, 24 were classed as brilliant, 60 as bright, 321 as moderate, and 1007 as weak or faint. Comparison of auroral character-numbers with the international magnetic character-numbers showed marked evidence for the occurrence of auroral maxima on the same day or one day after maxima in the magnetic character-curve. This has been suggested in a paper by E. O. Hulburt (Phys. Rev., July 15, 1929).

A period of 27 to 28 days is evidenced, corresponding to the period of rotation of the sun and also a short period of about four days. Much has still to be done before complete analysis of the auroral data can be submitted. All members of the Expedition cooperated in the auroral observations. The general interest shown by observers made the direction of the work a very pleasant task. (*Author's abstract.*)

Discussed by Messrs. HULBURT, HECK, GISH, and HUMPHREYS.

E. E. HAGLER, JR.: *The second principle of uncertainty.*

Discussed by Messrs. GIBSON, GISH, and DRYDEN.

G. R. WAIT, *Recording Secretary.*

# Obituary

RAOUL GAUTIER, a corresponding member of the ACADEMY, died in Geneva, Switzerland, on April 19, 1931. Previous to his retirement in 1927, he filled the chairs of professor of astronomy and of meteorology at the University of Geneva and was director of the Astronomical Observatory of Geneva. For many years he was a member of the Permanant Commission of the old International Geodetic Association and was largely instrumental in forming, during the World War, the "Association géodésique réduite entre états neutres." Through his efforts, the results obtained at variation-of-latitude stations in California, Japan, and Italy were computed and made available for the use of astronomers. In addition to his other duties he was for many years president of the Swiss Geodetic Commission. His keen intellect, scientific attainments, and personal charm made him a powerful influence for several decades among geodesists of the world, and they, as well as the astronomers, mourn his death.

## 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.

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## CONTENTS

### Original Papers



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# JOURNAL

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PHYSICAL GEOGRAPHY.—*Why the Mayan cities of the Petén District, Guatemala, were abandoned.*[1] C. Wythe Cooke, U. S. Geological Survey.

Two thousand years ago what is now the Petén District of Guatemala was the seat of a flourishing Mayan empire. Its massive temples and palaces still mark the sites of large cities which endured for many generations but were finally abandoned. Today, that once-populous region is, for the most part, totally uninhabited. The great cornfields which fed its people have reverted to the jungle, and the ruins of its public buildings lie hidden in a dense forest. The few permanent habitations are on the banks of perennial lakes and rivers along the main route of travel across the District. The remainder of the region is accessible only by means of narrow trails kept open by chicleros or cut by exploring archeologists.

My acquaintance with the Petén District was gained in March and April, 1931, when I was sent by the Carnegie Institution of Washington to study the geology of the region accessible from the camp of the Institution's Department of Historical Research at Uaxactún. I entered Guatemala at Yaloche, a customs house on the frontier, a day's ride northwest of Cayo, British Honduras, travelled 3 days westward to Uaxactun, spent 10 days there, and proceeded southward past Tikal to Remate, a settlement at the eastern end of Lake Petén. From this lake I followed a well-travelled road northeastward past Lake Macanxé to Yaxhá, a settlement between two lakes, thence to Tikan Sakan and down the valley of Río San Felipe to Fireburn on the frontier of British Honduras.

[1] Received June 5, 1931. Published by permission of the Acting Director of the U. S. Geological Survey.

Travel in the Petén is slow and tedious. The length of a day's journey varies according to the season and is determined in large part by the distance between water holes, for there are few perennial streams and many of the water holes become dry after the end of the rainy season.

Uaxactún lies on or near the divide that separates the drainage systems of the Gulf of Honduras from those of the Gulf of Mexico. Streams east of Uaxactún flow into Río Hondo or into Belize River, which empty into the Gulf of Honduras, but water falling west of Uaxactún finds its way into tributaries of the Usumacinta, which flows into Campeche Bay.

Because of the thick cover of forest which cuts off the view in all directions, it is difficult to visualize the topography of the Petén. The clearings around the camp at Uaxactún, which are on the lowlands, show only a shallow depression containing a plant-covered water hole (*aguada*), a grassy flat, and hillocks about twenty feet high, beyond which the view is stopped by the edge of the forest. Even from the top of the highest temple, nothing can be seen but the enclosing jungle. But from the window of a ruined Mayan building which is perched on a mound at the edge of the upland 150 feet above the aguada, one can look eastward over the tree tops and the clearings, across a wide forested plain to low, broken ridges on the horizon.

There are two very different kinds of topography in this part of the Petén—uplands and lowlands, or *bajos*. The uplands are hills and ridges of limestone which rise to a maximum height of several hundred feet above the bajos. They are barely covered by a thin soil of black clay, and are dotted here and there with sinks. In the neighborhood of Uaxactún, the highest hills stand 650 or 700 feet above sea level, and the bajos about 500 or 550 feet. The bajos are flat plains with almost no perceptible relief. They are underlain by tough black carbonaceous clay. The uplands are clothed with a fairly open forest containing many tall, large trees, such as mahogany, chicle, and ceiba but comparatively little underbrush. The bajos are covered with a tangled mass of low gnarled and twisted trees, such as logwood. Many of the trees in the bajos are small-leaved and thorny, and are festooned with large vines. During the rainy season the bajos are flooded; at the beginning of the dry season they are floored with deep tough mud which, later in the year, drys hard and cracks. At all seasons they are very unpleasant to travel through.

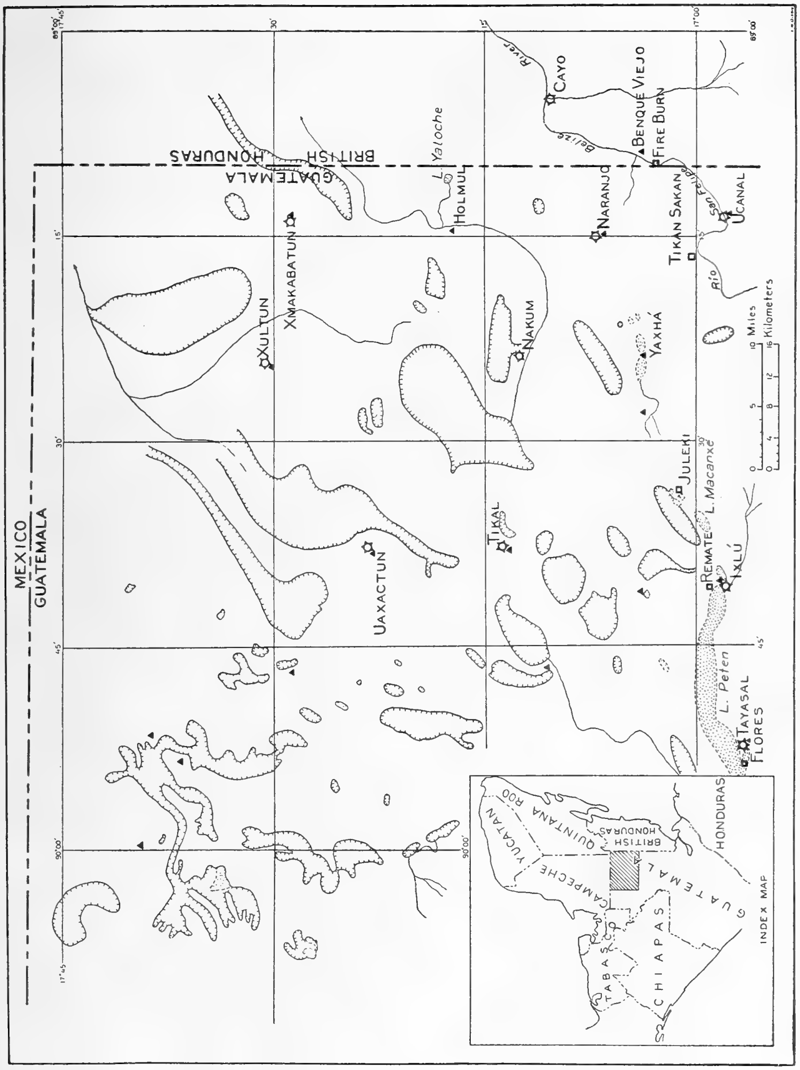



Figure 1. Sketch map of part of Guatemala showing bajos and lakes. Stars indicate places whose geographic position has been determined astronomically by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Solid triangles indicate Mayan ruins. Based on a map made by F. Vans-Agnew and Didier Masson for the P. W. Shufeldt Cía.

The bajos evidently once were lakes. They are still lakes during the rainy season, but they have been so nearly filled with silt that a slight depression of water level due to run-off or evaporation reduces them to ponds or drains them completely. The source of the clay that fills them is the soil of the uplands—black, carbonaceous clay formed by the decomposition and solution of limestone and mixed with organic matter.

The bajos are thickly scattered over the Petén (see figure 1), and some of them are very large. If the bajos were restored to their former condition, the Petén would be a region of many beautiful lakes. Travel in it would be easy, for one could go from place to place by boat, with only short journeys overland, from one lake to another, across country that offers little impediment to travel at any season. It is quite likely that many of the bajos are connected by waterways which carry off the surplus water during the rainy season, although others occupy enclosed basins from which the water drains away through underground channels. Some idea of what the country once was like can be gained from views of the beautiful lakes that still remain. Of these Lake Petén, about 18 miles long, is the largest and best known. Flores, the principal town of the district, lies on an island in Lake Petén and there are several smaller settlements on its banks. Many of the smaller lakes, such as the Laguna de Yaloche, are already silted up to such an extent that small fluctuations in water level cause great changes in area.

How long ago these ancient lakes became filled with silt and converted into bajos can not be determined precisely. Doubtless the process was continuous and gradual although there may have been times when silting was more rapid than at others. Silting is still going on but probably very slowly because the uplands from which the silt is derived are thickly forested. It is quite possible that the transition from lake to bajo may have occurred during the time of the Mayan Empire, when much of the uplands must have been under cultivation. The Mayas were an agricultural people and needed much cleared land to raise the great quantities of corn required to feed their large population. The rate of erosion of the soil must have been enormously accelerated when the forest was cut and the cultivated soil was exposed to the full force of the torrential rains. One may imagine the Petén when first occupied by the Mayas to have had a thick fertile black soil. During the many centuries of the Mayan occupation more and more of the soil was washed away until the bare limestone was exposed.

Then the land was abandoned and reverted to the jungle, soil erosion was greatly retarded, and today, after the lapse of several centuries, the ground is covered by a thin but fairly even coating of black clay through which the rock still shows in many places. Soil is probably being formed now more rapidly than it is being washed away.

One can scarcely imagine the Petén, in its present condition, as the home of a large permanent population. One difficulty is the lack of an adequate water supply. There are few permanent water holes in the Petén and some of the old Mayan town sites are without any obvious present source of water. The Mayas may have depended upon stores of rain water to tide them over the dry season, just as Belize today gets its entire water supply from the clouds, but the rainfall is much more seasonal in the interior than at Belize. Another difficulty is the lack of transportation facilities. If the geography during the time of the Mayan occupation had been like the present, all the provisions and merchandise would have had to be carried to or from the cities on the backs of men (for the Mayas had no beasts of burden), and the bajos would have offered almost impassable barriers to transportation during part of the year. If, however, the bajos were permanent lakes during the time of the Mayan occupation, there was plenty of water throughout the whole year and commerce was speeded at all seasons by water transportation.

Another way in which the transition from lakes to bajos may have influenced the occupation of the Petén is its effect upon the health and comfort of the people by the increase of mosquitoes. As long as the water remained deep near shore, mosquitoes probably were not very numerous, for their larvae would have fallen prey to fishes, but when the deep water was converted into swamps and marshes, swarms of mosquitoes must have plagued the people. If, about this time, malaria was introduced into the country, sickness and death may have taken their toll of the population.

Some of the factors, then, that may have caused the decline of the Mayan Empire and the depopulation of the Petén are (1) erosion of the soil and the consequent scarcity of arable land, (2) silting of the lakes and the destruction of water transportation, (3) diminution of the water supply during the dry season, (4) increase in the number of mosquitoes, and (5) introduction or increase of malaria.

BOTANY.—*Additional Costa Rican mosses, II.*[1] EDWIN B. BARTRAM, Bushkill, Pennsylvania.

Since the last paper on this subject was published the continued interest of Professor Manuel Valerio in the Costa Rican mosses has resulted in an accumulation of about 155 numbers, among which are some items of unusual scientific value.

The appended list includes only the species not recorded in the two previous publications (1, 2), to which has been added the description of a unique moss collected by Mr. Standley, which not only adds a new genus to the moss flora of North America but at the same time again emphasizes the close connection between the mosses of Costa Rica and those of the Cordilleran regions to the southward.

A complete series of specimens, including the types of the species described as new, has been deposited in the National Herbarium at Washington, D. C., and in the herbarium of the writer.

## DICRANACEAE

### DICRANELLA SUBINCLINATA Lor.

Chitaría, Province of Cartago, alt. 700 m., Dec. 20, 1928, M. Valerio no. 239. Previously known from Florida, the Antilles, Mexico and Panama.

### SYMBLEPHARIS HELICOPHYLLA Mont.

Syn.—*Symblepharis Oerstediana* C.M.

Volcán Irazú, alt. 3300 m., April 7, 1929, M. Valerio no. 297.

This is a decidedly more robust form than the plants I am familiar with in the southwestern United States and the leaf cells of the upper half of the blade are frequently in two layers. These characters are, however, by no means constant and it seems doubtful if the Costa Rican collections can be segregated from the type.

### CAMPYLOPUS DONNELLII (Aust.) Lesq. & James.

La Hondura, Province of San José, alt. 1400 m., Jan. 15, 1929, M. Valerio no. 261.

There is no record of this species outside of Florida, as far as I am aware, so that its occurrence in Costa Rica is of uncommon interest. A single fruiting plant in the above collection is worthy of a brief description, as the sporophyte has, until now, been unknown.

Sporophyte-bearing plant 2.5 cm. high; stem leaves erect-appressed, comose at summit; seta solitary, 5–6 mm. long, sinuose, smooth; capsule (immature) erect, symmetrical, 1 mm. long, slightly furrowed when dry; lid erect or slightly oblique, about 0.65 mm. high; peristome and calyptra unknown.

[1] Received April 25, 1931.

## POTTIACEAE

MERCEYA AGOYANENSIS (Mitt.) Broth.

Volcán Barba, alt. 2500 m., Dec. 16, 1930, M. Valerio no. 343.

So far as I know, this is the first species of *Merceya* to be recorded from tropical North America. The plants are somewhat larger than those of the type collection of *M. agoyanensis*, of Ecuador, which I have seen through the kindness of Mr. R. S. Williams, but the shape and structure of the leaves are identical in every particular.

RHAMPHIDIUM MACROSTEGIUM (Sull.) Mitt.

Chitaría, Province of Cartago, alt. 700 m., Dec. 20, 1928, M. Valerio no. 229*a*.

Previously known from the Antilles and South America but new to Costa Rica.

**Leptodontium Orcutti** Bartr., sp. nov.

Figures 8–12

Dioicous? male flowers not seen. Stems up to 1.5 cm. long, densely caespitose, yellowish-green above, pale-brown below, more or less pale-tomentose except at the tips, flexuose, simple or branched; leaves crowded toward the tips, more distant below, appressed with incurved slightly crisped points when dry, spreading to squarrose-recurved when moist, oblong-ligulate, sheathing at the base, carinate-concave above, abruptly acute, about 2 mm. long by 0.5 mm. wide; margin slightly reflexed in the middle, crenulate with projecting papillae, flat and spinulose-serrate above; costa pale-yellow, about 75$\mu$ wide, vanishing just below the apex, convex and minutely papillose on the back above; basal leaf cells rectangular, smooth with yellowish pellucid walls, shorter and subquadrate at the margins, quickly becoming shorter and papillose upward, upper cells rounded-hexagonal, 7–10$\mu$ in diameter, rather obscure, densely papillose with numerous low papillae, not or hardly incrassate except toward the margins where 4–6 rows are rather strongly incrassate with irregularly thickened pellucid walls; perichaetial leaves similar to the stem leaves, about 3 mm. long, the inner erect and strongly sheathing; seta about 12 mm. long, pale yellow; capsule erect or slightly inclined, cylindrical, 1.5–2 mm. long, stramineous, exothecal cells rectangular, thin-walled, delicate and pale except 5–7 rows around the mouth which are subhexagonal or transversely rectangular with dark, reddish-brown incrassate walls; peristome about 0.2 mm. long, of 16 pale, obliquely papillose-striate teeth, divided to the base into 2 linear, somewhat confluent forks; lid erect, conic-rostrate, 0.5 mm. long; calyptra not seen; spores greenish-brown, granulose, 14–18$\mu$ in diameter.

Type: Mineral del Chico, State of Hidalgo, Mexico, May 16, 1925, C. R. Orcutt no. 6731.

Other collections: Mexico: Pont de la Venta, Valle de Mexico, Bro. Arsène no. 1391. North Carolina; Chestnut Bald, Holz. Musc. Ac. Bor.-Amer. no. 264. Costa Rica; Volcán Irazú, alt. 3300 m., M. Valerio no. 293.

This species approaches *L. flexifolium*, of Europe, very closely but seems to be consistently distinct in several important particulars. The leaves are more broadly bordered with thick-walled cells often 5–6 rows wide, the capsule is paler in color, the exothecal cells are thin-walled, and the peristome teeth are obliquely papillose-striate. The plants collected by Dr. Grout in North Carolina, and issued by Holzinger as no. 264 of his exsiccati, under the name *Didymodon flexifolius,* while sterile, are indistinguishable from the Mexican and Costa Rican collections, and I am satisfied that they should be referred here rather than to the European species, which does not seem to occur in North America.

Sterile plants of this species were received from my good friend M. Thériot as an undescribed species of *Leptodontium,* from Bro. Arsène's Mexican collections, but as Orcutt's specimen was in good fruiting condition M. Thériot generously suggested that his own name be suppressed.

**Leptodontium filescens** (Hampe) Mitt. var. **denticulatum** Bartr., var. nov.
Figures 1–7

More robust than the species, with longer, more sharply denticulate leaves, more rounded upper leaf cells, and setae up to 18 mm. long.

Type: Southern slope of the Volcán de Turrialba, near the Finca del Volcán de Turrialba, Costa Rica, alt. 2000-2400 m., Feb. 22, 1924, Paul C. Standley no. 35160*a*. c. fr.

Other collections: near the type locality, Standley no. 34953; near Finca la Cima, above Los Lotes, north of El Copey, Standley no. 42777; Volcán Poás, alt. 2500 m., M. Valerio nos. 284 & 285*a*.

These Costa Rican specimens do not seem to differ structurally from the species but they are uniformly coarser. The stem leaves are up to 2.5 mm. long, sharply denticulate toward the apex, and the setae are about twice as long as in the type collection of the species from Colombia. Numerous axillary claviform or cylindrical, septate gemmae occur in all of the collections representing both the type and the variety.

TORTULA MINIFOLIA (Sull.) Mitt.

Chitaría, Province of Cartago, alt. 700 m., Dec. 20, 1928, M. Valerio no. 221. Previously known from Cuba, Bolivia and Peru but new to Costa Rica.

## BRYACEAE

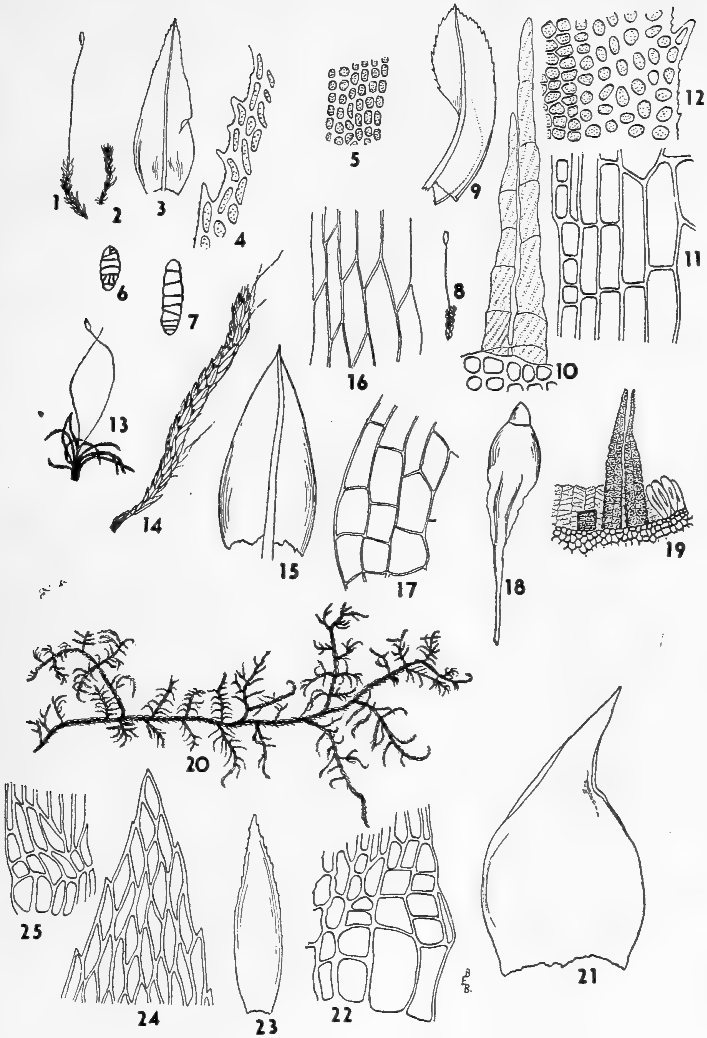
STABLERIA OSCULATIANA (DeNot.) Broth.

Volcán Irazú, alt. 3300 m., April 7, 1929, M. Valerio nos. 302 & 307.

I have referred these collections to the above species rather than to *S. tenella* (Mitt.) Broth. as the setae are all decidedly longer than the leaves. Specimens of the latter species in the writer's herbarium and in the herbarium of the New York Botanical Garden show considerable variation in this respect and it may, eventually, be necessary to reduce them to one species, in which event, *S. osculatiana,* being the older name, would be retained.

MIELICHHOFERIA PRATICOLA Card.

Volcán Irazú, alt. 3300 m., April 7, 1929, M. Valerio no. 303. Previously known only from Mexico.




Figures 1–7. *Leptodontium filescens* (Hampe) Mitt. var. *denticulatum* Bartr., var. nov. 1.—Fertile plant × 1. 2.—Sterile stem × 1. 3.—Stem leaf × 9. 4.—Upper leaf margin × 240. 5.—Upper leaf cells × 240. 6 and 7.—Gemmae × 40.

Figures 8–12. *Leptodontium Orcutti* Bartr., sp. nov. 8.—Fertile plant × 1. 9.—Stem leaf × 17. 10.—Part of peristome × 240. 11.—Lower leaf cells × 240. 12.—Upper leaf cells and margin × 240.

Figures 13–19. *Brachymenium filescens* Bartr., sp. nov. 13.—Plants × 1. 14.—Innovation × 5. 15.—Leaf of innovation × 40. 16.—Upper leaf cells × 240. 17.—Basal angle of leaf × 240. 18.=Capsule × 12. 19.—Part of peristome × 80.

Figures 20–25. *Acanthocladium costaricense* Dix and Bartr., sp. nov. 20.—Plant × 1. 21.—Stem leaf × 40. 22.—Basal angle of stem leaf × 240. 23.—Branch leaf × 40 24.—Apex of branch leaf × 240. 25.—Basal angle of branch leaf × 240.

**Brachymenium filescens** Bartr., sp. nov.

Figures 13–19

Dioicous? male flowers not seen. Plants slender, loosely caespitose, sordid yellowish-green, slightly glossy. Stems short, radiculose below, with slender flexuose innovations up to 1 cm. long; leaves of the innovations appressed, ovate-oblong, acute, concave, 0.6–0.7 mm. long by 0.3 mm. or less wide; upper leaf cells linear-rhomboidal, thin walled, 60–75 $\mu$ long by 12–15$\mu$ wide, narrower toward the margins but not forming a distinct border, shorter toward the base, several rows just above the insertion subquadrate; margin erect, entire below, usually minutely denticulate toward the apex; costa lutescent, percurrent or minutely excurrent; perichaetial leaves similar but slightly longer; seta red, slender, flexuose, about 14 mm. long; capsule erect or slightly inclined, 1.5–1.8 mm. long, claviform, reddish, gradually contracted to a slightly sulcate neck; peristome double, the inner a yellowish papillose tube without segments, about one third the height of the linear, papillose, well spaced teeth, annulus present; lid obtusely conic, about 0.3 mm. high; calyptra unknown; spores smooth, 10–12$\mu$ in diameter.

Type: Cebadilla, Province of Alajuela, Costa Rica, alt. 700 m., Nov. 14, 1928, M. Valerio no. 209.

This species is probably nearest *B. murale* Schp. and *B. vinulosum* Card. from Mexico, in the Section *Dicranobryum*, but differs from both in the long flexuose innovations with closely appressed leaves. The percurrent or excurrent costa is also a distinctive character as compared with *B. murale* while the longer areolation and longer marginal cells preclude any confusion with the other species.

Bryum Crugeri Hampe

Chitaría, Province of Cartago, alt. 700 m., Dec. 20, 1928, M. Valerio no. 222.

## EUSTICHIACEAE

Eustichia Spruceana (C.M.) Par.

Piedra Blanca, Province of San José, alt. 2100 m., April 28, 1929, M. Valerio no. 310.

This unique moss has very much the appearance of a *Fissidens* to the naked eye. Although it has been found in Ecuador and Bolivia, this seems to be the first record for North America. A critical comparison with *E. miradorica* (C. M.) Par. would be very desirable but Dr. Reimers has informed me that, unfortunately, no specimen of the Mexican plant can be located in the herbarium of the Botanical Museum in Berlin-Dahlem.

## BARTRAMIACEAE

Bartramia costaricensis C.M.

Volcán Irazú, alt. 3300 m., April 7, 1929, M. Valerio nos. 305–308.

Both collections are sterile but the vegetative characters correspond very well with Müller's description.

PHILONOTIS CRASSINERVIA Broth. & Par.

Santa Cruz, Province of Guanacaste, alt. 50 m., Dec. 24, 1928, M. Valerio no. 243; La Estrella, Province of Cartago, alt. 1700 m., in water, Jan. 26, 1929, Valerio no. 260.

Previously known only from Colombia.

## HOOKERIACEAE

DALTONIA TENUIFOLIA Mitt.

San José, Province of San José, alt. 1135 m., Nov. 30, 1928, M. Valerio no. 205*a*.

An interesting northward range extension of a rare South American species.

## BRACHYTHECIACEAE

BRACHYTHECIUM LAXIRETICULATUM Card.

Volcán Irazú, alt. 3300 m., April 7, 1929, M. Valerio nos. 300 & 301.

These collections match very closely the Mexican species to which they have been provisionally referred.

## FABRONIACEAE

FABRONIA FLAVINERVIS C.M.

Santa Ana, alt. 900 m., June 15, 1929, M. Valerio nos. 325, 326, 327, 328.

## PLAGIOTHECIACEAE

STEREOPHYLLUM CULTELLIFORME Sull.

Chitaría, Province of Cartago, alt. 700 m., Dec. 20, 1928, M. Valerio no. 238 New to Costa Rica.

In this connection an opportunity is offered to correct a signal error which Mrs. Britton has kindly called to my attention. The Honduras plants described under the name of *Rhynchostegium patulum* Bartr. (3) undoubtedly belong in *Stereophyllum* and are exceedingly close to and probably identical with *S. cultelliforme*. The inflorescence of this species is clearly autoicous and not dioicous as given by Brotherus in both editions of the Natürlichen Pflanzenfamilien.

STEREOPHYLLUM LEUCOSTEGIUM (Brid.) Mitt.

Santa Cruz, Province of Guanacaste, alt. 50 m., Dec. 24, 1928, M. Valerio no. 242.

## SEMATOPHYLLACEAE

APTCHELLA AMERICANA (Card.) Broth.

Volcán Barba, alt. 2700 m., Dec. 16, 1930, M. Valerio no. 350.

Cardot originally described this species from Mexico. It was subsequently collected by Mrs. Britton in Jamaica and Prof. Valerio's collection now extends its known range to Costa Rica. The characteristic propagulae at the tips of the branches are very abundant in the Costa Rican plants but the sporophyte is still unknown.

**Acanthocladium costaricense** Dix. & Bartr., sp. nov.

Figures 20–25

Plants in extensive, pale yellowish-brown glossy mats. Stems elongate, wiry, prostrate, proliferously branched; branches ascending, bipinnate, the ultimate branches somewhat flattened, curved and crisped when dry; leaves dimorphous, stem leaves erect-appressed with slightly curved or subfalcate points, ovate, short-acuminate, entire or minutely denticulate, about 1 mm. long by 0.5 mm. wide; margin more or less narrowly reflexed, branch leaves rather complanate, much smaller than the stem leaves, oblong-lanceolate, bluntly acute, denticulate above the middle, 0.4–0.5 mm. long by about 0.13 mm. wide; leaf cells smooth, echlorophyllose, the upper linear, 35–40$\mu$ long by 3–4$\mu$ wide, a few rows at the extreme base shorter, slightly incrassate and porose, alar cells few, oblong, golden-brown or hyaline, supra-alar cells smaller, subquadrate to oblong, hyaline or colored, nerve very short and double or wanting.

Type: On tree, vicinity of Santa María de Dota, Province of San José, Costa Rica, alt. 1500–1800 m., Dec. 26, 1925–Jan. 3, 1926, Paul C. Standley & Juvenal Valerio no. 43395.

Although the fruit of this moss is unknown the general habit and vegetative characters correspond very closely to those of the genus *Acanthocladium.* If this inference is correct the extension of such a purely austral genus into the range of the North American moss flora is especially noteworthy. *A. subnitidum* (Hampe) Broth., from Colombia, suggested a likely comparison and I am indebted to Mr. H. N. Dixon for the following comments which were made after comparing the Costa Rican moss with the type collection of the Colombian species in the Hampe herbarium.

"*H. subnitidum* is much more robust and rigid, both in branches and leaves. Nearly all the branches taper to a straight, rigid, narrow, cuspidate, microphyllous flagellum. The leaves are considerably larger, broader below, longly and finely acuminate and scarcely glossy. Branches all straight."

Sematophyllum cuspidiferum Mitt.

La Hondura, Province of San José, alt. 1400 m., Jan. 15, 1929, M. Valerio no. 270.

The robust habit and filiform-acuminate leaves distinguish this collection from any of the *S. caespitosum* group.

## HYPNACEAE

Isopterygium fecundum R. & C.

Volcán Poás, alt. 2500 m., Feb. 7, 1929, M. Valerio no. 285.

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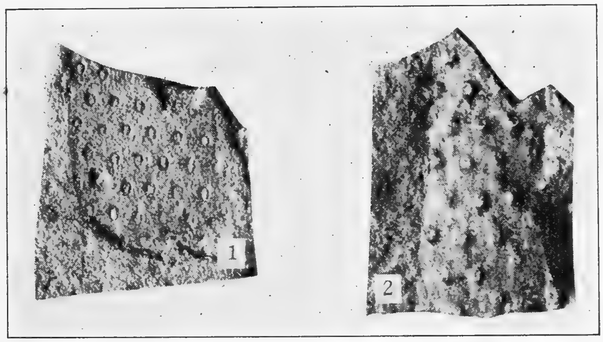
PALEOBOTANY.—*A* Bothrodendron *from Bolivia.*[1] EDWARD W. BERRY, Johns Hopkins University.

In a small collection of miscellaneous trails, fucoids (?), etc. from southeastern Bolivia submitted to me last year by C. F. Bowen of the Standard Oil Company of New Jersey there are three clearly marked specimens belonging to the Lepidophyte genus *Bothrodendron*, constituting, so far as I know, the first authentic record of this genus in South America.

The matrix varies from gray to rusty, and from a mudstone to a highly micaceous thin-bedded sandstone carrying flakes and patches of carbonized plant tissue. The *Bothrodendron* material occurs in the latter type of sediment and comes from two near-by localities—Quebrada Caigua and Quebrada Caiguami. All three specimens are small,




Figures 1 and 2.—*Bothrodendron* sp.

the two largest being figured. Two of these, including the original of fig. 1 are flattened patches of cuticle with the leaf bases as holes. The original of fig. 2 is an impression of a small branch preserving considerable of its original form. In fig. 1 the leaf scars are elliptical, about 1 millimeter wide and 1.5 millimeters long and are arranged in alternating whorls with a spacing, both transverse and longitudinal, of about 2.5 millimeters. The specimen exposes the inside of the cuticle so that the surface features are not visible. It does not, however, show any traces of ribbing. In the small axis shown in fig. 2, which is about 1.5 centimeters across, the leaf scars are slightly larger, more nearly circular, slightly farther apart, and somewhat elevated. The surface ornamentation is obsolete, but there is a distinct, although

[1] Received May 21, 1931.

faint, indication of slight ribbing. There is no reason to suppose that all three specimens do not belong to the same species.

This Bolivian *Bothrodendron* is not represented by extensive enough or complete enough material to warrant giving it a specific name so that it may be known simply as *Bothrodendron* sp. Indeed the specific limits of the fifteen to twenty species of *Bothrodendron* that have been described are, for the most part, rather vague, and certainly not reliable. Haughton originally described three species from the classic upper Devonian locality at Kiltorcan, Ireland, but Johnson[2] has rather clearly indicated the probability that but a single botanical species is represented at that locality, and Nathorst in particular has figured much good material from the upper Devonian of Bear Island illustrating the natural variation and the differences in appearance due to age and state of preservation.

As far as appearances go the Bolivian form appears to me to be most like *Bothrodendron kiltorkense* (Haughton) Kidston among the described species. A priori the likelihood that a single botanical species should range from Bear Island in the Arctic to Bolivia and New South Wales seem highly improbable, and conclusions from this resemblance regarding the age of the Bolivian deposit can not be regarded as conclusive. On the other hand the lack of known Lower Carboniferous (Mississippian) sediments in South America, and the abundance of shallow water lower and middle Devonian, lends probability to the conclusion that *Bothrodendron* sp. is of Devonian age. The sediments carrying it are referred to the Iquiri formation which is considered to be of Devonian, and probably upper Devonian, age.

Although *Bothrodendron* and its allies agree rather closely in habits and anatomy with some of the other Lepidophytes there is good ground for considering them as representing a distinct family—the Bothrodendraceae—which is, in some respects, intermediate between the Lepidodendraceae and the Sigillariaceae, being rather more like some of the former in anatomical features, and more like some of the latter in external features. Some of the fructifications attributed to the Bothrodendraceae resemble *Lepidostrobus* and others, *Bothrostrobus,* lack the sporophyll elongation so characteristic of the Lepidodendraceae and Sigillariaceae. The Bothrodendraceae are also somewhat earlier in their inception, for although they extend through the Carboniferous, they appear earlier and are relatively more abundant during the later Devonian and Lower Carboniferous (Mississippian).

The name *Bothrodendron* was proposed by Lindley & Hutton in 1833

[2] T. Johnson, Sci. Proc. Royal Dublin Soc., vol. 13, No. 34, 1913; vol. 14, No. 13, 1914.

with *Bothrodendron punctatum* as the genotype, a species marked by *Ulodendron*-like crateriform scars, now usually considered to represent the scars of deciduous branches. In 1860 Haughton proposed the generic term *Cyclostigma* (genotype *C. kiltorkense*) for material from the Irish upper Devonian, and in 1876 Boulay proposed the generic term *Rhytidodendron* (genotype *R. minutifolium*) for French material. It is only in more recent years that the generic identity of these has been accepted. The number of species is uncertain since many are founded wholly on external characters and insufficient material, and the appearance varies considerably with age. The leaf scars are always small, some show ligules and others do not, some show a central leaf-trace scar and two parachnoi, and others do not. The genus is especially abundant in the upper Devonian of Bear Island—the so-called Ursa stage of Heer—once believed to be intermediate in age between Devonian and Lower Carboniferous. It occurs in the Devonian of North America and Europe, in the Devonian or Lower Carboniferous of Europe, Asia, Africa and Australia, but has not heretofore been certainly collected in South America. In this connection attention should be called to the species *Lycopodiopsis derbyi* Renault[3] from the Brazilian coal measures, which is superficially similar to *Bothrodendron*.

Seward[4] recorded in 1922 a *Bothrodendron* (?) sp. from the Carboniferous of Paracas, Peru, the age of which he was inclined to regard as Lower Carboniferous. Gothan[5] has also discussed the flora from this locality in a recent publication, and has referred Seward's form to what he calls *Bothrodendron pacificum* Steinmann. Judging from the figures alone the Peruvian plant does not suggest *Bothrodendron* to me, and in any case it is not the same as the specimens under discussion.

In 1922 I described[6] much the largest collection of plants that was ever made at Paracas, personally collected, and after studying the local section and those around Lake Titicaca reached the conclusion that the age was not older than the Westphalian stage of the Upper Carboniferous. I see no reason for changing this opinion despite what can not but seem like a belated attempt on the part of Gotham to validate the original guess of Steinmann regarding the age.

Particular interest attaches to the other antipodean occurrences of

[3] David White, Final Rept. Brazilian Coal Comm., p. 437, pl. 5, fig. 11, 1908.

[4] A. C. Seward, Quart. Jour. Geol. Soc. London, vol. 78, p. 281, pl. 13, fig. 9 and text fig., 1922.

[5] W. Gothan, Neues Jahrb. Beil. Bd. 59, Abt. B, p. 296, pl. 13, fig. 3, 1928.

[6] E. W. Berry, Johns Hopkins Univ. Studies in Geology No. 4, pp. 9–42, pls. 1–8, 1922.

*Bothrodendron* in Africa and Australia, and it is unfortunate that this material, like that from Bolivia, is not good enough for precise comparisons. It is, perhaps, significant that both the African (*Bothrodendron leslii* Seward) and Australian (*Cyclostigma australe* Feistmantel) forms have been compared with *Bothrodendron kiltorkense.* As far as comparisons are possible with the poor material that served as the type of *Cyclostigma australe*[7] the Bolivian material could be referred to the same species, but in view of the nature of the remains this resemblance may have no significance.

ZOOLOGY.—*A* Microfilaria *from the blood of a wild rabbit.*[1]
BENJAMIN SCHWARTZ and JOSEPH E. ALICATA, Bureau of Animal Industry, U. S. Department of Agriculture.

Under date of April 2, 1931, Dr. C. M. Hamilton, of the Western Washington Experiment Station, Puyallup, Washington, forwarded to the Bureau of Animal Industry at Washington, D. C., two blood smears, with the following comments:

"A farmer in Arlington, Washington, found a rabbit in a stupor, and when it died later he mailed it to us for examination. There were four ticks, including one female specimen, on the back of the neck. Postmortem examination revealed nothing except a congested liver. However, in blood smears from the heart, parasites resembling nematodes were noted. Blood taken from the heart and diluted with distilled water showed these parasites to be alive."

On further inquiry, Dr. Hamilton advised the writers that the host in question was *Lepus washingtonii.*

A microscopic examination of the two blood smears, one of which had been stained with methylene blue and the other with Wright's stain, revealed the presence of microfilariae, in addition to blood cells. The former appeared to be sufficiently well stained to enable the writers to make out the morphological details commonly recognizable in well stained preparations containing microfilariae.

Although the specific identity of filarids cannot always be determined on the basis of their larval characters, it is not improbable that the microfilariae in question are the immature forms of *Dirofilaria scapiceps* (Leidy 1886), the only filarid known from North American rabbits. However, the final determination of the identity of these microfilarids

[7] O. Feistmantel, Palaeontographica, Suppl. 3, p. 70, pl. 1, fig. 6, 1878.

[1] Received May 8, 1931.

will have to be based on investigations of the further development of these larvae in suitable mosquito or other arthropod intermediate hosts, and on the subsequent transmission of the infective larvae to rabbits through the bites of the infected intermediate host. For the time being the larvae in question are assigned to the collective genus *Microfilaria* Cobbold, 1880.

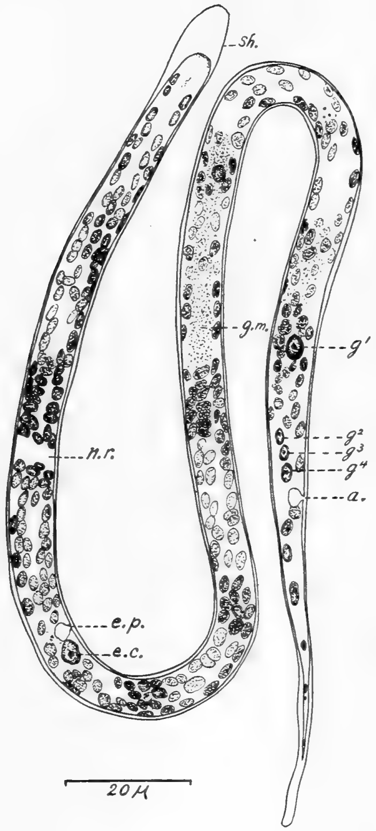



Figure 1.—*Microfilaria* species from *Lepus washingtonii*. *a*, anus; *e.c.*, excretory cell; *e.p.*, excretory pore; $g^1$, $g^2$, $g^3$, $g^4$, first, second, third, and fourth germ cells, respectively; *g.m.*, granular mass; *n.r.*, nerve ring; *sh.*, sheath.

### **Microfilaria** species (?Dirofilaria scapiceps)

Figure 1

In common with many other microfilariae from the blood of mammals, each larva is enclosed and retracted in a sheath. The larvae are from 303μ to 340μ long and 8μ in maximum width. The morphological details are as figured. The anterior extremity is bluntly rounded; the body is of more or less uniform width up to a point somewhat anterior to the first germ cell, where it begins to taper gradually and terminates in a long slender tail with a pointed tip. The stained specimens show numerous nuclei and a number of unstained areas. A small area immediately posterior to the head end is unstained. Another unstained area, which extends across the width of the body and is located at a distance of from 66 to 70$u$ from the anterior extremity, is the nerve ring. At a distance of from 22 to 29$u$ posterior to the nerve ring is the first so-called V-shaped spot which contains an opening to the outside; this is the excretory pore (*e. p.*). Immediately behind the excretory pore is the excretory cell (*e. c.*). At the point corresponding approximately to the middle of the body is the commencement of the so-called germinal mass (*g. m.*) which occupies an area about 40$u$ long and is characterized by the presence of minute granules; comparatively few nuclei are present in the field occupied by the granular mass. The nucleus of the first germ cell ($g^1$) is located at a distance of approximately 66$\mu$ from the posterior extremity; the remaining three germ cells ($g^2$, $g^3$, $g^4$) are smaller than and posterior to the

TABLE 1. Dimensions and Proportions of Microfilaria sp. in the Heart Blood of Lepus washingtonii at Arlington, Wash.

| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 |
|---|---|---|---|---|---|
| (1) Length (without sheath) | 340 | 315 | 320 | 303 | 315 |
| (2) Maximum width | 8 | 8 | 8 | 8 | 8 |
| (3) Distance from anterior extremity to nerve ring | 70 | 66 | 66 | 70 | 70 |
| (4) Distance from nerve ring to excretory pore | 29 | 26 | 24 | 22 | 25 |
| (5) Length of tail | 44 | 42 | 47 | 37 | 40 |
| (6) Percentage of body length anterior to nerve ring | 20.5 | 20.9 | 20.6 | 23.1 | 22.2 |
| (7) Percentage of body length anterior to excretory pore | 29.1 | 29.2 | 28.1 | 30.3 | 30.1 |
| (8) Difference between (7) and (6) | 8.6 | 8.3 | 7.5 | 7.2 | 7.9 |
| (9) Percentage of body length anterior to tail | 87.1 | 86.7 | 85.4 | 87.8 | 87.4 |

first one, and are located in a row one behind the other. The second unstained V-shaped spot contains an opening to the outside; this is the anal opening (*a*). The tail is from 37 to 44$u$ long and contains very few stained elements.

Table 1 shows the principal measurements, in microns, of five larvae, and certain size relationships in percentages. The specimens (two slides) are U. S. National Museum No. 30,105.

Microfilariae are known from the blood of various rodents, such as rabbits, ground squirrels, porcupines, and rats. Some of the forms which are known from these hosts are listed in a paper by Hall (1916). The occurrence of microfilariae in rabbits in North America was mentioned by Harken (1927) in a note dealing with the fluctuation in numbers of rabbits in Canada. This author states: "Specimen consisting of hind leg of rabbit was infected with *Coenurus serialis* which is an intermediate stage of a tapeworm, the other host of which is the dog tribe. The carcass was in poor condition for critical work but some microfilaria (microscopic worms) were found in the blood and some indication of the presence of protozoa." No further details concerning the microfilariae found in rabbits are given in Harken's brief report.

A species of microfilaria from a rabbit in Algeria, probably *Lepus sefranus*, specifically distinct from the worm discussed in this paper, was described by Foley, Catanei and Vialatte (1926), and regarded by these writers as probably identical with a microfilaria described by Balfour (1911) from a rabbit, probably *Lepus hawkeri*, from the Anglo-Egyptian Soudan, and also apparently identical with the larvae of *Filaria numidica* Seurat, 1917, from the abdominal cavity of *Lepus pallidor* and *L. kabylicus* of Algeria.

Considering the medical importance of filariasis and the need for further investigations on the therapeusis and other aspects of this disease, the occurrence of microfilariae in rabbits in North America, definitely established by the data presented in this paper, opens up the possibility of transmitting filariasis to domestic rabbits experimentally. In the event that this can be accomplished, it will facilitate investigations on the treatment and on various phases of the biology of filarial infections.

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L. G. SEURAT. *Une nouvelle filaire péritoneale des rongeurs.* Compt.-Rend. des Séances de la Soc. de Biol. **80**: 350–357. 1917.

ENTOMOLOGY.—*Three new Braconidae parasitic on bark beetles.*[1] R. A. CUSHMAN, Bureau of Entomology. (Communicated by HAROLD MORRISON.)

The three new species described below have all been reared in connection with studies of certain bark beetles, carried on by agents of the Bureau of Entomology. Of particular interest is the *Meteorus*, since most of the species of this genus are parasitic on lepidopterous larvae.

[1] Received May 19, 1931.

**Meterous hypophloei,** new species.

In Muesebeck's key to North American species[2] this species runs best to *fumipennis* Muesebeck. From that species it may be immediately distinguished by its stouter thorax, coarsely sculptured hind coxae, more slender subapical flagellar joints, and generally darker color, and by other details. Specimens with the wings less distinctly infumate will run to *humilis* (Cresson), differing in the longer malar space, much longer and more slender antennae, thicker head, smaller ocelli, and shorter ovipositor.

*Female.*—Length 3.5 mm. Head thick, not or barely twice as broad as thick medially, full behind the eyes; ocelli placed well in front of posterior tangent of eyes, very minute, the diameter of a lateral ocellus only about one-sixth the length of the ocell-ocular line; face nearly twice as broad as long, its shortest breadth subequal to the length of the eye; malar space fully as long as basal width of mandible; clypeus nearly twice as broad as long, arcuately emarginate at apex; vertex and temples polished, frons laterally punctate, face minutely rugulose opaque; antennae very nearly as long as body, slender, about 28-jointed, all flagellar joints longer than thick, Thorax hardly two and a half times as long as broad; notauli strong and meeting behind in a coarsely sculptured depression, prescutum densely punctate, lateral lobes polished; scutellum small, triangular, strongly convex, smooth and polished; propodeum irregularly reticulate rugose with more or less distinct median and basal carinae, posterior face impressed but only obsoletely outlined; thorax laterally, except small polished areas on mesopleurum, rugulose opaque; second abscissa of radius about twice as long as first; cubitus originating very close to parastigma; lower abscissa of basella about as long as nervellus; legs slender; hind coxae roughened and opaque. Abdomen about two and one-half times as long as broad; first tergite less than twice as long as broad at apex, obscurely longitudinally striate, with deep pits dorsally, the lateral edges nearly parallel; sheath a little more than half as long as abdomen, very slender, ovipositor slightly decurved.

Piceous black, with head and legs largely, pronotum and middle and extreme base of abdomen more reddish, the face and lower part of head and mandibles ferruginous; coxae sometimes nearly black; wings faintly infumate, more strongly so about junction of basal and median carinae and about base of radius, stigma blackish, pale at base, tegulae reddish.

*Male.*—Head even thicker than in female with temples and cheeks more strongly rounded; face distinctly broader than length of eye; abdomen about three times as long as broad; otherwise like female.

*Host.*—*Hypophloeus* sp.

*Type-locality.*—Metaline Falls, Wash.

*Type.*—Cat. No. 43,634, U.S.N.M.

Described from 13 females and 5 males reared April 25 to July 30, 1930, by Donald DeLeon under Hopkins U. S. No. 19758 from the larvae of the host species in western white pine trees killed by *Dendroctonus monticolae* Hopk.

[2] Proc. U. S. Nat. Mus., vol. 63, art. 2, 1923.

**Coeloides dendroctoni,** new species.

*Female.*—Length 4 mm. or less. Head nearly as broad behind eyes as at eyes, the temples strongly convex, the width from front to back about equal to that of eye; the so-called "mouth opening" much narrower than its distance from the eye and about as broad as length of malar space; malar space about half as long as eye; face minutely punctate; clypeal groove distinct medially; antennae slender, third joint of flagellum hardly concave below, very nearly as long as fourth, the latter fully twice as long as thick. Thorax weakly depressed, polished and virtually unsculptured throughout, only the metapleurum sparsely punctate; scutellar fovea minutely foveolate; stigma broad, radius slightly before middle; second cubital cell long, the second abscissa of radius much longer than first intercubitus and parallel with second abscissa of cubitus. First tergite much longer than broad, finely rugulose, the lateral furrows foveolate, the median area about three times as broad as the lateral rims; second tergite shorter than third, more or less emarginate in apical middle, more or less rugose medially and with a more or less distinct raised area in basal middle; sheath about three-fourths as long as body (relatively longer in small specimens).

Head black, orbits, cheeks, malar space, mandibles, and clypeus testaceous; labium, maxillae, palpi, and antennae black; thorax and legs black, trochanters and apices of front femur and tibia more or less reddish, postscutellum and a median streak on propodeum also more or less reddish; abdomen usually testaceous with only the first tergite black, in small specimens more or less blackish with tergites 2 and 3 pale or largely brownish black.

*Male.*—Essentially like female, but more frequently with abdomen largely blackish and often with apex and lateral areas of scutellum stramineous.

*Type-locality.*—Sula, Montana.

*Type.*—Cat. No. 43,635, U.S.N.M.

*Hosts.—Dendroctonus monticolae* Hopk.; *Ips oregoni* (Eich.).

Described from 32 females and 21 males reared by D. DeLeon of the Bureau of Entomology, United States Department of Agriculture, at type-locality (Hopkins U. S. Nos. 19676 [type], 19677, 19654, 19669 [allotype], 19607, 19653, 19679, 19673, 19675, 19660, 19661, 19668, 19670, 17269, 17270, 17271, 17272, 17273); Troy (Hopkins U. S. No. 19665) and Anaconda (Hopkins U. S. No. 19684), Montana; Spencer (Hopkins U. S. No. 19682), Idaho, and Metaline Falls (Hopkins U. S. No. 19801), Washington; and by J. E. Patterson, also of the Bureau of Entomology, at Crater Lake Park, Dugon (Hopkins U. S. Nos. 16266a and 16258a). The specimens under Nos. 17269 to 17273 from Sula, Montana, are labelled as having doubtfully been reared from *Ips oregoni*.

**Coeloides scolyti,** new species.

Very closely related to *brunneri* Viereck and perhaps only a variant of that species. Structurally the two species form an almost unbroken variation series, *scolyti* on the average having the thorax a little less depressed, the face a little broader, the head a little longer behind the eyes, the first tergite a little broader, the second a little more deeply emarginate in the middle, the ovipositor a little shorter, and the second abscissa of radius a little shorter as compared with the first intercubitus.

In color the two species are very similar, the head and abdomen being ferruginous and the thorax, legs, and antennae black or piceous. But whereas *brunneri* has the thorax and legs piceous, and the first tergite ferruginous and a diffusion of dark color about the ocellar spot especially in the male, in which sex nearly the entire vertex and frons are piceous, *scolyti* has the thorax and legs black or very nearly so, the first tergite largely blackish, and the black of the head in both sexes confined within the ocellar triangle.

*Female*.—Head in dorsal view nearly as long as broad, nearly as broad behind eyes as at eyes, temples very strongly convex, antero-posterior width distinctly greater than that of eye; "mouth opening" narrower than malar space, the latter half as long as eye; face minutely punctate, nearly a half broader than length of eye; clypeal groove distinct and punctiform medially; antennae slender, third joint of flagellum slightly concave ventrally and distinctly shorter than fourth, which is more than twice as long as thick. Thorax hardly depressed, polished, with only metapleurum sparsely punctate; scutellar groove minutely foveolate; stigma broad with radius far before middle; second cubital cell rather short, the second abscissa of radius at most only a little longer than first intercubitus. First tergite about a half longer than broad, its sides beyond the spiracles a little bulging, median area obscurely longitudinally striate; second tergite much shorter than third, deeply emarginate in apical middle, with a longitudinal elevation in basal middle, more or less distinctly rugulose medially, and with an oblique groove laterally terminating near the posterior margin in a distinct lunule; abdomen otherwise polished; sheath usually a little longer than body.

Head and abdomen bright ferruginous, with ocellar spot and first tergite except apex black; thorax, legs, and antennae black with legs apically and thoracic sutures more or less piceous, apex and lateral areas of scutellum sometimes pale; wings weakly infumate, venation blackish.

*Male*.—Essentially like female.

*Host*.—*Scolytus* spp.

*Type-locality*.—Metaline Falls, Wash.

*Type*.—Cat. No. 43,636, U.S.N.M.

Described from 9 females and 2 males as follows: two females including type, Hopkins U. S. No. 19899–1, from the type-locality, reared July 9, 1930, by Donald DeLeon from bark of white fir infested by *Scolytus* sp.; one female and one male, including allotype, Hopkins U. S. No. 19972, taken August 5 and 6, 1930, by D. DeLeon on *Abies grandis* infested by *Scolytus ventralis* at the type-locality; one male, Hopkins U. S. No. 19809–1, reared from *Scolytus* (?) in *Tsuga* August 16, 1930, by same collector and at same locality; three females, Hopkins U. S. No. 18146d, taken by F. P. Keen on *Abies concolor* at Pinehurst, Oregon; one female, Pyramid Ranger Station, Calif., July 22, 1915, F. B. Herbert; one female, Fallen Leaf, Calif., July 28, 1925, F. B. Herbert; and one female, Easton, Wash., Albert Koebele.

ENTOMOLOGY.—Adoretus luridus *Blanchard and its near relatives in the Philippine Islands.*[1] Edward A. Chapin, Bureau of Entomology. (Communicated by HAROLD MORRISON.)

*Adoretus luridus* Blanchard, a beetle of the subfamily Rutelinae of the family Scarabaeidae, was described in 1850 from a specimen or specimens taken at Manila, Luzon, P. I. The species has since been reported from various stations in the Philippines, from Malacca, and from southern Indo-China. One specimen from Singapore (C. F. Baker), which may belong to this species, is in the National collection.

A study of the specimens which have been determined in the past as this species and which are available to me shows them to fall naturally into three groups, characterized by differences in size, structure, and, to a degree, in geographical distribution. Starting with the belief that the material did actually represent a single species and intending to illustrate the variation which was thought to exist in the form of the aedeagus, the writer dissected most of the male specimens to disclose the chitinous parts of the genitalia. After learning that there were three types of aedeagus in the lot, with apparently no intergrading specimens, a study of the external anatomy was made. Differences, previously overlooked, were noted and the writer was forced to the conclusion that three closely related species were represented. The three species agree in the following points:

Upper surface sparsely and irregularly clad with pale, depressed setae. Clypeus broadly, almost semicircularly rounded with its anterior margin strongly reflexed, clypeus and frons furnished with aciculate punctures, a narrow transverse line across the vertex smooth and without punctures, occiput with coarse, transverse punctures. Eyes moderately prominent, ocular canthus narrow, reaching back about one-third diameter of eye. Pronotum transverse, about twice as wide as long, marginal bead complete on all sides. Elytron with three poorly defined costae, two of these discal, the other subhumeral, sutural bead broad. Abdominal sternites each with a transverse submarginal row of conspicuous spine-like setae, the row on the sixth sternite becoming marginal at the sides. Anterior tibiae with three teeth on outer side, middle and posterior tibiae surate, each with two oblique rows of four or five spines each. Outer claw of anterior and middle tarsi thickened and split at tip, that of posterior tarsus simple. In the descriptions that follow, the information given above is not repeated.

### ADORETUS LURIDUS Blanchard.

Figures 1, 4–9

Color yellow-brown, head, pronotum (flanks excepted), and elytral suture piceous, tarsi castaneous. Clypeo-frontal suture nearly straight. Pronotum never less than twice as broad as long, sides subangulately rounded, basal

[1] Received May 19, 1931.

angles broadly rounded, anterior angles almost right, hardly produced, lateral and basal marginal beads narrow, lateral margin finely crenulate, anterior marginal bead broad and flat. Punctures coarse and sparse, evenly distributed or nearly so. Scutellum with a few coarse punctures. Elytron with intercostal spaces densely set with coarse punctures, the punctures between the discal costae roughly arranged in four rows. Apical sutural angle well-defined but blunt. Pygidium finely but roughly sculptured at sides, nearly smooth at middle, pubescence longer and more conspicuous at middle, lower margin sinuate, apex subtruncate and slightly reflexed. Upper tooth of anterior tibia well-developed.

Length 9–10.5 mm.

Apparently a common species at Manila, whence it was originally described. Its distribution is to the south and along the south shore of Laguna de Bay. Specimens before me are from: Manila Prov., Manila; Cavite Prov., Bacoor; Laguna Prov., Los Baños and Mt. Makiling. While there is some variation in the intensity of the coloration (occasionally a specimen with an almost entirely pale pronotum occurs), none of the specimens fails to show the dark sutural stripe.

### Adoretus philippinicus Pic.

Figures 2, 10–21

Similar in general appearance to *A. luridus* Blanchard but smaller, with the antennal club (male) proportionately much longer. Color yellow-brown, head, pronotum (except for small spot on flanks), and tarsi piceous, elytra often entirely dark but always with a dark suture. Head flat, clypeo-frontal suture feebly angulate at middle. Pronotum never quite twice as broad as long, sides rounded, lateral margins distinctly crenulate, marginal bead complete, anterior angles almost right, somewhat blunted at apices, basal angles effaced. Disc with a very few large punctures, flanks more densely punctured. Scutellum rough, without definite punctures. Apical sutural angle of elytron very broadly rounded. Pygidium covered with very fine scratches and with some very fine punctures, from each of which there arises a yellowish hair. Anterior tibia with upper tooth very weakly developed.

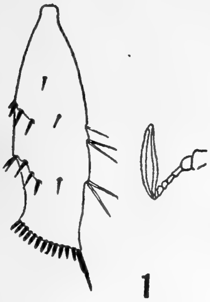
Length 7.5–9 mm.

*A. philippinicus* Pic. was described in Le Naturaliste, Ser. 2, Vol. 19, p. 131, 1905. The species is more northern in its distribution than *A. luridus* Blanchard, specimens having been identified from Benguet and Union provinces, as well as from Manila. The figure of the aedeagus given by Ohaus (Deutsche ent. Zeitsch., 1914, p. 472, fig. 1) as of *A. luridus* Blanchard appears to be of this species. The National collection contains specimens from: Benguet Prov., Baguio; Union Prov., Bayana; Manila Prov., N. W. shore of Laguna de Bay, and Manila. Also four specimens from the Baker collection labelled "Philippines-Schadenberg."

### **Adoretus lopezi**, new species.

Figs. 3, 22–27

Larger and paler than either of the preceding species, distinguished by the uniformly pale pronotum, the virtual absence of the sutural stripe on the



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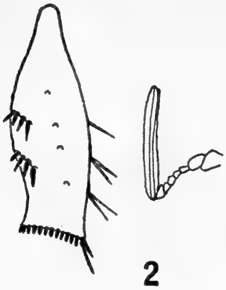

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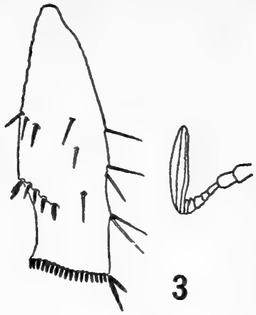

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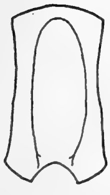

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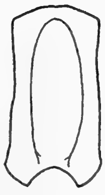

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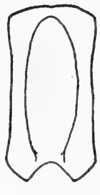

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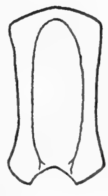

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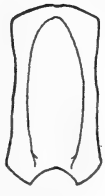

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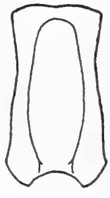

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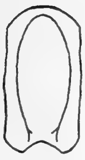

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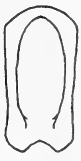

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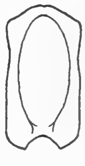

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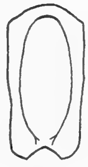

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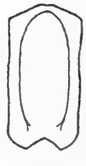

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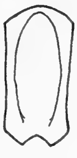

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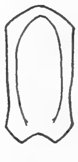

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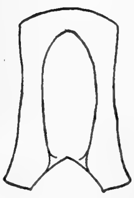

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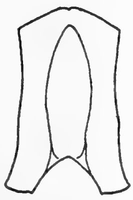

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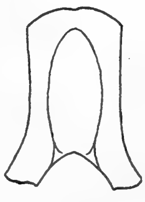

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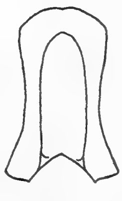

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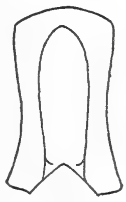

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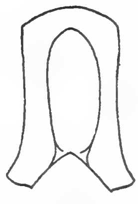

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elytra, by the form of the aedeagus, and by the different geographical distribution. Color yellow-brown, head, tarsi, and apices of tibiae darker. Head lightly convex, clypeo-frontal suture nearly straight. Pronotum never less than twice as broad as long, sides broadly and evenly rounded, lateral margins almost entire, basal angles effaced, anterior angles slightly produced. Disc convex, anterior half of pronotum sparsely punctured, posterior half almost impunctate. Scutellum smooth with a few coarse punctures. Pygidium finely wrinkled, clad with fine hairs, those at the middle longer and forming a distinct tuft. Upper tooth of anterior tibia strong.

Length 10–11 mm.

*Type.*—U.S.N.M. Cat. No. 43516, a male from La Carlota, Occidental Negros, May 17, 1930, A. W. Lopez, collector. *Paratypes*, three males and three females, same data; one male from Negros, May, 1911, C. V. Piper, collector; four males from Victorias, Occidental Negros, April 25–May 15, W. D. Pierce, collector.

The more evident differences between the species described above are given in the following synopsis.

1. Antennal club (male) about twice as long as preceding six segments combined; posterior tibia short, about twice as long as antennal club; size small, length not over 9 mm.; Luzon, mostly north of Manila **philippinicus** Pic.

Antennal club (male) not more than half again as long as preceding six segments combined; posterior tibia longer, about three times as long as antennal club........................................2.

2. Size moderate, 9–10.5 mm., elytra paler than pronotum but with sutural stripe and often with a poorly defined discal area dark, pronotum with flanks broadly paler, disc usually dark; Luzon, mostly south of Manila.......................................**luridus** Blanchard.

Size slightly larger, 10–11 mm., pronotum and elytra pale, sutural bead hardly darker, head sometimes dark, usually castaneous; Negros **lopezi** new species.

EXPLANATION OF FIGURES

1. *Adoretus luridus* Blanchard. Posterior tibia and antenna, Manila, May, 1925, R. C. McGregor.

2. *Adoretus philippinicus* Pic. Posterior tibia and antenna, Baguio, G. G. Haslam.

3. *Adoretus lopezi* n. sp. Posterior tibia and antenna, La Carlota, May 17, 1930, A. W. Lopez.

The following figures are of the distal portion of the aedeagus:

4–9. *Adoretus luridus* Blanchard. 4–6, Los Baños, April 17, F. X. Williams. 7, Laguna Province, P. Stangl. 8, 9, Bacoor, Cavite Province, P. Stangl.

10–21. *Adoretus philippinicus* Pic. 10, Manila, June, 1924, R. C. McGregor. 11, Manila, May, 1925, R. C. McGregor. 12, "Philippines, Schadenberg."

13–15, Manila Province, 1913, A. M. Reese. 16, Baguio, April 10, 1911, C. V. Piper. 17–21, Baguio, G. G. Haslam.

22–27. *Adoretus lopezi* n. sp. 22, Negros, C. V. Piper. 23, Victorias, April 21, 1928, W. D. Pierce. 24, Victorias, May 7, 1929. 25–27, La Carlota, May 17, 1930, A. W. Lopez.

ENTOMOLOGY.—*New species of melolonthine Scarabaeidae from the Philippine Islands.*[1] EDWARD A. CHAPIN, Bureau of Entomology. (Communicated by HAROLD MORRISON.)

Of the species described in this paper, all but one originated on the island of Negros, an island whose scarabaeid fauna appears to have been somewhat neglected in the past. The remaining species, from southern Luzon, has been included because of its evident relationship to one of the others and because of its very interesting pronotal development.

## STEPHANOPHOLIS Brenske.

This genus contains five species in addition to the one described below. Three of these are Ceylonese and are characterized by the presence of but five costae on each elytron. The type locality of the genotype, *S. melolonthoides* Brenske, is doubtful; however, the species agrees with the Philippine

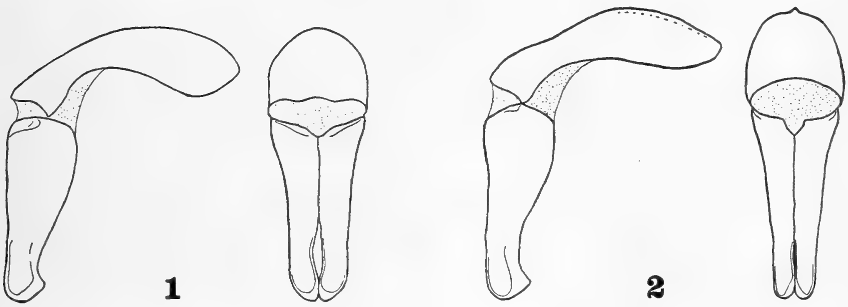


Figure 1. *Stephanopholis lopezi* n. sp. Aedeagus, side and front views.
Figure 2. *Stephanopholis philippinensis* Brenske. Aedeagus, side and front views.

members of the genus in having fourteen costae on each elytron. This species is described as having a median longitudinal furrow on the ventral face of the abdomen which is completely scaled. *S. philippinensis* Brenske and *S. lopezi* new species agree in having the scales of the ventral furrow, which is not continuous throughout its length, grouped in well-defined oval spots.

### **Stephanopholis lopezi** new species.

Figure 1

Near *S. philippinensis* Brenske, but distinguished from that species by the more robust form, the more uniform elytral costae, and the differences in the aedeagus of the male. Head and clypeus coarsely, shallowly, and not densely punctured, each puncture bearing a single elongate scale. Pronotum one and one-half times as wide as long, laterally angulate, sides parallel from basal angles to median angulations, thence strongly convergent to anterior angles

[1] Received May 19, 1931.

where width is slightly less than median length, lateral margins narrowly reflexed. Surface, on either side of the moderately broad and flat, smooth median ridge, rather less densely punctured than head, each puncture bearing a broadly oval scale. Elytra each with fourteen broad and nearly uniform costae, the intervening sulci densely set with small oval scales. Costae 1, 4, 7, 10, 13, and 14 reaching and joining the basal margin; 5 and 6, also 11 and 12, anastomosing both anteriorly and posteriorly; 4 and 7, also 3 and 8, forming complete loops posteriorly; 8 and 9 anastomosing posteriorly. Pygidium evenly scaled, sides nearly straight and strongly convergent, apex narrowly truncate. Underparts densely clad with small scales, sternites 2, 3, and 4 polished medianly and each with an oval spot of scales on the median line. Legs slender, anterior tibia bidentate, claw with a small sharp tooth just in front of the slight basal swelling of lobe.

*Male.*—Clypeus more than twice as broad as long (by measurement), strongly reflexed, broadly and shallowly emarginate anteriorly, anterior angles rounded. Antennal club longer than stem.

*Female.*—Clypeus trapezoidal, more than three times as broad as long, anterior margin more strongly reflexed at middle where it is slightly notched, anterior angles obtuse. Antennal club shorter than stem.

Length 21–26 mm.

*Type.*—U.S.N.M. Cat. No. 43472, a male from La Carlota, Occidental Negros, P. I., June, 1930, A. W. Lopez, collector. *Paratypes*, one male and two females, same data.

The aedeagus is less attenuated in this species (figure 1) than in *S. philippinensis* Brenske (figure 2), the tips of the lateral lobes are somewhat oblique, and the basal piece lacks the blunt carina as its posterior part.

### **Apogonia carlotae** new species.

Figure 3.

Near *A. adoretoides* Ritsema but larger and with distinctive differences in the aedeagus. Uniform deep piceous brown, evenly clad with short, depressed, ashy hairs. Clypeus evenly curved, anterior margin strongly reflexed, punctures coarse and closely set. Clypeo-frontal suture not sharply impressed. Frons slightly elevated, evenly convex, asperately punctured, the punctures smaller but about as numerous as those on clypeus. Pronotum twice as broad as long (by measurement), anterior margin not beaded, lateral and basal margins with fine bead, punctures moderately fine, notably more densely set laterally than on disc. Scutellum six-tenths as long as wide, uniformly and densely set with punctures similar in size to those on pronotum. Elytron evenly, densely and moderately finely punctured, toward apex the punctures becoming finer and even more closely set. Underparts densely and finely punctured. Anterior tibia bidentate toward apex and with a rudimentary tooth near base. Claw cleft to about middle of length, the inner ramus broader than outer.

Length 10–11 mm. (type 10.7 mm.).

*Type.*—U.S.N.M. Cat. No. 43473, a male from La Carlota, Occidental Negros, May 17, 1930, A. W. Lopez, collector. *Paratypes*, four males and two females, same data.

Compared with *A. adoretoides* Ritsema, the new species is larger. The longest of our twenty-three specimens of *A. adoretoides* Ritsema (from various localities on Luzon) measures 9.5 mm., the shortest 8.5 mm. In *carlotae* the tarsi, especially the posterior pair, and the posterior tibial spurs are broader than in *adoretoides.* The differences in the aedeagi of the two species are indicated in the drawings (figures 3 and 4). In both species the flagellum at the tip of the narrower of the lateral lobes is loosely attached and has freedom of motion in any direction.

**Holotrichia sexspecula** new species.

Near *H. mindanaona* Brenske but with the integuments generally pruinose and with a quite different development of the pronotum and elytra. Dark castaneous above, abdomen somewhat paler. Head shining, coarsely and densely punctured, clypeus feebly bilobed with anterior margin reflexed, frons with a median shallow depression flanked either side by a low tubercle.

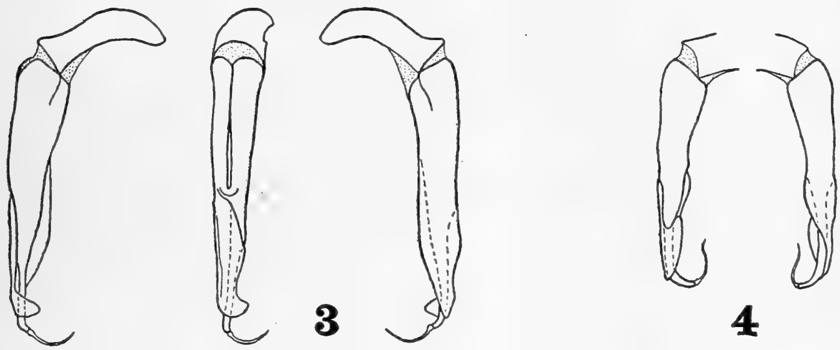


Figure 3. *Apogonia carlotae* n. sp. Aedeagus; right, front, and left views.
Figure 4. *Apogonia adoretoides* Rits. Aedeagus, right and left views.

Pronotum broader than long (length—width ratio = 46:76), sides angulately rounded at middle, anterior and posterior margins fine but complete, lateral marginal carina fine at posterior angle and continued so to the apex of the median angulation where it ceases. At the anterior angle the carina is modified into a broad, rounded explanate flap. Between the flap and the angulation, the normal course of the carina is traced by a series of punctures. Surface rather finely but not densely punctured, with an even pruinosity except for four spots: two semicircular spots on anterior margin, one either side of the middle, and one large rounded spot on anterior half of each lateral angular protuberance. Scutellum with a few scattered punctures. Elytra with suture tumid, densely punctured in the vicinity of the scutellum, more sparsely punctured elsewhere, pruinose except for a large lateral area commencing at humeral callus and reaching half way to apex. Close to the suture near apical fourth there is a roughened spot of small size from which grow two tufts of ferruginous hairs. Pygidium roughly triangular, apex rounded and very densely punctured, with a few hairs along its margin. Metasternum shaggy with whitish hairs, abdominal sternites with a few very short hairs, second visible sternite with a dense patch of hair laterally. Anterior tibia tridentate, posterior tibial spurs acute-spatulate, first segment of posterior tarsus shorter than second, claw strongly hooked, furnished with a small, acute, subbasal tooth.

Length (from apex of clypeus to apex of elytral suture) 19 mm.

*Type.*—U.S.N.M. Cat. No. 43474, a female from Cuernos Mountain, Oriental Negros, C. F. Baker, collector.

Owing to the unnatural distortion of the abdomen due to shrinkage, the over-all measurement is not given. The fascicles of hair on the elytra appear most unusual.

### **Holotrichia negrosiana** new species.

Figure 5.

In size, comparable to *H. philippinica* Brenske but differs from this species by the presence of a well-marked pruinosity in the male and by the long first posterior tarsal segment.

*Male.*—Color castaneous, head and pronotum darker, pruinose. Clypeus angulately emarginate, almost bilobed, anterior margin strongly reflexed, very coarsely and closely punctured. Clypeo-frontal suture angulate at middle, finely impressed. Frons coarsely but less densely punctured, that portion of vertex usually carried beneath the pronotum impunctate. Pronotum transverse, sides angulate at middle, lateral margin reflexed, strongly so before and feebly so behind the angulation, anterior marginal bead entire, moderately broad and finely crenulate along its posterior border, basal marginal bead incomplete across disc. Surface more finely and much more sparsely punctured than that of head. Scutellum laterally with a few punctures. Elytron finely and somewhat more densely punctured than pronotum, sutural margin feebly but broadly elevated, apical marginal region densely punctured. Pygidium rather sparsely punctured, its lower margin fringed with long hairs. Underparts sparsely punctured, median portions shining, lateral portions dull, legs shining, anterior tibia tridentate, first posterior tarsal segment as long as second, claw with a small, sharp, submedian tooth.

*Female.*—Similar to male except that the elytra are more coarsely punctured and, when clean, strongly shining.

Length 12.5–14.5 mm. (type 14 mm.).

*Type.*—U.S.N.M. Cat. No. 43475, a male from La Carlota, Occidental Negros, May 17, 1930, A. W. Lopez, collector. *Paratypes,* 22 males and 28 females (pinned) and numerous males and females in alcohol, same data.

The pinned material was passed through strong alcohol and xylol before pinning in order to extract the contained fat; in such specimens the more shining integuments of the females are readily observed. The aedeagus is figured (figure 5).

### **Holotrichia stylifer** new species.

Figure 6

Size and form of *H. mindanaona* Brenske. Shining, color pale brown with head, pronotum, and legs dark. Clypeus feebly, angulately emarginate at middle, anterior margin not strongly reflexed, punctures moderate in size and rather sparsely placed, clypeo-frontal suture sinuate, front more sparsely punctured than clypeus. There is a faint median depression on the frons. Pronotum transverse, widest across middle, sides obtusely angulate but not strongly produced, marginal bead fine and complete laterally and basally, anterior marginal bead broader and flat, its margins entire, surface more sparsely but equally coarsely punctured with head, anterior angles rounded and very slightly produced, lateral margin just behind the anterior angles slightly reflexed, basal angles rounded. Scutellum sparsely punctured. Elytron with punctures of equal size and density to those of pronotum, sutural margin faintly and broadly elevated, without other costae. Pygidium sparsely punctured, its lower margin fringed with long hairs. Underparts feebly punctured, shining but with latero-ventral opaque spots on 3rd and 4th sternites. Anterior tibia tridentate, first posterior tarsal segment equal in length to second, claw with a minute, sharp, recurved denticle on the basal lobe. Aedeagus shown in figure 6.

Length 16.5–19 mm. (type 18 mm.).

*Type.*—U.S.N.M. Cat. No. 43476, a male from La Carlota, Occidental Negros, May 17, 1930, A. W. Lopez, collector. *Paratypes*, two males and

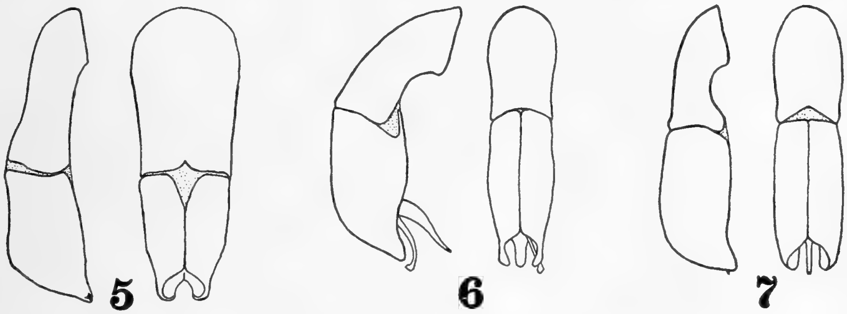

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Figure 5. *Holotrichia negrosiana* n. sp. Aedeagus, side and front views.
Figure 6. *Holotrichia stylifer* n. sp. Aedeagus, side and front views.
Figure 7. *Holotrichia sorsogona* n. sp. Aedeagus, side and front views.

one female, same data as type; one male from Saravia, Occidental Negros, May 12, 1929, W. D. Pierce, collector; three males and one female from Victorias, Occidental Negros, Oct. 4 and 7, 1927, Nov. 28, 1928, and Oct. 16, 1929, W. D. Pierce, collector; two males and one female, Cuernos Mountain, Oriental Negros, C. F. Baker, collector.

### **Holotrichia sorsogona** new species.

Figure 7.

Near to *H. stylifer* new species; shining, color light castaneous, head and pronotum slightly darker. Clypeus with a shallow, angulate emargination, anterior margin reflexed, surface rather coarsely and quite densely punctured, clypeo-frontal suture sinuate, frons as coarsely but less densely punctured than clypeus, with a broad, shallow, but very evident depression, vertex strongly punctured. Pronotum transverse, widest across apices of lateral angulations, lateral margins, commencing at the rounded and hardly produced anterior angle, running straight back for one-fourth length of pronotum, there turning sharply outward to form an angle of about 140°, then turning inward to the obtuse basal angle, forming a lateral angle of about 90°, which is itself broadly rounded. Marginal bead fine and entire, the anterior lateral margins slightly flattened and produced. Surface more finely and sparsely punctured than head. Scutellum evenly and densely punctured. Elytron more finely and densely punctured, with three faintly indicated costae in addition to the slightly raised sutural margin. Pygidium coarsely, deeply, but not densely punctured. Underparts finely and sparsely punctured, metasternum clad with long hairs, anterior tibia tridentate, first posterior tarsal segment shorter than second, claw with minute denticle on basal lobe. Aedeagus figured (figure 7).

*Type*.—U.S.N.M. Cat. No. 43477, a male from Sorsogon, Southern Luzon, C. F. Baker, collector.

In the structure of the male genitalia and in the tarsal claws this species is closely related to the preceding. There appears to be no supplementary style attached to the wall of the internal sac as in that species, however. The development of the sides of the pronotum is much more exaggerated here than in any other species of the genus known to me.

## SCIENTIFIC NOTES AND NEWS

DR. LELAND OSSIAN HOWARD, until his retirement in 1927 chief of the Bureau of Entomology, has been awarded the 1931 Capper Gold Medal and the sum of $5,000 for distinguished service to American agriculture. An informal reception in his honor was held at the Cosmos Club June 29 to give his fellow members an opportunity to greet him and to wish him well before his departure for France, where he will reside.

DR. C. HART MERRIAM has been awarded one of the three Roosevelt medals given each year by the Roosevelt Memorial Association for distinguished service. The award was given to Dr. Merriam for distinguished service in the advancement of the study of natural history. He founded, in 1885, the division of ornithology and mammalogy in the Federal Department of Agriculture, which later became the Bureau of Biological Survey, and, as its chief for 25 years, introduced methods of research and study which constitute the basic structure of the present American school of mammalogy.

DR. ALEXANDER WETMORE has been elected an honorary member of the Hungarian Ornithological Society, and has also been awarded the Otto Herman silver medal by that society.

NATHAN W. BASS has been reinstated in the Geological Survey and assigned to the geologic branch.

E. T. WHERRY, Associate Professor of Botany, University of Pennsylvania, is collecting and studying the Polemoniaceae or Phlox family in the Northwestern States.

On July 1, the division of agricultural engineering of the Bureau of Public Roads became an independent bureau of the Department of Agriculture, with the name, Bureau of Agricultural Engineering. S. H. MCCRORY, head of the former division, has been appointed chief of the new bureau.

## 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.

## CONTENTS

### ORIGINAL PAPERS



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# WASHINGTON ACADEMY OF SCIENCES



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*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.

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MATHEMATICAL PHYSICS.—*The quantum theory of Born and Wiener.* R. J. SEEGER, The George Washington University.[1] (Communicated by EDGAR W. WOOLARD.)

The quantum theory of Born and Wiener[2] was devised as an operational calculus to confine the infinite matrices of Heisenberg to a region of mathematics more highly developed analytically. Another merit was the utility of its structure for aperiodic, as well as periodic, motions. Despite both these advances, however, it soon succumbed to the simpler method of Schrödinger, which still holds sway. Indeed, Schrödinger's equation is now the epitome of quantum mechanics. But the more the success of the latter's applications is unquestionable, the more problematic is the interpretation of its usefulness. This has become the crux of the new theory so that much discussion of fundamental concepts has enlarged physics into metaphysics. At present, there are two schools of thought—not to mention pessimistic outlooks—: the one accepts the equation as an accidental revelation to be given a special, physical meaning; the other looks upon it as an incidental emergence to be evolved from a general, mathematical technique. This second view is precisely the one previously considered by Born and Wiener in a different application; hence, the desirability of extended work in this direction.

In particular, their theory attempts to fix operations which will yield the elements of the respective, associated matrices (if these exist) upon application to a given exponential function. The physical postulate, that the latter be real representations, necessitates matrices of the Hermitian type. The method is to subject the operational equations of motion to the quantum condition. It has been used so far to solve two problems: the linear, harmonic oscillator and the free

[1] Received June 23, 1931.

[2] Born, M. and Wiener, N. Zs. f. Phys. **36**: 174.

particle in one dimension. The following solution of a particle in a a uniform field is of additional value from a critical standpoint.

Consider a particle moving along the axis of a constant force F. If $m$ be the mass (nonrelativistic case), then the Hamiltonian expression for the total energy H is

$$H \equiv \frac{1}{2\,m} P^2 + FQ^2$$

where Q is the positional coordinate and P its corresponding momentum. Hence, the equation of motion is

$$\ddot{Q} = -\frac{F}{m}$$

Let $$Q \equiv t^2\,\Phi_1\,(D) + t\,\Phi_2\,(D) + \Phi_3\,(D)$$

where $t$ signifies the time and D the first derivative with respect to it. Using the definition

$$\dot{Q} \equiv DQ - QD$$

we have $$\ddot{Q} = 2\,\Phi_1\,(D)$$

$$\therefore \qquad \Phi_1\,(D) = -\frac{F}{2\,m}$$

and $$Q \equiv -\frac{F}{2\,m} t^2 + t\,\Phi_2\,(D) + \Phi_3\,(D)$$

The quantum condition is

$$PQ - QP = \frac{h}{2\,\pi\,i}. \qquad i \equiv \sqrt{-1}$$

Or, since $$P = m\,\dot{Q},$$

$$\therefore \qquad \dot{Q}Q - Q\dot{Q} = \frac{h}{2\,\pi\,i\,m}$$

i.e. $$\left\{-\frac{F}{m}t + \Phi_2\,(D)\right\}\left\{-\frac{F}{2\,m}t^2 + t\,\Phi_2\,(D) + \Phi_3\,(D)\right\}$$

$$-\left\{-\frac{F}{2\,m}t^2 + t\,\Phi_2\,(D) + \Phi_3\,(D)\right\}\left\{-\frac{F}{m}t + \Phi_2\,(D)\right\} = \frac{h}{2\,\pi\,i\,m}$$

Using Leibnitz' formula, namely,

$$\Phi\ (\mathrm{D})\ t \equiv t\ \Phi\ (\mathrm{D}) + \Phi'\ (\mathrm{D}) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

we obtain

$$-\frac{\mathrm{F}}{2\ m}\ \Phi''\ (\mathrm{D}) + \frac{\mathrm{F}}{m}\ \Phi_3'\ (\mathrm{D}) + \Phi_2'\ (\mathrm{D})\ \Phi_2\ (\mathrm{D}) = \frac{h}{2\ \pi\ i\ m}$$

Let this operate on $e^{\frac{2\pi i}{h} \mathrm{W} t}$, where W represents the value of the energy in the particular state concerned.

Put $$w \equiv \frac{2\ \pi\ i}{h}\ \mathrm{W}$$

$$\therefore \quad -\Phi_2''\ (w) + 2\ \Phi_3'\ (w) + \frac{2\ m}{\mathrm{F}}\ \Phi_2'\ (w)\ \Phi_2\ (w) = \frac{h}{\pi\ i\ \mathrm{F}}$$

$$\therefore \quad \Phi_2'\ (w) - 2\ \Phi_3\ (w) - \frac{m}{\mathrm{F}}\ \{\Phi_2\ (w)\}^2 = -\frac{h\ w}{\pi\ i\ \mathrm{F}} + \mathrm{A}_\phi \ldots\ldots (2)$$

where $\mathrm{A}_\phi$ is the constant of integration.

Put $$\frac{\Psi_2'\ (w)}{\Psi_2\ (w)} \equiv -\frac{\mathrm{F}}{m}\ \Phi_2\ (w)$$

$$\therefore \quad \Psi''\ (w) - \left\{-\frac{2\ m}{\mathrm{F}}\ \Phi_3\ (w) + \frac{h\ w}{\pi\ i\ m\ \mathrm{F}^2} + \mathrm{A}_\psi\right\} \Psi_2\ (w) = 0 \ldots (2\mathrm{A})$$

We note that (2A) is the specialized Riccatti equation, which has previously appeared in the new quantum mechanics in various forms as "Schrödinger's equation."

Let us now introduce the Hermitian condition, i.e.

$$\tilde{\mathrm{Q}} = \mathrm{Q}^*$$

where the wavy line indicates the operator which will yield the transpose-matrix of that given by Q, and the asterisk signifies the one which will give the complex-conjugate. In this case it becomes

$$-\frac{\mathrm{F}}{2\ m}\ t^2 + t\ \Phi_2\ (\mathrm{D}) + \Phi_3\ (\mathrm{D}) = -\frac{\mathrm{F}}{2\ m}\ t^2$$

$$+ \Phi_2^*\ (\mathrm{D})\ \{-t\} + \Phi_3^*\ (\mathrm{D})$$

Operating this on $e^{\frac{2\pi i}{h} W t}$, we have

$$t\,\Phi_2\,(w) + \Phi_3\,(w) = -\,\Phi_2^*\,(w)\,t + \Phi_3^*\,(w)$$

Again using relation (1), we obtain

$$\Phi_2\,(w) = -\,\Phi_2^*\,(w) \qquad (3a)$$

and

$$\Phi_3\,(w) = -\,\Phi_2'^*\,(w) + \Phi_3^*\,(w) \qquad (3b)$$

From ($3a$) we learn that $\Phi_2\,(w)$ is purely imaginary; from ($3b$), that the imaginary part of $\Phi_3\,(w)$ is equal to $-\frac{1}{2}\,\Phi_2'^*\,(w)$. Therefore, put

$$\Phi_3\,(w) = \Phi\,(w) - \tfrac{1}{2}\,\Phi_2'^*\,(w)$$

where $\Phi\,(w)$ is real. Substituting this in (2), we have

$$-\frac{m}{F}\,\{\Phi_2\,(w)\}^2 = -\frac{h\,w}{\pi\,i\,F} + 2\,\Phi\,(w) + A_\Phi \qquad (2B)$$

Put

$$\phi\,(w) \equiv -\frac{F}{m}\,\{2\,\Phi\,(w) + A_\Phi\}$$

$$\therefore \qquad \Phi_2\,(w) = \left\{\frac{h\,w}{\pi\,i\,m} + \phi\,(w)\right\}^{\frac{1}{2}}$$

and $\Phi_3\,(w) = \Phi\,(w) - \frac{1}{2}\left\{\dfrac{h}{2\,\pi\,i\,m} + \frac{1}{2}\,\phi'\,(w)\right\}\left\{\dfrac{h\,w}{\pi\,i\,m} + \phi\,(w)\right\}^{-\frac{1}{2}}$

$$\therefore \qquad Q \equiv -\frac{F}{2\,m}\,t^2 + t\left\{\frac{h\,D}{\pi\,i\,m} + \phi\,(D)\right\}^{\frac{1}{2}}$$

$$+\,\Phi\,(D) - \tfrac{1}{4}\left\{\frac{h}{\pi\,i\,m} + \phi'\,(D)\right\}\left\{\frac{h\,D}{\pi\,i\,m} + \phi\,(D)\right\}^{\frac{1}{2}} \qquad (4)$$

If $F = 0$, we have the case of a free particle. Then

$$Q_0 = t\left\{\frac{h\,D}{\pi\,i\,m}\right\}^{\frac{1}{2}} + \Phi\,(D) - \tfrac{1}{4}\left\{\frac{h}{\pi\,i\,m\,D}\right\}^{\frac{1}{2}} \qquad (4A)$$

Equation ($4a$) agrees with that obtained by Born and Wiener. It is to be noted that their transpose-operator is published incorrectly Another mistake in sign later happens to make matters right again.

We form the "Spaltensumme" thus:

$$Q\,(t, W) = e^{-\frac{2\pi i}{h}Wt}\,Q\,e^{\frac{2\pi i}{h}Wt}$$

$$\therefore\ Q\,(t, W) = -\frac{F}{2\,m}\,t^2 + \left\{\frac{2\,W}{m} + \phi\left(\frac{2\,\pi\,i}{h}\,W\right)\right\}^{\frac{1}{2}} t + \Phi\left(\frac{2\,\pi\,i}{h}\,W\right)$$

$$-\tfrac{1}{4}\left\{\frac{h}{\pi\,i\,m} + \phi'\left(\frac{2\,\pi\,i}{h}\,W\right)\right\}\left\{\frac{2\,W}{m} + \phi\left(\frac{2\,\pi\,i}{h}\,W\right)\right\}^{-\frac{1}{2}}$$

and
$$P\,(t, W) = -\,F\,t + \left\{\frac{2\,W}{m} + \phi\left(\frac{2\,\pi\,i}{h}\,W\right)\right\}^{\frac{1}{2}}$$

This agrees with the classical formula only for W large and for $\phi = 0$. Hence, there is an arbitrariness in the general solution. This lack of uniqueness and the relation to the Schrödinger type of equation are the distinctive features of this problem.

There is one point more, however, which is important. Born and Wiener deduce the Hermitian condition subject to the vanishing of the time-function $w(t)$ as $t$ becomes infinite. For then the following integral has a finite value in the limit:

$$U\,(\alpha) \equiv \lim_{T \to \infty} \frac{1}{2\,T}\int_{-T}^{+T} e^{i\,\alpha\,t}\,u\,(t)\,dt$$

In the problem of a free particle U $(\alpha)$ does not exist; for the integral becomes oscillatory as $T \to \infty$. In the case of a particle in a uniform field $U(\alpha)$ becomes infinite. And the former is again true for the linear harmonic oscillator. The question arises as to the validity of the proof for these applications. Perhaps it is advisable to look upon this particular operational form of the Hermitian condition as a generalized definition, a hypothesis to be justified pragmatically.

ENTOMOLOGY.—*Synopsis of* Perigaster (*Coleoptera: Curculionidae*).[1]
L. L. Buchanan, Bureau of Entomology. (Communicated by Harold Morrison.)

Some time ago, Mr. W. J. Brown of Ottawa, Ontario sent the writer an undescribed species of the ceutorhynchid genus *Perigaster*. The attempt to fit this species in the existing classification brought to light several unrecorded structural peculiarities that modify the generic and specific definitions heretofore followed.

In the first place, the scrobe, which has been described as linear, oblique, and directed beneath eye, is in reality no more than a terminal oval pit for receiving the globular base of scape. From this pit there extends directly toward the eye a variably distinct sulcus which, however, does not conceal or protect the scape in its position of rest. The sulcus is often partially, and sometimes entirely, obliterated, and is always more or less punctate and scaly, in these respects contrasting strongly with the normally formed scrobe, which is deep, glabrous, and without evident sculpture except for a shagreened or alutaceous surface. In some specimens of *Perigaster* this "false" scrobe is rather deep, but its vestigial nature is shown by indefinite margins, by the presence of punctures or scales, or by other indications. As the scrobe proper is virtually effaced, its direction can not be used as a generic character.

The published requirement for simple claws is only partly correct, the claws being simple in *obscura*, minutely toothed in *cretura* and *longirostris*, and strongly toothed in *tetracantha*.

The antennal funicle can be regarded as six-segmented, although in *tetracantha* especially, and in rare individuals of the other species, there is a fairly well differentiated seventh segment at the base of the club. In the great majority of specimens the funicle appears to be truly six-segmented.

The narrow shelf-like production of the second abdominal segment (see figure 1), forming the surface over which the third segment slides when tip of abdomen is depressed, has definite taxonomic value. This structure is called simply "shelf" in key and descriptions. When the abdomen is depressed, the visible surface of the third segment becomes equally broad from side to side; this fact should be kept in mind in interpreting the published statement, "third segment narrowed at sides."

As treated here, *Perigaster* shows the following generic characters:

[1] Received May 27, 1931.

Rostrum wider and thicker toward apex; scrobes vestigial except at tip; scape inserted at about apical one-third, the funicle six-segmented; posterior eye margin acutely elevated; prothorax with the four usual cusps well developed, and in addition generally with a minute one on anterior margin a short distance below apical cusp (see figure 1), ocular lobes feeble or absent; base of prothorax and elytra thickened and raised; fore coxae separated by one-third to two-thirds the width of a coxa, antecoxal ridges absent, prosternal emargination deep, U-shaped; femora mutic, third tarsal segment bilobed, claws simple or toothed; third ventral narrowed at sides with abdomen in normal position; male with mid and hind tibiae mucronate.

These characters apply more strictly to the northern species; as is brought out in the key, *tetracantha* Champion from Panama differs in several important respects and properly forms a distinct subgenus.

To avoid repetition, a few general characters common to the three or four North American species are briefly outlined here and are not mentioned again in the descriptions.

*Head:* Occiput with a distinct longitudinal carina; eyes one-half to two-thirds covered in repose; scape short, failing to reach eye by about length of first funicular segment; funicle with first three segments elongated, the first much stouter. *Prothorax* subconical in shape, the sides nearly straight to moderately arcuate, hardly constricted at apex. *Elytra* with tenth interval somewhat depressed at basal third, causing a sinuation of outline as seen from above, striae 2 to 6 inclusive, especially the latter, terminating at base in a pit, femora broadly and indefinitely annulated with scales at apical third. The standard markings above consist of a band of pale scales across base of head, a stripe along each side of pronotum, wider in front, and white spots on elytra as follows: One on third interval at basal third, one on seventh interval at or a little before middle, and occasionally a smaller one at apical termination of third interval, one or more of these spots commonly missing.

The remarkable dung-bearing habits of the externally feeding larvae are described by Knab (Proc. Ent. Soc. Wash., vol. 17, 1915, p. 194). Knab's specimens, or part of them, now preserved in the National collection, prove to be *cretura* instead of *obscura* as published.

### Key to Species of Perigaster

1. Scape very short, less than one-third length of funicle with club (ratio about 6 to 22), attached a little before middle of beak, scrobe merely an oval pit; rostrum short, scarcely longer than depth of head, in side view a little thicker at base than toward apex; distance between fore coxal almost equal to length of scape; pronotum more strongly arched longitudinally; dorsum with dense covering of minute, suberect, dark brown to black scales, with some white scales forming a stripe each side of pronotum and a very faint transverse median band on elytra reaching from margin inward about half way to suture, a few scattered white scales on apical half of elytra, on humeri, and at base of pronotum; under surface with small close-set white scales; tooth of tarsal claws long, one-half to

two-thirds length of claw; body form very stout, the elytra a little broader than long. Length, 2.45 mm.; width, 1.65 mm. Panama. **tetracantha** Champion.

Scape distinctly more than one-third length of funicle with club (ratio about 8 to 20), attached about one-third from apex; rostrum thicker toward apex; scape much longer than distance between fore coxae; scales on dorsum much larger, prostrate; tooth of tarsal claw minute or absent; form generally less stout. Species north of Mexico................2

2. Tarsal claws simple; shelf of second ventral segment not punctate and not rugose; profile of rostrum and head more abruptly discontinuous; rostrum stout, generally much less than twice as long as broad; pronotum generally uneven, due to a conspicuous median swelling; anterior coxae separated by about two-thirds their width; elytral intervals 3, 5, and 7 frequently elevated in basal half. Southeastern United States. **obscura** Leconte.

Claws with a minute basal tooth; shelf of second ventral generally sculptured to some extent; profile of head and beak less abruptly discontinuous; median pronotal swelling feeble or absent.........................3

3. Rostrum short and stout, almost always distinctly less than twice as long as broad; shelf of second ventral smooth or lightly punctate across a narrow basal strip; entire dorsum rather even, the pronotal swelling feeble or absent and alternate elytral intervals less elevated; anterior coxae separated by one-half to two-thirds their width; body stouter. Eastern United States.............................**cretura** Herbst.

Rostrum longer and more slender, a little more than twice as long as broad; shelf of second ventral coarsely sculptured; ground color darker, the dorsum often marmorated; third, fifth, and seventh elytral intervals more distinctly elevated; fore coxae separated by about one-third their width. Canada, south to New Jersey and west to Washington...**longirostris** n. sp.

* * * *

Rostrum scarcely as long as head, with an obtuse median carina; punctures of occiput in striae; elytra with alternate intervals wider and higher. Royal Palm Park, Florida, 1 female.....................**alternans** Blatchley. (Species not seen; possibly a well developed form of *obscura*).

PERIGASTER CRETURA Herbst. (QUADRISPINOSA Say)

Length, 2.5–3.2 mm.; width, 1.6–2.15 mm. Robust, dorsum generally even, scales of two sizes, the larger pale ones sparse or wanting on disk of pronotum, on humeral swelling, and on various small scattered areas on elytra, being replaced to some extent on these places by much smaller, narrower, coppery scales.

Rostrum feebly arcuate, above finely and closely punctate and frequently with a narrow median line either smooth or very finely grooved, scales small and sparse above but larger on sides near apex, a band of dirty white oval scales between eyes; head with a large median flattened or concave area opposite posterior eye margin, the occipital carina often extending down to the concavity. Pronotum finely and densely punctate, commonly with an indefinite medially interrupted line of dirty white scales, surface abruptly declivous at middle of base. Elytral intervals flat to feebly convex, more convex toward sides, third, fifth, and seventh slightly broader and higher in many specimens, surface of intervals finely but irregularly sculptured or granulose, the granules on fifth, seventh, and ninth sometimes developed into minute denticles, more evidently so near apex; striae deep, with small close-set punctures, each puncture partially closed by an oval or narrowly oblong longitudinally directed scale. Venter with close-set circular scales.

Oklahoma; Texas; Louisiana; Alabama; Florida; North Carolina; Virginia; Maryland; New Jersey; New York; Massachusetts; Michigan; Illinois. 150 specimens.

This species presents a characteristic habitus due to the very stout body form and the comparatively smooth dorsum. The relatively even distribution of vestiture gives the upper surface a smooth gray appearance, contrasting with the unevenly marked or marmorate dorsum in *longirostris* and *obscura*. *P. cretura* differs from these two also in having the scales on dorsum narrower, and the antennae inserted a little nearer to apex of beak. The apical prothoracic cusps are often feeble.

PERIGASTER OBSCURA Leconte (QUADRISPINOSA Gyll.).

Length, 2.4–3.1 mm.; width, 1.55–2.1 mm. Slightly less robust than *cretura*, the ground color darker, the larger pale scales sparser, the smaller brassy ones rather more conspicuous, the dorsum more uneven.

Rostrum moderately to rather strongly arched, finely punctate above, more coarsely at sides; head densely, more or less rugosely punctate, the area between and behind eyes flattened or concave, and often with brassy scales; pronotum typically with well developed median hump, the punctures either uniformly fine and dense, or coarser and finer intermixed, a feeble median longitudinal groove often evident; elytra with intervals convex, the third, fifth, and seventh generally somewhat elevated; striae rather deep, the strial punctures a little larger and sparser than in *cretura* or *longirostris*. The vestiture and punctation on venter, except on pro- and mesosterna, is generally sparser than in *cretura*.

Louisiana; Mississippi; Alabama; Florida; Virginia; Maryland; District of Columbia.

In typical examples from Florida, this species differs from the others in the shorter, stouter, more strongly arcuate beak, the sparser vestiture above and below, the sparser and more irregular pronotal punctures, the presence of a faint median pronotal sulcus, the feebler granulations on elytral intervals, etc. These differences break down, one by one, in the more northern specimens, leaving only the alutaceous shelf of second ventral and the absolutely simple tarsal claws as certain definitive characters. Only about two dozen specimens of this species have been seen; perhaps a greater number would contain exceptions to any single structural character.

The name *quadrispinosus* Gyll. 1836, a homonym of *quadrispinosus* Say 1824, was listed in the synonymy of *cretura* Hbst. by Leconte 1885 and by Dietz 1896. Gyllenhal's description, based on a Mississippi specimen, fits *obscura* Lec. better than *cretura* Hbst., so *quadrispinosus* Gyll. may be considered a synonym of Leconte's species.

**Perigaster longirostris,** new species.

Figure 1.

Length, 2.2–2.6 mm.; width, 1.35–1.75 mm. (19 specimens, male and female).

Rather stout, black or dark piceous, pronotum with a broad, indefinite, medially interrupted stripe of rounded scales, elytra with scattered brown to white rounded scales interspersed with minute narrow brassy scales giving the surface a marmorated appearance, the rounded scales more or less condensed along the suture, and sometimes also in a short transverse bar at basal third, thus forming a cross or inverted T, depending on length of sutural stripe, these marks not sharply defined. Legs reddish.

Rostrum moderately arcuate, a little more than twice as long as broad, finely and closely punctate, more sparsely toward apex, the punctures showing a tendency toward linear arrangement on upper surface behind antennal insertion, and often leaving a fairly distinct median line smooth; surface glabrous above, more or less scaly at sides. Scrobe an elongate pit one-third from apex of beak, false scrobe punctate and scaly, extending back to or almost to eye. Head densely, finely punctate, flattened or slightly concave between and behind eyes, with a band of oval scales between eyes. Pronotum densely punctate, moderately arched, abruptly declivous at middle of base; ocular

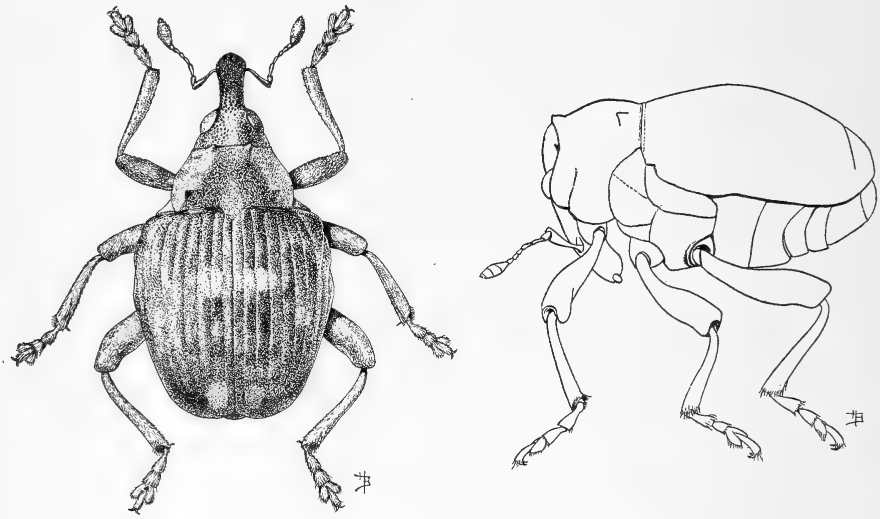

Figure 1. *Perigaster longirostris*, new species, × 18. (Drawn by Harry Bradford)

lobes more or less evident. Elytral striae rather broad and deep, strial punctures close-set, intervals convex, finely granulose, the granules on fifth, seventh, and especially on the ninth developed into minute denticles from each of which projects posteriorly a scalelike hair, the third, fifth, and seventh intervals as a rule broader and slightly elevated; humeri prominent and subglabrous; tenth interval depressed at basal one-third causing a sinuosity in outline of elytra from dorsal point of view. Venter with rounded pale scales, contiguous to overlapping over most of the surface, except on last four ventral segments and on lower part of propleura where they are sparser. Femora reddish, often with darker blotches near base and apex, indefinitely and broadly annulated with scales at apical third.

*Type locality:* Ottawa, Ontario (Harrington). 14 specimens, type and 13 paratypes.

Other localities (Paratypes): Mt. St. Hilarie, Quebec, 1 specimen; Detroit, Michigan (Hubbard and Schwarz), 1 specimen; Irvington, New Jersey

(Bischoff Collection), 1 specimen; Iowa (Wickham), 1 specimen; Pullman, Washington (J. F. Clarke), 1 specimen.

*Type:* A male, in Canadian National Collection.

*Paratypes:* 9 in Canadian National Collection; 9 in U. S. National Museum Collection, Cat. No. 43532.

The elytral vestiture varies considerably, showing a tendency toward the development of a transverse band beginning on suture at basal third and extending laterally either at right angles or obliquely backward to connect with spot on seventh interval. An irregular marmoration of the surface is conspicuous in well preserved specimens. The ocular lobe, a noteworthy character in this genus, varies from a feeble to a fairly well defined form, though never strongly developed; the lobe covers about three-fourths of the eye with rostrum in position of rest.

Properly mounted specimens of this species should be recognizable by the longer beak, narrowly separated fore coxae, presence of feeble ocular lobes, rugosely sculptured shelf of second ventral segment, better development of denticles on ninth interval of elytra, and the exceedingly minute tooth on tarsal claws. The last named character is difficult to see with less than about 40 magnifications. The upper eye margin is not so much elevated above head surface as in *cretura* and *obscura*. When the three species are compared in series, *longirostris* is seen to be distinctly the smallest.

## BOTANY.—*Nine new American Asteraceae.*[1] S. F. BLAKE, Bureau of Plant Industry.

This paper contains descriptions of nine new species of Asteraceae, of which one is from Utah, two are from Mexico and Central America, and six are from South America. Several transfers of names and new names and two new varieties are also included.

### **Vernonia calderoni** Blake, sp. nov.

Sect. *Eremoseos;* frutex; rami tomentosi glabrescentes; folia oblongo-ovata v. elliptica majuscula supra mox glabrata subtus laxe griseo-tomentosa; capitula parva 5-flora in axillis glomerata; involucrum dense tomentosum; achenia 5–6-costata dense breviterque pilosa.

Shrub 3 m. high; branches somewhat zigzag; leaves alternate; petioles thick, gray-tomentose, about 4 mm. long; blades 7–12 cm. long, 3–5 cm. wide, obtuse or acutish, apiculate, at base cuneate, remotely and obscurely callous-denticulate, papery, above dotted with sessile shining glands, glabrate except along costa, beneath thinly and somewhat floccosely but persistently tomentose and gland-dotted, featherveined, the lateral veins 8–10 pairs, prominulous beneath, the veinlets reticulate beneath; heads short-pedicelled or subsessile, crowded in axillary glomerules 1.5-2 cm. thick, these confluent at tips of stem and the short branchlets; involucre about 5 mm. high, strongly graduate, about 7-seriate, the phyllaries broadly triangular-ovate to lance-oblong and

[1] Received May 28, 1931.

(innermost) nearly linear, densely tomentose and somewhat gland-dotted, obtuse, the innermost acutish, deciduous; corollas about 4.5 mm. long; achenes 3 mm. long; pappus whitish, the outer of linear squamellae about 1.5 mm. long, the inner of aristiform barbellate bristles 4.5 mm. long.

SALVADOR: Sierra de Osicala, Dept. Morazán, April 1929, *Salvador Calderón* (type No. 1,406,895, U. S. Nat. Herb.; dupl. in herb. Field Mus.).

A species combining the inflorescence and achenes of *Vernonia standleyi* Blake with the leaves of *V. leiocarpa* DC.

**Lepidophyllum phylicaeforme** var. **resinosum** (Walp.) Blake.

*Vernonia phylicaeformis* var. *resinosa* Walp., Nov. Act. Acad. Caes. Leop.-Carol. **19:** Suppl. **1:** 253. 1843.

*Baccharis lucida* Meyen, Walp. Nov. Act. Acad. Caes. Leop.-Carol. **19:** Suppl. **1:** 253. 1843, as synonym.

Possibly a distinct species, but differing from typical *Lepidophyllum phylicaeforme* (Meyen) Hieron. only, so far as known, in its glabrous and resinous (not tomentose) stem and branches. *R. E. Fries* 675, from Argentina, distributed as *L. phylicaeforme,* represents this variety. I have elsewhere[2] discussed the identity of *Lepidophyllum phylicaeforme* and *Parastrephia ericoides* Nutt.

**Solidago auriculata** Shuttleworth, nom. nov.

*Solidago amplexicaulis* Torr. & Gray, Fl. N. Amer. **2:** 218. 1842. Not *S. amplexicaulis* Martens, Bull. Acad. Brux. **8:** 67. 1841.

*Solidago auriculata* Shuttl., A. Gray, Syn. Fl. N. Amer. $1^2$: 153. 1884, as synonym.

*Aster amplexicaulis* Kuntze, Rev. Gen. Pl. **1:** 317. 1891. Not *A. amplexicaulis* Lam. 1783, or Michx. 1803, or Muhl. 1803.

Torrey and Gray, when describing this species, did so under the name "*S. amplexicaulis* (Martens?)," stating that they attributed the name to the plant described merely on the basis of its appropriateness, not having seen the original publication of Martens. Chapman[3] in 1860 used the same name, with the authority Torrey & Gray, and Gray in his later writings continued to do so, after it had been ascertained that Martens' name referred to *S. riddellii* Frank. The appropriate name *S. auriculata,* under which the species was distributed by Shuttleworth (according to Gray), is here given proper publication.

**Solidago graminea** (Woot. & Standl.) Blake.

*Petradoria graminea* Woot. & Standl., Contr. U. S. Nat. Herb. **16:** 183. 1913.

A species closely related to *Solidago petradoria* Blake (*S. pumila* (Nutt.) Torr. & Gray, not Crantz; *Petradoria pumila* Greene), but with very much

[2] Contr. U. S. Nat. Herb. **26:** 232. 1930.

[3] Fl. So. U. S. ed. 1. 213. 1860.

narrower leaves. Originally described from northwestern New Mexico, it has also been found in the Kaibab National Forest in northern Arizona (specimens collected 13 Aug. 1926, received through Dr. C. D. Marsh; in U. S. Nat. Herb.) and about $7\frac{1}{2}$ miles south of Scipio, Millard County, Utah, alt. 1650 meters, 20 June 1930 (*G. D. Pickford* 28; herb. U. S. Forest Service).

**Aster pantotrichus** Blake, nom. nov.

*Aster missouriensis* Britton in Britton & Brown, Ill. Fl. **3**: 378. *f.* 3794. 1898. Not *A. missuriensis* (sic) Kuntze, Rev. Gen. Pl. **1**: 318. 1891. (Based on *Solidago missouriensis* Nutt.)

**Aster pantotrichus** var. **thyrsoideus** (A. Gray) Blake.

*Aster diffusus* var. *thysoideus* A. Gray, Syn. Fl. N. Amer. $1^2$: 187. 1884.
*Aster lateriflorus* var. *thyrsoideus* Sheldon, Bull. Torrey Club **20**: 286. 1893.

As the name *Aster missouriensis* Britton must be abandoned owing to the previous use of the same name by Kuntze, and as Gray's varietal name *thyrsoideus* is ineligible for raising to specific rank because of *Aster thyrsodeus* (E. Meyer) Kuntze,[4] it is necessary to provide the species with a new name.

**Erigeron phoenicodontus** Blake, s p.nov.

Perennis caespitosus ubique dense cinereo-strigosus, involucris dense breviterque hirsutis exceptis; folia basalia anguste oblanceolata acuta integra 1-nervia, petiolis base ampliatis albidis ciliatis, caulina parva linearia; caules simplices monocephali, capitulis mediocribus breviter pedunculatis; involucri paullum gradati phyllaria linearia, intima apice scariosa purpurea; radii ca. 40 albi parvi; achenia basi excepta glabra 10-nervia subteretia; pappus biseriatus, exteriore breviter setuloso.

Stems and leaves densely cinereous-strigose throughout, in small tufts from a few-branched, apparently deep and vertical cylindric root; fibrous bases of basal leaves persistent; stems 1–6 in a tuft, erect, simple, 1-headed, about 15 cm. high; basal leaves narrowly oblanceolate, 2.5–3.8 cm. long including the petioliform base, 2–3 mm. wide, acute, acuminate at base, entire, firm, 1-nerved, the base of the petiole somewhat enlarged, whitish, subscarious, ciliate, 3-nerved; stem leaves about 15, gradually reduced above, linear, the upper bracteiform and 3–6 mm. long; peduncles 1–15 mm. long; heads about 1.8 cm. wide; disk 1.3–1.5 cm. thick; involucre hemispheric, 4–5-seriate, slightly graduate, 5 mm. high, the phyllaries linear, acute to short-acuminate, densely hirsute with straight, mostly ascending hairs, the inmost phyllaries with green midline, whitish chartaceous margin, and scarious purple tips, the others with green midline and whitish margins; rays about 35–40, white, the tube sparsely pilose at apex with many-celled hairs, 2.5 mm. long, the lamina linear, tridenticulate, 4-nerved, 5 mm. long, 1.2 mm. wide; disk flowers very numerous, their corollas purplish above, sparsely pilosulous near middle, 4.5–5 mm. long (tube 1–1.5 mm., throat cylindric-funnelform, 3 mm., teeth 5, deltoid, papillose-crested, 0.5 mm. long); achenes of ray and disk similar, subterete, yellowish white, 9–10-nerved, glabrous except for a few bristles at extreme base, 2.3 mm. long; pappus of an outer series of minute setae about 0.3 mm. long and an inner series of about 35

[4] Rev. Gen. Pl. **1**: 317. 1891. (Based on *Solidago thyrsoidea* E. Meyer.)

whitish barbellate bristles 4 mm. long; style appendages depressed-deltoid, obtuse, finely hispidulous.

MEXICO: Sides of steep dry ravines, in red gravelly soil, Rancho Colorado, District of Guerrero, State of Chihuahua, alt. 2200 m., 27 May 1929, *Ynes Mexia* 2569 (type no. 1,409,875, U. S. Nat. Herb.).

A well-marked species, perhaps nearest *Erigeron ervendbergii* A. Gray, but with a different habit, much denser pubescence, and decidedly larger heads.

**Archibaccharis serratifolia** var. **paniculata** (J. D. Sm.) Blake.

*Diplostephium paniculatum* J. D. Sm., Bot. Gaz. **23**: 8. 1897.

*Hemibaccharis mucronata paniculata* Blake, Contr. U. S. Nat. Herb. **20**: 551. 1924.

*Archibaccharis mucronata paniculata* Blake in Standl., Contr. U. S. Nat. Herb. **23**: 1509. 1926.

*Archibaccharis mucronata* var. *paniculata* Blake, Amer. Journ. Bot. **15**: 64. 1928.

I have recently shown,[5] that the name to be adopted for the species long known as *Baccharis mucronata* H. B. K. is *Archibaccharis serratifolia* (H.B.K.) Blake.

**Pluchea salicifolia** var. **canescens** (A. Gray) Blake.

*Pluchea subdecurrens* var. *canescens* A. Gray, Proc. Amer. Acad. **5**: 182. 1861.

*Pluchea adnata canescens* Blake in Standl., Contr. U. S. Nat. Herb. **23**: 1510. 1926.

**Pluchea salicifolia** var. **parvifolia** (A. Gray) Blake.

*Pluchea subdecurrens* var. *parvifolia* A. Gray, Proc. Amer. Acad. **5**: 160. 1861.

*Pluchea adnata parvifolia* Blake in Standl., Contr. U. S. Nat. Herb. **23**: 1510. 1926.

I have recently shown[6] that the name *Pluchea salicifolia* (Mill.) Blake, based on *Conyza salicifolia* Mill., must be used in place of *P. subdecurrens* Cass. and *P. adnata* (Humb. & Bonpl.) Mohr.

**Gnaphalium paramorum** Blake, sp. nov.

Herba perennis caespitosa parva ubique dense et compacte sericeo tomentosa haud stolonifera; folia basalia rosulata subspathulata obtusa 1-nervia 1.5 cm. longa 5 mm. lata, caulina ca. 6–8 similia minora; capitula ca. 48-flora numerosa sessilia in glomerulum terminalem 1.5–2.5 cm. crassum aggregata; involucri ca. 5 mm. alti gradati phyllaria linearia apice rotundata v. obtusa basi castanea apice subaequali lactea opaca; flores fem. ca. 39, hermaph. ca. 9.

Stems few, ascending, 6–17 cm. high; basal leaves numerous, crowded, spreading, 1.2–2 cm. long, 2.5–6 mm. wide; stem leaves 1–2 cm. long, 2.5–4

[5] Contr. U. S. Nat. Herb. **26**: 236. 1930.

[6] Contr. U. S. Nat. Herb. **26**: 237. 1930.

mm. wide, sessile, not decurrent, the lower spatulate, the upper linear-oblong, all obtuse, not appendaged; glomerule involucrate by a few lanceolate or ovate leaves about 7 mm. long; phyllaries 0.6–0.8 mm. wide, somewhat woolly below middle, the tips radiating in age; pistillate corollas 2 mm. long, their achenes subfusiform, 1 mm. long, glabrous, the pappus of about 20 minutely roughened bristles 2.8 mm. long, not thickened upwardly, lightly connate in a ring at extreme base; disk corollas apparently brownish above, slender-funnelform, 2.8 mm. long, 5-toothed, the style shortly bifid with truncate hispidulous tips, the pappus bristles about 25, 2.8 mm. long, finely hispidulous, connate at base, apparently deciduous in groups.

VENEZUELA: Páramo Quirorá, Mérida, alt. 2900 m., 24 Feb. 1922, *A. Jahn* 883 (type no. 1,186,590, U. S. Nat. Herb.); Páramo del Jabón, Trujillo, alt. 3500 m., 2 Oct. 1910, *Jahn* 22.

An interesting plant, possessing much the appearance of *Gnaphalium antennarioides* DC. (*Elychrysum gnaphalioides* H. B. K., *Antennaria monoica* Wedd., *Leontopodium gnaphalioides* Hieron.), and probably most closely related to that species. In *G. antennarioides* the plant is stoloniferous and the leaves are longer, glabrescent and green or greenish above, and tipped with a brown callous point.

**Gnaphalium greenmanii** Blake, nom. nov.

*Gnaphalium linearifolium* Greenm., Proc. Amer. Acad. **32**: 308. 1897. Not *G. linearifolium* (Wedd.) French. 1892.

**Clibadium psilogynum** Blake, sp. nov.

Sect. *Euclibadii;* caulis strigosus; folia ovata opposita acuminata basi rotundata serrata triplinervia supra aspera subtus strigosa, petiolo tenui ca. 1.5 cm. longo; panicula terminalis densa; capitula mediocria sessilia; phyllaria 5–6 orbiculari-ovata obtusa v. minute apiculata sparse strigillosa sursum ciliolata 7–13-nervia; flores fem. 4, hermaph. 7–8; ovaria glaberrima.

Presumably a shrub; stem slender, terete, rather densely strigose with slightly tuberculate-based hairs; internodes 5.5–9 cm. long; petioles strigose, naked, 8–16 mm. long; blades 7.5–12 cm. long, 4–5 cm. wide, usually falcately acuminate, papery, dull green both sides, above evenly strigose or antrorsely short-hispid with tuberculate-based hairs, beneath evenly strigose on veins and surface, densely so on costa, serrate nearly throughout with small acute teeth (about 1 mm. long, 3–6 mm. apart), tripli- or subquintuplinerved, slightly prominulous-reticulate beneath; panicle dense, many-headed, 3 cm. wide, its hair looser than those of stem, mostly erectish; heads obovoid-oblong, about 8 mm. high (including corollas but excluding stamens), 4 mm. thick; involucre 6 mm. high; phyllaries 4.5–5 mm. long, 4–5 mm. wide; pistillate flowers 4, of which 3 are paleate, with pales similar to the inner phyllaries, the corollas white, glabrous, 4-toothed, 3 mm. long, the ovaries strictly glabrous, obovoid, 2 mm. long; hermaphrodite flowers 7–8, of which 1 is sometimes provided with a small pale, their corollas white, hispidulous on teeth, 3.8 mm. long (tube 1 mm., throat campanulate, 2 mm., teeth deltoid, 0.8 mm.), their ovaries linear-prismatic, 3 mm. long, glabrous or with a very few hairs at apex.

PERU: Marcapata Valley, near Chilechile, Prov. Quispicanchi, Dept. Cuzco, 21 Feb. 1929, *A. Weberbauer* 7864 (type no. 1,442,738, U. S. Nat. Herb.).

Related to *C. leiocarpum* Steetz and *C. anceps* Greenm., and distinguished by its combination of strigose branches and crowded but not glomerate heads.

**Rudbeckia californica** var. **glauca** Blake, var. nov.

Folia glauca margine tuberculato-hispidula ceterum glabra; phyllaria margine hispidula ceterum glabra vel subglabra.

OREGON: Just west of Cornutt, Douglas Co., 26 July 1918, *W. E. Lawrence* 2102; Rogue River Valley, 12 July 1887, *T. Howell;* near Wimmer, Jackson Co., 22 July 1892, *E. W. Hammond* 207; upland marshes near Waldo, 5 June 1884, *T. Howell.*

CALIFORNIA: One clump along brook, about 20 miles NE. of Crescent City, Del Norte Co., on road to Grants Pass, 30 Aug. 1927, *S. F. Blake* 10377 (type no. 1,488,180, U. S. Nat. Herb.); eight miles south of Waldo (Oregon), Del Norte Co., 14 June 1904, *C. V. Piper* 6103; Mt. Eddy, Siskiyou Co., 30 Aug. 1912, *A. Eastwood* 2047; same locality, 1 Sept. 1913, *L. E. Smith* 557; same locality, alt. 1675 m., 8 Sept. 1903, *E. B. Copeland* (distr. C. F. Baker 3862); railroad to Castle Lake, Siskiyou Co., 4 July 1913, *L. E. Smith.*

Typical *Rudbeckia californica* A. Gray, with the leaves green and rather evenly pubescent on both surfaces, especially beneath, with soft or rough hairs, and with dorsally pubescent phyllaries, is confined, so far as indicated by the material in the U. S. National Herbarium, to the Sierra Nevada of California from Tulare to Eldorado Counties. The form occurring on Mt. Eddy and in the Siskiyous appears very distinct in its usually glaucous and thicker leaves which are hispidulous on margin but glabrous on the surface, but in the absence of any observed distinctions in other characters, beyond a similar difference in the pubescence of the phyllaries, it does not seem to merit specific rank. In two sheets of the northern plant (*Hammond* 207 and *Lawrence* 2102) the leaves are sparsely strigose or hirsute on the costa beneath or on both sides and not obviously glaucous. All the specimens from Siskiyou County have somewhat thinner, coarsely dentate stem leaves; those of the other specimens cited, including the type, are thicker and entire or subentire.

**Wedelia ambigens** Blake, sp. nov.

Herbacea (?); caulis obtuse quadrangularis 4-sulcatus in angulis strigillosus; folia opposita ovata falcato-acuminata basi late rotundata triplinervia supra asperula subtus submolliter griseo-pubescentia crenato-serrata, petiolo tenui; capitula mediocria flava radiata pauca irregulariter cymosa; involucri ca. 7 mm. alti gradati phyllaria basi pallida indurata, apice herbaceo lanceolato acuminato squarroso subaequali; radii ca. 11, ca. 1.5 cm. longi; paleae rigide acuminatae; pappus coroniformis non stipitatus.

Sometimes subscandent; stem pithy, about 3 mm. thick; internodes usually 7–16 cm. long; petioles strigose or strigillose and somewhat hispid, 1–3.5 cm. long; blades 9.5–15 cm. long, 5–8.5 cm. wide, usually unequal at base, crenate-serrate (teeth small, acute, usually 1.5–4 mm. apart), thin, above deep green, antrorse-hispid with slightly tuberculate-based hairs and minutely tuberculate-hispidulous, beneath paler green or in youth griseous, rather densely hirsute-pilose with antrorse or spreading hairs (denser and longer along the veins) and sessile-glandular, triplinerved 5–10 mm. above base (sometimes with 2–3 pairs of weaker veins below) and loosely prominulous-reticulate beneath; cymes terminating stems and branches, irregular, 3–4-headed, the peduncles normally 1-flowered, 3–7.5 cm. long, densely strigose or erectish-pubescent, usually naked, slender; heads 2.5–3.5 cm. wide; disk about 6–8 mm. high, 1–1.2 cm. thick; involucre about 3-seriate, slightly graduate or subequal, the phyllaries lanceolate to lance-ovate, about 2 mm. wide, densely pubescent outside with subappressed hairs, the base indurated, 3–5-vittate, the squarrose herbaceous apex subequal or somewhat shorter; rays about 11, yellow, pistillate, the tube 1 mm. long, the lamina narrowly oblong, 2-dentate, sparsely hirsutulous at base and along nerves of back, 11–13-nerved, about 15 mm. long, 3–5 mm. wide; disk flowers numerous, their corrollas yellow, hispidulous above, about 6 mm. long (tube 1.5 mm., throat funnelform, 3 mm., teeth elongate-triangular, acuminate, 1.6-1.8 mm. long); receptacle flattish; pales of medium breadth, densely and minutely hispidulous on keel and above, ciliolate and sparsely hispid on margin above, firm, gradually narrowed into a stiff acuminate tip, about 5 mm. long; ray achenes plumply trigonous, minutely hispidulous at the subtruncate apex, 2 mm. long, 1.6 mm. wide, their pappus a thick denticulate crown about 0.3 mm. high; disk achenes plump, compressed, obovoid, broad-based, minutely hispidulous and obscurely biauriculate at the subtruncate apex, 2.3 mm. long, 1.8 mm. wide, their pappus a thick denticulate crown 0.3 mm. high; style branches tipped with subulate acuminate hispidulous appendages about 0.4 mm. long.

VENEZUELA: Hills, vicinity of Cristobal Colon, 5 Jan.–22 Feb. 1923, *W. E. Broadway* 149 (type no. 1,188,477, U. S. Nat. Herb.), 591; Chacaito Gorge, around Caracas, 24 April 1921, alt. 800–1000 m., *H. Pittier* 9487; forming thicket in damp shady places, descent from Valera to Motatan Bridge, on road to Carvajal, Dept. Trujillo, 21 Nov. 1922, *Pittier* 10754.

Like *W. penninervia,* to which it is not remotely related, this species has much the aspect of *Wulffia.* It is readily distinguished from *W. penninervia* by its triplinerved leaves and different stem pubescence. From *W. latifolia* DC., of Colombia, with which *W. heterophylla* and *W. symmetrica* Rusby are probably identical, it differs in stem, involucre, pales, pappus, and pubescence.

**Wedelia penninervia** Blake, sp. nov.

Herba (?); caulis quadrangularis 4-sulcatus dense breviterque patenti-hirsutus; folia opposita ovata majuscula acuminata base late rotundata crenato-serrata supra asperula subtus dense moliterque griseopilosa, petiolo nudo ca. 2.5 cm. longo; capitula mediocria apice caulis ca. 5–6 irregulariter cymosa pedunculata; involucri ca. 3-seriati paullum gradati ca. 7 mm. alti appressi phyllaria late ovata acuminata dense subappresse pubescentia subherbacea; radii ca. 14, 9 mm. longa; paleae rigide acuminatae; pappus coroniformis non stipitatus.

Stem ca. 3 mm. thick, obtusely 4-angled, usually deeply 4-sulcate, pithy, densely and rather harshly short-hirsute with spreading hairs about 0.7 mm. long, glabrescent below; internodes mostly 4–6 cm. long, sometimes greatly elongated; petioles pubescent like the stem, 1.5–2.8 cm. long; blades 10–17.5 cm. long, 4.5–7.5 cm. wide, falcate-acuminate, broadly rounded and usually slightly unequal at base, crenate-serrate nearly throughout (teeth acute, small, mostly 2–5 mm. apart), subchartaceous, above deep green, evenly antrorse-hirsute on surface, more densely so on veins, with minutely tuberculate-based hairs, beneath densely and uniformly pilose with antrorse or erect minutely tuberculate-based hairs, featherveined, the ca. 8–10 pairs of chief veins and the secondaries impressed above, prominulous-reticulate beneath; pedicels densely pubescent like the stem, at first only 1.5–3 cm. long, at length 3.5–6 cm.; heads hemispheric-campanulate, in anthesis 2.5 cm. wide; disk 8–9 mm. high, 1.5–1.8 cm. thick; phyllaries somewhat glabrescent below, 2.5–3.8 mm. wide, slightly indurate at base; rays about 14, yellow, pistillate, the tube obscurely puberulous, 1.5 mm. long, the lamina elliptic-oblong, unequally 2-dentate, puberulous on back and hirsutulous on the 2 chief nerves, 9–11-nerved, 9 mm. long, 3.5 mm. wide; disk flowers numerous, yellow, their corollas hispidulous above, 6 mm. long (tube 1.7 mm., throat cylindrid-funnelform, 3.1 mm., teeth triangular-ovate, 1.2 mm. long); pales hispidulous on keel, ciliolate above, gradually tapering into the stiff subulate erect tip, about 7 mm. long; ray achenes plumply trigonous, 2.5 mm. long, 2 mm. wide, puberulous on the subtruncate apex, auriculate on the 2 outer angles at apex, the pappus at first of 3 toothlike awns about 0.5 mm. long and a lacerate crown of connate squamellae about half as long, at maturity reduced to a denticulate crown about 0.3 mm. high; disk achenes plumply quadrangular, 3 mm. long, 2 mm. wide, puberulous on the truncate-rounded apex, their pappus a lacerate crown about 0.3 mm. high, about a third as broad as apex of achene; style branches tipped with a subulate acuminate appendage about 0.7 mm. long.

Colombia: Thicket in quebrada, Cordillera Oriental, east of Neiva, Dept. Huila, alt. 800–1000 m., 31 July 1917, *H. H. Rusby & F. W. Pennell* 410 (type in herb. N. Y. Bot. Gard.; photog. and fragm., U. S. Nat. Herb.); in quebrada, same locality and date, alt. 700–1500 m., *Rusby & Pennell* 513 (N. Y. Bot. Gard.).

A plant suggestive of some forms of *Wulffia* in appearance, and distinguished from related species of its region by its involucre and its penninerved leaves, which are densely and softly pubescent beneath. The smaller leaves are occasionally somewhat triplinerved through the enlargement of about the third pair of veins above the base. The type collection is described as a shrubby vine, the other collection as an herb. The plant is probably herbaceous or suffrutescent and occasionally leaning or subscandent.

**Wedelia trilobata** var. **pilosissima** Blake, var. nov.

Planta habitu, foliis trilobatis, pedunculis brevibus, etc., formae typicae *W. trilobatae* (L.) Hitchc. valde similis, differt caule densissime patenti-piloso pilis ca. 2 mm. longis.

Peru: Pebas, July 1929, *L. Williams* 1913 (type no. 1,444,044, U. S. Nat. Herb.); La Victoria, Aug.–Sept. 1929, *Williams* 2587; Caballo-Cocha, Aug. 1929, *Williams* 2313.

All the localities cited for this variety are on the Amazon River in the Department of Loreto.

**Wedelia brasiliensis** var. **villosa** (Baker) Blake.

*Wedelia paludosa* var. *villosa* Baker in Mart., Fl. Bras. **6**$^{3}$: 181. 1884.

A specimen without data collected in 1921 by the Mulford Biological Exploration of the Amazon Basin (no. 2172) agrees with Baker's description of this variety. I have elsewhere shown[7] that the name *Wedelia paludosa* DC. must be replaced by *W. brasiliensis* (Spreng.) Blake, based on *Acmella brasilensis* Spreng.

**Helianthus anomalus** Blake, sp. nov.

Herba, basi invisa; caulis albidus ramosus sparse breviterque tuberculato-hispida; folia alterna ovata v. lanceolato-ovate obtusa v. acuta basi cuneata integra 3-nervia crassa subcoriacea laete viridia tuberculato-hispidula, petiolo tenui longo; capitula 1–2 majuscula; involucri 2-seriati ca. 2 cm. alti gradati phyllaria lineari-lanceolata acuminata sparse tuberculato-hispida ad basim subciliata erecta discum superantia; radii flavi ca. 10 ca. 2 cm. longi; corollae disci tenues, dentibus purpureis; achenia disci appresse pilosa; pappus e aristis ca. 18 inaequalibus 1.2–4.5 mm. longis caducissimis compositus.

Plant 30 cm. high and more; stem stoutish, 4 mm. thick, leafy, rather sparsely short-hispid with white, tuberculate-based, upcurved conic hairs about 1 mm. long; internodes mostly 1.5–3 cm. long; petioles narrowly cuneate-margined at apex, 1.2–3.3 cm. long, pubescent like the stem; blades 4.5–8 cm. long, 1.2–3.2 cm. wide, cuneate or cuneate-rounded at base and then shortly and narrowly decurrent on apex of petiole, thick and rigid, evenly hispid or hispidulous on both surfaces with short conic tuberculate-based white hairs, those on the margin with extremely swollen bases; peduncles solitary at apex of stem and in the uppermost axils, 4–9 cm. long, slender, pubescent like the stem; heads about 5 cm. wide; disk hemispheric, about 1.5 cm. high. 1.5–2 cm. wide, smaller in reduced heads; involucre 1.7–2.7 cm. high, of about 16 linear-lanceolate acuminate herbaceous phyllaries, indurate at extreme base, 1-vittate, sparsely tuberculate-hispid and more or less definitely hispid-ciliate especially below, 1–2 mm. wide; rays yellow, 1.8–2.3 cm. long, 6–9 mm. wide, 11–13-nerved, emarginate; disk corollas stipitate-glandular and sparsely hispidulous on tube, finely hispidulous on base of throat and teeth, greenish white with purple teeth, 6.8–7.5 mm. long (tube 1.5–1.8 mm., throat cylindric-funnelform, 4.3–5.2 mm., teeth deltoid-ovate, 0.8 mm. long); pales scarious, hispidulous toward apex, usually 3-lobed, the lateral lobes merely small teeth, the median about 4 mm. long, acuminate, subulate-pointed, sometimes purplish-tinged at tip; ray achenes inane, their pappus much as in the disk; disk achenes oblong, plump, 4.5 mm. long, 1.8 mm. wide, mottled black and white, appressed-pilose with fulvous hairs; pappus of 2 slender hispidulous awns 4–4.5 mm. long and on each side between them about 6–8 similar unequal awns 1.2–3.5 mm. long, the whole caducous; style branches purplish, hispid dorsally, tipped with a linear-subulate obtusish hispidulous appendage about 0.8 mm. long.

UTAH: Desert south of Hawksville, Wayne Co., alt. 1370 m., 5 July 1930, *W. D. Stanton* 328 (type no. 1,487,743, U. S. Nat. Herb.; dupl. in herb. Brigham Young University, no. 4806).

A very interesting plant, amply distinct in characters of foliage and involucre, and remarkably set off from all other known species by its pappus, which carries to an extreme the tendency found in various other species to produce additional squamellae between the two constantly present marginal awns. Further specimens showing the base of the plant are much to be desired.

[7] Contr. U. S. Nat. Herb. **26**: 250. 1930.

**Enceliopsis covillei** (A. Nels.) Blake.

*Helianthella argophylla* Coville, Contr. U. S. Nat. Herb. **4**: 132. 1893, as to descr. only. (Not *H. argophylla* (D. C. Eaton) A. Gray.)
*Encelia grandiflora* Jones, Proc. Calif. Acad. II. **5**: 702. 1895. Not *E. grandiflora* (Benth.) Hemsl. 1881.
*Helianthella covillei* A. Nels., Bot. Gaz. **37**: 273. 1904.
*Enceliopsis grandiflora* A. Nels., Bot. Gaz. **47**: 433. 1909; Blake, Proc. Amer. Acad. **49**: 354. 1913.

**Oyedaea oxylepis** Blake, sp. nov.

Suffrutescens (?); Caulis strigosus; folia opposita elliptico-oblonga crenato-serrulata acuta basi cuneata penninervia supra aspera subtus hirsuto-pilosa ca. 8 cm. longa 3 cm. lata; capitula minuscula saepius solitaria terminalia breviter pedunculata; involucri 5–7 mm. alti subaequalis ca. 3-triseriati phyllaria ovato-lanceolata acuminata strigosa, apice herbaceo patente supra lepidoto-hispidulo.

Stem (above) slender, brownish, striatulate, subterete, densely strigose or erectish-hirsute with slightly tuberculate-based hairs and between them sordid-pilosulous; upper internodes 3–6 cm. long; petioles about 3 mm. long, pubescent like the stem; blades (4) 6–8.5 cm. long (1.5) 2–3.2 cm. wide, acute or acuminate, callous-tipped, above harshly pubescent with antrorse-curved hairs with persistent lepidote bases, antrorse-hirsute along costa, beneath evenly but not densely hirsute-pilose with spreading or antrorse-curved hairs and gland-dotted, crenate-serrulate above the entire cuneate base with about 5–9 pairs of apiculate depressed teeth (3–8 mm. apart). firm-herbaceous, the principal lateral veins about 6–12 pairs, with the minor veins prominulous-reticulate beneath; peduncles terminal in forks of stem and branches, 1(–2)-headed, naked or 1-bracteate, 1–2.5 cm. long, pubescent like the stem; heads 2 cm. wide; disk (as pressed) 9–10 mm. high, 7–10 mm. thick; involucre slightly obgraduate or subequal, the 2 outer series of phyllaries lance-ovate, 2.5–3 mm. wide at base, strigose and strigillose, the somewhat longer herbaceous apex spreading at least in age, lepidote-hispidulous above, the innermost series with short bluntish subherbaceous tips; rays about 8, yellow, neutral, the tube 2.5 mm. long, sparsely hirsutulous, the lamina narrowly oblong, emarginate, with 4 principal nerves, 11 mm. long, 3 mm. wide; disk corollas not very numerous, yellow, essentially glabrous except on teeth, 6.5 mm. long (tube 2.3 mm., throat slender-funnelform, 3.5 mm., teeth ovate, 0.7 mm. long, sparsely hispidulous at apex, papillose on margin within); pales narrow, acute, densely hirsutulous at apex, about 6 mm. long; disk achenes (submature) oblong, compressed, blackish, 3 mm. long, sparsely strigose on the faces, densely hispidulous-ciliolate on margin, very narrowly winged on one margin, scarcely at all on other; pappus of 2 slender fragile hispidulous awns 2.5–3 mm. long and on each side between them about 4–6 short awns, connate at base, mostly about 1.1 mm. long, the lateral ones sometimes up to 1.5 mm. long.

PERU: "Weed" in forest, San Roque, Dept. San Martín, alt. 1350–1500 m., 7 Jan. 1930, *Llewelyn Williams* 6992 (type No. 629616, herb. Field. Mus.; dupl. No. 1,495,543, U. S. Nat. Herb.).

A member of a group of half a dozen closely related Andean species, of which the closest is probably the Bolivian *O. rusbyi* Blake. In the latter the heads are numerous and the phyllaries have much shorter and relatively broader bluntish herbaceous tips.

**Actinea helenioides** (Rydb.) Blake.

*Picradenia helenioides* Rydb., Bull. Torrey Club **28:** 21. 1901.
*Hymenoxys helenioides* Cockerell, Bull. Torrey Club **31:** 481. 1904.
*Dugaldia helenioides* A. Nels. in Coult. & Nels., New Man. Bot. Rocky Mts. 562. 1909.

This species has continued to be known only from the type collection made at Sangre de Cristo Creek, south-central Colorado, alt. 2400–2700 m., 2 July 1900, by P. A. Rydberg and F. K. Vreeland (no. 5495). A considerable extension of range is shown by a specimen in the U. S. Forest Service herbarium collected on ridge running east from Castle Valley Ridge, about 5 miles southeast of Clearcreek, in the Manti Forest, Carbon Co., Utah, alt. 2930 m., 25 August 1914, by W. R. Chapline, Jr. (no. 80). Through the courtesy of Dr. E. D. Merrill, I have been able to compare with this specimen two sheets of the type collection in the herbarium of the New York Botanical Garden. In the original specimens the rays are not fully developed. Those of Mr. Chapline's plant have the lamina 1.8–2 cm. long and 4–6 mm. wide.

**Dyssodia remota** Blake, sp. nov.

Fruticulus diffusus; caulis obscure hirtellus ramosus; folia opposita pinnatipartita ca. 2.5 cm. longa, segmentis 5 lineari-ellipticis utrinque acutis glanduloso-crenatis glabris subcoriaceis; capitula terminalia solitaria mediocria flava radiata breviter pedunculata; involucri primarii 1 cm. alti 2-seriati aequalis phyllaria oblonga obtusa ad apicem ciliolata libera glanduloso-notata, calyculo e. phyllariis ca. 5 parvis subulatis sistente praediti; pappi paleae ca. 15, quaque in aristas 2–4 dissecta.

"Half-trailing" undershrub, several-stemmed, about 30 cm. long; stems oppositely branched; branches slender, obscurely hirtellous somewhat in lines, leafy; internodes 0.4–3.5 cm. long; petioles narrowly margined, 3–6 mm. long, glabrous, bearing toward base 1–3 pairs of setaceous lobes 2.5 mm. long or less; blades ovate in outline, 1–3.3 cm. long, 1–1.8 cm. wide, divided to the narrowly winged rachis, the leaflets 3–5, the lateral 5–11 mm. long, 1–2.5 mm. wide, the terminal 0.8–2 5 cm. long, 2–4 mm. wide, all sessile but usually contracted at base, crenate with 2–4 pairs of very rounded teeth, a round yellowish gland in each notch; peduncles 1–1.5 cm. long, slender, glabrous; heads about 2–3 cm. wide; disk campanulate, 14 mm. high, 10 mm. thick; involucre double, the outer of about 5 narrowly subulate phyllaries 3–5.5 mm. long, ciliolate, sometimes with 1 or 2 linear-lanceolate lobes toward base, the inner of about 9 equal 2-seriate phyllaries, these oblong, obtuse (the outer 3 mm. wide, the inner 4.5 mm.), ciliolate above, otherwise glabrous, erose below, substramineous, with indurated and thickened extreme base, 1-ribbed, finely several-vittate, bearing usually a pair of subbasal linear oil glands and 1 or 2 shorter subterminal ones; receptacle flat; rays about 5, yellow, fertile, the tube 4 mm. long, puberulous, the lamina elliptic, entire or 2-denticulate, 7–9-nerved, 7.5 mm. long, 3 mm. wide; disk flowers about 38, their corollas yellow, cylindric-funnelform, puberulous near middle and on teeth, 7 mm. long (tube 2.8 mm., throat 2.8 mm., teeth triangular, 1.4 mm.

long); achenes of ray and disk similar, linear-cylindric, subterete or somewhat flattened, 4 mm. long, densely hirsutulous; pappus 6 mm. long, straw-color, 1-seriate, of about 15 paleae dissected nearly to base into 2–4 slender hispidulous bristles, the lateral bristles somewhat shorter than the inner; style branches with short deltoid obtusish subglabrous appendages.

PERU: Half-trailing on grassy canyon ledges or slopes, Llata, Dept. Huanuco, alt. 2135 m., 21 Aug. 1922, *Macbride & Featherstone* 2241 (type no. 518725, herb. Field Mus.; dupl. no. 1,186,055, U. S. Nat. Herb.).

Nearest *Dyssodia jelskii* Hieron., also of Peru, which is described as having cuneate-obovate merely dentate leaves and outer phyllaries (bracteoles) equalling the inner.

**Cirsium rhothophilum** Blake, nom. nov.

*Carduus maritima* (sic) Elmer, Bot. Gaz. **39**: 45. 1905.
*Cirsium maritimum* Petrak, Beiheft. Bot. Centralbl. **35**: Abt. **2**: 288. 1917. Not *Cirsium maritimum* Makino, Bot. Mag. Tokyo **24**: 249. 1910.

Petrak's reason for transferring Elmer's name to *Cirsium,* when at the same time he cited an earlier use of the name *Cirsium maritimum* by Makino for a new species described from Japan, is not obvious. At any rate, this very distinct species, known only from the type locality at Surf, Santa Barbara County, California, must receive a new name. The one here given (from *ῥόθος, the dash of waves*) refers to its habitat on sand dunes on the seacoast.

## BOTANY.—*The genus* Lozanella.[1] E. P. KILLIP and C. V. MORTON U. S. National Museum.

*Lozanella,* a genus of Ulmaceae of the tribe Celtidoideae, was established by Greenman in 1905 and to it was referred a single species, *L. trematoides,* proposed at the same time and based upon a Pringle collection from Hidalgo, Mexico. Three years previously, however, Donnell Smith had described from Costa Rican material a species in the genus *Trema, T. enantiophylla,* which clearly is identical with *Lozanella trematoides.*

In the course of studies of tropical American Urticaceae which the senior author has been making, several specimens have been observed in unidentified material referred to that family which, though evidently representing a single genus, did not belong to Urticaceae. Comparison of these specimens with type material of *Lozanella trematoides* and *Trema enantiophylla* deposited in the National Herbarium shows that they represent two species of *Lozanella,* one the species described by Donnell Smith and by Greenman, the other new.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 1, 1931.

Of special note is the fact that the additional collections of the original species were made at widely separated localities, in Guatemala, in Costa Rica, in the Santa Marta Mountains and the Eastern and Western Cordilleras of Colombia, and in northern Peru. The second species has a more limited distribution, ranging from southeastern Peru to central Bolivia.

The tribe Celtidoideae is distinguished by its drupaceous fruit and curved embryos. *Celtis* and a few related genera are at once distinguished by their broad, contorted cotyledons. The remaining genera of the tribe have uncontorted narrower cotyledons. They are: *Trema, Parasponia, Aphananthe, Gironniera,* and *Chaetacme.* The relationship of *Lozanella* to these genera, which other than *Trema* are all Old World, is far from clear. They all have alternate leaves and narrow recurved cotyledons, whereas *Lozanella* has opposite leaves and broad, scarcely curved cotyledons. The united stipules of *Lozanella* are found also in *Parasponia, Gironniera,* and *Chaetacme.*

TABLE 1. CHARACTERS OF CERTAIN CELTIDOIDEAE

| | Lozanella | Trema | Parasponia | Aphananthe | Gironniera | Chaetacme |
|---|---|---|---|---|---|---|
| Range | Mexico to Boliva | Throughout Old and New World Tropics | Malay Archipelago and Pacific Is. | Japan, Philippine Is., Australia | Eastern Asia and Pacific Is. | Africa |
| Cotyledons | Broad, scarcely curved, equal | Narrow, recurved, equal | Narrow, recurved | Narrow, recurved | Narrow, recurved | Narrow, recurved, unequal |
| Leaves | Opposite, serrate | Alternate, serrate | Alternate, serrate | Alternate, serrate | Alternate, entire or serrate | Alternate, entire |
| Stipules | United | Free | United | Free | United | United |
| Inflorescence | Dioecious | Frequently monoecious | Frequently monoecious | Dioecious | Dioecious | Dioecious |
| Aestivation | Imbricate or slightly valvate above | Valvate or slightly imbricate above | Imbricate | Valvate | Imbricate | Valvate |
| Endosperm | Fleshy | Fleshy | Fleshy | Thin or none | Fleshy or none | Practically none |
| Other characters | Branches all opposite | | ♀ flowers solitary | | ♀ flowers cymose or solitary | Spines present |

The opposite branches of *Lozanella* are characteristic. The various characters are summarized in Table 1.

KEY TO SPECIES OF LOZANELLA

Mature leaves densely pubescent beneath, the hairs yellowish; petioles and rachises densely pubescent; pistillate inflorescences simple or with short lateral branches, the flowers congested; perianth lobes much imbricate 1. **L. permollis.**

Mature leaves not densely pubescent beneath, the hairs whitish; petioles and rachises sparingly pubescent; pistillate inflorescences conspicuously branched, the flowers solitary or clustered; perianth lobes imbricate below, becoming somewhat induplicate-valvate above......2. **L. enantiophylla.**

**Lozanella permollis** Killip & Morton, sp. nov.

Arbor inermis dioica; caules pubescentes; folia opposita, elliptica, petiolata, apice acuminata, basi late obliqueque cuneata, serrata, basi integra, supra scabra, subtus molliter lanata, nervis reticulatis, stipulis caducis, intraaxillaribus, in ramis cicatrices circulares conspicuas reliquentibus; ♂ inflorescentia cymosa, ramosa, floribus aggregatis, pedicellis brevibus, bracteatis; perianthium 5-partitum, laciniis imbricatis, carinatis, obtusis, ciliatis; stamina 5, perianthii laciniis opposita, hypogyna, sub disco piloso inserta, aestivatione erecta; filamenta subulata, exserta; antherae dorso supra basim adfixae, introrsae; ♀ inflorescentia axillaris, ramis lateralibus nullis vel brevibus; rachis dense pubescens; flores sessiles; perianthii laciniae aequales, oblongae, sub fructu persistentes; staminodia nulla; drupa parva, monosperma, stylis marcescentibus coronata; ovulum unum, pendulum.

Dioecious tree about 8 meters high; branches of previous season terete, sparingly pubescent, leafless; branches of the season leafy, more pubescent, increasingly so toward the growing tip, the hairs dense, matted, ferruginous; stipules united around the stem, caducous, leaving conspicuous circular scars; petioles flattened, 1.5 to 4 cm. long, densely spreading yellow-pubescent; leaves opposite, elliptic, broadest at middle, the blades 9 by 4 cm. to 17.5 by 8.5 cm., acuminate at apex, broadly cuneate and oblique at base, conspicuously serrate (teeth curving toward apex), entire near base, above dark green, prominently scabrous, the hairs white, pustulate, beneath paler, densely pubescent, the hairs appressed, long, yellowish, confined to the veins and veinlets (young leaves velvety pubescent), conspicuously reticulate-venose beneath, 3-nerved from the base, the midnerve giving rise to about 3 pairs of secondary veins, the two outer nerves exteriorly to 7 or 8 secondary veins, the principal nerves impressed above; staminate inflorescences cymose, several in each leaf axil, divaricately branched, the flowers borne in small clusters, the peduncle about 1 cm. long, with dense pubescence similar to that of stem and petiole, the pedicel very short or subobsolete, bracteate; perianth 5-lobed, the lobes 3 mm. long, about 1.6 mm. wide, obtuse, scarious-margined, conspicuously carinate, free almost to base, prominently imbricate in bud, sparingly pubescent on both sides, long-ciliate; hypogynous disk present, densely long white-hairy; stamens borne on border of disk, 5, opposite perianth segments; filaments 3 mm. long at maturity, subulate, glabrous, exserted; anthers erect from the beginning, introrse, oval, 1.2 mm. long; rudimentary ovary present, small; pistillate inflorescences several in each leaf axil, not divaricately branched, the lateral branches none or very short, the peduncle about 1 cm. long, densely pubescent like the petioles, the flowers borne in sessile clusters along the pubescent axis; flowers sessile; perianth segments 5, equal, imbricate, oblong, 1 mm. long, about 0.7 mm. wide, obtuse, sparingly pubescent on both sides, ciliate, persistent and becoming fleshy in fruit, the base then rather stipitate; hypogynous disk present, fleshy, densely long white-hairy; staminodia none; fruit a drupe, about 1 mm. wide and long, compressed laterally, green, glabrous, the flesh thin; styles 2, conspicuously hairy, about 1 mm. long, persistent on the fruit; seed oval, compressed, yellow, the pericarp thin; ovule solitary, pendulous from the summit of ovary; embryo immature.

Type of staminate plant in the U. S. National Herbarium, no. 1,156,898, collected at Unduavi, South Yungas, Department of La Paz, Bolivia, November, 1900, altitude 3100 meters, by O. Buchtien (No. 2814). Additional material of this collection, U. S. N. H. No. 1,044,987.

Type of pistillate plant in the U. S. National Herbarium, no. 1,156,897, collected at same time and place by O. Buchtien (No. 2815). Additional material of this collection, U. S. N. H. No. 1,044,988.

Additional specimens examined: BOLIVIA: COCHABAMBA: Incachaca, Province of Sacaba, 2500 meters alt. *Steinbach* 5788 (F[2]), 5819 (F). PERU: CUZCO: Lucumayo Valley, *Cook & Gilbert* 1376 (N).

**Lozanella enantiophylla** (Donn. Smith) Killip & Morton.

*Trema enantiophylla* Donn. Smith, Bot. Gaz. **33:** 259. 1902.
*Lozanella trematoides* Greenm., Proc. Amer. Acad. **41:** 236. 1905.

Specimens examined: MEXICO: HIDALGO: Near Honey Station, *Pringle* 8983 (N, type collection of *L. trematoides*). Barranca below Trinidad Iron Works, 1,550 meters alt., *Pringle* 13607 (N). GUATEMALA: CHIMALTENANGO: Volcán Acatenango, 2500 meters alt., *Kellerman* 6611 (F). COSTA RICA: HERIDA: Cerros de Zurquí, northeast of San Isidro, 2,000–2,400 meters alt., *Standley & Valerio* 50357 (N). SAN JOSÉ: Río Pedregoso, near El Copey, 1800 meters alt., *Tonduz* (Donn. Smith 7517B, Inst. Nat. Costaric. 11734, N). CARTAGO: Estrella, *Cooper* 325 (Donn. Smith 5949, N, type). El Muñeco, Río Navarro, 1,400–1,500 meters alt., *Standley & Torres* 51108 (N). COLOMBIA: MAGDALENA: Santa Marta Mountains, *H. H. Smith* 1437 (N). SANTANDER: Las Vegas, 2,600 meters alt., *Killip & Smith* 16133 (N). CALDAS: Río San Rafael, below Cerro Tatamá, 2,600–2,800 meters alt., *Pennell* 10373 (N). PERU: LIBERTAD: Río Mishiolla Valley, Province of Pataz, 2,000 meters alt., *Weberbauer* 7049 (F, N).

Standley notes that this is a shrub or tree, 3 to 5 meters high; Weberbauer that it is a shrub 7 meters high. The plant observed in the Eastern Cordillera of Colombia by Mr. Smith and the senior author was a tree 5 to 6 meters high, with a rather slender trunk and a rounded crown.

[2] F, Field Museum of Natural History; N, U. S. National Herbarium.

NECROLOGY.—*Raoul Gautier.*[1] GEORGES PERRIER, Secretary of the International Association of Geodesy. (Communicated by WILLIAM BOWIE.)

The International Association of Geodesy wishes to express, by my voice, the feeling of gratitude of all geodesists towards Raoul Gautier, their promise to treasure his memory faithfully while striving to follow his example.

Grandnephew of Alfred Gautier, the founder and first Director of the new Observatory of Geneva, son of Emile Gautier, who was its Director from 1883 to 1891, Raoul Gautier continued the glorious tradition of his family. Even if his work was mainly astronomical, many branches of geophysics, for example meteorology, are indebted to him for notable contributions.

But it was in geodesy that he played a rôle of particular importance. It is now forty years since, upon the death of his father, he joined the Swiss Geodetic Commission, created in 1861, forty years during which his geodetic activities have not flagged for a single instant.

Accredited representative of Switzerland, after the death of Hirsch, to all of the general assemblies of the old International Geodetic Association—Copenhagen (1903), Budapest (1906), London (1909), Hamburg (1912)—he acquired an undisputed authority among all the geodesists who attended these great tribunals of our science. Many of them are now gone but the survivors gladly recall these reunions, stamped with the impress of his kindly cordiality, where the geodesists formed one great, united family and where Gautier's influence again and again asserted itself.

Then came the somber days of the War, involving the dissolution of the old Association. It was a cruel blow to Gautier, who was profoundly attached to it but, with a few friends belonging to countries which, like Switzerland, were not involved in the terrible conflict, with admirable clear sightedness, he saw his duty plainly: to strive to maintain the spark which would later serve to rekindle the extinguished torch of international geodetic work. From this idea was born the Reduced Geodetic Association, created by the Neutral Countries, of which he became President and which carried on as far as possible the work of the vanished Association and, in particular, insured the continuance of the observations and computations of the important International Latitude Service.

[1] Address delivered at the funeral services of Prof. RAOUL GAUTIER, vice-president of the International Association of Geodesy, at the Protestant Church of Cologny, near Geneva, April 22, 1931. Translated by ADRIENNE ERVIN. Received June 6, 1931. Prof. Gautier was a member of the Washington Academy of Sciences.

Moreover, after an international conference held by the Allies and Neutrals at Brussels in 1919, he made a reality of the lofty conception of new international scientific unions, branches of a supreme council, the International Research Council, and when Raoul Gautier went to Rome in 1922 to attend the first General Assembly of one of these unions, the International Union of Geodesy and Geophysics, he was unanimously elected Vice President of the Section (now called Association) of Geodesy, an office that he held until his death.

Since that time, I have had the honor of collaborating intimately with him, as is shown by an active correspondence with him, which I shall never hereafter read over without emotion and heaviness of heart. The part played by Gautier was most difficult; to us geodesists of the succeeding generation he stood as the one who continued the traditions of the old Association and as a bond between the past and the present.

I can say that, always and everywhere, he was inspired by love of his country and by the higher interests of science. If the old Section of Geodesy of the Union, transformed to-day by the change of too modest a title into the International Association of Geodesy, now stands as a powerful organization that includes 37 civilized countries, it is due in large part to the mollifying influence and eminent authority of Raoul Gautier.

Alas, most of our colleagues of the Association saw him for the last time, four years ago, at the General Assembly in Prague. Age and the prudence imposed on him by attacks of an illness which impeded his physical activity without in any way diminishing his mental activity were the reasons which, notwithstanding his sincere desire to attend the General Assembly at Stockholm last year, forbade his going there. We missed him greatly. His experience, his shrewd grasp on the realities, his poise, would have been very useful to us at a difficult period in the existence of our Association, the moment of the renewal of the Statutes. I recall with what interest he heard the account that I gave him of our work, as he judged with serene impartiality our discussions and our decisions.

In the address that we sent him when, on February 25, 1928, his colleagues and friends in Geneva organized a ceremony in his honor on the occasion of his retirement, we expressed the wish and the hope that, for many years to come, he might aid us by his eminent experience and his counsel. That hope has been denied, but the memory of his life so nobly lived will remain for us a very real inspiration.

My dear Vice President, I bid you farewell, in the name of our President, Mr. Bowie, of your colleagues, of our Executive Committee, and of the geodesists who were your friends and who, at this very moment, feel as a cruel shock the news of your death.

Farewell!

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## ANTHROPOLOGICAL SOCIETY

### 631ST MEETING

The 631st meeting of the Anthropological Society of Washington was held on Tuesday, March 17, 1931, at 4:45 P.M., in Room 42–43, National Museum, President JOHN M. COOPER, presiding.

*Program:* FRANK M. SETZLER: *The Mound-Builder cultures of the Upper Mississippi Valley* (illustrated).—A review of the archeological cultures in Ohio, Indiana, Kentucky, Illinois and Wisconsin follows.

In Ohio three important mound-building cultures have been established. *Hopewell,* the most spectacular, is characterized by extensive and complex earthworks in geometric forms covering from one to one hundred acres; by mounds varying in height from one foot to thirty feet, usually covering the remains of wooden structures; by burials, the majority of which are cremated, though a minority are extended type placed in prepared graves of earth and log structures. Artifacts with the burials are for the most part made of material foreign to Ohio—obsidian, copper, mica, tortoise shell, galena, grizzly bear teeth, and hematite. Platform pipes show a high degree of sculpture; terra cotta figurines depict the costumes of the people. The skulls are predominantly dolichocephalic and show no evidence of artificial cranial deformation.

The *Fort Ancient* culture is the most extensive of the Ohio group. The mounds are small, and numerous village sites have yielded the majority of artifacts. Most of the burials are in cemeteries. Artifacts are of bone and shell primarily, and of other indigenous materials. This is the only culture in Ohio in which European objects have been found, which leads Dr. Swanton to believe that one of the sites—Madisonville—was inhabited by the Monsopelia.

The *Adena* culture is now considered a group distinct from the Hopewell. The mounds are usually conical and occur singly and unaccompanied by earthworks. Burials are made throughout the mound, frequently an important central grave occurring below the base line. Materials from distant sources were extensively used, and copper was employed only for ornamental objects, such as bracelets, finger rings, and gorgets. Other artifacts were tubular pipes and projectile points of the unnotched stemmed type.

In Indiana in the southeastern part a systematic survey and mound excavation revealed cultures similar to the Fort Ancient and Adena of Ohio. A mound in the southwestern part of the state exhibited characteristics evident in Lower Mississippi groups. Early reports indicate the possibility of a culture related to Hopewell.

In Kentucky along the Ohio River are cultures closely allied to the Fort Ancient. In the mountainous region of eastern Kentucky the rock shelters and caves contain ash layers at the bottom of which is the most primitive culture of the Mississippi region yet found. Even though "hominy holes," charred corn and gourd shards indicate that agriculture was practiced, there is no evidence of pottery. On the surface, however, pottery, woven fabrics and well fashioned artifacts appear. This pottery closely resembles that of the historic Cherokee. The culture in the central part of the state is characterized by truncated and domiciliary mounds and stone boxlike graves, traits which belong to the Tennessee-Cumberland cultures to the south.

In Illinois there are five cultures. The Cahokia, near St. Louis, is a northern extension of a southern culture, probably Etowah. Along the Illinois River there are two cultures, one known as the *Bluffs*, the other new and unnamed, which is likely the oldest in the state, characterized by an extremely long-headed people. Bordering the Mississippi River from Iowa to the junction of the Spoon River with the Illinois, there is a highly developed Hopewell culture. In the northwest corner of the state is the southern extremity of the effigy culture, which centers in Wisconsin.

Wisconsin contains four distinct archeological groups. The most widespread is known as the *Lake Michigan* culture, of which the effigy mounds are a sub-group. We find clay pipes, stone altars, bone harpoons, needles, and scrapers. The pottery strikingly resembles that of the eastern woodland Algonquin tribes. A rather extensive village-dwelling culture known as Upper Mississippi consists of triangular arrow points, snub nosed scrapers, flat stone grinding mortars, Siouan type of stone pipe, bone and shell implements, burials in the flesh both extended and flexed. Historically known Winnebago sites have produced exclusively pottery similar to the Upper Mississippi ware.

A close variant of the Cahokia pottery has been found at Aztalan. This site is characterized by truncated mounds, ear spools of bone, stone and pottery, large chipped hoes, disc beads, shells, three-notched triangular arrowpoints and perforated shell implements. The pottery is painted and burnished; the vessels are of a great variety of shapes.

Along the Mississippi River in the southwestern part of the state a variant of the Ohio Hopewell is found, consisting of large conical burial mounds, burials made in rectangular bark lined pits covered with poles and bark slabs, beneath the floor of the mound. Artifacts consist of large chipped implements of obsidian and flint, pearl beads, copper beads, plates, ear spools, celt, and axes. Pipes are of the concave-based type. The pottery is surprisingly similar to that found in Ohio.

The greatest need at the present time is to show the relationship between the Upper and Lower Mississippi cultures, and more especially the tie-up between the prehistoric and historic Indian tribes. (*Author's abstract.*)

## 632ND MEETING

The 632nd meeting of the Anthropological Society was held at the National Museum April 21, 1931.

*Program:* W. M. WALKER, Bureau of American Ethnology: *Archeological reconnaissance in the Hawaiian Islands* (illustrated).—The island of Maui was chosen as representative of the culture prevailing in the Hawaiian Islands before the advent of the whites, and a survey of all existing ruins was made during a stay of nine months in 1928–29 under the provisions of a research Fellowship provided by the Bernice P. Bishop Museum of Honolulu.

Ancient evidences of Hawaiian culture are to be found only on the surface as there is little top soil covering the underlying lava formations on the sites of aboriginal occupation. There are indications of but one such occupation, although legendary accounts imply possibly two or more. Construction in stone made no use of cut or shaped blocks or mortar. Simple blocks and pieces of rough lava or water-worn stones were used where found to build the platforms and walled structures known as *heiau* and used as places of worship. Some 230 of these sites were found on Maui, exhibiting a great variety of size, shape, and plan,—no two being exactly alike. Orientation toward the sea was a more important consideration than toward the cardinal points, and the site chosen was generally on some headland with a commanding view of the shore; if down in a valley the heiau was walled to provide greater privacy for the sacred ceremonies. The largest site found measured 425 feet long, 340 feet wide, and had a terraced slope 50 feet high where it extended over the edge of the hill. This temple is attributed to a Maui chief of the 16th century, which is as far back as any of the ruins can be dated with any accuracy, although it is believed at least 500 years have elapsed since the last great traditional period of voyages took place from the southern Polynesian islands.

Besides the heiau, the villages contain house platforms on which the grass houses were built, platforms for other small buildings, animal pens, enclosures for canoes, terraces for the cultivation of taro, small patches for sweet potatoes, gourds, etc. At many places by the shore small platforms of rocks and coral known as *koa*, or fishermen's shrines were found. Four of the old grass houses in various conditions of decay are all that remain on the island. In the windy sections the houses had stone walls and only the roof was of thatch.

Other archeological features included paved stone foot trails crossing the wildest and rockiest parts of the lava flows, and attributed to the genius of a legendary hero; artificial fishponds formed by building barriers of rock across a narrow bay or cove; playgrounds, such as tracks prepared down grassy slopes for games of sled coasting, and bowling grounds for the game of *maika* played with stone discs; and battle sites such as impregnable rocky headlands and steep ridges, as well as battle fields in the sandhills, etc. Burials of important chiefs were made in inaccessible cliffs which are only discovered by chance as all knowledge of them is held in the greatest secrecy. Common people were buried in sandhills or in some deserted gulch, which is still the practice in many places.

A detailed account of the reconnaissance will be published by the Bishop Museum of Honolulu.

Frank H. H. Roberts, Jr., *Secretary*

# SCIENTIFIC NOTES AND NEWS

## The Joseph Henry Lectureship of the Philosophical Society of Washington

The Philosophical Society of Washington, through its General Committee, has decided to establish a lectureship in honor of its first President, Joseph Henry. Such action at this time is particularly appropriate, since 1931 is the centenary of the discovery of electromagnetic induction, a discovery which has brought honor not only to Henry, but also to Faraday. The purpose and scope of the Lectureship can best be shown by quoting the report of the special committee, which was adopted by the General Committee.

"(1) There is at present in the hands of the Treasurer a cash balance . . . ., and the committee is in agreement that . . . . a portion of it be spent . . . . in some way which will advance the cause of science and reflect credit on the Society.

(2) It is proposed that at suitable intervals of time a speaker be selected to address the Society on one of the broad aspects of some field of science, the speaker to review the recent developments or present status of a subject included in or related to the Physical Sciences.

(3) It is further proposed that the complete address be put in form for publication and submitted to the JOURNAL of the Washington Academy of Sciences.

(4) It is further proposed that the aforementioned address shall be called the Joseph Henry Lecture in memory of the first President of the Philosophical Society.

(5) It is further proposed that the first Joseph Henry Lecture be delivered before the Society in the fall of 1931, and that thereafter the lecture shall be delivered annually before the Society in the spring of the year, starting in the spring of 1932.

(6) It is further proposed that the expenses of the speaker incidental to a visit to Washington shall be borne by the Society and that in addition an Honorarium of one hundred dollars ($100) shall be presented to the lecturer at a suitable time during his visit.

(7) The complete arrangements for any one meeting are to be made by a special committee of three who are to be responsible for selecting the speaker and securing the manuscript in form for publication. No member of the committee should have been a member of the immediately preceding similar committee."

The General committee further provided that the special committee for a given year shall be appointed before October 15 of the preceding year. In accordance with this action, the following committees have been appointed:

| 1931 | 1932 |
|---|---|
| C. G. ABBOTT | L. J. BRIGGS, *Chairman* |
| L. H. ADAMS, *Chairman* | J. H. TAYLOR |
| R. E. GIBSON | F. E. WRIGHT |

A transcontinental excursion from New York or Washington to San Francisco by airplane and return by train is being arranged for geomorphologists who will attend the International Geological Congress in 1933. The leader of the excursion will be Dr. A. K. LOBECK of Columbia University.

TAISIA STADNICHENKO and PARKER D. TRASK have been appointed associate geologists in the Geological Survey and assigned to the fuel section of the geologic branch.

M. N. SHORT, associate geologist of the Geological Survey, has been appointed professor of optical mineralogy at the University of Arizona.

# Obituary

Edward Goodrich Acheson, of St. Petersburg, Fla., a member of the Academy, died in New York, July 6, 1931, after a brief illness. He was born at Washington, Pa., on March 9, 1856, and at an early age became interested in experimental work. He was employed in Edison's laboratory from 1880 to 1882 in the development of filaments for the electric lamp. About 1891 he discovered a new chemical compound, silicon carbide, now known commercially as Carborundum, and in 1906 he devised a method of making colloidal graphite from it. For these and other discoveries, he was awarded many medals and prizes. The degree of Doctor of Science was conferred on him in 1909 by the University of Pittsburg. He was the founder and first recipient of the Acheson Medal, which is awarded by the American Electrochemical Society for a distinguished contribution in electrothermics.

Frank Wigglesworth Clarke, a past president of the Academy and for 42 years (1883–1925) Chief Chemist of the U. S. Geological Survey, died at his home in Washington May 23, aged 84 years. He was born in Boston March 19, 1847, and graduated from Harvard in 1867. He was professor of chemistry at the University of Cincinnati from 1874 to 1883 and had also taught at Cornell and Howard universities. Prof. Clarke was recognized as an international authority on atomic weights and as one of America's leading chemists. He was the recipient of several honorary degrees from universities both in this country and abroad. Prof. Clarke was one of the first to compile fundamental physical and chemical constants, and for many years he was chairman of the international committee on atomic weights. His *Data of geochemistry*, published in five editions by the Geological Survey, is a standard reference work. He was a member of the National Academy of Sciences, the Philosophical Society of Washington, and of many other scientific organizations, and an honorary member of the Chemical Society of London, the Mineralogical Society of London, the Russian Mineralogical Society, and the Manchester Literary and Philosophical Society. In 1900 he was made Chevalier of the Légion d'Honneur. He was president of the American Chemical Society in 1901 and of the Cosmos Club during 1917. As an honorary curator of minerals in the National Museum he did much to bring the collections to their present excellence. It was largely through his effort that this Journal was founded in 1911.

William Jasper Spillman, agricultural economist of the Department of Agriculture, died in Washington July 11, 1931. He was born in Lawrence County, Mo., Oct. 23, 1863, and studied at the University of Missouri, from which he received the degrees of bachelor of science (1886), master of science (1889), and doctor of science (1910). He was professor of science at the Missouri State Normal School (1887–89), Vincennes University (1889–91), and Oregon State Normal School (1891-94), and professor of agriculture at Washington College (1894-1901). He became an agrostologist in the U. S. Department of Agriculture in 1902, and from 1905 to 1918 was agriculturist in charge of farm management investigations. Among Dr. Spillman's best-known publications are *Farm grasses of the United States*, *Farm science*, and *Balancing of the farm output*.

## 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.

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## CONTENTS

### Original Papers



### Proceedings



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# WASHINGTON ACADEMY OF SCIENCES



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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.

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JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 21 SEPTEMBER 19, 1931 No. 15

BOTANY.—*New plants mainly from western South America—III.*[1]

ELLSWORTH P. KILLIP, U. S. National Museum.

Ten new species of plants are described in the present paper, and four transfers of species are made. Most of the novelties are in *Valeriana*, a highly critical genus well represented in the mountains of Peru.

STENOPHYLLUS ARGENTINUS (Palla) Killip

*Bulbostylis argentina* Palla, Oesterr. Bot. Zeitschr. **57**: 258. 1907.

Specimens examined (U. S. National Herbarium): ARGENTINA: Cordoba, *Stuckert* (*Kneucker* Cyperaceae 195, type collection). Bajo de Aufama, Dept. Tafi, Prov. Tucumán, 1800 meters, *Venturi* 3512. Cerro del Campo, Dept. Burreyero, Prov. Tucumán, 2000 meters, *Venturi* 7729.

BOEHMERIA PALLIDA (Rusby) Killip

*Boehmeria diversifolia* Wedd. Ann. Sci. Nat. IV. Bot. **1**: 202. 1854. Not *Boehmeria diversifolia* Miq. (1851).

*Phenax pallida* Rusby, Mem. Torrey Club **4**: 259. 1895.

POUZOLZIA POEPPIANA (Wedd.) Killip

*Margarocarpus poeppigianus* Wedd. Ann. Sci. Nat. IV. Bot. **1**: 204. 1854.

*Margarocarpus asper* Wedd. Ann. Sci. Nat. IV. Bot. **1**: 204. 1854.

*Boehmeria discolor* Poepp.; Blume, Mus. Bot. Lugd. Bat. **2**: 206. 1856.

*Boehmeria aspera* Blume, Mus. Bot. Lugd. Bat. **2**: 206, footnote. 1856.

*Pouzolzia discolor* Wedd. Arch. Mus. Paris **9**: 408. *pl. 13, A. f. 18–24*. 1856–57.

*Pouzolzia aspera* Wedd. in DC. Prodr. 16[1]: 233. 1869. Not *Pouzolzia aspera* Wight (1853).

Recent collections from Peru show that the differences relied upon by Weddell to separate the two species treated in his final monograph as *P. discolor* and *P. aspera* are not constant, and that only a single species is represented.

[1] Published by permission of the Secretary of the Smithsonian Institution. For proceding parts, see this JOURNAL **16**: 565–573. 1926, and **19**: 191–195. 1929. Received June 1, 1931.

**Phthirusa triplinervis** Killip, sp. nov.

Parasitic shrub, glabrous throughout, the branches terete, very slender, rugulose; leaves elliptic-lanceolate, 5 to 9 cm. long, 2 to 3 cm. wide, attenuate-acuminate at apex, acute at base (petiole 8 to 10 mm. long), triplinerved, verrucose-lenticulose; inflorescence paniculate, the main rachis terete, up to 5.5 cm. long, very slender, the panicle 3- or 4-branched, the branches subangular, 2 to 3 cm. long, the flowers solitary, opposite, sessile; bracts triangular, about 1 mm. long, acute; bractlets similar but smaller; fruit ovoid, 6 to 7 mm. long, 4 to 5 mm. in diameter.

Type in the U. S. National Herbarium, No. 1,444,051, collected at Hetuchá, Río Orteguaza, Caquetá Territory, Colombia, July 24, 1926, by G. Woronow and S. Juzepczuk (no. 6231). Duplicate in the Botanical Garden of the U. S. S. R. Academy of Sciences.

As this material is in fruit only, it is difficult to indicate the species' precise relationship. The shape of the leaves is suggestive of *P. theloneura*, but in that species the leaves are 1-nerved and the flowers are in racemes. Of the known species of the genus I find none described as having triplinerved leaves.

**Passiflora pilosissima** Killip, sp. nov.

Herbaceous vine, "up to 10 meters in length, profusely ramified;" stem subquinquangular, striate, the younger portions densely pilose; stipules narrowly linear-falcate, 3 to 4 mm. long, 1 mm. wide at base, purplish, deciduous; petioles 5 to 15 mm. long, glandless, pilose, purplish; leaves ovate, 5 to 12 cm. long, 2 to 7 cm. wide, 3-lobed at apex (middle lobe triangular, acute or subacute, cuspidate or mucronulate, much larger than the lateral lobes which often are reduced to mere cusps), rounded at base, entire, 3-nerved, obscurely ocellate beneath, membranous, densely appressed-pilose on both surfaces; peduncles in pairs; bracts narrowly linear, subverticillate or one borne just below the two others, 5 to 6 mm. long, 0.5 mm. wide, dark purple; flowers (only in bud in type specimen) "greenish white;" sepals ovate-lanceolate, obtuse, fleshy; petals ovate, obtuse, thin-membranous; corona filaments in 2 series, the outer linear-lanceolate, tapering gradually from base to apex, half as long as sepals, the inner filiform, minute; operculum closely plicate, denticulate; limen annular, prominent; ovary globose, densely hirsute.

Type in the U. S. National Museum, No. 1,343,569, collected in dense damp forests between San Gregorio and Nariño, Department of Antioquía Colombia, altitude 1700 to 2100 meters, December, 1891, by F. C. Lehmann (No. 7630).

In the list[2] of Lehmann's Passifloraceae this collection is referred to *P. mollis*, but the nature of the indument shows at a glance that it is quite unlike typical forms of *P. mollis*. A specimen of this has recently been received by the U. S. National Museum from the Royal Botanic Gardens, Kew, and I have thus had an opportunity of making a careful comparison with specimens of *P. mollis* from the type locality along the Quindio Trail. Although the flowers of this specimen are in bud only, the outer corona filaments are sufficiently developed to show an important difference between it and *P. mollis*; these filaments are linear-lanceolate, tapering from the base to the

[2] Bot. Jahrb. Engler **18:** Beil. **46:** 5. 1894.

apex, while in *P. mollis* they are liguliform or slightly fusiform. The leaf lobes of *P. pilosissima* are much sharper than in *P. mollis,* more nearly approximating those of *P. cuspidifolia,* of the Eastern Cordillera of Colombia.

Here probably belongs a sterile plant from La Crumbre, Department El Valle, Colombia (*Killip* 11342). The leaves are proportionately narrower, but are clothed with the same characteristic pubescence.

**Passiflora loretensis** Killip, sp. nov.

Herbaceous vine, essentially glabrous throughout; stem terete, striate stipules semi-oblong, 13 to 18 mm. long, 6 to 7 mm. wide, oblique, obtuse and mucronulate at apex, the midnerve slightly eccentric; petioles 1.5 to 2 cm. long, bearing 2 pairs of subulate glands, one pair near apex, the other near middle, the glands 1.5 mm. long; leaves lanceolate, 10 to 12 cm. long, 5.5 to 6 cm. wide, acuminate at apex, cordulate and subpeltate at base, entire, 7-nerved, reticulate-veined (nerves and veins strongly elevated beneath), coriaceous, scantily pilosulous on nerves beneath, concolorous; peduncles 1.5 to 3.5 cm. long, articulate about 5 mm. from apex; bracts cordate-ovate, 2 to 2.5 cm. long, 1 to 1.5 cm. wide, acuminate or abruptly acute, mucronulate, membranous, light green, persistent; flowers about 5 cm. wide, pink (?); calyx tube broadly campanulate, about 6 mm. long, 10 to 15 mm. wide at throat; sepals oblong, 1.8 to 2 cm. long, 6 to 8 mm. wide, obtuse, cucullate toward apex, carinate, the keel terminating in an awn 4 to 5 mm. long; petals slightly shorter than sepals; corona filaments in 5 series, filiform, the 2 outer radiate, about 1.5 cm. long, pale pink, the inner compact, 4 mm. long, deep pink; operculum membranous, 5 mm. long, fimbriate to middle, deep pink; nectar ring a low ridge; limen tubular, 4 mm. long, closely surrounding base of gynophore, crenulate; ovary broadly ovoid; fruit globose, about 5 cm. in diameter, the exocarp coriaceous; seeds narrowly cuneate, 7 to 8 mm. long, 2 to 3 mm. wide, coarsely reticulate.

Type in the U. S. National Herbarium, No. 1,470,093, collected at La Victoria, on the Amazon River, Department Loreto, Peru, in August or September, 1929, by L. Williams (No. 3086). Duplicate in Field Museum.

This is most closely related to *P. oerstedii,* and though the differences seem slight when stated in a key, these specimens of *P. loretensis* appear very unlike any material of *P. oerstedii* at hand. The leaves are much thicker and are green on both surfaces. The bracts are larger. The plant suggests also *P. amabilis,* which I know only from description and illustrations, but the shape of the petiolar glands and the coloring of the flowers are different, to mention only a few of the distinguishing characters.

**Clavija magdalenae** Killip, sp. nov.

Erect shrub, 2 to 3 meters high, the stem 8 to 20 mm. in diameter, castaneous, lepidote-punctate, sulcate, puberulous at end; petioles 2 to 5 cm. long, castaneous, puberulous, and subgeniculate at base, pale green and glabrous above; leaves ovate-elliptic or obovate, 15 to 30 cm. long, 8 to 12 cm. wide, acute or short-acuminate at apex, cuneate at base, decurrent on petiole, entire or remotely denticulate toward apex, conspicuously nerved and veined (midnerve stout, the principal lateral nerves 12 to 15 to a side, the venation closely reticulate), coriaceous, glabrous, drying yellowish green or pale green above, pale green beneath; staminate inflorescence loosely racemose, 12 to 15 cm. long, the rachis glabrous, the pedicels 2 to 3 mm. long, stout, clavate, recurved; flowers 5-merous; sepals united about halfway, suborbicular, 2 mm. wide, densely ciliate, orange-red, paler at margin; corolla orange-red, about 10 mm. wide, lobed about three-quarters of distance to base, the lobes ovate-spatulate, about 5 mm. wide, rounded, entire; staminodes 5, distinct, episepalous, 1 mm. long, flat; stamens united into a stout tube, barely 1 mm. long; pistillate inflorescence much reduced, the rachis (in fruit) up to 5 cm long; corolla orange-red, about 12 mm. wide, lobed nearly to base, minutely crenulate; stamens distinct, the filaments stout, 1 mm. long, the anthers sterile; ovary conical; fruit depressed-globose, 1.5 cm. long, 2 cm. in diameter, orange-yellow.

Type in the U. S. National Herbarium, Nos. 1,433,004 (staminate) and 1,433,005 (pistillate), collected at Piojó, near Barranquilla, Department Atlántico, Colombia, altitude 400 meters, January, 1929, by Brother Elias (No. 684). The description of the fruit is based upon a specimen collected at Estrella, Lands of Loba, Department Bolívar, Colombia, by H. M. Curran (No. 323). Local names for the plant are *huevo de morocoi* and *membrillo.*

On the basis of the flat staminodes this species comes nearest *C. tarapotana* in Mez' key. However, in shape and texture of the leaves the two are quite unlike.

### **Clavija reflexiflora** Killip, sp. nov.

Shrub or small tree, 1 to 3 (extremes up to 6) meters high, the trunk simple, erect, leafy only at summit, castaneous, finely rufo-tomentose, at length glabrous; leaves elliptic-oblong, 15 to 35 cm. long, 6 to 12 cm. wide, broadest just above the middle, acute or acuminate at apex, tapering to a petiole 4 to 7 cm. long (petiole castaneous, finely rufo-tomentose and geniculate at base, glabrous, sulcate above), entire, subcoriaceous, thicker at margin, glabrous, bright green when dry, lustrous, sparingly lepidote-punctate beneath, prominently nerved and veined, the midnerve coarse, the primary lateral nerves anastomosing 3 to 5 mm. from margin, the venation closely reticulate; inflorescence racemose, 7 to 8 cm. long, the rachis glabrous, the pedicels strongly reflexed, 3 to 4 mm. long, slender, glabrous; bracts triangular, 1 to 1.2 mm. long, minutely puberulous, persistent; flowers (only staminate seen) 4- or 5-merous; sepals united about halfway, ovate-orbicular, 1 to 1.2 mm. wide, rounded, glabrous, minutely ciliate, pale at margin; corolla coalescent nearly to middle, 6 to 8 mm. wide, orange-red or orange-yellow, the lobes obovate, 2 to 3 mm. long, 1.7 to 2 mm. wide, minutely crenulate; staminodes 5, distinct, episepalous, claviform, about 1 mm. in diameter, fleshy; staminal tube 1 mm. long, thick; fruit globose, 1.5 to 2 cm. in diameter, glabrous, orange-yellow or bright yellow.

Type in the U. S. National Herbarium, No. 1,462,724, collected in dense forest at San Antonio, on Río Itaya, Department Loreto, Peru, altitude about 110 meters, September 18, 1929, by E. P. Killip and A. C. Smith (No. 29345).

Additional specimens examined, all from the Department of Loreto, Peru: Mishuyacu, near Iquitos, *Klug* 219, 1320. Yurimaguas, *Killip & Smith* 27674 (in fruit). Between Yurimaguas and Balsapuerto, *Killip & Smith* 28112. Along Río Marañón between mouths of Río Pastaza and Río Huallaga, *Killip & Smith* 29191, 29203. Puerto Arturo, *Killip & Smith* 27916.

*Clavija reflexiflora* comes nearest *C. lancifolia* in the key in Mez' Monograph of Theophrastaceae, though the plant appears to be most closely related to *C. parviflora*. *Clavija lancifolia* has proportionately narrower leaves and smaller staminate flowers; *C. parviflora* has shorter petioles, erect pedicels, smaller flowers, and the staminodes are globose rather than claviform. The proposed species resembles also *C. poeppigii*, of which Mr. Smith and I collected several specimens in this general region, but the under surface of the leaves and the inflorescence of that plant are pilose, and the leaves are, on the average, much larger.

**Funastrum ovalifolium** (Rusby) Killip

*Philibertella ovalifolia* Rusby, Descr. S. Amer. Pl. 94. 1920.

Specimens examined: COLOMBIA: MAGDALENA: Mamateca, *H. H. Smith* 1683 (U. S. Nat. Herb., type coll.). About 9 kilometers south of Santa Marta, *Killip & Smith* 21105 (U. S. Nat. Herb.).

**Valeriana oligodonta** Killip, sp. nov.

Erect herb, about 30 cm. high, from a thickened root, essentially glabrous; basal leaves long-petioled (petioles 7 to 8 cm. long), simple, unlobed, ovate, 4.5 to 7 cm. long, 3 to 4 cm. wide, rounded at apex, abruptly narrowed, or tapering gradually to petiole, entire or undulate in upper half, irregularly crenate-dentate in lower, minutely ciliolate, obscurely flabellate-nerved, thin-membranous when dry; cauline leaves one pair, lanceolate, 2.5 to 4 cm. long, 1 to 1.5 cm. wide, tapering to an obtuse apex, subsessile, irregularly serrate or shallowly lobed toward base; flowers borne in dense globose heads about 1 cm. wide, their peduncles stout, those at the lower node about 2 cm. long, those at the upper node up to 1 cm. long or the heads subsessile; bracts linear, subentire, minutely ciliolate; bractlets linear-spatulate, 2 to 2.5 mm. long, rounded at apex; corolla tube funnel-shaped, 1.5 to 2 mm. long, the limb 4- or 5-lobed, 3 to 4 mm. wide.

Type in the herbarium of the Field Museum of Natural History, No. 580434, collected on the hills of the Saxaihuamán, Department Cuzco, Peru, altitude 3,500 to 3,600 meters, November 20, 1928, by F. L. Herrera (No. 2190).

This differs from *V. herrerae*, to which it seems to be most closely allied, in having a more compact inflorescence, the corolla being fully three times larger, with a deeper lobation. The leaves are much larger, and differently shaped.

**Valeriana maxima** Killip, sp. nov.

Coarse herb, 1.5 to 2.5 meters high, glabrous throughout except for a slight indument on the bracts; stem terete, up to 1 cm. thick, striate; basal leaves unlobed, ovate-elliptic, 8 to 10 cm. long, 3 to 4 cm. wide, acuminate, their petioles 7 to 10 cm. long; cauline leaves pinnatifid nearly to rachis (hence the rachis narrowly winged), up to 10 cm. long, sessile or the lower with stout petioles about 3 cm. long and connate at base, the lateral segments 1 to 3 pairs, oblong or ovate-oblong, 1 to 3.5 cm. long, 0.8 to 2 cm. wide, obtuse or subacute, entire or undulate, the terminal segment ovate, 7 to 10 cm. long, 3 to 3.5 cm. wide, acuminate; panicle diffuse, up to 75 cm. long, 25 cm. wide, the primary and secondary branches opposite, ultimately dichotomous; bracts triangular, 2 to 3 mm. long, pilosulous; bractlets linear, 1 to 1.5 mm. long;

corolla funnel-shaped, 1.5 to 2 mm. long, pure white; achenes lance-oblong, 2 mm. long, 3-nerved on one face, 1-nerved or other, pappose, the pappus tawny.

Type in the U. S. National Herbarium, Nos. 1,358,589–591, collected at Huacapistana, Department Junín, Peru, altitude 1,800 meters, June 5, 1929, by E. P. Killip and A. C. Smith (No. 24105).

This belongs to the group of *Valeriana* represented in Peru by *V. macbridei*, *V. bambusicaulis*, and *V. warburgii*. From these it differs in the cauline leaves being merely deeply pinnatifid, with a winged rachis, rather than pinnately compound. It resembles somewhat *V. dipsacoides*, also collected by Mr. Smith and myself (no. 24171) at Huacapistana, the type locality of the species, but in that plant the cauline leaves are unlobed.

### **Valeriana asplenifolia** Killip, sp. nov.

Cespitose herb, glabrous except at the nodes of the inflorescence, the rootstock elongate, thick, branched toward apex; leaves mainly basal, forming a rosette, linear-lanceolate in general outline, 5 to 15 cm. long (including a petiole about half their length), 0.5 to 1.5 cm. wide, pinnate, or pinnatifid toward apex, the leaflets 10 to 15 pairs, opposite or subopposite, ovate or lance-ovate, the lowermost up to 9 mm. long, 5 mm. wide, regularly crenate-serrate with 4 or 5 teeth to a side, obtuse, sessile and subdecurrent on rachis, the lower remote, the upper approximate and even imbricate; cauline leaves a single pair at base of inflorescence, much reduced, 5 to 7 mm. long, up to 2 mm. wide, pinnatifid at least toward base, sessile; stem up to 25 cm. high, the inflorescence racemose-paniculate, the flowers densely massed at the ends of short branchlets in subglobose heads up to 1 cm. wide; bractlets linear-oblong, 2.5 to 3 mm. long, 1 to 1.5 mm. wide, obtuse, dark green at center, pale at margin; corolla funnel-shaped, the tube 2.5 mm. long, 1.5 mm. wide at throat, white, the lobes linear, 1 mm. long, obtuse, greenish white; achenes narrowly lance-oblong, about 1 mm. long, dark brown, inconspicuously nerved, pappose, the pappus 10-rayed, brownish white.

Type in the U. S. National Herbarium, No. 1,357,123, collected in shade of rocks of puna on Mount La Juntay, near Huancayo, Department Junín, Peru, altitude 4,700 meters, April 27, 1929, by E. P. Killip and A. C. Smith (No. 22051).

From *V. thalictroides*, which it resembles in general appearance, this species is distinguished by the more prominent and more regular toothing of the leaves, much reduced cauline leaves, shorter bractlets, and narrower corolla lobes. The foliage greatly resembles the fronds of ferns in the group of *Asplenium lunulatum.*

### **Valeriana rufescens** Killip, sp. nov.

Cespitose herb, rufo-tomentellous nearly throughout, drying black; rootstock woody, 5 to 7 mm. thick, branched toward apex; leaves mainly basal, forming a rosette, narrowly lanceolate in general outline, 8 to 10 cm. long (including petiole 2 to 4 cm. long), 1.5 to 2 cm. wide, pinnate in lower half (leaflets oblong or oblong-spatulate, up to 1 cm. long, 0.5 cm. wide, obtuse, irregularly serrate with 2 or 3 serrations to a side, sessile), pinnatifid in upper half, the upper surface of the leaves densely rufo-tomentellous, the lower surface rufo-tomentellous on veins, otherwise glabrous; cauline leaves two pairs, pinnatifid, similar in texture and indument to the basal leaves, the lower pair short-petioled, the upper pair sessile; stem up to 20 cm. high; inflorescence racemose-paniculate, 7 to 8 cm. long, 2 to 2.5 cm. wide, the flowers borne in subglobose heads on short (up to 8 mm.) branches; bracts broadly spatulate, 3 to 4 mm. long, 2 to 2.5 mm. wide, truncate, obsoletely crenulate; achenes oblong, trigonous, about 1.5 mm. long, pappose, the pappus 8-rayed.

Type in the U. S. National Herbarium, No. 1,470,033, collected at Munna, Huallaga (Valley?), Peru, altitude 3,800 to 3,900 meters, by A. Weberbauer (No. 6786).

Like the preceding, this is related to *V. thalictroides*; from both of these it differs in being clothed nearly throughout with a dense reddish-brown indument. The leaves are not wholly pinnate, as in *V. thalictroides*, nor are the divisions regularly crenate-serrulate, as in *V. asplenifolia*.

**Valeriana agrimonifolia** Killip, sp. nov.

Slender herb, up to 65 cm. high, glabrous throughout, except fruit; stem reddish brown, terete; leaves all pinnate, the basal and lower ones 6 to 9 cm. long (including petiole about 1.5 cm.), the uppermost about 2.5 cm. long, the leaflets coarsely and regularly crenate-serrate, membranous, the lateral ovate, 7 to 15 mm. long, 5 to 7 mm. wide, sessile or subsessile, the terminal leaflet ovate or obovate, slightly larger, short-petiolulate; inflorescence racemose-paniculate, 40 to 45 cm. long, about 12 cm. wide (unusually regular for the genus), the primary and secondary branches opposite, the latter two or three times dichotomous, the flowers congested at the ends of the ultimate branches; bracts narrowly linear, about 4 mm. long; bractlets linear-spatulate, about 3 mm. long, green, purplish at tips; corolla tube narrowly funnel-shaped, 0.5 mm. long, cream-white, the lobes orbicular; achenes ovate, 1 to 1.5 mm. long, subfalcate, 3-nerved on one side, 1-nerved on other, pilosulous, pappose, the pappus 8-rayed, light green, purplish at base.

Type in the U. S. National Herbarium, No. 1,357,035, collected at Tarma, Department Junín, Peru, altitude 3,100 meters, April 22, 1929, by E. P. Killip and A. C. Smith (No. 21933).

This probably is nearest *V. warburgii*, but it differs in the size and toothing of the leaflets and the congested grouping of the flowers at the ends of the branches of the inflorescence.

HERPETOLOGY.—*A new lizard* (Anolis pinchoti) *from Old Providence Island.* DORIS M. COCHRAN, U. S. National Museum. (Communicated by C. WYTHE COOKE.)[1]

In 1929 the United States National Museum received from Mr. Gifford Pinchot an exceedingly valuable collection of natural history specimens collected on various tropical islands touched at by the Pinchot South Sea Expedition. Among the preserved material was a pair of lizards from Old Providence, an island in the Caribbean Sea belonging to Colombia, which represent a species new to science. I take pleasure in dedicating the new species to the donor.

**Anolis pinchoti** new species.

*Diagnosis.*—Tail subcylindrical; dorsal scales keeled, considerably larger than those on the flanks; gular and ventral scales keeled; digital expansion strongly developed; occipital scale larger than ear-opening, separated from supra-orbital semicircles by two or three rows of scales; the semicircles separated from each other by one or two scales; median snout scales smooth or very faintly rugose, those nearing the canthus with slight irregular keels; enlarged supraoculars faintly keeled; anterior half of superciliary ridge with two elongate scales, the first the longest; one or two series of somewhat irregularly enlarged scales paralleling the infralabials below, and separated from them by two rows of smaller scales; tibia measuring more than four-fifths the distance from end of snout to posterior border of ear-opening; the adpressed hind limb reaching beyond the eye.

*Description of the type.*—U. S. N. M., No. 76945, an adult male from Old Providence Island, Colombia, collected on April 23, 1929 by Dr. A. K. Fisher. Head one and three-fourths as long as broad, longer than the tibia; forehead slightly concave; frontal ridges nearly obsolete; upper head-scales medium in size, the inner ones practically smooth, those nearing the canthus faintly rugose; scales of supraorbital semicircles conspicuously enlarged, separated by two scales; supraocular disk composed of three large inner scales and four or five smaller outer scales, each with a single low keel, the inner ones separated from the supraorbital semicircles by one row of granular scales, the outer separated from the superciliaries by from one to three rows; occipital shield nearly round, larger than the ear-opening, separated from the semicircles by two or three rows of scales; canthus rostralis quite distinct, composed of five or six keeled scales, the anterior small, the fifth the longest, the sixth continuing backward in line with the two keeled superciliaries, the first of which is quite long; posterior half of the superciliary ridge granular; a series of enlarged, keeled suboculars, not reaching the lip, but in contact with several of the supralabials; about four rows of more or less rugose loreal scales; eight keeled lower labials to below center of eye; ear-opening moderate, vertically oval; dewlap moderate with a thickened edge of densely set, coarse scales, those on sides of appendage elongate, relatively large and set in regular rows; gular scales small, elongate, keeled; median dorsal scales keeled, somewhat smaller

[1] Received June 20, 1931. Published by permission of the Secretary of the Smithsonian Institution.

than the ventrals but distinctly larger than those on the flanks, the three median dorsal rows rather abruptly larger than the remaining dorsals, which are likewise keeled; no dorsal crest in evidence; a low nuchal crest; ventral scales moderate in size, imbricate, distinctly keeled like all the scales of the underside; scales on anterior surfaces of limbs somewhat larger than ventrals, keeled; tail sub-cylindrical, not verticilate, its lateral scales keeled, about the size of the ventrals, the median row above and the three or four median rows below being considerably enlarged and keeled; body compressed; adpressed hind limb reaching beyond the eye; a pair of greatly enlarged post-anals present.

*Dimensions.*—Snout to vent, 44 mm.; snout to posterior border of ear, 13 mm.; head width, 7.5 mm.; tibia, 11 mm.; fore leg, 20 mm.; hind leg, 36 mm.; tail reproduced.

*Color* (in alcohol).—Back and sides drab; limbs, snout, tail and under parts light russet brown; a few indistinct dark dots on the sides, and some dusky, ill-defined bands on the limbs and tail; a large sepia patch across the occiput; skin and scales of gular fan pale fawn color.

*Variation.*—In comparison with the type, the only paratype, a female, U. S. N. M. No. 76946, from the same place, has the scales on the snout slightly more rugose. The occipital plate is somewhat smaller and consequently the ear appears much larger. A dark median dorsal stripe bordered by two narrow light dorso-lateral stripes appears in the female, while the cross-banding of the limbs is more accentuated. In the scalation of the loreal and supraocular regions, the two specimens are practically identical. The female is 7 mm. shorter than the male. Both unfortunately have lost their original tails.

The new species is obviously related most closely to *Anolis stigmosus* from Taboga Island, Panama, as identified by Dunn.[2] The style of body and tail scalation is much alike in both species and the head plates are similar in arrangement. The most striking difference is in the snout, which is relatively much longer in *pinchoti* than in *stigmosus*. The former likewise has a shorter tibia and slightly larger head- and body-scales. The color pattern of the head supplies another difference, for the dark patch of *pinchoti* is placed relatively farther forward on the occiput and is broader and rather ill-defined in outline, while the small dark spot found in most specimens of *stigmosus* is very distinct and placed farther backward on the nape.

In April, 1884, the United States Fish Commission Steamer *Albatross* secured one *Anolis* on Old Providence. This specimen is now completely macerated, but it probably belonged to the species described above.

[2] E. R. Dunn. *Notes on Central American* Anolis. Proc. New England Zool. Club **12**: 17. Aug. 7, 1930.

ZOOLOGY.—Chondronema passali (*Leidy, 1852*) *n.g.* (*Nematoda*), *with notes on its life history.*[1] J. R. CHRISTIE and B. G. CHITWOOD, Bureau of Plant Industry. (Communicated by N. A. COBB.)

Joseph Leidy (1852) found, near Carlisle, Pa., large numbers of larval nemas inhabiting the body-cavity of adults of the very common and widespread beetle, *Passalus cornutus* (family Lucanidae). Leidy suspected that the adult of this nema occurs as a parasite of some other animal, the beetles acting only as secondary host. He endeavored to rear adult nemas by feeding infested beetles to frogs (*Rana pipiens*) but failed. Since Leidy's discovery, this parasite must have come to the attention of many entomologists; but his seems to be the only published record.

We have studied several hundred adult specimens of *Passalus cornutus* from Maryland, Delaware, Virginia, North Carolina, Illinois and Louisiana, and found nearly all of them infested. (Leidy reports 90 per cent). Of the relatively few grubs examined, one-fifth were infested. The nema was also found in the pupae, but too few were examined to determine the proportion infested. Most adult beetles harbor the parasites in large numbers (estimated at from 500 to 1000) and always in various stages of development, from very young to full grown individuals. Although the oldest larvae in the body-cavity are not sexually mature, they do not increase in size after leaving the host. Infested beetle grubs and pupae appear to harbor fewer parasites.

*Passalus cornutus* occurs in decaying wood, usually in galleries in partly decayed stumps and logs, and its eggs are evidently laid in these galleries, for here the young grubs develop and pupate.

We thought it very improbable that this nema, in its adult stage, is a parasite of any vertebrate, for even if a vertebrate were able to find and eat the beetles, or otherwise become infested, the possibility of the eggs or larvae of the parasite getting back into the galleries of the beetle and bringing about such a widespread pronounced infestation seems very remote. Furthermore the nema bears little resemblance to any known parasite of vertebrates. We therefore concluded that the entire life cycle probably takes place in or near the beetle galleries and that the adult nemas live free in the moist, decayed wood or frass; and, after many hours of tedious searching of such material, we finally discovered the adult nema.

[1] Received May 30, 1931. Published by permission of the Chief of the Bureau of Plant Industry.

This nema seems most closely related to *Allantonema*, *Bradynema*, *Howardula*, *Tylenchinema* and their relatives. The large, lateral pores on the tail remind one of similar structures possessed by certain parasites of earthworms, a matter which will be alluded to later. However, we do not deem it advisable to assign this species to any existing genus, and therefore propose the new genus *Chondronema* for it.

### **Chondronema** new genus

Head with four well marked papillae. Dorsal esophageal gland (intestinal gland or Schlunddrüse of some other authors) present. Amphidial openings lateral, slightly nearer mouth than papillae; amphidial glands large. Esophagus without bulb-like swelling. A pair (one right, one left) of large lateral pores (Phasmids?) on the tail. Male with slight bursa; two spicules, without gubernaculum. Testis reflexed. Vulva functionless unless used in copulation. Body of female degenerating into nearly structureless sack filled with developing embryos. Body-cavity parasites throughout larval development, but free-living throughout adult stage.

*Type species—Chondronema passali* (Leidy 1852).

*Sphaerularia* and *Atractonema* are at once differentiated by the presence of a prolapsed uterus. *Chondronema* is further differentiated from all other apparently related genera by the fact that the vulva, if it functions at all, serves only for the purpose of copulation, later becoming vestigial. It never serves for the extrusion of eggs or larvae. The larvae remain parasitic until full grown, and the adults remain free-living.

### **Chondronema passali** (Leidy, 1852)

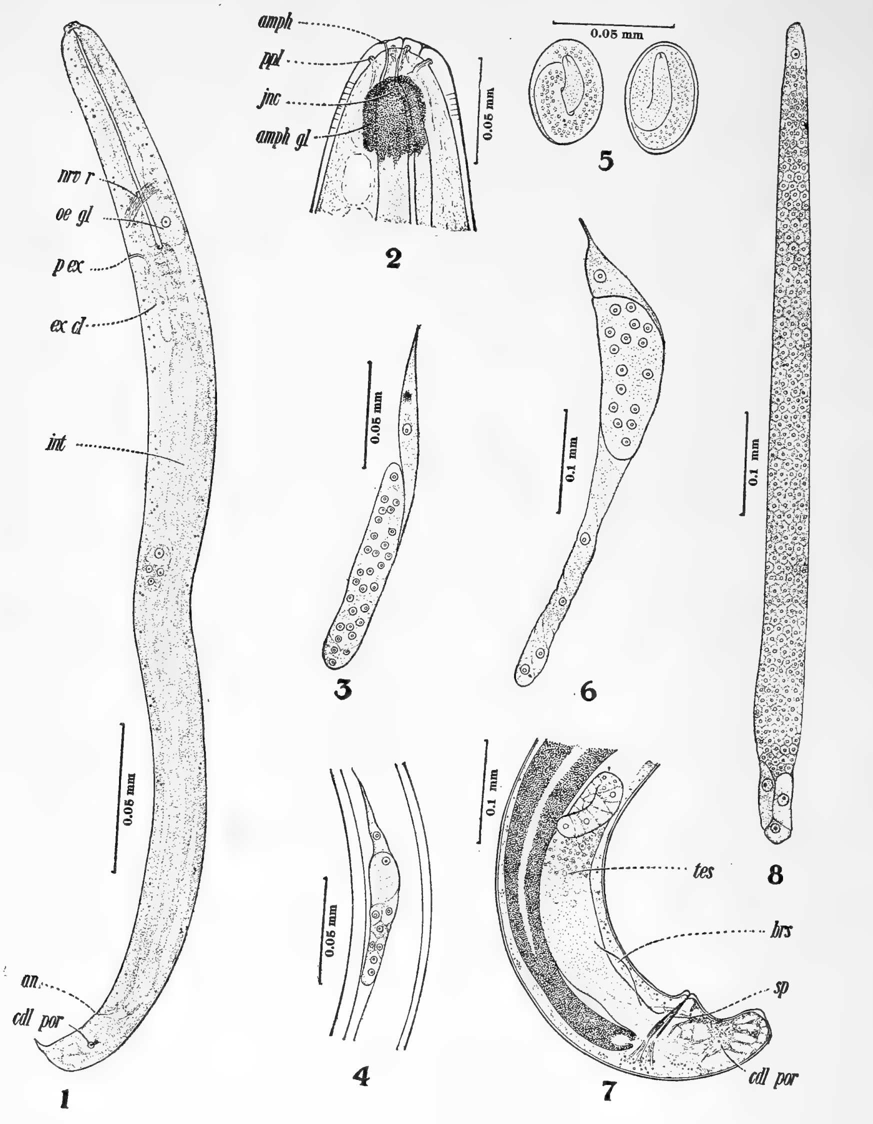
*Body-cavity larvae:* Head papillae in form of distinct elevations. Mouth minute, spear slender, $2\mu$ long, without basal swelling. Amphidial openings small, amphidial glands nearly filling body in head region. Lateral caudal pores large, conspicuous, with distinct ducts. Anus distinct. Tail with short caudal projection.

*Male:* Head papillae not in form of distinct elevations. Spear degenerate or lacking. Amphidial openings distinct, amphidial glands with brownish pigment. Excretory pore and renette cell obscure. Lateral caudal pores present. Spicules nearly straight, $50\mu$ long; bursa inconspicuous, in front of anus.

*Female:* Body retaining original shape but degenerating into nearly structureless sack, filled, first with ova, later with motile larvae. Traces of mouth and anus sometimes visible. Vulva becoming vestigial.

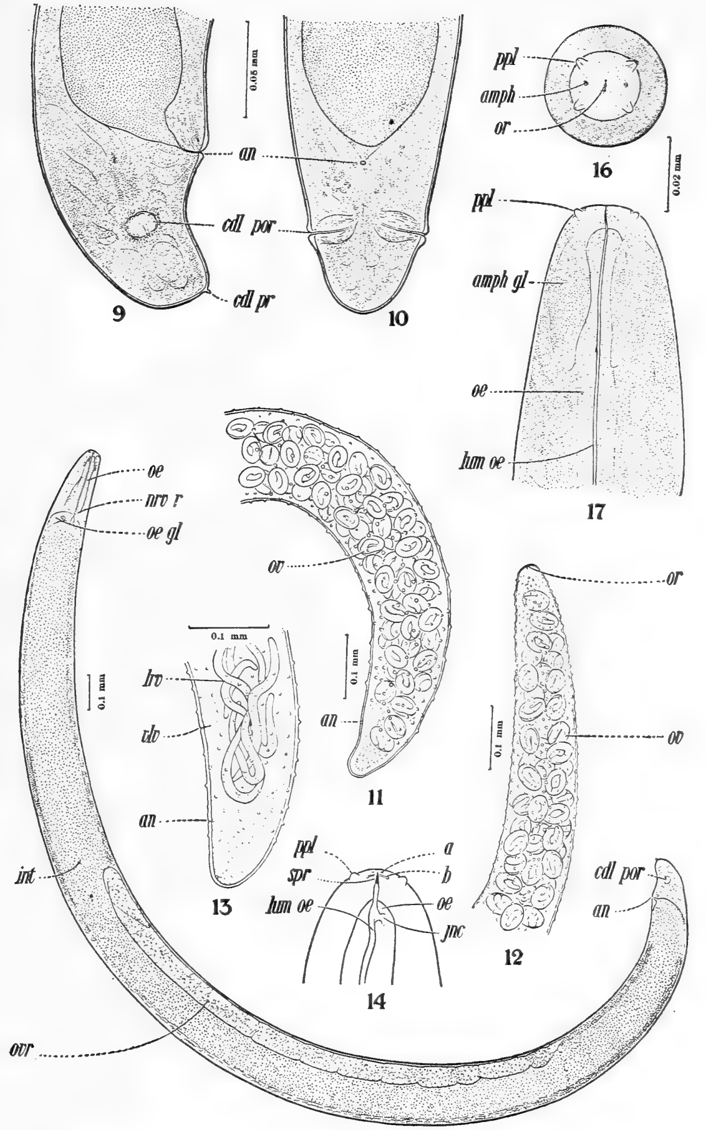
#### MORPHOLOGY

*Larvae from uterus of female.* These larvae have a length of 0.2 mm. and a body diameter of $12\mu$. The slender spear, $2\mu$ long appears to have two minute thickenings. The anterior end of the esophagus is faintly differentiated. The region of the body later to be occupied by the intestine is indicated by a somewhat coarser and darker granulation.




Figs. 1–8. 1, Youngest body-cavity larva, lateral view. 2, Head of adult male, lateral view. 3, Gonad of young female larva. 4, Gonad of larva .87 mm. long, probably a male. 5, Ova from body of mother nema. 6, Gonad from female larva 1.45 mm. long (somewhat older than in fig. 3). 7, Tail end of adult male, lateral view. 8, Gonad from male larva 3.2 mm. long.

*a*, dark spots in dorso-ventral plane opposite anterior end of spear; *amph*, amphids; *amph gl*, amphidial gland; *an*, anus; *b*, crescent-shaped element crossing spear in dorso-ventral plane; *brs*, bursa; *cdl pr*, caudal projection; *ex cl*, excretory or rennette cell; *int*, intestine; *jct*, junction of esophageal tube with duct from esophageal gland; *lrv*, larvae in body of mother nema; *lum oe*, lumen of esophagus, (esophageal tube); *nrv r*, nerve ring; *oe*, esophagus; *oe gl*, esophageal gland; *or*, mouth; *ov*, ova; *ovr*, ovary; *p ex*, excretory pore; *cdl por*, caudal pore; *ppl*, papillae; *sp*, spear; *tes*, testis.




Figs. 9–17. 9, Tail end of last stage body-cavity female larva, lateral view. 10, As in fig. 9, ventral view. 11, Posterior end adult female containing eggs, lateral view. 12, Same female as in fig. 11, anterior end, lateral view. 13, Posterior end adult female containing motile larvae, lateral view. 14, Head of male, body-cavity larva 1.1 mm. long, lateral view. 15, Last stage, body-cavity female larva, lateral view. 16, Last stage, body-cavity, female larva end view of head. 17, As in fig. 16, dorsal view of anterior end.

*Youngest body-cavity larvae.* $\dfrac{1.31 \quad 16.5 \quad 21. \quad \text{Juv.} \quad 91.}{2.9 \quad 5.3 \quad 5.8 \quad 5.3 \quad 3.7}$ 0.38 mm.

The minute mouth is located on a distinct elevation. The slender spear is about $2\mu$ long. About one third the distance from the point to the base of the spear, it is crossed by a darkened, crescent-shaped structure, lying in a dorso-ventral plane, with the convex side anteriad, and each arm ending in a slight enlargement. This structure (fig. 14), together with the spear, gives the appearance of a miniature anchor. The esophagus, whose contour can be faintly seen, is nearly cylindrical, and has a diameter of about 6 to $7\mu$; it is constricted at the nerve ring. On the dorsal side of the body, back of the nerve ring and between it and the anterior end of the intestine (fig. 1), is a large, finely granular, unicellular body with a large nucleus, the esophageal gland (intestinal gland of Goodey 1930, and Schlunddrüse of Wülker 1923). An esophageal lumen, 1 to $1.5\mu$ in diameter with a cuticularized wall, extends from the pharyngeal region to the intestine. The renette cell, $32\mu$ long by $6\mu$ in maximum diameter and possessing a nucleus, lies on the ventral side of the body with its anterior end opposite the excretory pore, at the base of the esophagus. The tail end has the form shown in fig. 1. On each side of the tail, about half way to the end is a relatively very large pore. These pores are similar to those found in last-stage larvae and will be described later. The genital primordium is located at about the middle of the body (fig. 1). The sexes at this stage of development were not distinguished.

*Last-stage body-cavity larvae.* $\dfrac{0.26 \quad 4.86 \quad 5.6 \quad \text{Juv.} ♀ \quad 2.3}{1.77 \quad 2.44 \quad 2.56 \quad 4.36 \quad 2.6}$ 3.9 mm.

$\dfrac{0.29 \quad 3.87 \quad 4.7 \quad \text{Juv.} ♂ \quad 2.05}{0.88 \quad 2.5 \quad 2.65 \quad 4.7 \quad 2.05}$ 3.3 mm. The males are easily distinguished, being considerably more transparent than the females. In addition there is a difference in the developing gonads. In both sexes the body is nearly cylindrical, tapering slightly and gradually at the extremities. The head is nearly truncate and the mouth is not elevated as in very young larvae. Crossing the spear in a dorso-ventral plane is the crescent-shaped element as described for the younger stage. Slightly in front of this crescent-shaped structure and also in a dorso-ventral plane may be seen two dark spots, one on either side of the spear (fig. 14). Around the mouth, on the outer-anterior margin of the head are four large papillae placed about equidistant from one another. The openings of the amphids are slightly nearer the mouth than the papillae and quite small. They are circular or possibly slightly ellipsoidal. Internally each amphidial tube leads to a large gland (fig. 17). The esophagus has an average diameter of from 15 to $20\mu$, and is nearly cylindrical. It appears to be non-muscular, is without bulb-like swellings, and is traversed throughout by a lumen with a diameter of from 1.5 to $2\mu$ and a heavily cuticularized wall. At the point where this esophageal tube enters the intestine there is a slight constriction followed by a small enlargement, a character observed in larvae of all ages (fig. 15). The dorsal, esophageal gland is usually somewhat flattened against the anterior end of the intestine. From this gland a duct leads forward on the dorsal side of the body and empties into the esophageal tube near the base of the pharynx. The junction of the duct with the esophageal tube is easily seen, but its course posteriad is more difficult to follow (fig. 14).

The well developed intestine is granular in appearance and possesses a lumen filled with a homogeneous and apparently more or less gelatinous substance. The anus is a distinct opening leading into a short rectum. It probably does not function in extruding fecal material. When specimens are placed under pressure a droplet of a semi-gelatinous substance is sometimes extruded through the anus. The tail (figure 9) is terminated by a small projection about 3 to 4$\mu$ long. Located on the sides, about half way from the anus to the tip of the tail, are the lateral, caudal pores, nearly a micron in diameter and surrounded by slightly protruding lips. A distinct duct leads inward, passing through a somewhat light-colored area 10 to 15$\mu$ in diameter (figs. 9 & 10). This does not appear to be a gland nor could any glands be definitely associated with these structures. One is reminded of similiar organs on the tail of *Dicelis filaria* (Dujardin and *Ungella secta* Cobb, both parasites of earthworms. In the case of the former species, as figured by Wülker (1926) the resemblance is especially marked.

Many of the body-cavity larvae are characterized by having the body divided into what appears, under low magnification, to be long segments. These pseudosegments vary in number and length and in many cases are restricted to the anterior half of the body. They are formed by the darker periphery of the intestine or the tissue underlying the body wall, extending inward and constricting the clearer, inner portion of the intestine. This condition seems to have disappeared in the oldest body-cavity larvae, nor is it always present in the younger stages.

*Development of the gonads.* In the youngest parasitic larva secured (fig. 1) the genital primordium was composed of a large, anterior, terminal cell and three slightly smaller posterior cells, each with a large nucleus. What is evidently an anterior cap cell (as described by Wülker, 1923, for *Allantonema mirable*) was present although the corresponding posterior cap cell was not observed. The sexes were not distinguished at this stage.

A slightly later stage of development is shown in figure 4, as found in a larva 0.87 mm. in length taken from a *P. cornutus* grub. It is composed of a large anterior terminal cell and a group of about 10 or 12 smaller posterior cells. A large, elongated cell occurs in front of what is designated above as the anterior terminal cell. It is also present in older stages of both sexes (figs. 3 and 6) and somewhat resembles a similiarly placed cell in the larva of *Tylenchinema oscinellae* which Goodey believes to be the primordium of what he calls the intestinal gland. In the present case, however, the esophageal gland is already formed.

In a larva 3.2 mm. long the male gonad has progressed to the stage shown in figure 8. It is composed of a large, anterior, terminal cell, a long, cylindrical mass of small polyhedral cells of more or less uniform size, and five large posterior terminal cells with large nuclei, the last mentioned presumably destined to form the vas deferens.

The gonad of the adult male (fig. 7) is markedly shorter than the developing gonad in a larva 3.2 mm. long. Wülker (1923) noted a similiar shortening of the testis of *Allantonema mirable.* He points out that as the maturing of the spermatozoa begins at the posterior end of the organ and progresses anteriad, the mature spermatozoa occupy less space than the cells from which they are formed, resulting in a shortening of the organ.

A fairly young stage of the female genital primordium is shown in figure 3. It consists of an anterior terminal cell, a large, multinucleated ovarian cell and about three to five posterior cells. A further development of the female genital primordium, from a specimen 1.45 mm. long, is shown in figure 6.

*Adult female.* All adult females obtained for study were filled, from one end to the other, with developing ova or, in older ones, motile larvae. The shape of the body remains about the same as that of the oldest body-cavity larvae. (See p. 360). Faint traces of the mouth and anus could sometimes be seen and in one case a rudimentary vulva 115$\mu$ in front of the anus. All other internal structures were obliterated. The body is covered with small cuticular bosses, irregularly placed and somewhat more numerous in the head region.

*Adult male.* 1st specimen $\dfrac{0.9 \quad 5.9 \quad 7.7 \quad {}^{15'}\mathrm{M} \quad 94.}{1.8 \quad 3.2 \quad 3.6 \quad 5.9 \quad 3.4}$ 2.0 mm.

2nd specimen $\dfrac{? \quad 7.5 \quad 9.4 \quad {}^{15'}\mathrm{M} \quad 95}{? \quad 4.5 \quad 4.9 \quad 5.7 \quad 3.6}$ 2.4 mm.

The mouth is small and without differentiated lips and the spear appears to be lacking. The amphidial glands, with brown pigment, cover the anterior end of the esophagus back for a distance of about 40$\mu$. The posterior part of the esophagus is twisted and the esophageal gland is apparently degenerating. For the shape of the tail see figure 7. The nearly straight, equal, rather slender spicules, 50$\mu$ long, taper slightly throughout to sharp points. The testis extends forward about 0.3 mm. and the blind end is reflexed for about 0.15 mm. The small thin, transparent bursa is entirely in front of the anus. Caudal pores are present in essentially the same form as in the parasitic larvae, although perhaps not quite so conspicuous. The caudal projection has disappeared and in its place there is a small, rounded and slightly elevated scar.

## LIFE HISTORY

The parasites enter the host as very young larvae. The method of entering is not known. It seems unlikely that such immature larvae, possessing a small and apparently ineffective spear, are able to penetrate the hard exoskeleton of adult beetles. That beetles are being continually infected is indicated by the fact that very young parasites are present regardless of the age of the beetles or the time of the year when they are collected. It seems to us more probable that the larval parasites are taken per os while the beetles are feeding. The exceedingly heavy infestations encountered suggests the possibility that the mother nemas with their entire progeny may be swallowed. The young larvae moult once while still in the body of the mother nema and another moult probably takes place soon after emergence from the host.

Experiments to discover the as yet unknown method of exit from the host by keeping beetles in confinement were inconclusive, but it was at least demonstrated that during the time of the experiments larvae were not escaping from the beetles in any considerable numbers. Whenever beetles were killed and placed in cultures of moist, decayed wood, all the body-cavity parasites died, which seems to render the possibility of the parasites being liberated through the death of the host as unlikely. The oldest of the body-cavity larvae were on many occasions removed from the beetles and placed in moist, decayed wood and various other types of cultures, but they always died, although in one instance such a larva was kept alive for ten days, at the end of which time the indication of an approaching moult seemed evident.

Wülker (1923) when studying *Allantonema mirable* found that the larvae entered the intestine of the beetle from the body cavity and were passed out with the feces. When larvae were taken directly from the body cavity of the host to cultures they often lived for a considerable period but did not develop to sexual maturity. He concluded that the sojourn in the intestine of the host is necessary in preparing the larvae for a free-living existance. Fuchs (1929), working with *Parasitylenchus contortus*, var. *typographi*, appears to have been more successful in rearing body-cavity larvae to maturity in cultures, and takes issue with Wülker on this point. Fuchs believes that failure was due to the fact that the larvae selected had not remained in the host long enough.

Wülker also points out that in the cases of *Allantonema, Bradynema* and *Parasitylenchus*, where the method of exit from the host has been studied, it takes place only at the time when the host insects are sexually active, i.e. egg-laying time. This is true for *Howardula benigna* Cobb, 1926 and apparently also for *Tylenchinema oscinellae*. Failure to secure free-living stages of *Chondronema passali* in cages where the beetles were confined may have been due to the fact that the beetles were not sexually active at the time.

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## PALEONTOLOGY.—Indianites, *new name for the Cambrian crustacean* Indiana *Ulrich and Bassler*.[1] E. O. Ulrich and R. S. Bassler.

Recently we published a work entitled *Cambrian bivalved crustacea of the Order Conchostraca*,[2] in which we endeavored to retain as many of the previously described genera and species of these interesting Cambrian fossils as possible by redescription and illustration. In emending the genus *Indiana* Matthew, 1902, we selected a new genotype in place of the one that had been cited because the latter, which was inadequately described and figured, was found after careful preparation and study to be a good species of *Bradoria*. The other species referred to *Indiana* by Matthew proved to belong to a well defined generic group, and so in order to preserve Matthew's name we selected one of these, *Indiana lippa*, as its genotype and also proposed the new family Indianidae with *Indiana* based upon this selected species as its type genus. Prof. T. D. A. Cockerell, whose keen interest in nomenclatural questions as well as other branches of biology is well known, has called our attention to the fact that in spite of our good intentions we are violating the rules of nomenclature and suggested that we correct this error. Therefore, we now propose the new name *Indianites* as a substitute for *Indiana* Ulrich and Bassler, 1931, and the new family Indianitidae in place of the one previously named Indianidae.

[1] Received July 22, 1931.

[2] Proc. U. S. Nat. Mus. vol. 78, no. 2847, art 4, pp. 1–130, pls. 1–10, 1931.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## GEOLOGICAL SOCIETY

### 474TH MEETING

The 474th meeting was held at the Cosmos Club, February 25, 1931, President MEINZER presiding.

*Informal communications:* W. P. WOODRING displayed by lantern slides two aeroplane views disclosing presumed earthquake cracks in the vicinity of the Elk Hills, San Joaquin Valley, California. The cracks, now nearly obliterated, are marked by trenches 1 to 2 feet deep and a few feet wide which cross drains and divides alike. They are presumably secondary earth cracks of the type described by Lawson as shatter cracks caused by the intense vibration.

Discussed by Messrs. HESS and GILLULY.

JOSIAH BRIDGE summarized recent studies of a fossil fauna from the Ellenburger limestone of central Texas, and correlated the faunal horizons with the stratigraphic sequence of the Ozark region and of Wisconsin. The studies show that the Ellenburger fauna includes species from both eastern and western sources.

*Program:* PHILIP B. KING: *Geology of the Marathon District, Texas.*—The Marathon uplift, lying immediately east of the Cordilleran ranges in western Texas, is a Cenozoic dome from which the Cretaceous cover has been stripped. The center of the dome reveals Paleozoic rocks that possess an Appalachian type of structure. Erosion of the Paleozoic rocks under arid conditions has etched out the weaker strata into broad flats and has left some layers of novaculite and other resistant beds standing out in sharp ridges as a skeleton of the ancient structure. The lowlands of Paleozoic strata are surrounded by escarpments in which limestones of Permian and Comanche age crop out.

The Paleozoic rocks total 22,000 feet in thickness, and are subdivided as follows:

| | | *Feet* |
|---|---|---|
| Permian series | Dolomite, limestone, shale, and much conglomerate, divided into six formations | 7,500 |
| Pennsylvanian series (Possibly including some Mississippian in lower part) | Gaptank formation (conglomerate, limestone, sandstone, and shale) | 1,800 |
| | Haymond formation (sandstone and shale, with a boulder bed in upper part) | 2,500 |
| | Dimple formation (limestone and shale) | 700 |
| | Tesnus formation (sandstone and shale) | 500–7,000 |
| Devonian (?) system | Caballos novaculite (including bedded chert) | 400 |
| Ordovician system | Maravillas chert | 300 |
| | Woods Hollow shale | 500 |
| | Fort Pena formation (limestone, chert, and conglomerate) | 150 |
| | Alsate shale | 50 |
| | Marathon limestone | 800 |
| Cambrian system | Dagger Flat sandstone | exposed, 250 |

During the Paleozoic era the Marathon region was subject to intermittent crustal unrest and—as in the post-Paleozoic Coast Ranges of California—deposition and uplift went on simultaneously in adjacent areas, peculiar conglomerates which indicate a complex tectonic history were deposited, and a relatively great thickness of siliceous rocks was deposited. Later orogeny was prepared for as early as Cambrian and Ordovician time by the formation of a geosyncline in the Marathon region. The first great uplift in the area, approximately correlative to the Taconic movements farther east, occurred between Middle and Upper Ordovician time, when boulder beds containing rocks as old as Cambrian were formed. The lower part of the Carboniferous system consists of a monotonous alternation of sandstone and shale and resembles the Flysch of the Alps and Carpathians. In the upper part of this "Flysch series" is a boulder bed that contains great exotic blocks and masses of fault breccia, which bear witness to the first strong diastrophism. The exotic blocks are probably contemporaneous with a system of folded overthrusts exposed in the southeastern part of the district. The succeeding Gaptank formation consists of marine shales and limestones, interbedded with conglomerates which indicate another epoch of folding. These beds are similar to the Alpine Molasse. The Gaptank formation is itself deformed, and in the northwest part of the district is cut by a flat overthrust fault, not folded, on which there has been a displacement of more than 5 miles. The faulted Gaptank formation is overlain unconformably by Permian marine strata. These Permian rocks were laid down after the climax of the orogenic epoch, yet were deformed slightly at least three times before the Cretaceous period. When the Cretaceous seas advanced, the region had been worn down to a peneplain, indicating a period of crustal quiesence in early Mesozoic time. (*Author's abstract*).

Discussed by Messrs. MISER, HESS, and G. R. MANSFIELD.

W. W. RUBEY: *The Illinois River, a problem in channel equilibrium.*—Throughout its lower 250 miles the Illinois River exhibits many abnormal characteristics and its regimen differs greatly from that of nearby portions of the Mississippi and Missouri rivers. The slope or gradient is less than 2 inches to the mile,—somewhat less than the slope of the Mississippi from Memphis, Tenn., to the Gulf. This flat slope is not the result of a meandering round-about stream course. In fact, the Illinois follows a more direct route than the other streams of the region and the thalweg, or line of deepest water, has the almost unique characteristic of flowing close against the inside, not the outside, of the few curves. The flat slope probably explains the sluggish current and the fineness of the silt that is carried. The Illinois is also a much narrower and somewhat deeper stream than the Mississippi or Missouri, but the most surprising characteristic of the river is the stability of the present channel. Despite the great range between flood and low-water volumes, the Illinois does not shift its course perceptibly. Undercut banks are uncommon, there are very few abandoned meanders on the flood plain, and the remarkable similarity between early maps and channel measurements and those made recently all show that the channel is essentially adjusted or graded to present conditions.

These peculiar features have not been caused by recent artificial modifications of the river for they were all noted by the earliest travellers in the region. Nor are these peculiarities due simply to an inheritance by the present stream of a channel built by some ancient river. The Illinois has had a long and complex geologic history but the present river flows entirely within a wide flood plain made of its own deposits and distinctly younger than the Late Wisconsin terrace. However, it is significant that the bed-rock floor beneath the alluvial deposits, although more than 100 feet below the flood plain and so beyond the reach of present-day scouring, appears from scattered borings to have the same flat gradient as the present river.

The essential equilibrium between the present channel of the river and the conditions of load, size of grain, volume, etc., cannot be explained solely in terms of the familiar concept of graded stream slopes. The concept of adjusted channel cross sections, as pointed out by G. K. Gilbert and by canal engineers, is also essential. Alluvial streams tend to establish channels that are neither too deep nor too shallow. Semicircular cross sections oppose the least possible rubbing surface per unit area and hence give the maximum efficiency of channel; but natural streams, flowing in crooked channels between erodible banks, are unable to maintain so narrow a cross section. The adjusted cross sections actually established are the deepest ones that the streams are able to maintain.

Combining the two concepts, adjusted cross sections and graded slopes, the general conditions of dynamic stream equilibrium may be stated somewhat as follows: An underloaded stream tends to erode and an overloaded stream to deposit, either at the sides or the bottom of the channel. Erosion increases and deposition decreases the load. Erosion on the bottom lowers the slope and so decreases the velocity whereas deposition on the bottom has the opposite effect. Erosion at the sides widens the cross section and so reduces the efficiency of the channel whereas deposition at the sides has the opposite effect. Erosion, whether at the sides or on the bottom, increases the load and decreases the velocity, and deposition in either place decreases the load and increases the velocity. These changes continue until an approximate balance is struck between load and capacity.

The conditions of dynamic equilibrium may be summarized in an approximate but convenient equation:—$S_G^a \, X_A \propto \frac{L^b D^c}{Q^d}$ where $S_G$ = graded slope, $X_A = \frac{\text{depth}}{\text{width}}$ = adjusted cross section or proportionate depth, L = quantity of load transported, D = mean diameter of sediment transported, Q = discharge or volume of water, and $a$, $b$, $c$, and $d$ are exponential constants. This approximate equation rests not only upon theoretical analysis but it can be derived from Gilbert's general empirical formula of the transportation of débris by running water and it is supported by many other empirical relationships.

The concept of adjusted cross sections seems to afford a basis for the rational interpretation of the peculiar regimen of the Illinois River. If slope and proportionate depth are adjusted to load jointly and not separately, then an over-steepened slope may be compensated by a relatively wide cross section and an over-flattened slope by a relatively narrow cross section. Perhaps the Platte River in Nebraska is an example of the first type and the Illinois River of the second. By this interpretation the flat bed-rock floor was cut by some much larger Pleistocene river and subsequent aggradation in the Mississippi River has caused the present Illinois to build up a flood plain roughly parallel to this inherited bed-rock floor. In so doing, essential equilibrium has been maintained, despite the extreme flatness, by the greater proportionate depth of the present stream (*Author's abstract.*)

Discussed by Messrs. MENDENHALL, MEINZER, and ALDEN.

N. H. HECK, U. S. Coast and Geodetic Survey: *Some recent developments in the field of seismology.*—A broad view of the recent progress in seismological investigation was given. The annual earthquake activity of the United States and all the principal activity from the earliest times were shown by slides, and the new seismological stations and their relation to the various earthquake regions were demonstrated. New stations equipped with modern instruments are now being established at many places. Three types of instruments developed in the United States were described and their purposes discussed. These are the Wood-Anderson torsion seismometer, chiefly for near earthquakes; the Wenner seismometer, using galvanometric registration for precise recording of all distant earthquakes, and the McComb-Romberg tilt-compensation seismometer, which is particularly suited to the earthquake at a moderate distance and which by means of an oil coupling eliminates the effect of tilt on the records.

The special triangulation and leveling work in California was briefly described and also the determination of tilt in regions subject to strong earthquakes which has been the subject of an investigation in Japan with promising results in connection with the possible prediction of the approximate time of severe earthquakes. The coöperative nature of the work and the duty of the geologists to make use of the precise data obtained was stressed. (*Author's abstract.*)

Discussed by Mr. LOUGHLIN.

### 475TH MEETING

The 475th meeting was held at the Cosmos Club, March 11, 1931, President MEINZER presiding.

*Informal communications:* F. L. HESS exhibited a radiograph showing the relative radioactivity of minerals in a specimen from Haliburton, Ontario. A certain purple fluorite was found to be most radioactive, uraninite less active, and apatite least active. Mr. Hess also discussed the paragenesis of the radioactive minerals, which partly replace the calcite filling of vugs in a pegmatite. The radiograph was made by covering a sensitive plate with colorless celluloid about 0.01 inch thick, placing thereon a polished section of the radioactive material, and leaving the section in contact for 24 hours.

G. R. MANSFIELD summarized the history of test drilling in search of potassium salts in the Permian basin of New Mexico and Texas. In the past five years at least 45 test holes have been put down by core drills; 20 holes have been drilled by the U. S. Geological Survey and the U. S. Bureau of Mines in coöperation, and 25 or more by commercial enterprise. One of the commercial organizations, the United States Potash Co., has sunk a shaft more than 1,000 feet deep, has drifted along beds of potassium salts, and has advertised its readiness to deliver ore containing 15 or 20 per cent $K_2O$ on February 15. The principal potassium minerals disclosed by this shaft are sylvite ($KCl$) and carnallite ($KCl$, $MgCl_2$, $6H_2O$). Other minerals discovered by the core drill are polyhalite ($2CaSO_4$, $MgSO_4$, $K_2SO_4$, $2H_2O$) and langbeinite ($K_2SO_4$, $2MgSO_4$), both of which promise to become commercial sources of potassium in the United States. Specimens of these minerals were exhibited.

Discussed by Mr. PARKER.

L. W. STEPHENSON showed by lantern slides a small duplex overturned fold in a limestone bed in the lower part of the Eagle Ford shale in Uvalde County, Texas. The folded portion of the limestone member was 2 inches thick; its maximum thickness elsewhere was 5 inches. The original length of the folded portion was 12½ feet; its shortened length was 4½ feet. The folded limestone is enclosed in shale that is underlain by undisturbed Buda limestone.

Discussed by Messrs. ATWOOD, GOLDMAN, RUBEY, and BRADLEY.

*Program:* C. E. VAN ORSTRAND: *Results of some recent geothermal surveys in the United States.*

Discussed by Messrs. R. C. WELLS, MEINZER, and RUBEY.

C. E. TILLEY, Cambridge University: *Structure and metamorphism of the southern Highlands of Scotland.*

## 476TH MEETING

The 476th meeting was held at the Cosmos Club, March 25, 1931, President MEINZER presiding.

*Informal communications:* E. T. MCKNIGHT exhibited a specimen of ore from the Governor Eagle mine, 10 miles northwest of Yellville, Arkansas, that contained enargite as an accessory ore mineral. This is the first discovery of enargite in any of the Mississippi Valley ore deposits.

Discussed by Mr. LOUGHLIN.

C. E. RESSER showed an undescribed crustacean discovered by an amateur collector in the Middle Cambrian of the House Range, near Delaware, Utah. The crustacean is a primitive form ancestral to the eurypterids and not a trilobite.

*Program:* C. P. ROSS: *The physiography of south-central Idaho.*—Most of south-central Idaho was exposed to subaerial erosion from the close of the Paleozoic to the Oligocene or later. By the beginning of the Tertiary a peneplain had been formed, but this was uplifted and youthfully dissected prior to being covered by the Challis volcanics. The summit peneplain or partial peneplain generally recognized in the present topography is in part cut across the Challis volcanics (Oligocene or Miocene). Part of the confusion as to the dating of this peneplain is removed by the discovery that the so-called "lake beds" are integral parts of the Challis volcanics and not restricted, as had been supposed, to certain valleys.

The remnants of the summit peneplain in the northwestern part of south-central Idaho are more extensive and flatter than farther east, where the original topography was more rugged. They correlate with similar summit areas in the Clearwater Mountains regarded by several geologists as older than the Columbia River basalt of that district.

Subsequent to the post-Challis peneplanation, the drainage pattern has been complicated by superposition and differential tilting with consequent piracy. The main tilting was toward the northwest. The Salmon River is made up of parts of several pre-existing streams. It is impossible from present data to reconstruct the drainage pattern existing at any particular time in the Tertiary, partly because of the uncertainty as to the origin of the elongate ranges and their bordering valleys in the southeast part of the region. So far as present data go these may quite as well be products of erosion guided by ancient structures as the products of block faulting of the Basin Range type as some have regarded them.

The numerous basins, which are mainly on the headwaters of the larger streams, are regarded as the products of an incomplete erosion cycle. There seems no reason to regard most of them as results of faulting, as has been postulated.

Erosion in northern Idaho since the eruption of the "Columbia River basalt" (which there is regarded as Upper Miocene) has been interpreted as mainly confined to valley cutting with little lateral planation. This difference with the history of neighboring regions may result from retardation of erosion through subsidence related to the basaltic eruptions.

In south-central Idaho there was glaciation in Nebraskan (?) and Wisconsin time and canyons more than 1,000 feet deep were cut in the interval between glaciations. One to four terraces in different places record pauses in this cutting. Locally the Snake River basalt, probably in the Pleistocene, dammed streams issuing from south-central Idaho onto the Snake River Plain. (*Author's abstract.*)

Discussed by Messrs. ATWOOD and MATTHES.

G. F. LOUGHLIN: *Geology of Leadville and vicinity, a review of old and recent studies.*—This paper was a review of the main features of the geology and ore deposits of the Leadville district and vicinity as expressed in U. S. Geol. Survey Prof. Paper 148 and in more recent papers, published and unpublished, by Kirk, Behre, and Singewald. The outstanding changes in stratigraphy that have resulted from recent work are (1) the correlation of the Ordovician "White" limestone with the Manitou rather than the Yule formation, and (2) the recognition of the "Parting" quartzite and the lower 75 feet of the Leadville or "Blue" limestone as Devonian, approximately equivalent to the Ouray limestone. New work on structural problems adds detailed information that confirms the conclusions set forth in Prof. Paper 148. The mineral composition and structural relations of ore deposits in the outlying areas indicate that they were formed by solutions derived from the main, or Breece Hill, source of the Leadville ores rather than from local sources. (*Author's abstract.*)

Discussed by Messrs. HESS, HEWETT and FERGUSON

## 477TH MEETING

The 477th meeting was held at the Cosmos Club, April 8, 1931, President MEINZER presiding.

*Informal communications:* FRANK LEVERETT, of the University of Michigan and the U. S. Geological Survey, summarized his study of the Pensacola terrace or shore line in the eastern Gulf coastal States in the past two years. He pointed out that the altitude of the Pensacola shore line is more than 40 feet above sea level on the east coast of Florida, as shown by the Interlachen topographic quadrangle, near Jacksonville; also that its altitude is above 33 feet at Tampa Bay on the west coast of Florida, above 22 feet on the east side of Mobile Bay near Fairhope, Alabama, and above 13 to 15 feet along the west side of Lake Pontchartrain, Louisiana. These altitudes show that the Pensacola shore line declines toward the west, that is, toward the delta of the Mississippi River. Leverett referred to the hypothesis that the tilting is due to yielding of the crust under the load of the delta and pointed out—as direct evidence of subsidence—that undoubted erosion forms in the head of small creeks near Baton Rouge are now in coastal swamps. He also recalled that a former shore line about Cuba is reported to decline toward the west and that the difference that may exist between the slope of shore lines on Cuba and on the mainland would indicate the magnitude of the subsidence due to delta load. The Pensacola beach is relatively very young.

Discussed by Messrs. MEINZER, HESS, RUBEY, and WOODRING.

*Program:* J. C. REED and JAMES GILLULY: *Heavy mineral assemblages in some plutonic rocks from eastern Oregon.*—Plutonic igneous rocks constitute a large proportion of the pre-Tertiary terrane of the Blue Mountains of northeastern Oregon. Gabbro, hornblende-quartz diorite, biotite-quartz diorite, trondhjemite, and albite granite are abundant. The biotite-quartz diorite is notably less sheared than the other plutonic rocks and may belong to a later igneous cycle. On the other hand, it may belong to the same cycle as the other rocks and may be more massive because it was intruded near the close of the orogenic activity. Accordingly the correlation of the plutonic rocks is of major importance in the study of the regional geology.

The heavy residues of nineteen samples of plutonic rocks were examined by a method similar to that used by A. W. Groves for correlating some of the rocks of the Channel Islands.

The study has shown that the biotite-quartz diorite contains a suite of heavy minerals that is quite as diagnostic as the essential minerals. However, the heavy mineral suites of the more basic rocks are less trustworthy as a basis for classification, but if a number of slides of the heavy residue are studied it is generally possible to classify the rock. The fact that the distinction between the several suites is less definite than in the case of the biotite-quartz diorite may strengthen the field hypothesis of consanguinity of the gabbro, hornblende diorite, trondhjemite, and albite granite.

The fact that apatite is less abundant in the gabbro than in the diorite may mean that apatite does not always crystallize first, or that—because its crystals are usually small—the apatite is carried away from the larger separated crystals of augite and plagioclase by movements of the rest-magma.

The zircon and apatite crystals of the hornblende-quartz diorite and trondhjemite commonly appear to be corroded. This fact gives some reason to question the commonly accepted idea that these minerals, because they are among the first to crystallize, are stable throughout the later magmatic history. (*Author's abstract.*)

Discussed by Messrs. Hess and Gilluly.

A. M. Piper: *Observations in the Dalles region, Oregon, bearing on the history of the Columbia River.*—The oldest erosion form of the Dalles region was originally a featureless plain where it was cut across the weak Dalles formation but was an undulating plain where it was cut across anticlines of the resistant Yakima basalt. Its existing remnants include Mount Hood Flat and other extensive interstream tracts that are about 2,000 feet above sea level 3 miles south of The Dalles and that rise southwestward about 50 feet in a mile. This surface is correlated tentatively with the Ochoco erosion surface of central Oregon, that Buwalda ascribes to the early or middle Pliocene.

The Columbia River has cut down 2,000 feet below Mount Hood Flat in several partial erosion cycles of which the latest three formed intracanyon terraces along the river and its tributary creeks. These are designated the 300-foot terrace, the 150-foot terrace, and the 50-foot terrace, from their respective altitudes at The Dalles.

The 300-foot terrace is cut on bedrock in the middle and upper reaches of the tributary canyons, but in the lower reaches is in part constructed of older alluvium. It includes two prominent wind gaps that cross the divide between Fifteenmile Creek and the river. The existing remnants of the terrace rise upstream 25 to 50 feet in a mile along the river and 50 to 100 feet in a mile along the tributaries. The older alluvium is fine-grained where it rests on the Dalles formation, but consists of coarse sand, gravel and boulders where it rests on the basalt. It is believed that much of this alluvium was transported only a short distance from its source and that it was transported by and deposited in streams of moderate velocity. The older alluvium is 10 to 150 feet thick in the tributary canyons and thickens rapidly downstream, for it fills bedrock trenches that slope more steeply than the terrace and that follow the existing canyons. The older alluvium is tentatively correlated with the Sangamon stage of the Pleistocene.

The 150-foot terrace is a bench from a quarter of a mile to nearly a mile wide cut on the basalt along the south bank of the river near The Dalles. It forms discontinuous benches on one or both valley walls in the lowermost 1 to 3 miles of the tributaries but farther upstream forms the valley floors.

The 50-foot plain comprises the bottom land of the river but is not developed in the tributary valleys.

Two modes of origin of the terraces suggest themselves. The first is the usual valley-within-valley sequence—that is, (1) a 300-foot plain was first cut on rock; (2) the streams then cut down to altitude 150 feet; and (3) the inner trench was filled by alluvium up to the 300-foot plain. The alternative sequence is: (1) the streams first cut down to altitude 150 feet along their present courses; (2) this trench was filled up to or somewhat above an altitude of 300 feet; and (3) the streams planed laterally on both fill and bedrock to form the 300-foot terrace and the two wind gaps. From the pattern of the tributary streams in relation to the course of the river and to the two wind gaps it is postulated that the second sequence is the more likely. The later stages of the two modes of origin are the same, namely: most of the older alluvium was swept from the inner rock trenches, the 150-foot plain was cut by lateral planation, and finally the river cut down its valley to altitude 50 feet.

Bretz classifies certain deposits of the older alluvium in the lower part of Fifteenmile Creek as bars composed of long deltaic foresets built in virtually their present form by the Columbia River when it overflowed the two wind gaps during the hypothetical "Spokane flood." However, forset bedding seems generally to exist only within true beds less than 10 feet thick, even though the gravel is 150 feet thick. Moreover, patches of gravel occur on both walls of the valley and approximately up to the same altitude throughout the lower reaches of the tributaries.

It seems unnecessary to resort to a cataclysm such as the "Spokane flood" to account for any of the land forms of the Dalles region. Rather, those forms may be explained rationally as the product of several partial cycles of stream erosion. (*Author's abstract*).

Discussed by Messrs. SEARS, PARKER, and GILLULY.

R. C. WELLS: *Van't Hoff's studies of minerals deposited from sea water.*—Attention was called to solubility determinations made by van't Hoff and his students showing the effect of one salt on the solubility of another salt, to the conditions necessary to obtain recrystallization of double salts, to the graphic representation of the composition of solutions of reciprocal salt pairs in equilibrium with different solid phases, and to the solid phases formed from solutions containing chlorides and sulphates of sodium, magnesium, and calcium at 25° and 83°C. The minerals that might separate on simple evaporation of sea water are aragonite, gypsum, anhydrite, halite, polyhalite, epsomite, kainite, kieserite, and carnallite. Rising temperature causes the separation of water from several of these minerals and the possible formation of langbeinite and sylvite. Sylvite may also be formed by the solution of carnallite and other double salts and subsequent evaporation or cooling of such solutions. Thus the potash minerals found in New Mexico are probably the result of cycles of deposition and in part the result of subsequent alteration. (*Author's abstract.*)

C. H. DANE, ARTHUR M. PIPER, *Secretaries*

## BOTANICAL SOCIETY

### 230TH MEETING

The 230th regular meeting was held on Tuesday evening, January 6, 1931, in the Conference room of the Administration Building of the Department of Agriculture, 102 members and guests being present. President N. E. STEVENS presided.

The following were unanimously elected to membership: DR. JULIUS MATZ, D. F. FISHER, PAUL V. MOOK and DR. FRED J. STEVENSON.

*Program:* DR. E. F. GAINES, cerealist at the Washington State College, gave an interesting account of his trip to England, Scotland, Denmark, Sweden and Germany. Although primarily interested in cereal breeding and diseases, Dr. Gaines did not confine his talk to that line, but happily mixed the more general topic of botany with personal experiences and impressions obtained in visiting the various botanical and agricultural institutions.

The second half of the program was devoted to reports by several members of the Society who had attended the meetings at Cleveland. DR. CHARLES BROOKS reported on the phytopathological meetings, dwelling especially upon the DeBary program. He also gave some interesting side lights on the tobacco meetings. MRS. ANNIE GRAVATT gave a summary of the papers presented on the Dutch Elm disease. DR. E. V. MILLER reported on the physiological meetings, giving a brief resumé of the papers presented before that section. DR. F. J. STEVENSON reported on the potato meetings, especially on the paper of Krantz on inbreeding of potatoes.

*Brief Notes and Reviews:* DR. MARTIN reviewed the recent book on plant physiological chemistry by R. B. Harvey, the only book of its kind in English. DR. NORTON cited the present trend of botany as exemplified by the current program of the meeting of the Maryland State Agriculturists. Twenty-five years ago the meetings were largely taken up by plant pathology and entomology, whereas now only one session was devoted to those topics.

After adjournment, a social hour was enjoyed with "unemployed apples."

## 231ST MEETING

The 231st regular meeting was held on Tuesday evening, February 3, 1931, in the assembly hall of the Cosmos Club. President N. E. STEVENS presided; attendance about 150.

*Program:* H. S. DEAN and FREEMAN WEISS: *Informal report on the Narcissus and bulb conference.*—Mr. Dean reviewed the history of the quarantine and what it aimed to accomplish. Mr. Weiss gave his impressions of the conference, which seemed to indicate that there was a mutual desire for protection from the eelworm.

DR. R. F. GRIGGS: *Five thousand miles for a liverwort.*—Dr. Griggs described his 1930 expedition to the Valley of Ten Thousand Smokes, illustrating his talk with excellently colored lantern slides. A motion picture taken on a previous trip was shown and this was followed by the one taken last summer. He reported that the valley is not the inferno it was ten years ago, but has cooled off to a great extent. The Liverwort alone seems able to establish itself upon the ash. Its source of nitrogen has not been determined, although Dr. Griggs is of the opinion that it may obtain it from the air. When the liverwort has built up sufficient organic matter on the surface of the ash, mosses and higher plants appear. In closing he expressed the hope that this great national park might be increased in size to offer better protection to the animals which have come back into the region.

In adjourning the meeting, President Stevens called attention to the list of food materials taken on the expedition by Dr. Griggs. This was followed by a social hour with refreshments prepared by the students of Dr. Griggs under the leadership of Miss Nance.

### 232ND MEETING

The 232nd regular meeting was held on March 3, 1931, in the Court of the Administration Building of the Department of Agriculture. President STEVENS presided; attendance about 200.

The following were unanimously elected to membership: CHARLES B. READ, DR. ROLAND W. BROWN, DR. PAUL L. HARDING, M. H. HALLER, MISS ALICE M. ANDERSON, and MISS MILDRED PLADECK.

Preliminary announcements were made regarding the outing of the Appalachian Trail Club in the Great Smoky Mountains in June and also regarding the conference on soil fertility at State College, Pennsylvania, in June.

*Program:* PAUL W. BOWMAN: *Pollen and peat.*—The method of examining peat for pollen grains was described and the occurrence of various pollen grains in peat was illustrated by lantern-slide graphs. The paper was discussed by DR. WAITE and MR. BOWMAN.

*Brief Notes and Reviews:* DR. SHEAR called attention to six volumes containing original drawings and notes on fungi by James Bolton which are now in the Library. These were purchased from a dealer in Switzerland and are in a good state of preservation. DR. WAITE exhibited apple branches which had been injured by summer sun scald and compared them with the injury due to winter sun scald.

*Program:* R. KENT BEATTIE: *Botanical notes from Japan.*—Mr. Beattie traced the origin of the Japanese people, described the character of the country and told of his experiences in collecting seeds and scions of chestnuts for importation to this country. Between 90 and 100 varieties of chestnuts are named in Japan as our fruits are named. In a certain part of the country, three crops of nuts are raised each year. The lecture was fully illustrated with lantern slides. The paper was discussed by DR. HITCHCOCK.

An exhibit of azaleas, a part of eighty named varieties brought back by Mr. Beattie, was arranged in each side of the patio.

The Japanese refreshments of rice, a meat concoction and tea which followed adjournment were commented upon by DR. MILLER.

### ANNUAL DINNER

A buffet dinner was served in the Court of the Administration Building of the Department of Agriculture, on March 24, 1931, at 7 P.M. Attendance 170.

After the dinner, President N. E. STEVENS introduced H. L. WESTOVER who gave an illustrated travelogue on Spain and Portugal where he was searching for varieties of alfalfa.

K. A. RYERSON followed with a travelogue on Spain and particularly on Northern Africa, where he and Mr. Westover were looking for new varieties of fruits and alfalfa.

The travelogues were followed by dancing in the Conference Room.

### 233RD MEETING

The 233rd regular meeting was held in the Court of the Administration Building of the Department of Agriculture on April 7, 1931, Vice-president L. H. FLINT presided. Forty-one members and guests were present.

DR. VINNIE A. PEASE was unanimously elected to membership.

*Brief Notes and Reviews:* DR. WAITE explained by graphs and figures that the lateness of the vegetation this spring was due to the low daily maxima of temperature. Only on one day during March did the temperature exceed

60°F. The average for the month was about normal, due to rather high daily minima.

*Program:* E. S. SCHULTZ: *Virus diseases of potatoes.*—He discussed and illustrated by lantern slides the various symptoms produced by virus infection.

F. J. STEVENSON: *Genetics in relation to potato breeding.*—He brought out the difficulties which beset the breeder of potatoes, the progress made, and what it was hoped to accomplish.

W. M. PEACOCK demonstrated a simple method for determining the presence of reducing sugars in potatoes, which had been developed in cooperation with chemists.

An exhibit of potato chips made from potatoes having various percentages of reducing sugars was explained by MISS FULLER.

After adjournment, refreshments of potato salad and orangeade were served.

### 234TH MEETING

The 234th regular meeting was called to order in the Dining Hall of the University of Maryland by President N. E. STEVENS at 8 P.M., Wednesday, May 6, 1931. Ninety-six members and guests were present.

Prior to the regular meeting, some of the members visited the new buildings on the campus, and the remainder botanized in Cat-tail Hill bog where the rare climbing fern (*Lygodium*) was seen. Dinner was served at 7 P.M.

The following were unanimously elected to membership: MISS FRANCES MARGARET MILBURN, MRS. CLARA JAMIESON WELD, MISS JESSIE M. ALLEN, MR. Y. L. KENG and MR. W. A. MCCUBBIN.

*Brief Notes and Reviews:* DR. NORTON exhibited a book for amateur botanists by J. E. Harned of Oakland, Maryland, entitled, *Wild flowers of the Alleghenies,* and published by the author. DR. WAITE recalled a lecture before the Society by Dr. McKay on broken tulips and exhibited specimens taken from his own collection.

The meeting then adjourned to the auditorium of the University where the regular program was begun. Attendance in the auditorium was about 140.

*Program:* F. L. GOLL: *Glimpses of agriculture in southern Spain* (illustrated).

DR. J. HENDERSON-SMITH, in charge of virus diseases of plants, Rothamsted Experiment Station: *Cytological studies of mosaic of tobacco.*—The lecture was illustrated by lantern slides and by a film in which the formation of cell inclusions was followed in the living undisturbed cell. The evidence indicates that the cell inclusions are not living but are aggregates of smaller particles which have coalesced. These aggregates, which are protein in nature, finally become vacuoled and crystallize.

NATHAN R. SMITH, *Recording Secretary.*

## SCIENTIFIC NOTES AND NEWS

According to *Industrial and Engineering Chemistry* plans have been drawn and approved for a headquarters building for American pharmacy to be erected in Washington near the building of the National Academy of Sciences. About $817,000 has been collected or pledged for the undertaking, and actual construction is only awaiting completion of plans by the Federal Government for the development of that part of the city. The building will provide a permanent repository for historical material bearing on the profession of pharmacy as well as a library and facilities for research. It will also contain offices for the various activities of the American Pharmaceutical Association. An effort will be made to endow the building to the extent of one million dollars. It is expected that construction of the building will be completed by the close of 1932.

The Divisions of Mineral and Mechanical Technology of the National Museum have been consolidated into a new division with the title Division of Engineering and including three sections, as follows: Section of Mechanical Technology, under the immediate supervision of FRANK A. TAYLOR, assistant curator; Section of Aeronautics, PAUL E. GARBER, assistant curator; and Section of Mineral Technology, which continues under the immediate charge of CARL W. MITMAN, who has been appointed curator of the new division.

FOSTER H. BENJAMIN, who has been engaged for the past three years in work on the Mexican orange worms and the Mediterranean fruit fly for the Plant Quarantine and Control Administration, has been transferred to the Bureau of Entomology and assigned to a position in the National Museum where he will devote a large part of his time to the identification of North American Lepidoptera.

A. S. HITCHCOCK, senior agrostologist, Bureau of Plant Industry, and custodian of grasses, National Museum, has been elected a corresponding member of the Deutsche Botanische Gesellschaft.

RAYMOND C. SHANNON, who worked on Diptera in the National Museum some years ago and has since been continuing with mosquito work in Brazil under the International Health Board, returned to Washington August 3 and will remain in the United States about six months. He will devote most of this time to the study of mosquitoes.

ALAN STONE has been appointed to the staff of the Bureau of Entomology as a specialist on mosquitoes and will take charge of the collection of mosquitoes in the National Museum.

## Obituary

ARTHUR M. FARRINGTON died August 3 in Washington, D. C. He was born at Brewer, Maine in 1856, and practically his entire career was with the Bureau of Animal Husbandry. After serving as chief of various divisions he was appointed to the position of Assistant Chief of that Bureau, which position he held until his retirement in 1921.

RUSSELL ARTHUR OAKLEY, a member of the ACADEMY, died August 6, in Monrovia, California. He was born in Marysville, Kansas, September 7, 1880, and was educated at Kansas State Agricultural College and at the University of Chicago. He became connected with the Bureau of Plant Industry in 1903, and for many years devoted himself to the study and improvement of turf grasses. Silages and the photoperiodism of alfalfa were among the other subjects to which he devoted attention. For several years previous to his death he served as Principal Agronomist in charge of the Division of Forage Crops and Diseases.

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## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcements of Meetings

| | |
|---|---|
| Saturday, September 19 | The Helminthological Society |
| Thursday, October 1 | The Entomological Society |
| Saturday, October 3 | 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.

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# CONTENTS

## Original Papers



## Proceedings



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# WASHINGTON ACADEMY OF SCIENCES



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POPULATION ANALYSIS.—*The extinction of families*—I.[1] ALFRED J. LOTKA, New York.

The theoretical discussion of the chances of extinction of a line of descent was first given by H. W. Watson in 1889, following a suggestion of Francis Galton. Watson showed that the chances of ultimate extinction of a male line of descent, reckoned at the moment of birth of the first male in the line, is given by the positive root inferior to unity, if such a root exists, of the equation for $x$

$$x = C_o + C_1 x + C_2 x^2 + \ldots \qquad (1)$$

where $C_N$ denotes the probability, at birth, that a male shall eventually have just $N$ sons. From the nature of the coefficients $C$ it is clear that

$$\sum_o^\infty C_n = 1 \qquad (2)$$

The same problem has also been discussed, essentially with the same results, by J. F. Steffensen (Mathmatisk Tidskrift 1930 p. 19).

The theoretical treatment of the problem is thus available in the existing literature. But there remains to be established a working connection between the analytical formula and available statistical data.

*Probability of eventually having n children.* If $p(a)$ is the probability, at birth, of reaching age $a$, and if $m_n(a)$ is the rate at which $n$th children are born of parents of age $a$ and of given sex, per head of population of age $a$ and of that sex, then evidently, the probability that a newborn child of the given sex shall eventually have *n or more* children is given by

$$\begin{aligned} A_n &= \int_0^\infty p(a)\ m_n(a)\ da \qquad (n = 1, 2, 3, \ldots) \\ A_o &= 1 \end{aligned} \qquad (3)$$

[1] Received August 6, 1931.

and the probability that it will eventually have *just n* children is

$$c_n = A_n - A_{n+1} \tag{4}$$

So far no attention has been paid to the particular sex of the original ancestor and the progeny under consideration. It is now necessary to take this into account, because the numerical values of the characteristics involved are different for the two sexes. Chief interest attaches to the male sex, because the family name is perpetuated in direct ancestral male line. Now the published statistics for the United States do not give directly all the data required to form the products $p(a)$ $m_n(a)$ for the male sex specifically. It is necessary to obtain them by a series of indirect steps, as follows:

*Data available directly.* The annual reports of births in the United States give explicitly a tabulation of total births[2] in the year of the report, classified *by age of mother and by order of child at birth.*[3]

Another table gives the total births, irrespective of order of child, classified *by age of father and of mother.*[4]

On the assumption, admittedly approximate, that the relation between the ages of father and mother is essentially the same for children of all orders, the data of the first-mentioned table were redistributed, for each order of child taken separately, in accordance with the ratios appearing in the second table, so as to give the number of births classified *by age of father and by order of child at birth.*

Having thus obtained figures for births classified by age of father and by order of child, these figures were then divided each by the corresponding male population of the same age. The result is what may be called the paternity frequency among males of specified age, counting only children of specified order, and *of both sexes*; it is the quantity denoted by the symbol $m_n(a)$ in equation (3) above, in the case that we are considering the male parents. We are, therefore, now in a position to determine by (4) numerical values of the quantities $c_n$, which measure the probability that a male just born shall eventually have just $n$ children, counting both sons and daughters.

One step now remains to be performed. From the series of values $c_n$ we must derive the corresponding probabilities $C_N$ that a male just born shall eventually have just $N$ *sons.*

The process of deriving the values $C_N$ from the set of $c_n$'s is best explained by reference to the accompanying Table 1. This is built up from the data appearing in the bottom line of the table, which are the

[2] In the Birth Registration Area. For 1920 see Ann. Rep. p. 201, Table 7.

[3] Counting all the liveborn children of the family, whether living or deceased.

[4] For 1920 see Ann. Rep. p. 193, Table 6.

values of the $c_n$'s (probability, at birth of eventually having just $n$ children), determined according to (4). Each figure appearing in this bottom line has been distributed over the entries in the column above, in accordance with the frequency with which $N$ sons will occur among $n$ children in the same family. This frequency is given by the coefficient of $p$ in $(px + q)^n$, where $p$ and $q$ are, respectively, the probabilities of a birth being male or female. The exact numerical values of $p$ and $q$ for the sex ratio at birth in the general population are 0.515 and 0.485. It is not strictly permissible to use this same figure as representing the sex ratio at birth among children of one family, because within one

TABLE 1.—CHANCES, PER 10,000, THAT A NEWBORN MALE WILL EVENTUALLY HAVE $n$ CHILDREN, COMPRISING $N$ SONS

United States White Males, 1920

| $N$ | $n$ | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | Σ (2) |
| 0 | 3686 | 787 | 319 | 122 | 44 | 15 | 5 | 2 | 1 | | | | | | | | | | | 4981 |
| 1 | | 788 | 639 | 364 | 177 | 77 | 33 | 14 | 7 | 3 | 1 | | | | | | | | | 2103 |
| 2 | | | 319 | 364 | 266 | 153 | 82 | 43 | 24 | 10 | 6 | 2 | 1 | | | | | | | 1270 |
| 3 | | | | 122 | 177 | 153 | 109 | 73 | 47 | 24 | 15 | 6 | 3 | 1 | | | | | | 730 |
| 4 | | | | | 44 | 77 | 82 | 72 | 58 | 37 | 26 | 12 | 6 | 3 | 1 | | | | | 418 |
| 5 | | | | | | 15 | 33 | 43 | 47 | 36 | 30 | 18 | 11 | 5 | 2 | 1 | | | | 241 |
| 6 | | | | | | | 5 | 14 | 24 | 24 | 26 | 17 | 12 | 5 | 3 | 1 | 1 | | | 132 |
| 7 | | | | | | | | 2 | 7 | 10 | 15 | 12 | 10 | 6 | 4 | 2 | 1 | | | 69 |
| 8 | | | | | | | | | 1 | 3 | 6 | 6 | 6 | 5 | 4 | 2 | 1 | 1 | | 35 |
| 9 | | | | | | | | | | | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 15 |
| 10 | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | | | 5 |
| Σ(1) | 3686 | 1575 | 1277 | 972 | 708 | 490 | 349 | 263 | 216 | 147 | 126 | 75 | 53 | 29 | 17 | 8 | 5 | 2 | 1 | 10,000 |

Σ (1): Chance that a newborn male shall have $n$ children.
Σ (2): Chance that a newborn male shall have $N$ sons.

family the sexes of the several children cannot be regarded as independent or "uncorrelated." There is a marked tendency, due undoubtedly to physiological causes, for some families to exhibit a marked preponderance of one sex, either male or female. But as a first approximation we may employ the values of $p$ and $q$ as observed in the general population, and, furthermore, it will greatly simplify our arithmetic if in place of the exact values 0.515 and 0.485 we employ the approximate values 0.5 and 0.5; that is, if we disregard the slight bias in favor of the birth of males.[5]

[5] In the United States the average of the sex ratio at birth over many years is 106 boys to 100 girls.

After the body of the table has thus been filled in by distributing the figures from the bottom line over the corresponding columns, the figures in the last column are finally obtained by summing the figures in each horizontal line. The figures thus obtained, and shown in the last column of Table 1, are the values of $C_N$ that is, the probability for a male, at birth, that he shall eventually have just $N$ sons.

We are now in a position to make numerical application of the fundamental formula (1), in which we have

$$\begin{aligned} C_o &= 1 - A_1 \\ C_N &= A_N - A_{N+1} \end{aligned} \tag{5}$$

so that

$$x = 1 - A_1 + (A_1 - A_2)\, x + (A_2 - A_3)\, x^2 + \ldots \tag{6}$$

$$1 = A_1 + A_2\, x + A_3\, x^2 + \ldots \tag{7}$$

Under ordinary conditions, if a root of (7) inferior to unity exists, it will be but little below unity. The solution of that equation is therefore best effected by introducing a new variable

$$\xi = 1 - x \tag{8}$$

Making this substitution in (7) we obtain, after some simplification,

$$1 = R_o - Q_1\xi + Q_2\,\xi^2 - Q_3\,\xi^3 + \ldots \tag{9}$$

where $R_o$ is the ratio of total male births in two consecutive generations, namely

$$R_o = \int_0^\infty p(a) \sum_1^\infty m_N\,(a)\, da \tag{10}$$

and where the coefficients $Q$ take the form

$$Q_k = \sum_{s=k+1}^{s=\infty} A_s \binom{s-1}{k} \tag{1z}$$

The equation (9) is readily solved by successive approximations, since $\xi$ is small. As applied to the data for the United States in 1920 it gave the following values for $x$, the probability of the male line of descent, from a newborn male, ultimately becoming extinct: First approximation, .8930; second approximation, .8800; fifth and six approximations, identical to four places of decimals, .8797.

PHYSICAL CHEMISTRY.—*The cubic compressibility of certain substances.*[1] L. H. ADAMS and R. E. GIBSON. Geophysical Laboratory, Carnegie Institution of Washington.

In the course of several years we have accumulated results on the cubic compressibility of a number of unrelated solids and liquids. These compressibilities were determined directly at pressures ranging from 1 to 12,000 bars[2] by the piston-displacement method which has been used in the Geophysical Laboratory for the last fifteen years and which is described in detail elsewhere.[3] The work leading to the estimation of the compressibility of a substance by this method may be divided into three main parts.

1. The volume of the specimen, $V_a$, is accurately determined at atmospheric pressure. This gives, incidentally, a reliable estimate of the density or the specific volume of the substance.

2. The accumulation of data necessary for the compilation of a table of $(k - k')$ at intervals of 1 kilobar from 2 to 12 kilobars.[4]

The significance of $k$ and $k'$ may be elucidated by brief reference to the actual experimental procedure. The specimen under investigation is placed in a heavy-walled cylinder or bomb and immersed in *n*-butyl ether. The ether is then compressed between the walls of the bomb and the lower surface of a leak-proof piston which is forced into the bomb. The pressure is measured with an electrical pressure gauge and at even kilobars the displacement of the piston is read. From these readings, after the application of a few corrections, the change in volume of the contents of the bomb for each kilobar rise in pressure may be calculated. In order to eliminate the volume change due to the pressure fluid (butyl ether) and to the distortion in the bomb, a run is made under exactly similar conditions and in identically the same way with a standard material, Bessemer steel, whose compressibility is known. From these two series of readings it is possible to compute the relative change in volume per $cm^3$ of the specimen when the pressure is raised from atmospheric pressure to any pressure $p$.

This relative volume change for which the name, the *bulk compression,*[5] or simply the *compression,* is advocated, is denoted by the symbol $k$.

[1] Received August 5, 1931.

[2] 1 bar = $10^6$ dynes per $cm^2$ or a c.g.s. atmosphere.

[3] Adams, Williamson, and Johnston. Journ. Am. Chem. Soc. **41**: *12*. 1919; Adams and Williamson. Journ. Franklin Inst. **195**: *475*. 1923.

[4] 1 kilobar = 1000 bars = 1000 c.g.s. atmospheres.

[5] See Parsons and Cook. Proc. Roy. Soc. **85**: *332–48*. 1911.

Hence $k = \dfrac{V_a - V_p}{V_a}$ where $V_p$ is volume of specimen at pressure $p$ and $V_a$ is its volume at atmospheric pressure.

For convenience in working we make measurements from an arbitrary zero of pressure, viz. 2 kilobars. The symbol $k'$ is used to denote shrinkage in volume per $cm^3$ produced when the pressure surrounding the substance is increased from 1 to 2000 bars. Hence $(k - k')$ is the decrease in volume which one $cm^3$ of the substance measured at atmospheric pressure suffers when its pressure is raised from 2 kilobars to any pressure $p$.

3. By the method of least squares $(k - k')$ is expressed as a function of the pressure and hence the compressibility $\beta = \dfrac{d(k - k')}{dp}$ is evaluated.

In this communication we shall classify the results according to the substance examined, giving under each heading the object of the determination, the density of the material, tables of $(k - k')$ at different pressures, and the value of $\beta$ which we consider most probable. The tables of results give $k$ or $(k - k')$ as a function of pressure. In most cases an equation of the form

$$(k - k') = a + bp + cp^2$$

was fitted to the data by the method of least squares. The column labelled "least square residuals" gives the difference between the observed values of $(k - k')$ and those calculated from the appropriate quadratic equation whose coefficients $a$, $b$ and $c$ appear at the head of the table. This column illustrates how well the equation represents the data.

*Standard of comparison.* The cylinder of Bessemer steel which has always been used for this purpose in this Laboratory served as the standard of comparison and Bridgman's[6] value for the *bulk compression* of steel, viz. $10^5\, k = 59.9\, p - 0.22\, p^2$, was assumed as a basis on which to compute the results.

*Pyrex glass.* Since piezometers and capsules made from pyrex glass are continually used in this Laboratory, it is desirable for practical reasons to have an accurate knowledge of the compressibility of this material. From measurements of the linear compressibility of pyrex glass, Bridgman[7] gave the following value for the cubic compressibility:

$$10^5\, \beta = 304.1 + 1.46\, p \text{ reciprocal kilobars.}$$

A startling feature of this result was the increase in compressibility

[6] P. W. Bridgman. Proc. Am. Acad. Arts Sci. **58**: *174*. 1923.
[7] P. W. Bridgman. Am. Journ. Sci. **10**: *363*. 1925.

with pressure exhibited by this glass. It was considered worth while checking this result by a direct determination of the *cubic* compressibility.

The sample of pyrex glass examined was in the form of a rod $\frac{5}{8}$ inches in diameter and 4 inches long which was practically free from bubbles. It was made available for our use through the courtesy of the Corning Glass Works. The density of the glass determined at 23.2° by the Archimedes method was 2.233 g/cm$^3$ and its refractive index,[8] $n_D$, was 1.473.

The results of the two latest determinations of the compressibility of pyrex glass are given in Table 1.

TABLE 1. EXPERIMENTAL RESULTS FOR PYREX GLASS

| Pressure (kilobars) | 1<br>$a = -615$<br>$b = 302.4$<br>$c = 0.87$ | | 2<br>$a = -620$<br>$b = 306.5$<br>$c = 0.55$ | |
|---|---|---|---|---|
| | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) |
| 12 | 3135 | −4 | 3128 | −9 |
| 11 | 2828 | 12 | 2829 | 11 |
| 10 | 2497 | 1 | 2504 | 4 |
| 9 | 2158 | −19 | 2169 | −14 |
| 8 | 1865 | 6 | 1876 | 9 |
| 7 | 1546 | 1 | 1550 | −3 |
| 6 | 1243 | 12 | 1244 | 5 |
| 5 | 913 | −6 | 917 | −9 |
| 4 | 612 | 4 | 615 | 1 |
| 3 | 287 | −13 | 299 | −6 |
| 2 | 0 | 7 | 0 | 5 |
| 1 | −320* | | −325* | |

* Not used in least square calculation.

The mean of the two results gives the following value of $k$, the total *bulk compression* produced by increase of pressure from atmospheric pressure to $p$ kilobars:

$$10^5\, k = 304.5\, p + 0.71\, p^2 \tag{1}$$

This value is substantiated by two determinations made in 1925 which gave as an average:

$$10^5\, k = 303.2\, p + 0.18\, p^2 \tag{2}$$

Taking into account the recent improvements in our technique we are inclined at this time to give all the weight to equation (1) and to

[8] We are indebted to Dr. H. E. Merwin of this Laboratory for this value.

give as our estimate of the most probable value of the cubic compressibility of pyrex,

$$10^5\,\beta = 304.5 + 1.42\,p \text{ recip. kb. at } 25°\text{C.}$$

The agreement between this value and Bridgman's is obvious, and in particular all our results confirm his observation that the compressibility of pyrex increases with pressure.

*Vitreous silica.* According to Bridgman[7], who gives as the compressibility of vitreous silica,

$$10^5\,\beta = 269.9 + 3.66\,p \text{ recip. kb at } 30°,$$

TABLE 2. Experimental Results for Vitreous Silica

| Pressure (kilobars) | 1: $a = -560$, $b = 273.6$, $c = 1.84$ | | 2: $a = -563$, $b = 275.8$, $c = 1.60$ | |
|---|---|---|---|---|
| | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) |
| 12 | 2977 | −11 | 2972 | −4 |
| 11 | 2683 | 11 | 2665 | 1 |
| 10 | 2369 | 9 | 2356 | 1 |
| 9 | 2043 | −9 | 2048 | 0 |
| 8 | 1748 | 2 | 1751 | 5 |
| 7 | 1445 | 0 | 1450 | 4 |
| 6 | 1157 | 9 | 1158 | 9 |
| 5 | 842 | −12 | 837 | −19 |
| 4 | 561 | −3 | 557 | −9 |
| 3 | 277 | 0 | 284 | 5 |
| 2 | 0 | 5 | 0 | 5 |
| 1 | −271* | | −286* | |

* Not used in least square calculation.

this glass exhibits the greatest increase of compressibility with pressure of any substance yet examined. Our results confirm this statement. We made experiments on a cylinder of perfectly clear vitreous silica whose only flaws were a few long, exceedingly fine capillaries—probably elongated bubbles. The volume of the specimen at atmospheric pressure was 20.262 cm³, and its density, determined at 23°C. by the Archimedes method, was 2.204 g/cm³. The specimen came from the General Electric Company's works at Lynn, Massachusetts. Five series of measurements on this specimen were made, three in 1925, and two in 1930. Table 2 gives the results of the last two determinations. On averaging the coefficients in this table we obtain equation (3):

$$10^5\, k = 274.7\, p + 1.72\, p^2 \qquad (3)$$

$$10^5\, k = 257.4\, p + 2.79\, p^2 \qquad (4)$$

In the three earlier results the values of the coefficients $b$ and $c$ were 258.1, 259.9, and 253.3; and 2.61, 2.86, and 2.90 respectively. The average of these gives equation (4). In assigning a most probable value to the compressibility we have again taken the improvement in our technique into account and have given the later result twice the weight of the earlier one. Our estimate of the compressibility of vitreous silica is, therefore,

$$10^5\, \beta = 268.9 + 4.15\, p,$$

which agrees very closely with Bridgman's value.

TABLE 3. Experimental Results for Obsidian

| Pressure (kilobars) | 1 $a = -571$ $b = 285.7$ $c = -0.58$ | | 2 $a = -570$ $b = 283.9$ $c = -0.38$ | |
|---|---|---|---|---|
| | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) |
| 12 | 2770 | −4 | 2781 | −1 |
| 11 | 2509 | 7 | 2507 | 0 |
| 10 | 2226 | −2 | 2226 | −5 |
| 9 | 1953 | 0 | 1952 | −2 |
| 8 | 1681 | 3 | 1687 | 10 |
| 7 | 1406 | 5 | 1406 | 7 |
| 6 | 1131 | 9 | 1124 | 4 |
| 5 | 824 | −19 | 823 | −17 |
| 4 | 557 | −6 | 550 | −9 |
| 3 | 287 | 6 | 284 | 6 |
| 2 | 0 | 2 | 0 | 4 |
| 1 | −313* | | −287* | |

* Not used in least square calculation.

*Obsidian.* The compressibility of the specimen of obsidian described in a previous paper[9] was redetermined largely with a view to establishing more firmly the sign and magnitude of the pressure coefficient of the compressibility. Glasses with high silica content, e.g. pyrex glass, resemble vitreous silica in exhibiting an increase of compressibility with pressure, while glasses with low silica content behave in the ordinary way. Obsidian is a naturally occurring glass containing over 70 per cent of silica, and its compressibility shows very little

[9] Adams and Williamson. Journ. Franklin Inst. **195:** *483.* 1923.

change with pressure. It is evidently on the border line between the glasses which behave normally under pressure and those which do not. The volume of the specimen we used was 20.007 $cm^3$ and its density at 25°C. was 2.333 grams per $cm.^3$ The experimental results are given in Table 3.

The equation, $10^5\,k = 284.8\,p - 0.48\,p^2$, represents the mean of these results and leads to the following equation for the compressibility:

$$10^5\,\beta = 284.8 - 0.96\,p.$$

Adams and Williamson found that as far as their results could show the bulk compression of obsidian was a linear function of the pressure and that the value of $\beta$ at 7 kilobars was $2.83 \times 10^{-3}$ reciprocal kilo-

TABLE 4. EXPERIMENTAL RESULTS FOR DURALUMIN

| Pressure (kilobars) | $a = -259$<br>$b = 121.0$ | |
|---|---|---|
| | $(k-k') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) |
| 12 | 1184 | −9 |
| 11 | 1094 | 22 |
| 10 | 947 | −4 |
| 9 | 817 | −13 |
| 8 | 706 | −3 |
| 7 | 592 | 4 |
| 6 | 476 | 9 |
| 5 | 352 | 6 |
| 4 | 212 | −13 |
| 3 | 87 | −17 |
| 2 | 0 | 17 |

bars. This value may be compared with $2.78 \times 10^{-3}$ reciprocal kilobars, which is the compressibility of obsidian at 7 kilobars as computed from the results in this paper. Bridgman[10] measured the compressibility of a sample of obsidian from Ascension Island by the linear method. He interpreted his results as indicating that the compressibility of this natural glass first decreases and then increases as the pressure is raised. His value of the compressibility at 7 kb is considerably lower than ours, being of the order of $2.55 \times 10^{-3}$ reciprocal kilobars. Two considerations prevent close comparison between Bridgman's results and ours. First, the sample of obsidian he examined contained three per cent less silica than our sample—a circumstance

[10] P. W. Bridgman. Am. Journ. Sci. **10**: *364*. 1925.

which would call for a lower compressibility in Bridgman's sample. Second, as Bridgman himself implies, especially in the case of a basaltic glass from Kilauea, the linear method cannot be trusted too far to give the cubic compressibility of natural glasses.

*Duralumin.* The sample of duralumin examined was in the form of a cylinder built of disks and held together by gold wire. Dr. L. B. Tuckerman of the U. S. Bureau of Standards was kind enough to supply the specimen, which was described as 45-duralumin, Bureau of Standards Number 6532 E-4.

Only one determination was made, and the results are given in Table 4. A linear equation was used to express $(k - k')$ as a function of the pressure.

TABLE 5. EXPERIMENTAL RESULTS FOR THREE SALTS

| Pressure (kilobars) | Ammonium nitrate $a = -638$ $b = 668.9$ $c = -13.86$ | | Potassium sulphate $a = -318$ $b = 331.8$ $c = -3.83$ | | Sodium sulphate $a = -212$ $b = 237.1$ $c = -2.38$ | |
|---|---|---|---|---|---|---|
| | $(k-k'') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) | $(k-k'') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) | $(k-k'') \times 10^5$ (obs) | Least square residuals $\times 10^5$ (obs-calc) |
| 10 | 4666 | 1 | 2618 | 1 | 1912 | 1 |
| 9 | 4278 | 19 | 2358 | 0 | 1704 | −16 |
| 8 | 3804 | −22 | 2082 | −9 | 1499 | −25 |
| 7 | 3360 | −5 | 1825 | 8 | 1334 | 10 |
| 6 | 2869 | −7 | 1525 | −10 | 1123 | 4 |
| 5 | 2367 | 7 | 1244 | −1 | 904 | −5 |
| 4 | 1816 | 0 | 948 | 0 | 702 | 8 |
| 3 | 1258 | 14 | 665 | 22 | 490 | 15 |
| 2 | 656 | 12 | 332 | 2 | 263 | 12 |
| 1 | 0 | −17 | 0 | −10 | 0 | −22 |

The average compressibility of this substance between 2 and 12 kilobars is $1.21 \times 10^{-3}$ reciprocal kilobars.

*Solid salts.* We have also determined the compressibilities of three solid salts, *ammonium nitrate, potassium sulphate,* and *sodium sulphate.* The last-named salt was in the form, $Na_2SO_4V$, or thenardite. All these salts received the same treatment. The powdered salt (J. T. Baker's C. P. Analyzed) was pressed into extremely compact pellets with the help of a testing machine capable of exerting a force of 5000 kg. Enough pellets were weighed out to give a total volume of salt of 10 cm³. This was the volume of the salt, not that of the salt plus the pore space. The pellets were placed in a steel capsule and submitted to hydrostatic pressure. A comparison run with 10 cm³ of steel instead of the salt in the capsule enabled us to estimate directly the difference between the compressibility of the salt and of the standard, steel. The ammonium nitrate was not compressed to pellets but melted and cast into a cylinder. Two series of measurements were made on ammonium nitrate, two on potassium sulphate, and one on sodium sulphate. The average observed values of the *compressions* are recorded in Table 5. Equations (5), (6), and (7) represent the average results for ammonium nitrate, potassium sulphate, and sodium sulphate respectively:

$$10^5\ k = 668.9\ p - 13.86\ p^2 \tag{5}$$

$$10^5\ k = 331.8\ p - 3.83\ p^2 \tag{6}$$

$$10^5\ k = 237.1\ p - 2.38\ p^2 \tag{7}$$

The compressibility, $\beta$, of any of these salts may be obtained by differentiation of the appropriate equation.

*N-butyl ether.* Contrary to expectation, this remarkable liquid, although relatively non-volatile, does not freeze at pressures as high as 12,500 bars at room temperature. In addition it appears to be comparatively fluid at these high pressures and so is an excellent pressure-transmitting liquid. The n-butyl ether we used came from the Eastman Kodak Laboratories. It is listed as No. 173 B.p. 142–144°. Two series of determinations were made over the high-pressure range and a special piezometer method was employed to measure the *bulk compression* up to 2 kilobars, which, it should be remarked, is more than one-third of the bulk compression produced when the pressure is raised from zero up to 12 kilobars.

In Table 6 we record the second series of results. It was found that the points from 7 to 12 kilobars for both series were represented accurately by equation (8),

$$10^4\ k = 1058 + 187.8\ p. - 4.88\ p^2 \tag{8}$$

Below 7 kb, however, the differences between the values of $k$ as calculated by equation (8) and those observed increased enormously.

For the second series of results these differences could be represented by the equation

$$10^4 \triangle = 1028 e^{-0.70p} \tag{9}$$

where $\triangle$ is the difference between the observed value of $k$ and that calculated by equation (8). Hence the equation

$$10^4\ k = 1058 + 187.8\ p - 4.88\ p^2 - 1028\ e^{-0.70p} \tag{10}$$

was used to express the second set of results and gives the values of $10^4 k$ shown in column 3. The differences at low pressures were greater than might be desired, a fact which is partly due to the difficulty we encountered in estimating exactly the values of $k$ between 0 and 2 kb. In the first series of results where the uncertainties at low pressures were greater, the value of ($k_{obs} - k_{calc}$) at 0, 1, 2, 3, and 4 kb were –30, 42, –4, –15, and 6, respectively, although, as has been mentioned, equation (13) fitted accurately above 6 kb.

It is of interest to note that a mass of *n*-butyl ether which occupies 100 cm³ at atmospheric pressure occupies 89.5 cm³ at 2000 bars and 74 cm³ at 12,000 bars.

TABLE 6. RESULTS FOR N-BUTYL ETHER

| Pressure (kilobars) | $10^4$k (obs) | $10^4$k (calc) | Difference × $10^4$ (obs-calc) |
|---|---|---|---|
| 12 | 2608 | 2609 | −1 |
| 11 | 2532 | 2534 | −2 |
| 10 | 2448 | 2447 | 1 |
| 9 | 2353 | 2351 | 2 |
| 8 | 2246 | 2244 | 2 |
| 7 | 2132 | 2125 | 7 |
| 6 | 1998 | 1994 | 4 |
| 5 | 1843 | 1844 | −1 |
| 4 | 1665 | 1668 | −3 |
| 3 | 1441 | 1452 | −11 |
| 2 | 1156 | 1160 | −4 |
| 1 | 747 | 733 | 14 |
| 0 | 0 | 30 | −30 |

*Conclusion.* This communication illustrates the variety of ways in which the compressibility of matter changes with pressure. At one extreme there are the silica-rich glasses whose compressibility increases markedly at the high pressures. At the other extreme a liquid such as butyl ether decreases in compressibility very rapidly up to five kilobars while at higher pressures its compressibility changes no more than that of a solid like ammonium nitrate. Intermediate between these two extremes come substances like obsidian and duralumin where the decrease of compressibility with pressure is barely detectable over a range of twelve thousand atmospheres. Lastly, the salts may be taken as typical of the ordinary not too incompressible crystalline solid whose rate of decrease of compressibility, although large at first, diminishes steadily as the pressure rises.

It will, therefore, be obvious that any general rules for estimating the magnitude of the change of compressibility of a substance from observations on other substances should only be applied after careful consideration of the nature and structure of the substances involved. In particular, rules deduced for the rate of change of compressibility of holocrystalline materials should not in general be applied to glasses.

## PALEONTOLOGY.—*New Carboniferous invertebrates*—III.[1] George H. Girty, U. S. Geological Survey.

### **Schizophoria peculiaris** n. sp.

Figs. 1–4

Shell very small, broadly ovate in outline, varying in proportions but always wider than long, highly convex, coarsely striated.

The pedicle valve may be compared to a cone which is elliptical at the base, very depressed, very oblique, and considerably arched in the apical part. The hinge line is equal to about half the greatest width but when the valve is viewed from above it is mostly concealed by the projecting umbonal parts. The outline, due to these two factors, has an ovate shape but little interrupted by the cardinal angles, with well rounded and strongly divergent sides and a broad gently convex or sometimes faintly emarginate anterior margin. The cardinal area is high, but not so high as it is wide and it is neither strongly arched nor strongly inclined backward. The beak tapers rapidly to a point and is not greatly incurved. The convexity is high and regular, though chiefly localized in the posterior part and the median line may be depressed into an obscure sinus.

The brachial valve differs in shape but little from the pedicle valve. The cardinal area is lower and it lies essentially in the plane of the shell margins. Though lower than the cardinal area of the pedicle valve, it extends almost as far beyond the hinge line and is relatively high for a shell of this kind and size. The beak (compared with the ventral beak) is blunter and more incurved. A median sinus is of more common occurrence in this valve than in the other, and though never strong, it is likewise more distinct. If a sinus is present, and especially if a sinus is also present in the pedicle valve, the outline in front is correspondingly emarginate.

The surface is marked by radial lirae that are exceptionally strong and coarse for a shell of this size. They are separated by relatively wide interspaces, though many of the interspaces are partly occupied by interstitial lirae which subsequently become as large as the others. The lirae vary in size and spacing and the surface generally has an irregular appearance. To this appearance of irregularity the tendency of the larger lirae to end abruptly in a large pore or hollow spine contributes somewhat, and also the varices of growth that some specimens developed. Hollow, prominent and interrupted lirae are not a conspicuous feature and on many specimens they are difficult to distinguish at all. They are mostly to be looked for on the pedicle valve. The varices of growth which are especially common and especially strong on these shells, of course interrupt all the lirae simultaneously.

[1] Published by permission of the Acting Director of the U. S. Geological Survey. For the previous papers of this series, see this Journal **19**: 135–142 and 406–415. Received July 29, 1931.

Most of the Schizophorias in our American Carboniferous faunas are large shells. The present species differs from them not only in size, but in other respects, so much that detailed comparisons seem unnecessary. That the shells included here merely represent the immature condition of some larger species seems unlikely, not only because they are associated with no large species of which on other grounds they could be the immature form, but because they occur in considerable numbers and are more or less uniform in size and in other characters. The largest specimen referred here has a width of 12 mm., the next largest, 10 mm. and so on down.

Horizon and locality: Upper part of the Hueco limestone; Marble Canyon, east face of the Diablo Plateau, Hudspeth County, Texas (station 6681).

**Pustula palmeri** n. sp.

Figs. 5–10.

Shell small, rarely 10 mm. in width, highly convex (in the pedicle valve), lacking both radial costae and concentric wrinkles that are either systematic or pronounced but marked by numerous small spines which project from large rounded bases.

Pedicle valve subquadrate in outline except for the projecting umbonal parts, the front and sides being more or less straightened merging in strong curves around the antero-lateral angles. The proportions vary in different specimens, but the width seems to be regularly greater than the length. The hinge line is about equal to the width below, but it is more apt to be slightly shorter than slightly longer. The shell is strongly and rather regularly arched. Transversely the curvature is somewhat subdued across the median part with a steep descent on either side to the small depressed auricles. The umbonal parts are rather prominent and they project considerably beyond the hinge when the valve is viewed from above but not more than is common.

The surface is primarily marked by spines which arise from large well defined nodes. The spines are numerous and though actually small, are rather large for the size of the shell. They are more or less regularly arranged on a plan which is fundamentally alternating or quincunxial. This arrangement, however, is not as a rule conspicuous, a formation in transverse rows being more obvious than any other. In some specimens curving oblique rows are formed at the sides and in others the development of spines and nodes is accompanied by a tendency to form large indistinct radial costae on the anterior parts. The nodes and spines become gradually smaller and more closely arranged toward the hinge line, near which all the transverse features converge to some extent. Several specimens have a row of small spines along the hinge margin, but this may not be a constant feature. On one of these especially the spines were developed in connection with a series of small, sharp, regular plications extending downward from the margin, a spine to each plication. The spines with their nodose bases are more numerous on some specimens than on others, and aside from number, the nodes vary also in size and prominence. On some specimens they are by no means conspicuous. The surface is marked by striae of growth in the nature of microscopic and irregular concentric wrinkles. Some of these are delicately lamellose. Though not developed regularly or at regular intervals, other striae much larger than the incremental ones occur here and there between the rows of spines and pustules. More regularly large wrinkles or plications are developed near the hinge line but they lose their strength within a short distance except as they may be represented by the stronger grooves that pass between and emphasize the rows of spines.

The brachial valve corresponds in shape with the pedicle valve in the usual manner. It is strongly transverse and in outline rather subquadrate than semi-circular. It is gently concave so that a relatively ample cavity is left within. The curvature is not quite regular, being low over the visceral disk and more pronounced over the marginal parts without, however, any marked discrepancy.

The most conspicuous surface feature in this valve consists of small rounded indentations or dimples which evidently correspond individually to the nodes on the surface of the pedicle valve. These indentations become deeper and more elongate toward the cardinal margin, so that the elevations between them take the shape of more or less irregular wrinkles. Microscopic wrinkles of incremental nature cover the entire surface which sometimes also is marked by concentric undulations (broad grooves and narrow ridges), all very faint but fairly regular where they occur at all.

This valve also is armed with spines which are at least as numerous as the spines of the pedicle valve and much smaller. They occur distributed among the dimples and spring from the surface without giving rise to appreciable nodes.

Species of the general character of *P. palmeri* are rare in our Pennsylvanian faunas and I am able to name but two which can profitably be compared with it. *P. keytei* has fewer and smaller spines which were developed without appreciably disturbing the even curvature of the pedicle valve by giving rise to nodes or spine bases. Although the nodose or monticulate surface is not a constant feature in *P. palmeri*, at least in a conspicuous degree, it is a very common one. *P. keytei* is also somewhat smaller and it is somewhat differently proportioned, being comparatively long whereas *P. palmeri* is comparatively broad. *Pustula globosa* is more comparable to *P. palmeri* in size and shape but it has much fewer spines and the spines, though leaving large scars on the surface, did not produce distinct elevations in the nature of spine bases.

Horizon and locality: Cherokee shale; mine dumps near Joplin, Missouri.

## **Pustula keytei** n. sp.

Figs. 11–14.

Shell very small, hemispherical, without radial costae, and without concentric plications, but covered with numerous small spines.

Pedicle valve irregularly ovate in outline with length and width about equal though commonly somewhat longer than wide. Outline in front of the hinge rather regularly rounded. Hinge a little shorter than the width in front, mostly concealed by the umbonal parts when the valve is viewed from above. Convexity high. Umbonal region rather gibbous descending abruptly to the small, ill-defined auricles and projecting well beyond the hinge. A section longitudinally would show the greatest height posterior to the mid-length with a gradually decreasing curve forward.

The surface, which is without even traces of radial costae, is marked by fine, incremental lines. The sides of the vault and the auricles show small subequal concentric plications most of which spread out and become indistinguishable over the intermediate parts. A few of the grooves may persist, marking off concentric bands but this is more or less sporadic and developed especially on the visceral disc. Some of the striae also are lamellose along the posterior side. The spines which are represented by scars or by fragments of the basal parts, were apparently small and perpendicular to the surface, from which they were developed without giving rise to conspicuous nodes or spine bases. They show a general tendency to form concentric rows and occur scatteringly over the median part of the vault but in more close arrangement on its sides.

The brachial valve is semicircular in outline. The width, though greater than the length, is by no means twice as great. The curvature is moderately strong but much lower than that of the pedicle valve so that a considerable space is left between them. The curvature is also fairly regular—perhaps a little strengthened over the marginal parts. The surface features are so subdued as to be rather inconspicuous. Very fine incremental striae can be seen and descending from the hinge fine obscure wrinkles which either lose themselves in passing across the intermediate part or give rise to faint concentric undulations. Scattered over the surface, though scarcely to be seen except in a favorable light, are small dimple-like depressions that correspond to spines on the pedicle valve and were apparently developed simultaneously with them. This valve also was provided with spines but in comparison with the spines of the pedicle valve, they are smaller and less numerous. Because they are small, however, some may have been overlooked and their number may really be greater than it appears.

Mr. Mather has described a species very similar to this from the Morrow group of Arkansas, of Pottsville age. I have a number of specimens from the Morrow that would naturally be referred under *P. globosa* and among them it is possible to find individuals that do not differ greatly from *P. keytei*, but most of the specimens and apparently the more typical ones, are relatively broader and were armed with distinctly larger spines. The spines are not only larger but apparently also less numerous on the sides of the vault and less closely arranged; the specimens from Arkansas, however, are not as favorably preserved as those from Colorado, and it has not been possible to compare them satisfactorily in a number of details. The superficial features of the brachial valve, for instance, are neither adequately described by Mather, nor are they in certain details adequately shown by my specimens. This valve is described as flattened over the visceral disk and abruptly deflected around its margins. Here again the two species appear to differ inasmuch as the brachial valve of *P. keytei* is regularly arched. It should be remarked, however, that some of my specimens of *P. globosa* (if correctly identified) are equally regular though others have a flattened visceral disc and a deflected margin as described. Another similar but less closely related form is *P. palmeri*. In *P. palmeri* the spines are more numerous and more regularly arranged and they spring from relatively large, rounded nodes which, by reason of their regular arrangement, produce here and there the appearance of large, ill-developed radial costae.

Horizon and locality: Fountain formation (Glen Eyrie shale member); Glen Eyrie, El Paso County, Colorado (station 5100).

### **Avonia williamsana** n. sp.

Figs. 15–19

Pedicle valve small, rarely more than 15 mm. in width. Width and length about equal, though the width is commonly somewhat the greater. Outline broadly subovate. Vault moderate in height, gradually enlarging, conspicuously ovate and without a sinus. Hinge line equal to the width in front. Auricles quadrate in outline, small, depressed, ill-defined.

Sculpture comprising growth lines, concentric striae, spines with their bases, and radial costae. The growth lines are fine and inconspicuous. The concentric striae may be fairly strong and numerous, or on the other hand, few and obscure. They are not restricted to the visceral disk but may occur at irregular intervals throughout the entire length of the valve. Not rarely they are so shaped as to make a step-like descent forward. Broadly speaking, the posterior half of the valve is marked by spiniferous nodes and the anterior half by spiniferous costae, but the one type of sculpture graduates into the other, and the change occurs at different stages of growth in different specimens. The umbonal region which is somewhat finely and irregularly corrugated, is marked by numerous nodes which are rather large and surmounted by spines which are rather small. In a general way the nodes occur in transverse rows and alternate in the rows. As growth proceeded the nodes became more elongated, passing into short costae that are interrupted by the transverse striae and these shortly became continuous costae that the weakened striae fail to disturb. The spines are numerous over all parts of the surface and produce nodes where they occur, but where the spines take off from continuous costae, the nodes do not conspicuously deform them. The transverse arrangement of the spines in rows in many places is very striking, but the rows are irregular, crooked, or discontinuous. The costae are strong and rather regular; about 7 or 8 occur in 5 millimeters.

The brachial valve is deeply semicircular in outline and considerably wider than long. In the form of an external mold it is moderately convex but it is decidedly less convex than the pedicle valve, especially over the umbonal parts. These are rather exceptionally prominent for a brachial valve, however, and indeed the curvature of the whole valve though varying in different specimens is exceptionally strong and rather regular.

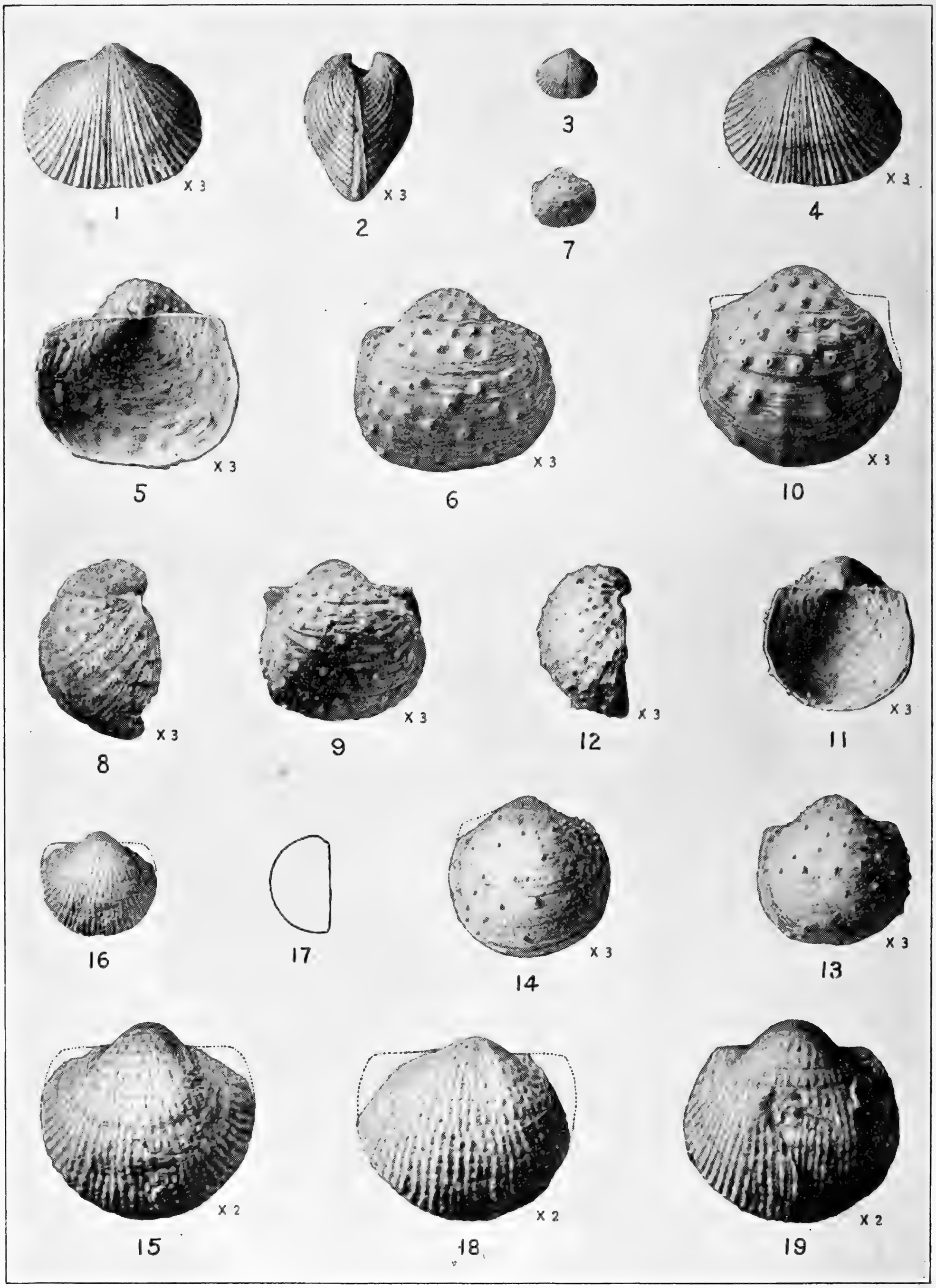
The surface markings, still in terms of the external mold, are a close repetition of the surface markings of the pedicle valve. Small nodes cover the posterior part and pass by gradual elongation into continuous costae, also faintly nodose, the costae corresponding to the costae of the pedicle valve and the nodes to the spines upon them. This valve equally with the other, is equipped with numerous small spines, and here also the spines are conspicuously but irregularly alined in transverse rows. They occur in the grooves between the costae and the grooves are slightly depressed or enlarged where they occur. Of course the grooves represent costae on the shell itself and the enlargements slight nodes at the bases of the spines. Returning to the valve in its condition of external mold, some specimens are crossed by delicate flat-lying but conspicuous lamellae spaced at fairly regular but remote intervals and marking stages of growth. Other specimens appear to lack the lamellose feature, and to present instead a surface marked by rather fine concentric wrinkles, which are obscure over the median region but gain in strength and regularity as they pass onto the sides of the vault and onto the auricles.

If *Avonia williamsana* is brought into comparison with other *Producti* at present known in our Mississippian faunas it is found to have many distinctive characters. It has much in common with some forms of *Productus arcuatus* to judge from Professor Weller's figures, but *P. arcuatus*, in its characteristic expression is a member of the *semireticulatus* group; the visceral disc in the pedicle valve is marked by concentric corrugations, the costae are coarser than those of *A. williamsana* and the spines fewer and much larger. Differences still more noteworthy are found in the brachial valve in which the visceral disk is well differentiated from the trail and strongly wrinkled, while spines, which are common on the brachial valve of *A. williamsana*, appear to be entirely wanting.

If that species were developed on a more generous scale, *A. williamsana* might be compared to the form that Professor Weller in his monograph figures from the Burlington limestone as *Productus* sp. (plate 14, figs. 26 and 27). Besides being much larger *A. williamsana* is distinguished among other differences by the more numerous spines and the more gradual appearance of the costae. The specimens used to represent the Burlington species in this comparison had their source in the white chert of Burlington age at Louisiana and Kinderhook, and without much question they represent the *Productus* sp. of Weller's monograph.

It is possible that instead of being described as new, *Avonia williamsana* should be identified with *A. pustulifera* Moore. The evidence on this head is somewhat contradictory. As represented by Moore's figures, *A. pustulifera* has a less spreading shape, coarser costae, and less numerous spines, so that *A. williamsana* appears to be something quite distinct. My collections from Osceola, however, contain a number of specimens which, on the one hand appear to be identical with *A. williamsana* but which I should be tempted to identify with *A. pustulifera* on the hypothesis that the original figures, even though they are photographic, do not fully or accurately portray the specific characters. My specimens, however, did not come from the same horizon as Doctor Moore's, a circumstance that may vitiate the fact that they came from the same locality. Moore did not describe the brachial valve of *A. pustulifera* so that the factors of identification are thereby much reduced.

Horizon and locality: Boone limestone (in beds of Keokuk age); Joplin, Missouri (station 1301A).




Figs. 1–19. For explanation, see page 397

DESCRIPTION OF FIGURES

*Schizophoria peculiaris* n. sp.

Figs. 1–4. Different views of one of three cotypes. Fig. 3 is of the natural size; the others are enlarged to about 3 diameters. Hueco limestone; Marble Canyon, east face of Diablo Plateau, Hudspeth County, Texas, (Station 6681).

*Pustula palmeri* n. sp.

Figs. 5–10. Different views of 3 cotypes, figs. 5–8 representing one specimen, fig. 9 another, and fig. 10 a third. Fig. 7 is of the natural size; the others are enlarged to about 3 diameters. Cherokee shale; mine dumps near Joplin, Mo.

*Pustula keytei* n. sp.

Figs. 11–14. Different views of two cotypes, all ×3. Figs. 11–13 represent one specimen, fig. 14 another. Glen Eyrie shale member of the Fountain formation; Glen Eyrie, El Paso County, Colorado.

*Avonia williamsana* n. sp.

Figs. 15–19. Different views of 3 out of 7 cotypes. Figs. 15–17 represent one specimen, fig. 15 being an enlargement to two diameters. Fig. 18 represents an external mold of a brachial valve ×2. Some of the holes made by the small spines are here shown. Fig. 19 represents a pedicle valve, ×2. This specimen like the original of fig. 15 is practically an internal mold. Cherty beds of the Boone limestone; Joplin, Mo., (Station 1301A).

ZOOLOGY.—*The copepod genera* Broteas *Lovén,* Paradiaptomus *Sars,* Lovenula *Schmeil,* Metadiaptomus *Methuen, and* Adiaptomus *Cooper.*[1] C. DWIGHT MARSH, Bureau of Animal Industry.

In connection with a study of *Diaptomus* it became necessary to determine somewhat clearly what species should be separated from *Diaptomus* and referred to the proposed genera *Broteas, Paradiaptomus, Lovenula, Metadiaptomus,* and *Adiaptomus.* It was found difficult to get from the authors who have used these names any method of determining by a few characters the generic limits of these proposed divisions of the Diaptomidae. Gurney, 1929, discussed the matter somewhat elaborately, but did not make clear a practical method of separating the genera. This led the writer to go over the literature to see if he could find out how the authors used these names and whether it might be possible, in some fairly simple way, to make diagnoses of the genera. This was necessarily nothing but a study of the literature, as no material of these forms was available for examination. Such a critical study is always difficult because many published descriptions are incomplete and there is always a possibility, especially in the examination of minute structures, that there may be mistakes of observation, in making sketches, or of interpretation. When there is a discrepancy between authors, it may be assumed that the later author is right, although, of course, this would not always be true.

In 1847 Lovén proposed the generic name *Broteas* for a South African copepod giving a somewhat elaborate description with figures. This

[1] Received August 3, 1931.

differed from the recognized characteristics of *Diaptomus* in that the female abdomen was composed of two segments instead of three, the maxillipeds were long and powerful instead of rather weak and inconspicuous, the endopodites of the swimming feet were all two-segmented, while in *Diaptomus* the endopodites of the first feet are two-segmented and of the second, third, and fourth three-segmented, and the first antennae contained 27 segments instead of 25. The exopodite of the left 5th foot of the male was armed with a conspicuous hook, apparently terminal, and an acute spine.

In 1895 Sars described *Paradiaptomus lamellatus*, proposing the new genus *Paradiaptomus*. This, like *Broteas*, has two-segmented female abdomen and long and powerful maxillipeds; the endopodite of the maxilliped consisted of three segments instead of five as in *Diaptomus*. The swimming feet were like *Diaptomus*,—first foot two-segmented and the others of three segments. The exopodite of the left 5th foot of the male was armed with three spines.

In Giesbrecht and Schmeil, 1899, Schmeil proposed *Lovenula* in place of *Broteas*, since *Broteas* was preoccupied. His description was practically like that of Lovén, but he added that the endopodite of the maxilliped consisted of three segments. Thus the main distinction between *Lovenula* Schmeil, or *Broteas* Lovén, and *Paradiaptomus* Sars was that the endopodites of the swimming feet of *Lovenula* have *two segments*, while those in *Paradiaptomus* Sars are like those in *Diaptomus*, two-segmented in the first, and three-segmented in the others. Giesbrecht and Schmeil, 1898, diagnosed *Paradiaptomus* in accordance with the description of Sars as having the two-segmented female abdomen and three-segmented endopodite of the maxilliped as in *Lovenula* and the segmentation of the endopodites of the swimming feet as in *Diaptomus*.

Sars in 1899, from some collections in which he recognized, as he thought, the original species of Lovén, published a detailed description under the title "On the Genus *Broteas* of Lovén with Description of the Type Species: *Broteas falcifer* Lovén:" this description was accompanied with rather elaborate illustrations. He stated that Lovén was doubtless in error in the number of antennal segments which are 25 instead of 27. The last segment of the right antenna bears a small hook. The swimming feet, instead of having two-segmented endopodites, are like those in *Diaptomus*. He considered that these facts make *Broteas* identical with his *Paradiaptomus* and, as *Paradiaptomus* is the more recent name, he made it a synonym of *Broteas*.

Van Douwe, 1912, made some criticisms of preceding descriptions, but stated nothing that adds to our knowledge of the generic distinctions.

Gurney, 1904, in his description of "*Lovenula mea*" which is now considered identical with *Paradiaptomus falcifer* stated that the endopodites of the maxillipeds were *four*-segmented.

Brady, 1913, considered that *Paradiaptomus* should be used to include *Broteas* and *Lovenula*.

Grochmalicki, 1913, made *Paradiaptomus* Sars a synonym of *Lovenula* Schmeil, and listed 3 species of *Lovenula*, *L. falcifera* Loven, *L. lamellata* Sars, and *L. mea* Gurney. He added another species, *L. stolzmanni*.

Rühe, 1921, stated positively that the endopodite of the maxilliped of *Paradiaptomus* has *five* segments. Rühe claimed that Sars was in error in regard to the left fifth foot of the male; he stated that two spines are borne on the external margin of the second segment of the exopodite and a hyaline lamella on the internal margin; that there is a definite line separating the first and second segments which leave the spines on the second segment. Both Sars and Rühe make the left exopodite two-segmented, but they differ in the location of the division.

Sars, 1927, published descriptions of *Lovenula falcifera* and *L. barnardi*, and revived the genus name *Paradiaptomus* for *L. lamellatus*. In both *Lovenula* and *Paradiaptomus* he found the swimming feet like *Diaptomus*, the two-segmented female abdomen, and the endopodites of the maxillipeds *five-segmented*. He made *Paradiaptomus* somewhat different in form from *Lovenula*, the maxillipeds less powerfully developed, and no hook on the ultimate segment of the right male antenna.

Brehm, 1927, stated that the family Diaptomidae has only two genera, *Paradiaptomus* and *Diaptomus*, evidently discarding *Broteas* and *Lovenula*.

In 1906 Cooper proposed the name *Adiaptomus* for a species which he named *A. natalensis*. He stated that it has antennae of 26 segments, female abdomen of 2 segments, and his figure shows the male fifth foot of the same general form as that found in *Lovenula* Schmeil. The endopodites of the maxillipeds are three-segmented, and the swimming feet are like *Diaptomus*. There seems to be no reason for separating *Adiaptomus* from *Lovenula* except the 26-segmented antennae and possibly there was a mistake about this.

*Metadiaptomus* was proposed by Methuen in 1910 with the type species *M. transvallensis*. The antennae are of 26 segments, as stated for *Adiaptomus.* The female abdomen is three-segmented. The swimming feet are like *Diaptomus.* In the male fifth feet, fig. 3, the second basal segment of the right foot is very much enlarged on the inner border, and this border and part of the dorsal surface is spinose. The left exopodite of the male fifth foot is one- or possibly two-segmented and bears two processes, a strong curved spine on the dorsal surface which, in the type species, is nearly as long as the whole exopodite, and a small terminal spine.

Gurney, 1929, recognized the two genera *Paradiaptomus* and *Metadiaptomus,* dividing *Paradiaptomus* into a *Paradiaptomus* and a *Lovenula* series.

The various ideas about the genera are summarized in Table 1. *Diaptomus* is added for comparison.

It appears that the original descriptions of *Broteas* and *Lovenula* made them differ from *Diaptomus* in the prominence of the maxillipeds, the segmentation of the swimming feet, the female abdomen, and the endopodite of the maxilliped. *Paradiaptomus* Sars 1895 differs from *Broteas* Lovén and *Lovenula* Schmeil in having the swimming feet like those of *Diaptomus,* and in the structure of the exopodite of the left 5th foot of the male. In regard to the segmentation of the endopodite of the maxilliped there has been a progressive change in authors' statements, the more recent making it five, like *Diaptomus.* If we assume, as one naturally would, that the later authors are more correct, it is probable that we should consider that this segmentation is five. It appears, however, that while the division of this endopodite in *Diaptomus* is clearly in five segments they are not so clearly marked in the other genera and hence have been sometimes overlooked. The maxilliped is highly developed and conspicuous in *Paradiaptomus, Lovenula,* and *Broteas,* and inconspicuous in *Diaptomus* and *Metadiaptomus.* There is a small hook on the ultimate segment of the right male antenna in *Broteas* and *Lovenula* of Sars and *Paradiaptomus* of Gurney.

The female abdomen in *Broteas, Paradiaptomus, Lovenula,* and *Adiaptomus* is 2-segmented, while in *Diaptomus* and *Metadiaptomus* it is 3-segmented. This is not a hard and fast distinction, however, for a few species of *Diaptomus* have 2-segmented abdomens. Sars writes of some *Diaptomi* in which the female abdomen has the last two segments "confluent." One might raise the question whether, in such cases, if they were "confluent," it might not be better to consider the abdomen to be two-segmented.

There are differences in the male fifth feet which help materially in distinguishing the genera. As shown in the copy of Sars' figure of the fifth feet of *Broteas falcifer* (Fig. 1), which now should be called *Lovenula,* the left exopodite has a well developed terminal hook and an acute spine. The left endopodite is either lacking or rudimentary.

TABLE 1. SUMMARY OF CHARACTERS

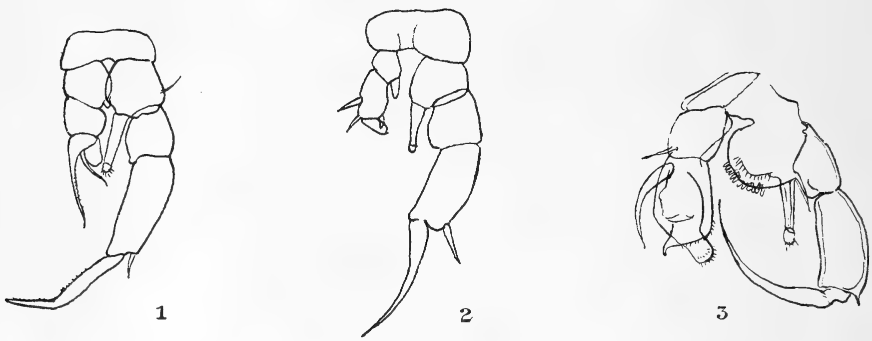
| | Swimming feet | Female Abd. | Endop. Maxilliped | Ult. seg. male rt. ant. | Armature left endop. of male 5th ft. |
|---|---|---|---|---|---|
| Broteas Loven 1847 | 1–4, 2 seg. | 2 seg. | | | Hook & acute spine. |
| Paradiaptomus Sars 1895 | 1, 2 seg.<br>2–4, 3 seg. | 2 seg. | Prominent,<br>Endop. 3 seg. | | 3 stout spines. |
| Lovenula Schmeil 1898 | 1–4, 2 seg. | 2 seg. | Prominent,<br>Endop. 3 seg. | | Hook & acute spine. |
| Paradiaptomus 1898 | 1–2 seg.<br>2–4, 3 seg. | 2 seg. | Prominent,<br>Endop. 3 seg. | | 3 spines. |
| Broteas Sars 1899 | 2–4, 3 seg. | 2 seg. | Prominent,<br>Endop. 3 seg. | Ter. hook. | Hook & acute spine. |
| Lovenula Gurney 1904 | | | Prominent,<br>Endop. 4 seg. | | Hook & acute spine. |
| Paradiaptomus Brady 1913 | | 2 seg. | | | Hook & acute spine. |
| Paradiaptomus Rühe 1921 | | | Prominent,<br>Endop. 5 seg. | | 2 spines & hyaline lam. |
| Lovenula Sars 1927 | 2–4, 3 seg. | 2 seg. | Prominent,<br>Endop. 4 seg. | Ter. hook | Hook & acute spine. |
| Paradiaptomus 1927 | 2–4, 3 seg. | | Prominent,<br>Endop. 4 seg. | | 3 spines. |
| Paradiaptomus, including Lovenula, Gurney 1929 | | 2 seg. | Prominent,<br>Endop. 5 seg. | Ter. hook | |
| Adiaptomus Cooper 1906 | 2–4, 3 seg. | 2 seg. | Endop. 3 seg. | | Hook & spine. |
| Metadiaptomus Methuen 1910 | 2–4, 3 seg. | 3 seg. | | | Large curved spine on posterior surface. Small spine near end. |
| Diaptomus | 2–4, 3 seg. | 3 seg. | Not prominent<br>Endop. 5 seg. | | |

*Paradiaptomus* Sars, as shown in his figure of *P. lamellatus* (Fig. 2) has a distinct left endopodite and the exopodite is armed either with three rather stout spines, as stated by Sars, or with two spines and a hyaline lamella according to Rühe.

*Adiaptomus* has male fifth feet like *Lovenula*. *Metadiaptomus*, as shown in the figure from Methuen of *M. transvaalensis* (Fig. 3), has a stout curved spine on the posterior face of the exopodite and a smaller terminal spine. In addition, the second basal segment of the right foot is much enlarged on the inner side and the inner border and part of the posterior surface is armed with spinules.

The following suggestion then is made for distinguishing between these genera:

*Lovenula* Schmeil has 2-segmented female abdomen, prominent maxillipeds, the left exopodite of the male fifth foot armed with a terminal hook and an acute spine.



1 2 3

Fig. 1. Fifth foot of male of *Lovenula falcifera*. After Sars.
Fig. 2. Fifth foot of male of *Paradiaptomus lamellatus*. After Sars.
Fig. 3. Fifth foot of male of *Metadiaptomus transvaalensis*. After Methuen.

*Paradiaptomus* Sars has 2-segmented female abdomen, prominent maxillipeds, the left exopodite of the male fifth root armed with 2 stout spines and a hyaline lamella.

*Metadiaptomus* has 3-segmented female abdomen, maxillipeds not prominent, the left exopodite of the male fifth foot armed with a curved spine on the posterior surface and a small terminal spine. The second basipodite of the right male fifth foot is enlarged on the inner side and spinulose.

*Adiaptomus* is a synonym of *Lovenula*.

*Lovenula* will include *Broteas falcifer* Loven 1847, *Lovenula excellens* Kiefer 1921, *Adiaptomus natalensis* Cooper 1906, *Diaptomus bouvieri* Daday 1910, *Paradiaptomus biramata* Lowndes 1930, *P. biramata* Rühe 1921, *P. biramata* Van Douwe 1912, *Broteas falcifer* Sars 1899, *Lovenula falcifera* Sars 1927, *L. barnardi* Sars 1927, *Paradiaptomus falcifer* Brady 1913, *Lovenula* Giesbrecht & Schmeil 1898, *Broteas falcifer* Metheun 1910, *Lovenula mea* Gurney 1904, *Diaptomus africanus* Daday 1908, *D. aethiopicus* Daday 1908, *Lovenula simplex* Kiefer 1929, *Diaptomus pictus* Brady 1913 (which as suggested by Gurney 1929 is probably a synonym of Cooper's *Adiaptomus natalensis*), and possibly *Diaptomus alluaudi* DeGuerne & Richard 1890 (but female has 3-segmented abdomen).

*Paradiaptomus* will include *Paradiaptomus lamellatus* Sars 1895, *P. lamellatus* Rühe 1921, *P. lamellatus* Giesbrecht & Schmeil 1898, *Broteas* lamellatus Sars 1899, *Paradiaptomus lamellatus* Sars 1927, and *Lovenula stolzmanni* Grochmalicki 1913.

*Metadiaptomus* will include *M. transvaalensis* Methuen 1910, *Paradiaptomus transvaalensis* Kiefer 1929, *Paradiaptomus colonialis* Kiefer 1928, *Diaptomus meridianus* Van Douwe 1912, *D. mascalus* Brady 1913, *D. capensis* Sars 1901, *D. purcelli* Sars 1901, *D. chevreuxi* De Guerne & Richard 1894, *D. alluaudi* De Guerne & Richard 1890, *D. rigidus* Sars 1927, Probably *D. asiaticus* Uljanin 1875, *D. rehmanni* Grock 1913, and *D. tibetanus* Daday 1908.

*Diaptomus greeni* Gurney 1907, called *Paradiaptomus greeni* Gurney 1931, and the two species described by Van Douwe 1912 as *Paradiaptomus schultzei* and *P. similis*, are considered as probably *Diaptomi*. Gurney 1907 stated that the female abdomen in *D. greeni* was 3-segmented. Van Douwe stated that the female abdomen was 2-segmented in *Paradiaptomus schultzei* and *P. similis*. Gurney, 1931, reported as the result of an examination of new material of *P. similis* that the female abdomen is 3-segmented: this would be presumptive evidence that these forms should be considered as *Diaptomi*. It seems probable, moreover, that *P. schultzei* and *P. similis* are not specifically distinct and should be considered as synonymous.

As pointed out by Gurney, 1929, it is sometimes difficult to separate these genera. The typical large, curved spine on the posterior surface of the exopodite of the male fifth foot in *Metadiaptomus* may be much smaller in some species and may be found more distad on the exopodite until it is sometimes difficult to decide whether it should be considered as located on the posterior surface or as terminal. That is, the terminal hook of *Lovenula* is doubtless homologous with the curved spine of *Metadiaptomus*. Probably it is also homologous with the "external" spine of *Paradiaptomus*.

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ZOOLOGY.—Metagonimoides oregonensis, *a new trematode from a raccoon.*[1] EMMETT W. PRICE, Bureau of Animal Industry, United States Department of Agriculture. (Communicated by ELOISE B. CRAM.)

Among some specimens recently referred to the writer by Dr. D. Sinitsin were a few specimens of a trematode which had been collected by Dr. J. N. Shaw, Oregon State College, Corvallis, Oregon, from the intestine of a raccoon. This fluke is closely related to species of the heterophyid genus *Metagonimus* Katsurada, but differs from them in certain characters which are regarded as sufficient to warrant the erection of a new genus. For this form the name *Metagonimoides oregonensis.* n.g., n. sp., is proposed.

### **Metagonimoides** new genus.

*Generic diagnosis.*—Heterophyidae: Body piriform in outline, strongly flattened dorso-ventrally. Oral sucker terminal; acetabulum well developed, lateral, directed antero-medially, and opening into a shallow genital sinus as in *Metagonimus.* Seminal vesicle slender and showing several constrictions. Testes oval, situated opposite each other at posterior end of body. Ovary irregular in shape, pretesticular, slightly to right of median line; seminal receptacle well developed; Laurer's canal present. Vitellaria lateral, extending from level of base of pharynx to posterior end of body. Uterus S-shaped, never extending caudad of ovary. Excretory vesicle Y-shaped, with short, wide stem and relatively short branches. Parasitic in intestinal tract of mammals.

*Type species.*—*Metagonimoides oregonensis* new species.

### **Metagonimoides oregonensis** new species.

Figs. 1, 2.

*Description.*—*Metagonimoides:* Body piriform in outline, 589 to 688$\mu$ long by 573 to 852$\mu$ wide, strongly flattened dorso-ventrally. The cuticle is missing in all specimens available and it is not possible to determine whether spines are present or not. Oral sucker cup-shaped, 93 to 114$\mu$ in diameter, terminal

[1] Received August 3, 1931.

in position, and with its aperture slightly subterminal; prepharynx very short; pharynx strongly muscular, 77 to 109$\mu$ long by 46 to 93$\mu$ wide; esophagus short and slender; intestinal cæca slender and extending to posterior end of body. Acetabulum 124 to 233$\mu$ in diameter, situated in equatorial zone at right side of body, its aperture directed antero-medially and opening into a shallow genital sinus. Opening of genital sinus irregular and with two papilla-like ridges projecting into sinus, the larger of these ridges situated at postero-median border and the smaller situated at anterior margin. These structures have been interpreted by Witenberg[2] as a modified gonotyl or so-called genital

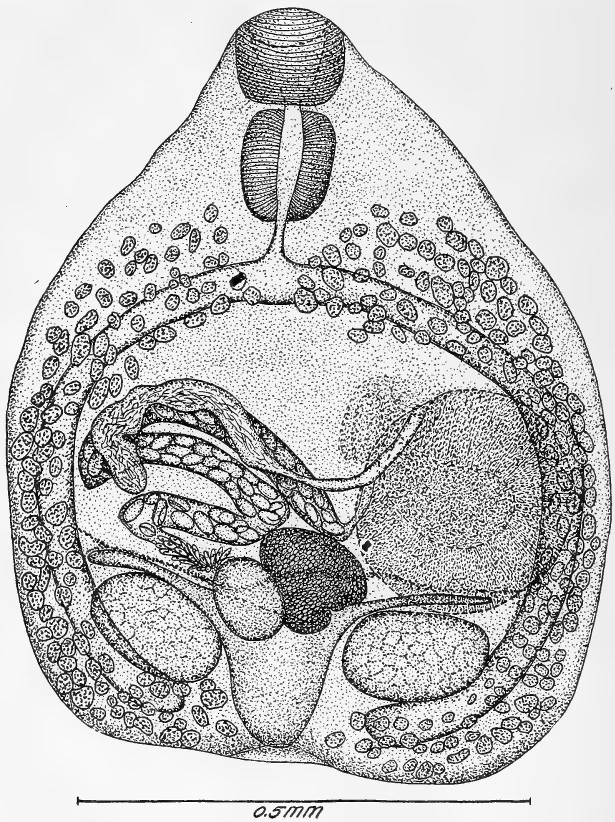


Fig. 1.—*Metagonimoides oregonensis* Price. Dorsal view.

sucker. No cirrus pouch present. Seminal vesicle slender, shaped somewhat like a transversely placed interrogation mark, and lying dorsal to uterus in left lateral field. Hemaphroditic duct opens into genital sinus at base of anterior ridge-like papilla. Testes oval, 112 to 150$\mu$ by 150 to 200$\mu$, and situated opposite each other in posterior part of body, their median border being separated by the stem of excretory vesicle. Ovary more or less irregular in outline, at posterior border of acetabulum in some specimens and median

[2] G. Witenberg. *Studies on the trematode-family Heterophyidae.* Ann. Trop. M. and Parasit., Liverpool. **23**: 131–239, figs. 1–33. 1929.

to it in others; Laurer's canal present. Vitellaria lateral and composed of medium sized follicles which extend from level of posterior end of pharynx to posterior end of body; they are separated anteriorly and posteriorly by a narrow space. Uterus relatively short and forming a low S-shaped loop which lies chiefly in left lateral field; it does not extend caudad of ovary as in the case of *Metagonimus.* Eggs oval, 33$\mu$ long by 18$\mu$ wide, golden yellow in color. Excretory vesicle Y-shaped, with wide stem and relatively short, slender branches; excretory pore terminal.

*Host.*—*Procyon lotor.*

*Location.*—Small intestine.

*Distribution.*—United States (Corvallis, Oregon).

*Specimens.*—U. S. National Museum Helminthological Collection No. 30862 (type and paratypes).

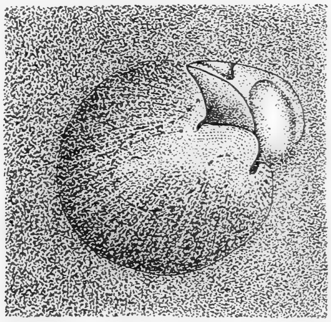

Fig. 2.—*Metagonimoides oregonensis* Price. Acetabulum and genital sinus. Ventral view.

This trematode is distinguished from species of *Metagonimus* (*M. yokogawai* (Katsurada), and *M. ciureanus* (Witenberg) ( = *Dexiogonimus ciureanus* Witenberg) by the distribution of the vitellaria and the course of the uterus. In *Metagonimus* the vitellaria do not extend anteriorly beyond the ovarial zone and the uterine coils extend caudad of the ovary and seminal receptacle, while in *Metagonimoides* the vitellaria extend as far anteriorly as the pharynx and the uterine coils do not extend caudad of the ovary and seminal receptacle.

## SCIENTIFIC NOTES AND NEWS

### Sixteenth International Geological Congress

According to a circular letter recently issued by the committee on organization of the International Geological Congress, the sixteenth session will meet in Washington in June, 1933. The following topics for discussion have been proposed:

Measurement of geologic time by any method.
Batholiths and related intrusives.
Zonal relations of metalliferous deposits.
Major divisions of the Paleozoic system.

Geomorphogenic processes in arid regions and their resulting forms and products.
Fossil man and contemporary faunas.
Orogenesis.

It is planned to offer the following excursions before the sessions:

A-1. An 11-day tour of eastern New York and western New England by bus, starting from New York City.

A-2. A 12-day tour of the mining districts of the southern Appalachians and the Mississippi Valley by special train from Washington.

A-3. A 10-day trip by bus through the Appalachian Valley in Virginia and portions of bordering States, from Washington.

A-4. A 10- or 11-day tour of northern New York by bus, from Albany.

A-5. A 10-day trip by boat to classic Cretaceous, Tertiary, and Pleistocene localities on Potomac River and Chesapeake Bay, from Washington.

A-6. An 11-day trip by train from Washington to the oil fields of Oklahoma and Texas.

A-7. A 5-day trip by bus from New York to Washington, primarily for geomorphologists.

A-8. A 4- or 5-day trip from New York to Washington by bus, primarily for economic geologists.

A-9. A transcontinental excursion, lasting 12 or 14 days, from San Francisco to Washington.

There will also be a series of 12 short excursions of one or two days length, starting from New York. Some of these will be offered before and others after the "A" series of excursions.

It is proposed to devote three days during the session to short excursions to points of interest near Washington.

The following excursions after the session are planned:

C-1. A transcontinental excursion by special train from Washington, 35 days. The major features of this excursion will be a series of side trips, generally by bus, to points of particular interest.

C-2. A transcontinental excursion by train from Washington, 35 days. This excursion has been planned so as to give a general cross section of the geology of the United States. The main emphasis is on regional and structural geology, physiography, and Tertiary stratigraphy, including volcanics.

C-3. A 10-day excursion by train to Chicago, thence by bus, to study the glacial geology of the Central States.

C-4. A 10- or 11-day excursion to the iron and copper deposits of the Lake Superior region.

C-5. A 35-day transcontinental excursion from New York or Washington to San Francisco by airplane with return by train, primarily for geomorphologists.

Copies of the circular, which contains detailed information regarding these excursions, may be obtained from the General Secretary, Sixteenth International Geological Congress, U. S. Geological Survey, Washington, D. C.

## OFFICIAL COMMUNICATIONS

### THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

#### Announcements of Meetings

| | |
|---|---|
| Tuesday, October 6 | The Botanical Society |
| Wednesday, October 7 | The Washington Society of Engineers |
| | The Medical Society |
| Thursday, October 8 | The Chemical Society |
| Saturday, October 10 | The Philosophical Society |
| Tuesday, October 13 | The American Institute of Electrical Engineers |
| Wednesday, October 14 | The Geological Society |
| | The Medical Society |
| Thursday, October 15 | The Academy |
| Saturday, October 17 | 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:* N. A. Cobb, Bureau of Plant Industry.
*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*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.

Vol. 21 October 19, 1931 No. 17

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OF THE

# WASHINGTON ACADEMY OF SCIENCES



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## 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.

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*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. 21 OCTOBER 19, 1931 No. 17

CHEMISTRY.—*Further studies of kolm.*[1] R. C. WELLS and R. E. STEVENS, U. S. Geological Survey.

INTRODUCTION

Swedish kolm, a material resembling oil shale, has recently become of special interest as one of the very few substances whose age can be determined both from fossils and from the lead-uranium ratio. Interest in this material has been stimulated by Professor A. C. Lane, Chairman of the National Research Committee on the Measurement of Geologic Time by Atomic Disintegration, through whose efforts various studies have been made of it, including those described in this paper. One of the significant results is that the lead extracted from the kolm is the purest uranium lead so far found; its atomic weight determined at Harvard by Baxter and Bliss[2] is 206.008, whereas that of ordinary lead is 207.218.

According to Sjögren[3] kolm was known to Cronstedt as early as 1758. It occurs in limestone and alum shale quarries in the form of ellipsoidal nodules several decimeters thick. It was studied chemically by Nordenskiöld,[4] who also sent a sample to Prof. Winkler at Freiberg in 1901. Winkler found the combustible contents of the kolm to occur in the same proportions as in anthracite (about 5 per cent O, 88 per cent C, and 7 per cent H). He also confirmed the presence of free nitrogen (0.50 per cent). The ash consisted mostly of $SiO_2$, $Al_2O_3$, and $Fe_2O_3$, with small quantities of MnO, MgO, CaO, alkalies, and $U_3O_8$. Nordenskiöld had earlier found sulphur, uranium, and small proportions of nickel, cobalt, copper, molybdenum, vanadium, and the cerium and gadolinium earths. Miss Naima Sahlbom,

[1] Published with the permission of the Acting Director, U. S. Geological Survey. Received August 26, 1931.

[2] Baxter and Bliss. Jour. Am. Chem. Soc. **52**: 4848. 1930.

[3] Hj. Sjögren. Arkiv. Kemi, Mineral. och. geol., Stockholm, 1905, Band 2, Häfte 5, pp. 1–6.

[4] Nordenskiöld. Compt. rend. **120**: 859. 1895.

assistant to Sjögren, identified barium, lead, tin, and lithium in the kolm.

Our sample of kolm, which was received through Professor A. H. Westergaard, was "collected from the middle and lower parts of the Peltura beds of the shale quarry of Gullhogen near Skovde in the province of Westergötland. These beds we consider to be of Cambrian age. Undoubtedly they are of pre-Ordovician age, as the overlying bed is formed by alum shale with *Dictyonema flabelliforme* Elchw." The beds are therefore of Upper Cambrian age.

Some of this material gave roughly 1.8 per cent moisture, 29.5 volatile matter, 43.6 fixed carbon, and 35.1 ash, according to the U. S. Bureau of Mines. Mr. M. F. Connor kindly determined the approximate composition of the ash to be $SiO_2$ 48.68 per cent, $Al_2O_3$ 20.34, $Fe_2O_3$ 20.00, CaO 0.90, MgO 1.40, $Na_2O$ 0.60, $K_2O$ 5.84, $SO_3$ 0.62, $TiO_2$ 0.20, $P_2O_5$ 0.15, undetermined 1.27, with S in the kolm 4.74, and Fe 3.85, as pyrite. Later tests (by R. C. Wells) showed about 0.003 per cent $V_2O_5$, referred to the kolm, about 0.04 ZnO, 0.13 rare earths, 0.013 Mo, 0.003 MnO, 0.004 NiO and no Zr, Be, or Th. The ash was 31.25 per cent of the weight of the kolm used in the final work. Bismuth and cobalt were not noted, though they might have been present. Titanium and phosphorus were not mentioned by Sjögren.

The uranium in the kolm is supposed by Lindgren to have been segregated by organisms. It appears to be free from thorium. Its percentage was carefully determined by Mauzelius.[5] Later determinations with the electroscope by one of us, also by S. C. Lind, R. B. Moore, and Herman Schlundt, who used the emanation method, indicated somewhat less uranium than that found in the regular analytical way. The cause of this slight discrepancy is not yet entirely clear. Part of the difficulty, however, may consist of freeing the uranium entirely from silica and alumina, or, if the cupferron or titration methods are used, of avoiding the presence of zinc or overreducing the uranium solution previous to titration.

## ANALYTICAL DETERMINATIONS

The principal object of the analytical work was to determine the age of the kolm from the ratio of lead to uranium. As the percentages were small this work was very laborious and time consuming. In general the method consisted of (1) getting all the lead in one portion, (2) all the uranium in another portion, and (3) separating each in a pure and determinable form. The method finally used was as follows:

[5] R. Mauselins. Tekn. Tidskr., Uppl. C, Kemi och Bergvet, H. 2, 1914.

About 50 grams of a large finely powdered uniform sample (originally prepared by R. B. Moore) was gently ignited in a platinum dish. The ash was treated with water, about 23 ml. of sulphuric acid, and an excess of hydrofluoric acid and evaporated to fumes. The residue was dissolved in water and again heated to fumes. It was then again dissolved, transferred to a flask, made up to 500 ml., saturated with hydrogen sulphide, heated, cooled, again saturated with hydrogen sulphide, and allowed to stand at least overnight. The solution was then filtered and the precipitate well washed with water containing hydrogen sulphide, whereby all the lead was separated in the impure precipitate from all the uranium in the filtrate with most of the iron and aluminum.

The precipitate containing the lead sulphide was extracted on the filter paper with hot dilute hydrochloric and nitric acids and the solution set on the steam bath to evaporate. The insoluble part, after gently burning off the filter paper, was fused with sodium carbonate, leached with water, and the solution filtered and discarded. The precipitate was dissolved in hot dilute hydrochloric acid, nearly neutralized with sodium carbonate with litmus paper, and heated just to boiling, whereby much of the titanium was precipitated almost free from lead. This was filtered off and the lead in the filtrate precipitated with hydrogen sulphide as before, finally dissolved, and added to the main solution of lead nitrate. The titanium precipitate was reworked by the sulphate method to recover the small quantity of lead in it. All the filter papers used were finally ignited, the ash fused with sodium carbonate, and any lead present recovered in the usual way. The final solution containing all the lead was heated to fumes with a small excess, 0.2 or 0.4 gram, of sulphuric acid, diluted about 20 times, allowed to stand overnight, and filtered, whereby molybdenum and copper were removed. The lead sulphate was then dissolved in hot ammonium acetate solution and the solution allowed to stand overnight and filtered. After collecting traces of lead from all remaining ignited filter papers by means of a fusion, separation as sulphate, and solution in ammonium acetate, the total lead was again precipitated as sulphide, filtered off, dissolved in nitric acid, and converted to sulphate in a weighed porcelain crucible. From this weight was calculated the percentage of lead.

The filtrate containing the iron, aluminum, and uranium was heated with nitric acid to oxidize the iron, neutralized with ammonia, precipitated with ammoniacal ammonium carbonate in excess, and filtered. Two reprecipitations were made to extract all of the uranium. The combined filtrates were evaporated to small bulk, heated with an excess of nitric acid for some time to destroy ammonium salts, diluted, precipitated with ammonia, and the filtrate containing calcium discarded.

The uranium precipitate was tested for rare earths by means of hydrofluoric acid at this point, but no precipitate was obtained. The uranium was then converted to sulphate, diluted to 150 ml., neutralized with sodium carbonate, and an excess of 1.5 grams of sodium bicarbonate added. After heating to boiling the precipitate was filtered off, dissolved in nitric acid, and reprecipitated. As a small quantity of uranium seemed to be persistently retained by the precipitate in some tests the precipitate was dissolved in hydrochloric acid, evaporated nearly to dryness, sodium chloride added, then potassium ferrocyanide in excess. On filtering the precipitate off, washing, transposing with hot sodium hydroxide solution, filtering, washing, dissolving in nitric acid, and treating again with sodium carbonate and bicarbonate the remaining quantity of uranium passed into the filtrate and was recovered and added to the main portion, which was again converted to sulphate.

The solution was brought to 12 per cent by volume of sulphuric acid, then, after cooling in ice water, a solution of cupferron was added. The small precipitate was filtered off, the cupferron in the filtrate destroyed by nitric acid, the uranium reduced in 4 per cent sulphuric acid in a zinc reductor, brought to 6 per cent sulphuric acid, then precipitated by cupferron, filtered off and ignited. This material was dissolved in nitric acid, a slight quantity of insoluble material filtered off, the solution diluted, boiled, and cooled and the uranium again precipitated with ammonia to eliminate zinc sulphate, filtered off, ignited and weighed as $U_3O_8$. From the weight was calculated the percentage of uranium, as shown in Table 1.

TABLE 1.—LEAD-URANIUM RATIO OF THE KOLM.
(By R. C. Wells.)

| *Experiment* | *Pb* *Per cent* | *U* *Per cent* |
|---|---|---|
| 1. . . . . . . . . . . . . | 0.0261 | — |
| 2. . . . . . . . . . . . . | — | 0.440 |
| 3. . . . . . . . . . . . . | .0264 | — |
| 4. . . . . . . . . . . . . | .0268 | .412 |
| 5. . . . . . . . . . . . . | — | .442 |
| 6. . . . . . . . . . . . . | — | .425 |
| Weighted mean. . . . . . . . . . | 0.0264 | 0.432 |

Pb:U = 0.061

The figure for U in experiment 4 is given only half weight, as presumably some uranium was lost.

Owing to uncertainties in the factor a simple formula will suffice to calculate the age for the present.

$$\text{Age} = \frac{\log (U + 1.156\ Pb) - \log U}{6.5 \times 10^{-5}} \text{ million years}$$

This gives 458 million years, which is a little lower than the figure generally ascribed to the Cambrian, 500 to 600 million years, thus tending very slightly to shorten up the Paleozoic and bring the pre-Cambrian a little nearer.[6]

[6] After the work described above was completed some tests of the precipitation of uranous salts by cupferron made by J. G. Fairchild in the Survey laboratory indicated that the results tend to come a little low, possibly as much as 4 or 6 milligrams of $U_3O_8$. The question needs further study, and by several analysts. If a correction on this account is applicable it might raise the uranium percentage given above to 0.445, but the size of the correction is not yet definitely established and it should not be applied until the matter is investigated in greater detail.

## PERMEABILITY OF THE KOLM TO GASES

(R. E. Stevens)

The low results generally found for the age of minerals by the helium-lead ratio, and usually ascribed to a loss of helium, made it of interest to see how permeable the kolm might be to gases.

For the measurement of diffusion through kolm use was made of the apparatus previously described by one of us.[7] It consists essentially of two glass chambers between which is sealed the specimen to be tested. After the apparatus has been evacuated, one of the chambers is filled with gas at atmospheric pressure. By means of manometer tubes readings are taken, at intervals, of the pressure in each chamber, from which the volume of gas diffused and the permeability of the sample may be calculated.

The very small permeability of the kolm made the presence of leaks a grave source of error, and much time and care was taken in assembling and testing the apparatus. The specimen of kolm was sealed between the two chambers and the junction heavily coated with sealing wax. Two coats of shellac were added. Both chambers were then evacuated and pressure readings taken over a four-day period, showing an increase in pressure of 3 mm. The pressure seemed to reach a steady value after one day, and it appeared evident that the change was due to escape of gas held within the kolm. For this reason the apparatus was first allowed to stand evacuated for a day before making a determination.

Decreasing the size of the chambers in order to increase the sensitivity made it necessary to determine, in each test, the change in volume due to displacement in the mercury columns. The size of manometer tubes was measured, as well as the volume of the chambers, so that corrections could be applied.

In conjunction with the readings of the mercury columns, the temperature and barometric pressure were noted, pressure within the chambers being obtained by difference. The volume of gas in each chamber was then reduced to standard conditions. Decreases in volume in one of the chambers were in good agreement with increases in the other. and an average was taken as the volume of gas diffused.

The results of experiments with air and with hydrogen are given in Table 2. In the last column is tabulated the permeability constant, $k$, for the kolm. In the formula for $k$, $V$ is the volume of gas diffused, $L$ and $A$ the length and area, respectively, of the kolm specimen, $M$

[7] R. C. Wells. This JOURNAL **19**: 321. 1929.

the molecular weight of the gas, $p_1 - p_2$ the average pressure gradient in atmospheres, and $T$ is the time in hours.

There is a small difference in the value of $k$ obtained with the two gases. This may be due in part to the fact that air is a mixture of gases and some fractionation may have occurred. Another small variation may be caused by the relative viscosities of the two gases.

A conception of the dense nature of kolm is obtained by comparison with the previous study[8] of diffusion through ball clay with the same apparatus. The value of $k$ for ball clay was found to be over 600,

TABLE 2.—PERMEABILITY OF KOLM TO GASES
(By R. E. Stevens.)

| Gas used | Time (hours) | At right of plug | | At left of plug | | Volume, V, diffused at 760 mm. (ml.) | Average pressure gradient in atmospheres $(p_1 - p_2)$ | $k = \frac{VLM}{(p_1 - p_2) A.T.}$ |
|---|---|---|---|---|---|---|---|---|
| | | Pressure, $p_1$ (mm.) | Volume at 760 mm. and 0°C. (ml.) | Pressure, $p_2$ (mm.) | Volume at 760 mm. and 0°C. (ml.) | | | |
| Air | 0 | 0.5 | 0.01 | 764 | 58.5 | | | |
| | 48 | 113.0 | 7.61 | 675 | 51.1 | 7.40 | 0.87 | 0.032 |
| | 24 | 154.0 | 10.40 | 640 | 48.0 | 2.95 | .69 | .033 |
| | 24.5 | 189.0 | 12.90 | 611 | 45.6 | 2.45 | .60 | .031 |
| | 23.5 | 217.0 | 14.80 | 583 | 43.3 | 2.10 | .52 | .032 |
| Hydrogen | 0 | 2.0 | 0.13 | 767.5 | 58.9 | | | |
| | 4 | 38.0 | 2.52 | 742.5 | 56.8 | 2.25 | .968 | .028 |
| | 20 | 157.0 | 10.66 | 649.5 | 48.9 | 8.00 | .788 | .025 |
| | 24 | 246.5 | 17.00 | 564.0 | 41.8 | 6.70 | .533 | .026 |
| | 48 | 341.0 | 23.92 | 477.5 | 35.0 | 6.85 | .299 | .023 |

Molecular weight of air = 29.0 Molecular weight of hydrogen = 2.02
Dimensions of kolm: Diameter = 2.92 cm.; thickness = 0.23 cm.

with time expressed in hours, as compared with 0.03 for the kolm. Even with the small permeability found for kolm it is assumed that the gas must have passed through pores and not through the material of the kolm itself (as helium seems to pass through silica glass). Moreover the experiments were made at relatively low pressures after pumping out most of the moisture in the material.

## SUMMARY

1. The lead-uranium ratio of Swedish kolm is found to be 0.061, a figure that will enable Cambrian time to be dated when certain factors are determined more accurately. Provisionally it gives about 460 million years.

2. The kolm is found to have a very low permeability to gases, 0.03, as compared with 600 for a ball clay previously studied.

[8] *Loc. cit.* p. 325.

PALEONTOLOGY.—*Contributions to the paleontology of Peru, V.* Nodosaria pozoensis *W. Berry, n. sp.*[1] WILLARD BERRY. (Communicated by EDWARD W. BERRY.)

During the course of examining numerous well samples from the Tertiary of Northwest Peru, I commonly found separate chambers of a species of *Nodosaria.* Occasionally several were found together but more often they were widely scattered throughout the sample. In examining the samples from one well a larger piece of cutting yielded a nearly complete specimen. This specimen, which was slightly damaged in cleaning, was found in hard, gray, slightly sandy shale or "grada." This species is probably from the Negritos formation (?) of the Eocene. The exact horizon is questionable due to the lack of exact correlation of the wells in this older part of the Eocene.

This organism must have lived in fairly quiet waters as evidenced by its extremely weak structure. That the water was fairly deep or else was not affected by a large run off is shown by the fineness of the shale. The species may be described as follows.

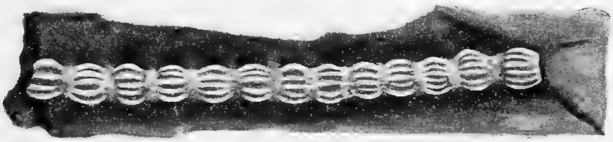


Fig. 1. *Nodosaria pozoensis* W. Berry, × 3.

**Nodosaria pozoensis** W. Berry, n.sp.

Test large elongate, very slightly curved, untapered, composed of more than 13 chambers, initial end rounded, (broken in cleaning type) apertural end always missing, sutures straight, distinct, depressed; walls costate, costae not running from chamber to chamber but stopping at each suture and not lining up exactly, the younger chambers having less costae, chambers inflate. Usually found as separate chambers.

Length, 10 mm.; diameter, 0.75 mm.

*Nodosaria pozoensis* has the general appearance of *N. raphanus* (Linnaeus) but lacks the pointed initial end and is larger with a larger number of costae on each chamber. This species is easily recognized even in the separate chambers by the heavy costae and the almost round character of the chambers.

Locality—Eocene well #1920, depth 1980 feet, Negritos, Peru.

[1] Work carried out under a grant in aid from the National Research Council. Received August 26, 1931.

ZOOLOGY.—*New pocket gophers from Arizona and Utah.*[1] E. A. GOLDMAN, U. S. Biological Survey.

During recent years many additional specimens of pocket gophers from typical regions and from localities tending to fill gaps in geographic ranges, as previously known, in Arizona and adjoining territory have been acquired. Study of this material has afforded a clearer concept of the status and relationships of the numerous forms inhabiting the highly diversified general area.

Leaving *Thomomys fossor,* a representative of a well marked group apart, out of consideration, the pocket gophers of Arizona are currently assigned to two groups. These are the "*perpallidus*" and "*fulvus*" groups respectively. In revising the genus *Thomomys* Bailey (North Amer. Fauna, No. 39, p. 33, Nov. 15, 1915) aligns these groups as follows: "The *perpallidus* group includes mainly pale desert forms with very small ears, but has no very distinctive group characters. . . . The *fulvus* group includes several mountain forms of rather bright tawny shades, and paler tawny valley forms in the surrounding country." He also says: "The *bottae* group is large, variable, and not sharply separated from the *perpallidus* and *fulvus* groups; all of them agree in number and arrangement of mammae, short ears, and many other characters."

Passing in review the material now available the writer is forced to the conclusion that not only are there no characters warranting the recognition of *T. perpallidus* and *T. fulvus* as separate groups, but they are united by forms so closely interrelated that even specific distinction disappears. Complete intergradation is evident in some cases and the kind and combination of characters presented indicate such close relationships that it can safely be assumed in others.

The ranges of a chain of forms connecting *perpallidus* and *fulvus* extend across the lower part of the Colorado River valley, interrupted by the river channel. The valley is inhabited on the two sides by forms that differ only slightly in average characters, some individuals being indistinguishable. This close alliance is readily understood when it is remembered that, from time to time, shifting channels along the lower Colorado transfer areas of considerable size from one side to the other.

[1] Received September 3, 1931.

The near relationship of *perpallidus* and *fulvus* is clear, but it seems best in the present faunal treatment of pocket gophers arbitrarily to draw a line between the two at the Colorado River rather than to invite the confusion that would result through an attempt to transfer all of the forms of *perpallidus* to *fulvus*, the older name. Incidentally, general comparisons strongly indicate that forms currently placed under *perpallidus* and *fulvus* may eventually have to be listed as subspecies of *bottae*, a still older name. In order to avoid confusion in describing new subspecies the following forms from east of the Colorado River currently assigned, except *cervinus*, to *perpallidus* are transferred to *fulvus:*

*Thomomys fulvus chrysonotus* Grinnell
Ehrenberg, Yuma County, Arizona.
*Thomomys fulvus cervinus* Allen
Phoenix, Maricopa County, Arizona.
*Thomomys fulvus aureus* Allen. . . Bluff City, San Juan County, Utah.
*Thomomys fulvus apache* Bailey
Lake La Jara, Jicarilla Indian Reservation, New Mexico.

Pocket gophers inhabit nearly every part of Arizona and adjoining territory, but the ranges even of subspecies are irregularly interrupted owing to rock formations, adverse soil, food, or other conditions. The multiplicity of forms appears to be the expression of environmental factors and the sedentary habits of the group. Some occupy extensive ranges and others are quite restricted. Habitats vary from alluvial river bottoms and sterile desert plains near sea level to high forested plateaus and rugged mountains, often rising abruptly to high elevations.

## Descriptions of New Subspecies

### **Thomomys fulvus flavidus** subsp. nov.

### Golden Pocket Gopher

*Type.*—From Parker, Yuma County, Arizona (altitude 350 feet). No. 181065, ♂ adult, U. S. National Museum (Biological Survey collection), collected February 1, 1913, by E. A. Goldman. Original number 21810.

*Distribution.*—Known only from alluvial bottom lands along the Colorado River in the vicinity of the type locality.

*General characters.*—A large ochraceous buff or golden yellowish subspecies with an angular, massive skull. Similar in color to *Thomomys fulvus chrysonotus* (somewhat paler than the type), but upper parts clearer ochraceous buff; under parts, especially inguinal region, and hind limbs all around irregularly marked by pure white areas, the white extending to roots of hairs (these parts in *chrysonotus* plumbeous basally); skull very similar but exhibiting a departure in detail. Allied to *Thomomys fulvus desertorum* but larger, much paler and cranial characters distinctive. Very similar in general color and superficially resembling the geographically removed form, *Thomomys fulvus aureus;* upper parts more uniform rather pale ochraceous buff (varying to richer buffy tones, with dorsum moderately overlaid with black in *aureus*); under parts with irregular white markings (normally absent in *aureus*); skull more angular and massive and differing in important details.

*Color.*—*Type* (winter pelage): Upper parts near ochraceous buff or golden yellow, the back scarcely modified by dark-tipped hairs, becoming light ochraceous buff on sides; under parts in general overlaid with light ochraceous buff, the basal color plumbeous, irregularly and extensively invaded on inguinal region by pure white, the white extending to roots of hairs and including hind limbs all around; a pure white pectoral spot; black auricular spots small, not reaching anterior part of ear; feet and tail thinly clothed with whitish hairs. *Young* (in first pelage): Light ochraceous buff above, creamy white below.

*Skull.*—Very similar in general to that of *T. f. chrysonotus,* but larger; supraoccipital region indented mesially and more distinctly concave in transverse section over foramen magnum; auditory meatus opening more widely; mastoid process of squamosal less deflected forward; auditory and mastoid bullae large and fully inflated and dentition heavy as in *chrysonotus.* Similar to that of *T. f. desertorum* but larger, more angular and massive; auditory and mastoid bullae larger, more fully rounded; mastoid bullae more swollen and bulging posteriorly, and less broadly overlapped by exoccipitals; dentition similar but heavier. Compared with that of *T. f. aureus* the skull is similar in size, but more angular and massive; maxillary arm of zygoma heavier; nasals longer and broader posteriorly; ascending branches of premaxillae narrower, more tapering posteriorly; pterygoids broader; interpterygoid space more narrowly V-shaped (more or less distinctly U-shaped in *aureus*); auditory meatus opening more widely; paroccipital process in adult male more strongly overlapping auditory bulla; bullae large and swollen, and dentition much as in *aureus.*

*Measurements.*—*Type:* Total length, 249 mm.; tail vertebrae, 83; hind foot, 33. Average of three adult male topotypes: 238 (232–250); 75 (66–86); 33.5 (32.5–34.5). Average of nine adult female topotypes: 221 (210–236); 70 (57–78); 32 (31–32.5). *Skull* (type): Condylobasal length, 41.7; zygomatic breadth, 27.2; greatest breadth across squamosals (over mastoids), 21.8; interorbital constriction, 6.8; length of nasals, 15; alveolar length of upper molariform tooth row, 8.8.

*Remarks.*—The clear, nearly uniform golden yellowish general color and extensive pure white areas irregularly invading the under parts and usually involving both hind legs well up toward the hips all around distinguish this form externally from its near relatives. It bears a rather close superficial resemblance to *aureus,* but the ranges of the two are completely separated by those of interposed forms.

*Specimens examined.*—Sixteen, all from the type locality.

### **Thomomys fulvus modicus** subsp. nov.

*Type.*—From La Osa (near Mexican Boundary), southern end of Altar Valley, Pima County, Arizona. No. 59203, ♂ adult, U. S. National Museum, collected by E. A. Mearns and F. X. Holzner, December 14, 1893. Original number 2681.

*Distribution.*—Desert plains and valleys of central southern Arizona, and probably adjoining parts of Sonora, Mexico.

*General characters.*—Closely allied to *Thomomys fulvus cervinus* of the Salt River Valley, but smaller, color darker, near wood brown instead of vinaceous buffy or fawn color in winter pelage; cranial characters distinctive. Related to *Thomomys fulvus chrysonotus* of the lower Colorado River Valley, but prevailing color wood brownish instead of pale ochraceous buffy; skull differing in detail. Similar in general to *Thomomys fulvus toltecus* of Chihuahua, but color duller, wood brownish instead of rich ochraceous buffy in winter pelage; skull more slender in form.

*Color.*—*Type* (winter pelage); Upper parts near wood brown, purest along sides, thinly overlaid with dusky on head and over back; under parts pale ochraceous buffy, the plumbeous basal color showing through; ears encircled by conspicuous deep black areas; forearms, feet, and tail whitish. Some specimens in worn summer pelage are rich ochraceous buffy above.

*Skull.*—Similar in general form to that of *T. f. cervinus* but smaller and of slenderer proportions; rostrum narrower, more constricted or compressed laterally in front of zygomata; nasals narrower; jugal shorter. Compared with those of *T. f. chrysonotus* and *T. f. toltecus* the skull is less massive than either; maxillary arm of zygoma sloping more strongly backward; jugal shorter, the result being a distinct shortening of the outer side of the zygoma, rostrum and nasals more slender; incisors narrower.

*Measurements.*—*Type:* Total length, 238; tail vertebrae, 79; hind foot, 30. Average of four adult male topotypes: 214 (204–222); 67 (55–75); 28 (25.5–30). Average of six adult female topotypes: 208 (198–224); 69 (60–74); 27.5 (26.5–28). *Skull* (type): Condylobasal length, 40.5; zygomatic breadth, 25; greatest breadth across squamosals (over mastoids), 20; interorbital constriction, 6.7; length of nasals, 13.7; alveolar length of upper molariform tooth row, 8.

*Remarks.*—While *modicus* is usually much larger than *intermedius* and differs widely in color, the skulls of some females, especially, are similar in size in the two forms, and in other respects indicate probable intergradation. This desert race tends to bridge the gap between *chrysonotus*, the pallid subspecies inhabiting the region east of the lower Colorado, and the darker forms occupying the higher country in southeastern Arizona. It partakes also of the characters of *cervinus*, the lighter colored, more robust animal of the Salt River Valley.

*Specimens examined.*—Total number, 20, all from Arizona as follows: Calabasas, 1; Fort Lowell, 2; Indian Oasis, Baboquivari Valley, 2; La Osa (type locality), 11; Tucson, 4.

## **Thomomys fulvus catalinae** subsp. nov.

### Santa Catalina Mountain Gopher

*Type.*—From Summerhaven, Santa Catalina Mountains, Pima County, Arizona (altitude 7,500 feet). No. 244081, ♂ adult, U. S. National Museum (Biological Survey collection), collected by E. A. Goldman, August 6, 1923. Original number 23517.

*Distribution.*—Known only from the upper slopes of the Santa Catalina Mountains, Arizona.

*General characters.*—A small, dark, richly colored subspecies. Allied to *Thomomys fulvus toltecus*, but smaller, much darker, with a narrower, less massive skull. Similar in general to *Thomomys fulvus intermedius* of the Huachuca Mountains, but larger; color of upper parts more uniform, without the broad, blackish median dorsal area usually continuous from head to base of tail in *intermedius*, and sides brighter, more tawny; cranial characters distinctive.

*Color.*—*Type* (summer pelage): Upper parts between tawny and ochraceous tawny, clearest on lower part of sides, the top of head and back heavily mixed with black, the black predominating on middle of face; under parts over laid with light tawny, the under color everywhere dark plumbeous; ears completely within deep black spots; feet and tail thinly clothed with dull whitish hairs. Some specimens exhibit small median dorsal blackish areas.

*Skull.*—Narrower and less massive than that of *T. f. toltecus*; zygomata more slender and much less widely spreading; dentition similar. Compared with that of *T. f. intermedius* the skull is larger; rostrum less constricted in front of zygomata; nasals broader, less wedge-shaped posteriorly; auditory bullae larger, more smoothly and evenly rounded (more or less distinctly truncate anteriorly in *intermedius*).

*Measurements.*—*Type:* Total length, 218; tail vertebrae, 65; hind foot, 31. Average of four adult male topotypes: 211 (204–220); 64 (58–72); 28.5 (27.5–30). Average of four adult female topotypes: 202 (196–212); 59 (55–62); 25 (24–26). *Skull* (type): Condylobasal length, 38.6; zygomatic breadth, 23.8; greatest breadth across squamosals (over mastoids), 19.5; interorbital constriction, 6.5; length of nasals, 13; alveolar length of upper molariform tooth row, 8.1.

*Remarks.*—*T. f. catalinae* somewhat resembles its geographic neighbor *intermedius* but the upper parts are richer, more tawny instead of cinnamon brownish, and the general color is more uniform, without the broad blackish median dorsal area normally extending from top of head to base of tail in *intermedius*. It is probably restricted to the Santa Catalina Mountains which rise island-like from the desert plains.

*Specimens examined.*—Ten, all from the type locality.

## **Thomomys fulvus grahamensis** subsp. nov.

### Graham Mountain Pocket Gopher

*Type.*—From Graham Mountains (Pinaleno Mountains on some maps) Graham County, Arizona (altitude 9,200 feet). No. 204313, ♂ adult, U. S. National Museum (Biological Survey collection), collected by E. G. Holt, June 7, 1914. Original number 269.

*Distribution.*—Known only from the upper slopes (6,100–9,200 feet altitude) of the Graham Mountains, Arizona.

*General characters.*—Closely allied to *Thomomys fulvus toltecus*, but color darker; skull narrower. Resembling *Thomomys fulvus fulvus* of the high plateau region in color, but duller, less ochraceous tawny; skull differing in detail. Similar in size to *Thomomys fulvus catalinae* but lighter, the sides of body ochraceous buffy instead of ochraceous tawny; combination of cranial features distinctive. Differing from *Thomomys fulvus intermedius* in decidedly larger size, lighter color and well-marked skull characters.

*Color.*—*Type* (summer pelage): Upper parts dark ochraceous buff, purest along sides, rather heavily mixed with black on top and sides of head and over dorsum, the dark hairs becoming somewhat thinner on rump; face blackish; ears encircled by deep black; under parts overlaid with light ochraceous buff, the basal color plumbeous everywhere; feet dull whitish; tail whitish, interrupted by irregular dusky sections above.

*Skull.*—Similar to that of *T. f. toltecus*, but narrower; braincase narrower; zygomata much less widely spreading; maxillary arm of zygoma more slender, the external angle narrower and less prominent; jugal less expanded anteriorly and more strongly inclined upward to point of union with maxilla; auditory bullae smaller; dentition very similar. Similar to that of *T. f. fulvus*, but narrower and flatter; zygomata much less widely spreading; auditory bullae rather small, much as in *fulvus*. Not very unlike that of *T. f. catalinae* in size and general form, but rostrum deeper; jugal slanting more strongly upward from squamosal to point of union with maxilla (jugal more nearly horizontal in *catalinae*) bullae slightly smaller. Compared with that of *T. f. intermedius* the skull is larger and heavier; nasals broader posteriorly; rostrum less constricted or compressed laterally in front of zygomata; ascending branches of premaxillae broader posteriorly; auditory bullae larger, more smoothly rounded.

*Measurements.*—*Type:* Total length, 231; tail vertebrae, 71; hind foot, 29. Two adult male topotypes: 217, 225; 68, 68; 27, 28. Two adult female topotypes: 215, 228; 69, 76; 27, 28. *Skull* (type): Condylobasal length, 38.3; zygomatic breadth, 23.3; greatest breadth, across squamosals (over mastoids), 19.2; interorbital constriction, 7.5 length of nasals, 13.8; alveolar length of upper molariform tooth row, 8.5.

*Remarks.*—The present form appears to be restricted to the upper slopes of the Graham Mountains, doubtless intergrading lower down with *toltecus* which inhabits the Gila Valley and neighboring areas. In general color it somewhat resembles typical *fulvus* but the ranges of the two are separated by an arm of that of *toltecus* along the Gila River valley, and distinctive characters have been pointed out.

*Specimens examined.*—Ten, all from the Graham Mountains, Arizona.

### **Thomomys fulvus collinus** subsp. nov.

### Chiricahua Mountain Pocket Gopher

*Type.*—From Fly Park, Chiricahua Mountains, Cochise County, Arizona (altitude 9,000 feet). No. 66053, ♂ adult, U. S. National Museum (Biological Survey collection), collected by A. K. Fisher, June 10, 1894. Original number 1527.

*Distribution.*—Known only from the upper slopes of the Chiricahua Mountains, Arizona.

*General characters.*—Closely allied to *Thomomys fulvus toltecus*, but smaller and darker; skull of lighter proportions. Similar in size and color to *Thomomys fulvus grahamensis*, but skull more slender. About like *T. f. catalinae* in size, but color much lighter, the sides ochraceous buffy instead of rich tawny, and skull differing in detail.

*Color.*—*Type* (summer pelage): Upper parts dark ochraceous buff, purest along sides, rather heavily mixed with black on top of head and over back; under parts overlaid with rich ochraceous buff, the hairs plumbeous at base; feet and tail whitish. In one specimen from 7,500 feet altitude the under parts are creamy white.

*Skull.*—Not very unlike that of *T. f. toltecus* but smaller, relatively narrower, less massive. Similar in size to that of *T. f. grahamensis*, but more slender in form; rostrum, braincase, and interorbital constriction usually narrower; nasals narrower; jugal nearly horizontal (not distinctly inclined upward anteriorly as usual in *grahamensis*); auditory bullae larger; incisors usually narrower. Compared with that of *T. f. catalinae* the skull is similar in size and form but is usually narrower; rostrum more slender; bullae usually smaller; dentition about the same.

*Measurements.—Type:* Total length, 225; tail vertebrae, 68; hind foot, 29. Two adult males from Pinery Canyon (altitude 7,500 feet), Chiricahua Mountains: 210, 190; 74, 60; 27, 26. Two adult females from same locality: 200, 190; 74, 62; 27, 27. *Skull* (type): Condylobasal length, 39; zygomatic breadth, 24; greatest breadth across squamosals (over mastoids), 19.8; interorbital constriction, 6.6; length of nasals, 12.4; alveolar length of upper molariform tooth row, 8.3.

*Remarks.—T. f. collinus* is a small dark high mountain subspecies readily distinguished from the larger lighter ochraceous *toltecus* of the neighboring plains. Specimens from the mouth of Turkey Creek at 5,000 feet altitude are dark in color, but the skulls are heavier than in typical *collinus* and indicate gradation toward *toltecus.* The present form resembles *grahamensis* externally but differs in combination of cranial characters, and the ranges of the two are separated by an arm of that of *toltecus.*

*Specimens examined.*—Total number, 24, all from the Chiricahua Mountains, Arizona, as follows: Fly Park, 1 (type); Pinery Canyon (7,500 feet), 6; Rucker Canyon, 6; Turkey Creek (mouth, 5,000 feet), 11.

### **Thomomys fulvus pusillus** subsp. nov.

### Coyote Mountain Pocket Gopher

*Type.*—From Coyote Mountains, Pima County, Arizona (altitude 3,000 feet). No. 209290, ♀ adult, U. S. National Museum (Biological Survey collection), collected by E. A. Goldman, September 4, 1915. Original number 22722.

*Distribution.*—Known only from the Coyote Mountains; probably inhabiting other desert mountain ranges of central southern Arizona.

*General characters.*—A small, rich ochraceous tawny form with a slender, delicate skull and large, fully distended bullae. Similar in size to *Thomomys fulvus intermedius,* but general color above rich ochraceous tawny (without a broad blackish median dorsal line) instead of cinnamon brown, and cranial characters, especially form of zygomata and large bullae, quite distinctive. Much smaller than *Thomomys fulvus modicus,* color richer, more tawny, and skull differing in detail.

*Color.—Type:* Upper parts between tawny and ochraceous tawny, purest along sides, the top of head and back somewhat darkened by black-tipped hairs; muzzle blackish; black auricular spots small, encircling entire ears; under parts ochraceous buffy; feet white; tail grayish dusky above, whitish below.

*Skull.*—Similar in size and general form to that of *T. f. intermedius,* but flatter; zygomata diverging and widest anteriorly (instead of posteriorly as in *intermedius*); nasals broader posteriorly, the ends emarginate as usual in *intermedius;* premaxillae narrower posteriorly; basioccipital narrower; auditory and mastoid bullae much larger, more swollen and smoothly rounded; molariform toothrows shorter. Compared with that of *T. f. modicus* the skull is very much smaller and flatter; zygomata widest anteriorly instead of posteriorly; auditory and mastoid bullae similarly inflated.

*Measurements.—Type:* Total length, 201; tail vertebrae, 65; hind foot, 27.5. *Skull* (type): Condylobasal length, 32.6; zygomatic breadth, 19.7; greatest breadth across squamosals (over mastoids), 17.1; interorbital constriction, 6.2; length of nasals, 11; alveolar length of upper molariform tooth row, 6.8.

*Remarks.*—This small desert-mountain form approaches *intermedius* in size, but in the sum of its characters is more nearly related to the much larger lowland subspecies *modicus*. It may be expected to occur in other desert mountain ranges in the region of the type locality. It is based on a single specimen which presents cranial characters that appear to be quite distinctive.

### **Thomomys fulvus peramplus** subsp. nov.

Tunicha Mountain Pocket Gopher

*Type.*—From Wheatfield Creek, west slope of Tunicha Mountains, Apache County, northwestern Arizona (altitude 7,000 feet). No. 247632, ♂ adult, U. S. National Museum (Biological Survey collection), collected by Paul Trapier, June 23, 1927. Original number 720.

*Distribution.*—Mountains of northeastern Arizona and northwestern New Mexico (altitude 7,000–8,800 feet).

*General characters.*—A large dark-colored subspecies closely resembling *Thomomys fulvus apache*, of northern New Mexico, but upper parts still duller, the sides vinaceous instead of dull ochraceous buffy; skull more elongated and presenting a departure in detail. Contrasting strongly with *Thomomys fulvus aureus* of southeastern Utah in dark, dull coloration, but cranial characters indicate close relationship and the two doubtless intergrade along the basal slopes of the mountains. Color much duller than *Thomomys fulvus fulvus* of the high plateau region of Arizona, and skull quite distinctive.

*Color.*—Upper and under parts near vinaceous buff, clearest along sides, the top of head and posterior part of back blackish; dark plumbeous basal color tending to show through nearly everywhere and accentuating the dull general tone; black auricular spots inconspicuous, nearly confluent with general color of dorsum; ankles dusky; fore feet grayish or light brownish; hind feet white; tail above clothed with brownish hairs on proximal half, becoming white beyond to tip and whitish below.

*Skull.*—Closely aproaching that of *T. f. aureus* but rostrum longer; nasals broader posteriorly and premaxillae correspondingly reduced. Similar to that of *T. f. apache*, but more elongated; rostrum decidedly longer; nasals longer and broader posteriorly, less wedge-shaped; premaxillae narrower posteriorly; interorbital constriction narrower; bullae large and rounded, about as in *apache*. Compared with that of *T. f. fulvus* the skull is similar in general form, but larger, more angular and massive; nasals less wedge-shaped, broader posteriorly, the ends irregularly truncate instead of emarginate; auditory bullae much larger, bulging farther below basioccipital; dentition heavier.

*Measurements.*—*Type:* Total length, 260; tail vertebrae, 80; hind foot, 35. Average of four adult male topotypes: 246 (240–255); 80 (60–90); 35 (34–37). Average of six adult female topotypes: 230 (225–240); 75 (65–88); 32 (31–33). *Skull* (type): Condylobasal length, 45.6; zygomatic breadth, 28; greatest breadth across squamosals (over mastoids), 23; interorbital constriction, 6.7; length of nasals, 16.8; alveolar length of upper molariform tooth row, 8.8.

*Remarks.*—In dark, dull coloration this high-mountain form resembles *apache*, but in cranial characters reveals closer relationship to the vividly tinted subspecies *aureus* of the surrounding deserts. Its known vertical range is from 7,000 to 8,000 feet. At the type locality it occurs in close proximity to the distinct species, *Thomomys fossor,* which seems to replace it at about 9,000 feet altitude along the crest of the Tunicha Mountains.

*Specimens examined.*—Total number, 33, as follows:
Arizona: Canyon de Chelly (7 miles above mouth), 1; Fort Defiance (12 miles northwest), 1; Saint Michaels, 2; Tunicha Mountains (type locality), 16.
New Mexico: Chusca Mountains, 13.

### **Thomomys perpallidus osgoodi** subsp. nov.

*Type.*—From Hanksville, Wayne County, Utah. No. 158530, ♂ adult, U. S. National Museum (Biological Survey collection), collected by W. H. Osgood, October 20, 1908. Original number 3701.

*Distribution.*—Fremont River Valley near Hanksville, Utah; limits of range unknown.

*General characters.*—A very light ochraceous buffy or light yellowish form with a rather massive skull. Somewhat resembling *Thomomys fulvus aureus* from Bluff, San Juan County, Utah, but upper parts contrasting in decidedly lighter ochraceous buffy tones, and cranial characters distinctive. Related to *Thomomys perpallidus planirostris* from Zion National Park, but much paler, and skull differing in important features, especially the arched instead of flattened or depressed upper surface near anterior roots of zygomata.

*Color.*—*Type* (winter pelage): Upper parts very light ochraceous buff, richest on posterior part of back, unmodified by dark-tipped hairs present in most related forms; middle of face, nose, and area near mouth indistinctly dusky; under parts and well up on flanks and outer sides of limbs creamy white; black auricular spots small, but conspicuous and completely encircling ears; feet and tail white. Five other specimens are practically identical in color.

*Skull.*—Similar in general form to that of *T. f. aureus,* but smaller; occipital region more smoothly rounded above, tending to bulge posteriorly below slightly developed lambdoid crest; premaxillae narrower posteriorly and tapering to a more acute point; sides of zygomata more or less distinctly bowed inward near middle (sides more nearly straight in *aureus*); interpterygoid fossa more narrowly V-shaped (usually more nearly U-shaped in *aureus*); basioccipital shorter; bullae slightly smaller, but fully inflated; dentition about the same. Compared with that of *T. p. planirostris* the skull is arched, instead of flattened or depressed, and more or less distinctly concave in cross section along the median line near anterior roots of zygomata; occipital region more projecting posteriorly below lambdoid crest; auditory bullae larger, more distended below level of basioccipital.

*Measurements.*—*Type:* Total length, 233; tail vertebrae, 72; hind foot, 30.5. Two adult male topotypes: 215, 225; 68, 70; 29, 29. Average of three adult female topotypes: 197 (184–203); 58 (51–63); 27 (27–27.5). *Skull* (type): Condylobasal length, 39; zygomatic breadth, 24.2; greatest breadth across squamosals (over mastoids), 20.3; interorbital constriction, 6.9; length of nasals, 13.8; alveolar length of upper molariform tooth row, 8.

*Remarks.*—*T. p. osgoodi* superficially resembles *aureus,* but is lighter yellowish and in cranial characters presents a marked departure. Moreover, it is separated from *aureus* by the effective barrier of the Colorado River. It is a well marked subspecies more closely allied to *planirostris* and other forms inhabiting the territory north and west of the Colorado River.

*Specimens examined.*—Six skins and skulls and two skulls without skins, all from the type locality.

**Thomomys perpallidus dissimilis** subsp. nov.

Henry Mountain Pocket Gopher

*Type.*—From east slope of Mount Ellen, Henry Mountains, Garfield County, Utah (altitude 8,000 feet). No. 158526, ♀ adult, U. S. National Museum (Biological Survey collection), collected by W. H. Osgood, October 15, 1908. Original number 3677.

*Distribution.*—Known only from the type locality; probably generally distributed over the upper slopes of the Henry Mountains.

*General characters.*—Closely allied to *Thomomys perpallidus osgoodi* but upper parts near light buff, instead of light ochraceous buff, and skull differing in detail. Similar in general to *Thomomys fulvus aureus* but smaller, light buffy color contrasting strongly with rich ochraceous buff of *aureus*, and cranial characters distinctive. Differing from *Thomomys perpallidus planirostris* in pallid coloration, and important cranial features.

*Color.*—*Type* (winter pelage): Upper parts near light buff, faintly darkened along the median dorsal area by dusky-tipped hairs; muzzle dusky; black auricular spots small, but including entire ears; under parts, forearms and hind legs creamy white; feet and tail whitish. *Young* (in first pelage): Similar to type but inclining toward light ochraceous buff on top of head, neck, and shoulders.

*Skull.*—Most closely resembling that of *Thomomys perpallidus osgoodi*, but more elongated; rostrum longer; zygomata more slender, more strongly converging anteriorly; bullae less rounded, more compressed laterally; incisors pale, the ends less recurved. Compared with that of *T. p. planirostris* the skull is arched, instead of flattened or depressed and more or less distinctly concave in cross section along the median line near anterior roots of zygomata; occipital region more projecting posteriorly below lambdoid crest; zygomata narrower, more slender, more strongly converging anteriorly; auditory bullae more elongated, more compressed laterally and projecting below level of basioccipital. Similar in general to that of *T. f. aureus*, but smaller, more slender, and differing in important details as follows: Occipital region more smoothly rounded above, tending to bulge posteriorly below lambdoid crest; zygomata narrower, more slender and converging anteriorly; interpterygoid fossa more narrowly V-shaped; auditory bullae narrower, less fully inflated; teeth smaller, the incisors less recurved.

*Measurements.*—*Type:* Total length, 211; tail vertebrae, 60; hind foot, 27. *Skull* (type): Condylobasal length, 37; zygomatic breadth, 21.6; greatest breadth across squamosals (over mastoids), 18.8; interorbital constriction, 6.8; length of nasals, 12.2; alveolar length of upper molariform tooth row, 7.6.

*Remarks.*—Pocket gophers from high mountains are usually dark, but *T. p. dissimilis* is remarkable for its pallid coloration. Near relationship to *osgoodi* of the adjoining Fremont River Valley is evident but the unusual color and the combination of cranial characters are distinguishing features.

*Specimens examined.*—Three, from the type locality.

**Thomomys perpallidus absonus** subsp. nov.

Houserock Valley Pocket Gopher

*Type.*—From Jacob's Pools, Houserock Valley, Coconino County, northern Arizona (altitude 4,000 feet). No. 250016, ♂ adult, U. S. National Museum

(Biological Survey collection), collected by E. A. Goldman, June 7, 1931. Original number 23569.

*Distribution.*—Known only from the type locality.

*General characters.*—A dull grayish buffy subspecies of medium size, with a narrow, slenderly formed skull. Closely allied to *Thomomys perpallidus planirostris* but paler, with differential cranial characters, especially the higher midline of the fronto-nasal region. Similar in general to *Thomomys perpallidus osgoodi* and *Thomomys perpallidus dissimilis,* but much darker, and skull presenting a different combination of characters.

*Color.*—*Type* (acquiring summer pelage): Upper parts near light ochraceous buff, purest along sides, thinly mixed over top of head and back with pale dusky hairs producing a dull rather grayish buffy combined effect; muzzle dusky; black postauricular spots rather large, extending forward to include anterior margins of ears; under parts overlaid with pale ochraceous buff; forearms, ankles, and feet whitish; tail whitish, becoming pale buffy above near base. In some specimens the under parts vary to light ochraceous buff.

*Skull.*—Similar in general structure to that of *Thomomys perpallidus planirostris,* but of slenderer proportions, the zygomata very weak, and the lambdoid crest and temporal ridges slightly developed even in adult males; frontal region and posterior part of rostrum less flattened or depressed along the median line, and lacking the concavity in cross section characterizing *planirostris;* ascending branches of premaxillae narrower, less extended posteriorly beyond nasals; palate usually narrower; teeth smaller. Compared with that of *T. p. osgoodi* the skull is more slender in form; rostrum longer and relatively narrower; zygomata more slender, the jugal, especially, more attenuate; palate narrower; auditory bullae less inflated, less bulging below basioccipital; dentition similar. Differing from that of *T. p. dissimilis* in more squarely spreading zygomata; auditory bullae broader, more rounded, less laterally compressed and less projecting below basioccipital; incisors slightly more recurved.

*Measurements.*—*Type:* Total length, 230; tail vertebrae, 79; hind foot, 30. Average of three adult male topotypes: 231 (228–234); 77 (74–82); 31 (30–32.5). Two adult female topotypes: 210, 217; 69, 70; 30, 29. *Skull* (type): Condylobasal length, 40; zygomatic breadth, 24.4; greatest breadth across squamosals (over mastoids), 19.5; interorbital constriction, 6.6; length of nasals, 13.7; alveolar length of upper molariform tooth row, 7.3.

*Remarks.*—*T. p. absonus* is a fairly well marked form probably restricted to Houserock Valley which occupies a broad depression with a generally level bottom lying along the northern side of the Marble Canyon of the Colorado River. This reach of the river bisects the interior basin of which Houserock Valley is the northern half, at the upper entrance to the Grand Canyon, and forms a barrier limiting the distribution of most of the smaller mammals. The species or subspecies usually differ on the opposing sides of the stream. The bottom of Houserock Valley is gashed by side canyons of the Colorado and the dispersal of this pocket gopher is much restricted even here. It has been found inhabiting soft sand extending for about two miles out over the floor of the valley from near Jacob's Pools, a spring at the western base of the escarpment marking the great fault line known as the Vermilion Cliffs.

*Specimens examined.*—Twelve, from the type locality.

MAMMALOGY.—Akodon chacoensis, *a new cricetine rodent from Argentina.*[1] H. HAROLD SHAMEL, U. S. National Museum. (Communicated by JOHN B. REESIDE, JR.)

A new cricetine rodent has been found in a collection of mammals from Argentina that was made in 1920 by Dr. Alexander Wetmore. This specimen was discovered at the same time as *Marmosa formosa*, which I described in March, 1930, but until it could be compared with specimens in the British Museum I hesitated to publish on it. It has since been compared with specimens in the British Museum by Dr. W. H. Osgood, and this comparison bears out my original conclusion.

## **Akodon chacoensis** sp. nov.

Figs. 1, 2.

*Type.*—Adult male, skin and skull, No. 236239, collected in Las Palmas, Chaco, Argentina, by Dr. A. Wetmore, June 20, 1920.

*Diagnosis.*—In its external measurements it is practically the same size as *Akodon arenicola* from Argentina, but considerably darker in color. Enamel folds, on the inner side of the tooth row, somewhat flattened and folded distinctly backward; reentrant angles closed; without groove on anterior surface of $m^1$ or inner surface of $m^3$.

*Skull.*—The skull, when compared with that of *Akodon arenicola*, is characterized by the large size of the brain case in proportion to the rather weak short rostrum. The anterior edge of the zygomatic plate is perfectly straight and projects forward scarcely at all. The drop downward of the zygoma from the plate is very abrupt, so much so, that the arch formed by the infraorbital plate and the inferior border of the zygoma is almost completely hidden when the skull is viewed from the side. The drop of the zygoma is so abrupt downward that there is rather a well defined angle where it joins the zygomatic plate. The lowest dip of the zygomatic arch is in its center, while in other species it is found at the posterior curve. The rostrum is short. The distance from the anterior edge of zygomatic plate to anterior surface of incisor, 4.6 mm. The lateral depressions of the basioccipital are deep and are scooped out abruptly back of the basal suture. The palate, which extends well behind $m^3$, is broad at posterior end of the tooth row (4.4 mm.) and not waist-like. Six small pits in the palate, three on each side, but none farther back than a line joining the centers of $m^3$. The palatal foramen extends from the middle of first molar until it almost touches the incisors.

*Teeth.*—The enamel folds of the upper molars are more or less flat, and are folded distinctly backward; the reentrant angle on the inner side of the tooth row is directed forward and closed. In other forms of *Akodon* the enamel folds are rounded, not folded backward, and the reentrant angle is open. On the outer side of the tooth row the reentrant angle is directed backward, except the first reentrant angle of $m^2$ which points straight inward. The teeth are well

[1] Published by permission of the Secretary of the Smithsonian Institution. Received August 8, 1931.

worn; $m^1$ has three cusps on the outer edge with a secondary one between the second and third, and three on the inner side; $m^2$ has four cusps on its outer edge, one and three being secondary, two on the inner edge. The anterior surface of $m^1$ and the inner surface of $m^2$ are smooth. $m^2$ is a round peg-like tooth with two well defined enamel islands. The incisors are curved more abruptly inward toward the throat than any other species examined, and according to Thomas are what would be called opisthodont.

*Color.*—The general color is olivaceous with some buff about the eyes and sides of head and along the sides of the body; but the back is very dark, almost black from the shoulders down to the base of the tail. The underparts are whitish, with a very slight buffish tinge; hairs basally dark slate both above and below. The feet appear to be dark brown clothed in short white hair, but this is because the hairs which cover them are brown at the base and tipped with white. The digits are white.

*Measurements.*—Type: total length, 160 mm.; tail, 66 mm.; hind foot, 22.5 mm.; greatest length of skull, 25.0 mm.; condylobasal length, 22.4 mm.; zygomatic breadth, 12.2 mm.; interorbital breadth, 4.5 mm.; length of nasals, 8.4 mm.; breadth of braincase, 12.6 mm.; diastema, 5.5 mm.; maxillary tooth row, 4.0 mm.; mandibular tooth row, 4.0 mm.; length of mandible, 14.6 mm.

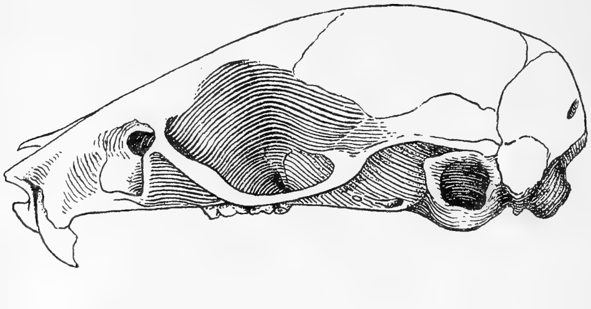


Fig. 1. *Akodon chacoensis*, lateral view of skull × 3. U. S. N. M. No. 236239.

I have compared this specimen with the following species of *Akodon: arenicola, arviculoides, bogotensis, boliviensis, canescens, cursor, lenguarum, mollis, neocenus, pulcherimus, surdus, tolimae.* In only one species of *Akodon* was the brain case any wider and that was in *A. lenguarum* (13.2 mm. as against 12.6 mm.), and *A. lenguarum* is a much larger animal. In all other species the brain case is smaller. Some of the differences between the specimen from Chaco and other species of *Akodon* may be summarized as follows:

1. Much larger brain case in proportion to length of rostrum.
2. Palatal foramen extends nearer the incisors.
3. Palate extends farther behind $m^2$.
4. Palate behind $m^2$ not waist-like.
5. Zygomatic plate has a well defined angle.
6. Zygoma drops much lower, particularly anteriorly.

7. Enamel folds on inside of tooth row folded backward on one another like window shutters.

8. Incisors curve inward more abruptly toward the throat.

9. Reentrant angles closed.

This specimen was taken to the British Museum by Dr. W. H. Osgood and compared with South American specimens there. Dr. Osgood had the following to say:

> There is nothing like this in the British Museum. The species is doubtless new and the genus is uncertain. . . .
>
> This may be a new genus, but until more than one specimen can be examined, it would not help much to name it. The relationships of those already named are very obscure and Thomas has reversed himself on them several times. There are a lot of species which won't fit exactly into any of the groups he has recognized.

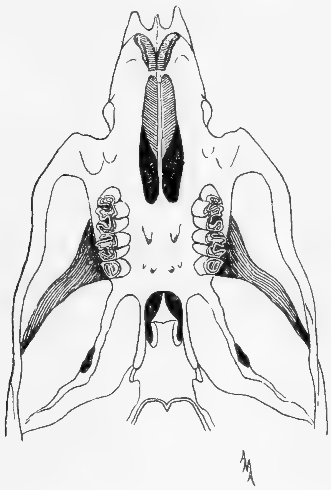


Fig. 2. *Akodon chacoensis*, palatal view of skull × 3. U. S. N. M. No. 236239.

Dr. A. Wetmore at the time he collected this specimen made the following note:

> Number 1059 was secured in a small patch of marsh grass, about ten feet square, in an open savannah. The white toes with square cut demarcation behind were especially noticeable. This animal had a skin as tender as a rabbit's, and thus differed from any other mouse that I have handled.

It is doubtless best, under the present condition of uncertainty with respect to some of the South American genera, to make this only a new species. However, the characters of the enamel folds, without considering other peculiarities, are so distinctive that there is no doubt in my mind that when other specimens are taken they will show that this animal represents a new genus.

ENTOMOLOGY.—*New Jassinae, with notes on other species.*[1] P. W. OMAN, U. S. Bureau of Entomology. (Communicated by HAROLD MORRISON.)

### PLATYMETOPIUS HYALINUS Osb.

*Platymetopius cinctus* Mats., Jour. Col. Agr., Tohoku Imperial Univ., Vol. 5, part 7, p. 215, 1914.

This pretty little leafhopper was described by Osborn (Ent. News, XI, p. 501, 1900) from specimens taken in Washington on an introduced maple. He and later workers in the group have strongly suspected that the species was an introduced one, but knowledge of original habitat has not heretofore been available. However, in looking over the leafhoppers in the C. F. Baker collection the writer found two specimens of this insect from Japan labeled *Platymetopius cinctus* Matsumura determined by Matsumura. *P. cinctus* was not described until 1914 (Jour. Col. Agr., Tohoku Imperial Univ., vol. 5, Part 7, p. 215) so it becomes a synonym of *P. hyalinus* Osb. Matsumura reports the species from Hokkaido, Honshu (Tokyo, Gifu, Takasago) and Kiushu (Satsuma) and says it was collected in numbers from a species of maple. This evidence strengthens the assumption of Dikerson and Weiss (Ann. Ent. Soc. Amer. vol. 12, p. 372, 1919) that the hopper was brought into this country on imported maples. Since its importation it has spread rather rapidly and is now reported as far west as Ohio. The writer has also examined specimens in the collection of the University of Kansas taken at Portland, Oregon, Aug. 12, 1920, by A. A. Nichol, indicating the introduction of the species to the west coast as well as the east.

### **Laevicephalus excavatus** n. sp.

Figs. 3, 3a, 3b

Resembling *Laevicephalus striatus* (L) but slightly smaller, with the male plates longer and the last ventral segment of the female roundingly excavated. Length 3–3.5 mm.

*Color:* Much as in typical *striatus* but variable. Darker specimens show a pair of triangular brown spots at the apex of the vertex and two pairs of quadrangular spots behind these. Paler specimens may have only the spots at the apex. Pronotum with four faint longitudinal brown stripes. Veins of elytra whitish, cells variously embrowned.

*Form*: Vertex one-fourth wider than long, distinctly right-angled. Head slightly wider than pronotum. General appearance more robust than *striatus*.

*Genitalia:* Last ventral segment of female slightly longer than preceding with a median U-shaped excavation extending half-way to the base, length next the excavation exceeding length at side of abdomen. Male valve as in *striatus* but plates slightly more exposed and divergent at the tips than in that

[1] Received August 15, 1931.

species. In the internal male genitalia the shaft of the oedagus, from the point of union of the two forks to the point of articulation of the penis, although much heavier and broader, is less than half as long as the corresponding portion in *L. striatus* (L.).

*Holotype* female from Gazelle, California, Sept. 4, 1897, A. Morse, Collection C. F. Baker (2373).

*Allotype* male, same data.

*Paratypes*, 24 males and 5 females with the above data, one male from Siskiyou, Oregon, Sept. 6, 1897, A. Morse, Collection C. F. Baker (2381), and 8 males and 7 females from Lakeside, Lake Tahoe, California, June 29, 1927, J. M. Aldrich.

*Types.*—Cat. No. 43584, U. S. N. M.

LAEVICEPHALUS DEBILIS (Uhler).

*Deltocephalus cadyi* Deay, Can. Ent., vol. 59, pp. 54–55, 1927.

*Laevicephalus orbiculus* DeL. & S. Ann. Ent. Soc. Amer., vol. 22, p. 103, 1929.

In his description of the species (Bul. U. S. Geol. Geog. Surv., 1, p. 360 [94], 1876) Uhler gives, as the locality, "Colorado, on the sides of the high mountains, and near Fair Play, in South Park." Of the original series, so far as the writer is able to determine, there are only two specimens remaining. Both are females, one labeled "Col. Mts." and evidently one of those referred to as occurring "on the sides of high mountains," while the other is from Fair Play. Both labels are in Uhler's handwriting. Since the specimen labeled "Col. Mts." has locality preference and answers in all respects to the description, it should be considered as typical of the species. The example from Fair Play is another species, apparently *exectus* DeLong, and does not fit Uhler's characterization of *debilis.* However, the specimen at hand from "Col. Mts." is not the species heretofore known as *debilis*, but is identical with specimens of *L. orbiculus* DeL. & Slmn. (Ann. Ent. Soc. Amer. vol. 22, p. 103, 1919) and with paratypes of *L. cadyi* (Deay) (Can. Ent., vol. 59, pp. 54–55, 1927), obtained through the kindness of Dr. P. B. Lawson. The above-mentioned species hence must be accepted as synonyms of *L. debilis* (Uhler) while the species commonly known as *debilis* is unnamed and will be described later in this paper.

That Uhler's description does not apply to the larger species formerly known as *debilis* is shown by the fact that he gives the length of 3.5 mm., and says the front is "stained with black above and on each side." These characters fit his example but cannot be applied to the larger species. There are also in the Uhler collection examples of this larger species from the C. F. Baker collection. These Uhler had labeled "*Deltocephalus debilis* Uhler var."—further evidence that he recognized them as not being typical of *debilis.*

*L. debilis* (Uhl.) seems to be limited in distribution to the higher altitudes in the northwestern part of the United States. I have seen specimens from Wyoming, Colorado, and Montana.

### **Laevicephalus uhleri** n. sp.

Similar to *L. debilis* (Uhler) but larger and more robust, the female genital segment without prominent lateral angles. Length of female 4 mm., of male 3.75 mm.

*Color:* General ground color yellowish green, front usually brownish with pale arcs over the entire surface. Elytra occasionally black, in part or wholly. Tip of last ventral segment of female black. Abdomen variously infuscated.

*Form:* Somewhat variable, about as in *debilis* but more robust. Last ventral segment of female with rounding lateral angles, produced medially and slightly bifid. Male valve bluntly triangular, plates large and broad, bluntly rounded and not equaling pygofer.

Most references in literature to *L. debilis* (Uhl.) apply to this species, one of the commonest in high altitude and northern regions. However, this species lacks the prominent lateral angles on the female segment which are characteristic of Uhler's species, and has the front usually wholly uniformly brownish with faint arcs, while *debilis* is marked with black only toward the apex and on the sides of the front, the remaining portion being distinctly lighter.

*Holotype* female and *allotype* male are from Forrester's Ranch, Laramie Co., Colorado, August 3, 1896, C. F. Baker, Collection C. F. Baker (2020).

Numerous paratypes from Forrester's Ranch, collection C. F. Baker (2020 and 2013) and Morris Ranch, Laramie Co., Colorado, July 11, 1896, C. F. Baker, Collection, C. F. Baker (2009). There are also specimens at hand from other localities in Colorado, Idaho, Montana, Utah, Washington, and Canada.

*Types.*—Cat. No. 43585, U. S. N. M.

### **Deltocephalus lineatifrons** n. sp.

Figs. 2, 2a, 2b

Size and form of *D. chintinomy* DeLong but with two black longitudinal stripes on the front. Length of male 2.75 mm., of female 3 mm.

*Color*: General ground color pale yellow. Front and vertex yellow except for two wide parallel stripes of black which cover the sides of the frons and a portion of the genae, and extend to the disc of the vertex, coming closer together as they do so, with a partial break at the apex of the vertex. Pronotum with anterior margin irregularly infuscated, as in the scutellum. Clavus of each elytron with an oblique fuscous mark, the two together forming a rough V on the dorsal median line. A large irregular fuscous spot on the disc and a smaller one near the apex of the corium. Abdomen infuscated. Central portion of hind margin of last ventral segment of female pale brown.

*Form:* General appearance robust. Vertex well produced and rounded to the front, length on the median line two-thirds the width at base. Pronotum with anterior margin strongly convex, posterior margin straight, length at middle exceeding length of vertex, sides very short. Elytra of male exceeding abdomen; of female, short, leaving tip of abdomen exposed.

*Genitalia:* Last ventral segment of female twice longer than preceding, lateral angles rounded, central portion rather broadly excavated, a small tooth at the bottom of the excavation. Sides and base of notch brownish. Male valve broad and slightly triangular, plates together broad at base and well produced with rounded tips.

This species belongs to the *fuscinervosus* group but appears to be most closely related to *chintinomy* DeLong, from which it may be separated by the markings of the vertex and front.

*Holotype* male and *Allotype* female from Spicer's, North Park, Colorado, July 18, 1896, C. F. Baker, Collection C. F. Baker (2024).

*Paratypes.*—6 males and 4 females with the above data, 2 males and 2 females from Rabbit Ears Pass, Colorado, July 21, 1896, C. F. Baker, Collection C. F. Baker (2019), and one male from Cameron Pass, N. Colorado, July 30, 1896, C. F. Baker, Collection C. F. Baker (2150).

*Types.*—Cat. No. 43586, U. S. N. M.

It is interesting to note that North Park, Colorado, has a mean altitude of from 8,000 to 9,000 feet and Rabbit Ears Pass and Cameron Pass are both near 10,000 feet in altitude. C. F. Baker's collection notes state that 2024 was "on grass, *Carex*, and a little *Potentilla*," and 2150 was "on mostly *Carex*." From this it is evident that the species is confined to situations in high altitudes, apparently alpine meadows.

### THAMNOTETTIX SIMPLEX (Herrich-Schäeffer).

*Deltocephalus chlamydatus* Prov., Pet. Faune Ent. Can., vol. 2, p. 339, 1890.

The writer has compared specimens of *Thamnotettix chlamydatus* (Prov.) from Colorado, Canada, and Alaska with examples of *Thamnotettix simplex* (H.S.) from Europe and finds them to be identical in all external characters and in the internal male genitalia. *Th. simplex* (H. S.) has priority.

The species is apparently common in both North America and Europe. In North America it is limited in distribution to northern localities or high altitudes.

### DRYLIX TRUNCATUS Sleesman

Fig. 4

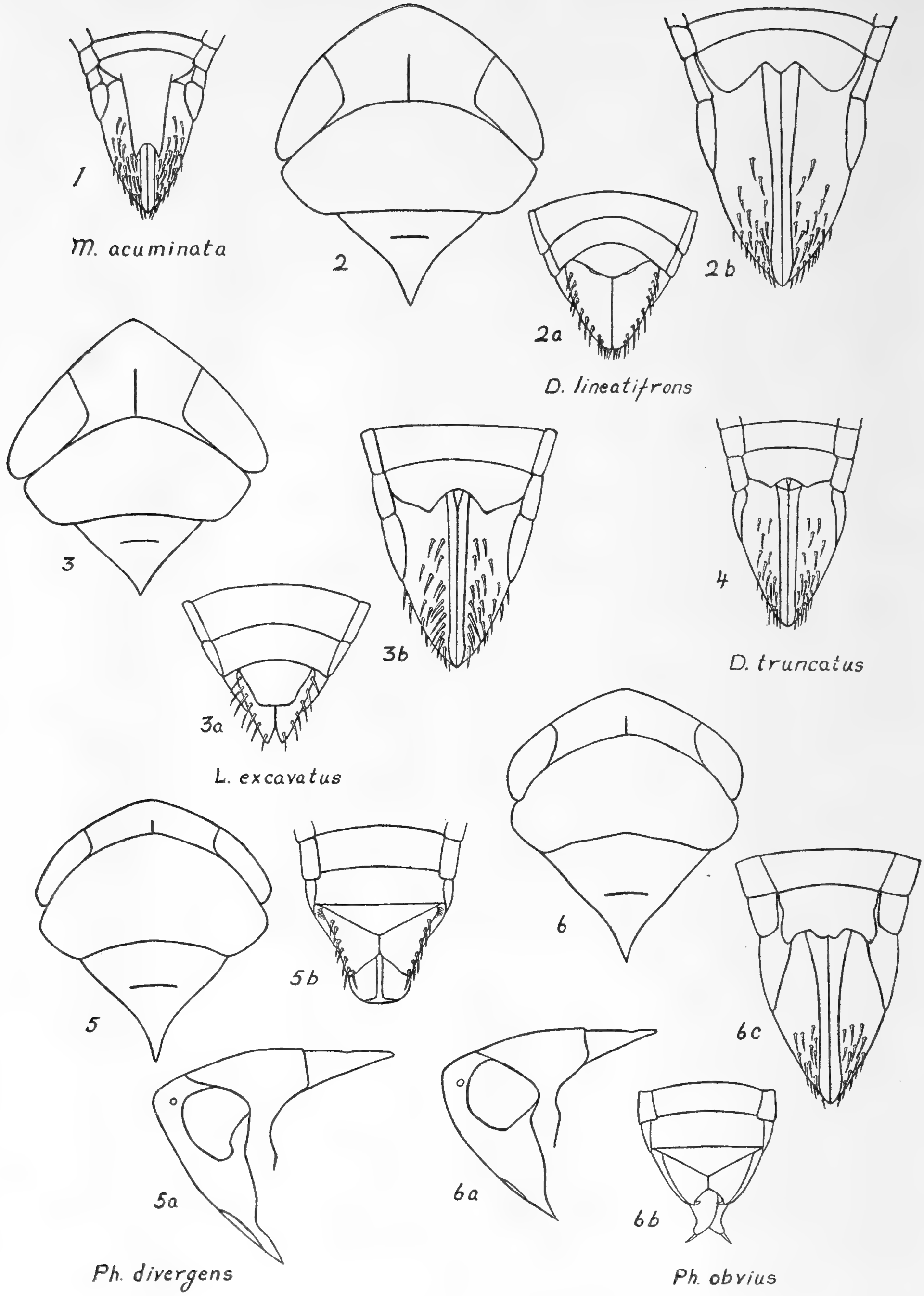
*Female:* Similar to male, but slightly longer. Last ventral segment slightly longer than preceding, with a median shallow, rounded excavation; the sides of this more produced than the sides of the segment. Disc of segment usually yellowish, hind margin dark, darker in excavation. Ovipositor black.

This species was described from two males from Ohio (Ent. Amer., vol. X, No. 2, 1929). The description of the female is based upon one specimen from Chicago, Illinois, two from New Jersey, and two from Norwood, Maryland (Uhler). There are also males at hand from New Jersey.

### MENOSOMA ACUMINATA (Bak.)

Fig. 1

This species was described by Baker (Psyche, vol. 7, Suppl. 1, p. 25, 1896, *Athysanus*) from a single male. Osborn and Ball, in their monograph of the group (1902), stated that "This species is only known by the single, faded, male type and while it without doubt belongs to the subgenus *Conosanus* its character could not be made out with sufficient certainty to warrant including in the synopsis." Sleesman (1929) did not mention it in his monograph of the Euscelis group.




Explanation of Figures

Fig. 1. *Menosoma acuminata;* female genitalia. × 15.5.

Fig. 2. *Deltocephalus lineatifrons;* 2a, male genitalia; 2b, female genitalia. × 31.

Fig. 3. *Laevicephalus excavatus;* 3a, male genitalia; 3b, female genitalia. × 31.

Fig. 4. *Drylix truncatus;* female genitalia. × 15.5.

Fig. 5. *Phlepsius divergens;* 5a, lateral view of head; 5b, male genitalia. × 15.5.

Fig. 6. *Phlepsius obvius;* 6a, lateral view of head; 6b, male genitalia; 6c, female genitalia. × 15.5.

Some time ago there was sent to the Bureau of Entomology by Mr. Van E. Romney from Alamo Alto Sta. in Western Texas a single female which was identified by the writer as *acuminata* (Baker). Subsequently, when the group was being arranged, a pair of specimens was found labeled by Dr. E. D. Ball: "This is *Athysanus acuminatus* Bak." Since these are the only known records of the female of the species a description is here added.

Similar in size and coloration to the male. Last ventral segment with a long, median, spatulate process ending in two lateral points, between these a U-shaped excavation. Segment, aside from process, short, longer next the process than at lateral margins.

The male types seems to be quite typical in color for the species. Ball (Florida Ent., vol. XV, No. 1, p. 5, 1931) has recently placed the species in the genus *Menosoma* Ball.

### **Phlepsius divergens** n. sp.

Figs. 5, 5a, 5b.

Resembling *Phlepsius mimus* Baker in form and coloration but larger, with the vertex shorter and the male plates flat and strongly divergent at the tips. Length of male 6.5 mm.

*Color:* General ground color creamy to gray. Fuscous irrorations over face and entire dorsal surface without definite pattern. Femora distinctly twice-banded with black. Hind margin of pygofer black.

*Form:* Vertex short, scarcely longer at middle than next the eye, very slightly angled and not carinate between disc and front. Pronotum over two and one-half times as long as the vertex. Elytra extending well beyond tip of abdomen.

*Genitalia:* Male valve very short and broad, obtusely angled at the middle. Plates flat and broad, outer margins nearly parallel but slightly concave and converging; inner margins contiguous for a short distance, then sharply diverging, the plates together thus having the appearance of a triangular incision from the hind margin. Pygofer strongly exceeding plates, margins thick and heavy.

Because of the very distinct male genitalia there is no hesitancy in describing this form from a single specimen, the holotype male from Forestburg, Texas, taken in June, 1928.

*Type.*—Cat. No. 43587, U. S. N. M.

### **Phlepsius obvius**, n. sp.

Figs. 6, 6a, 6b, 6c.

Very similar in size and form to *Phlepsius mimus* Baker but with the elytra much more finely and densely irrorate and the female genital segment broadly produced medially. Length of male 6.25 mm., of female 7 mm.

*Color:* Dirty white to gray, heavily irrorate with brown. Hind margin of female genital segment dark centrally.

*Form:* Vertex broad, one-half longer at the middle than next the eye, very bluntly angled and rather rounding to the front. Pronotum nearly twice as long as vertex. Elytra long, tips slightly flaring.

*Genitalia:* Last ventral segment of female nearly twice as long as preceding, lateral angles well produced and rounded, hind margin shallowly excavated, the median portion with a short, blunt, slightly bifid tooth. Male valve triangular, broad and rather short. Plates short and broad, diverging at tips, somewhat similar to those of *Phlepsius divergens* n. sp. but with the tips thin and curled upward. Pygofer extending beyond plates, tips thin and bluntly pointed.

*Holotype* male, *Allotype* female, and one female *paratype* from Clyde T. Reed, Kingsville, Texas.

*Types.*—Cat. No. 43588, U. S. N. M.

BOTANY.—*Two new grasses from Mexico.*[1] JASON R. SWALLEN, Bureau of Plant Industry. (Communicated by A. S. HITCHCOCK.)

Among the grasses collected by Prof. H. H. Bartlett on the Expedition of the University of Michigan to the Sierra de San Carlos, Tamaulipas, Mexico, in the summer of 1930, the following two species are new.

**Panicum transiens** Swallen, sp. nov.

Perenne; culmi erecti 60–65 cm. alti, pubescentes vel pilosi, ramosi; vaginae papilloso-pilosae, quam internoda culmorum breviores, quam internoda ramorum longiores; laminae 5–12 cm. longae, 6–14 mm. latae, lanceolatae, pubescentes, marginibus albis scabris, basi papilloso-ciliatae; panicula 8–15 cm. longa, ramis adscendentibus vel divergentibus; spiculae appressae, 4 mm. longae, basi attenuatae, papilloso-pubescentes; gluma prima subacuta 2 mm. longa; gluma secunda quam spicula paulo brevior; lemma sterile spiculam aequans; lemma fertile 3 mm. longum, subacutum apice pubescens.

Perennial, culms erect, 60–65 cm. tall, freely branching, pubescent or pilose; sheaths papillose-pilose, densely pubescent on the collar, those of the main culm shorter than the internodes, those of the branches much longer than the internodes; blades 5–12 cm. long, 6–14 mm. wide, lanceolate, flat, pubescent on both surfaces, the white scabrous margins papillose-ciliate toward the rounded base; ligule densely ciliate, about 0.5 mm. long; panicles 8–15 cm. long, the short-branches stiffly ascending or spreading; spikelets (except the terminal ones) short-pediceled, appressed to the branches, 4 mm. long, pointed at the apex, attenuate at the base, papillose-pubescent; first glume 2 mm. long, subacute, the margins somewhat hyaline; second glume a little shorter than the spikelet exposing the fruit; sterile lemma equaling the spikelet; fruit 3 mm. long, subacute, smooth and shining, puberulent at the apex.

Type in the United States National Herbarium No. 1501526, collected on Mesa de Tierra, vicinity of San José, altitude 1000 meters, Sierra de San Carlos, Tamaulipas, Mexico, July 19, 1930, by H. H. Bartlett (No. 10454).

Another specimen (Bartlett 10090) collected at La Vegania, vicinity of San José, Tamaulipas, Mexico, is also referred to this species.

*Panicum transiens* is allied to *P. pedicellatum* Vasey of Texas and *P. nodatum* Hitchc. & Chase of Texas and northern Tamaulipas. From the

[1] Received August 11, 1931.

former it differs in having longer spikelets, 4 mm. long, from the latter in having a longer subacute first glume, and from both in being a larger plant with much longer and wider blades. These three species compose the Pedicellata group which is intermediate between the subgenus *Dichanthelium* and true *Panicum.*

**Eragrostis longiramea** Swallen, sp. nov.

Perennis; culmi erecti, 150–160 cm. alti, laeves vel scaberuli; vaginae dense papilloso-pilosae; laminae 35–60 cm. longae, 4–8 mm. latae, planae, elongatae, attenuatae, scabrae, basi angustae et sparsim papilloso-pilosae; panicula 50–60 cm. longa, ramis gracilibus, scabris, adscendentibus vel divergentibus, inferioribus 15–25 cm. longis; spiculae 3–5 mm. longae, 5–7 florae; glumae acutae vel acuminatae, 2 mm. longae, carinis scabris; lemmata 2 mm. longa.

Perennial; culms apparently single, erect, 150–160 cm. tall, smooth or minutely scaberulous; sheaths rounded on the back, shorter or longer than the internodes, densely papillose-pilose with spreading hairs, especially on the collar; blades 35–60 cm. long, 4–8 mm. wide, flat, elongate, attenuate to a fine point, narrowed toward the base, sparsely papillose-pilose on both surfaces near the base, scabrous above and toward the margins beneath, the lower surface otherwise smooth; panicle 50–60 cm. long, the axis glabrous or retrorsely pilose, the branches slender, scabrous, ascending or spreading, pilose in the axils, the lower ones 15–25 cm. long; spikelets 3–5 mm. long, plumbeous, the pedicels long and slender, spreading or sometimes appressed, 5–7 flowered, the florets rather crowded; glumes acute or acuminate, 2 mm. long, scabrous on the keel; lemmas 2 mm. long, slightly keeled toward the minutely scabrous apex, the lateral nerves indistinct.

Type in the United States National Herbarium No. 1501524, collected on Pico del Diablo, vicinity of Marmolejo, Sierra de San Carlos, Tamaulipas, Mexico, August 12, 1930, by H. H. Bartlett (No. 10910).

One other specimen besides the type has been seen. This is Bartlett 10433 collected on Mesa de Tierra, vicinity of San José, Sierra de San Carlos, Tamaulipas, Mexico. This differs from the type in having the axis of the panicle retrorsely pilose.

This species is allied to *E. lugens* Nees and *E. polytricha* Hack., differing from them in being a much larger plant with broader, elongate blades.

## BOTANY.—*The juice sac of the orange with some observations on the plastids of citrus.*[1] M. B. MATLACK, U. S. Department of Agriculture. (Communicated by J. A. LECLERC.)

The writer became interested in the structure of the juice sac of the orange when he observed that only a small part of the liquid contained therein ran out when the juice sac was pricked with a needle. He also noted what appeared to be a cellular structure in the inner portion of the juice sac when it was flattened out on a slide and observed under a microscope. This led him to make some sections of the sacs. The

[1] Food Research Division Contribution No. 104. Published by permission of the Chief of the Bureau of Chemistry and Soils. Received August 1, 1931.

only sections of which the writer is aware are those of Tschirch and Oesterle.[2] These investigators show only sketches of the cross section of the juice sacs of mature and immature bitter oranges.

The juice sacs were fixed in Carnoy's fluid and embedded in paraffine by the usual method. The process had to be carried on very gradually in order to prevent collapse of the material. The sections were cut 20 microns thick by means of a rotary microtome. Bismark brown was used as a staining agent. Haemotoxylin stains the sections well but makes the material more difficult to photograph. The walls of the juice sac are very thin and take up little of the stain, consequently they transmit too much light. However, by using the brown stain and blue light fairly satisfactory photographs were obtained. Exposures of one hour and twenty minutes were used. Figure 1 shows a cross section and Figure 2 a longitudinal section. Owing to the delicacy of the material it was impossible to obtain a section which was entirely perfect. From the standpoint of edibility this very tenderness is of great importance.

While working on the juice sac it was noted that they contained numerous plastids. These cannot be shown in this type of section since they are removed by the fixing and mounting operations. By teasing out the inside portion of the fresh juice sac these plastids can easily be observed under the microscope. Their size and shape appear to be characteristic of the species from which they are obtained, which fact might be of use in genetical studies. For instance the tangerine, satsuma, and willow-leaved mandarin oranges have spindle-shaped plastids. The grapefruit has what appears to be elaioplasts or colorless groups of oil-like droplets. The Sampson tangelo has a red meat like the tangerine, and the chromoplasts are numerous and spindle shaped. The Thornton tangelo has a yellow meat with a slight orange tint, colorless globules, as in the grapefruit, and small orange isodiametric plastids. Lastly the Nocatee tangelo has only the colorless globules or elaioplasts, and the general appearance of the meat is the same as that of the grapefruit. It is thought by some botanists that the king orange does not belong to the same species as the mandarin. Observations disclose that, as noted above in the tangerine, satsuma, and willow-leaved mandarin the chromoplasts are spindle-shaped, whereas in the king orange they are isodiametric.

[2] Anatomischer atlas der Pharmakognosie und Nahrungsmittelkunde, 1900. Tab. 69 and 70. Fig. 44 and 45.

In general the plastids of citrus fruits can be divided into three groups. The first includes isodiametric plastids as found in the king

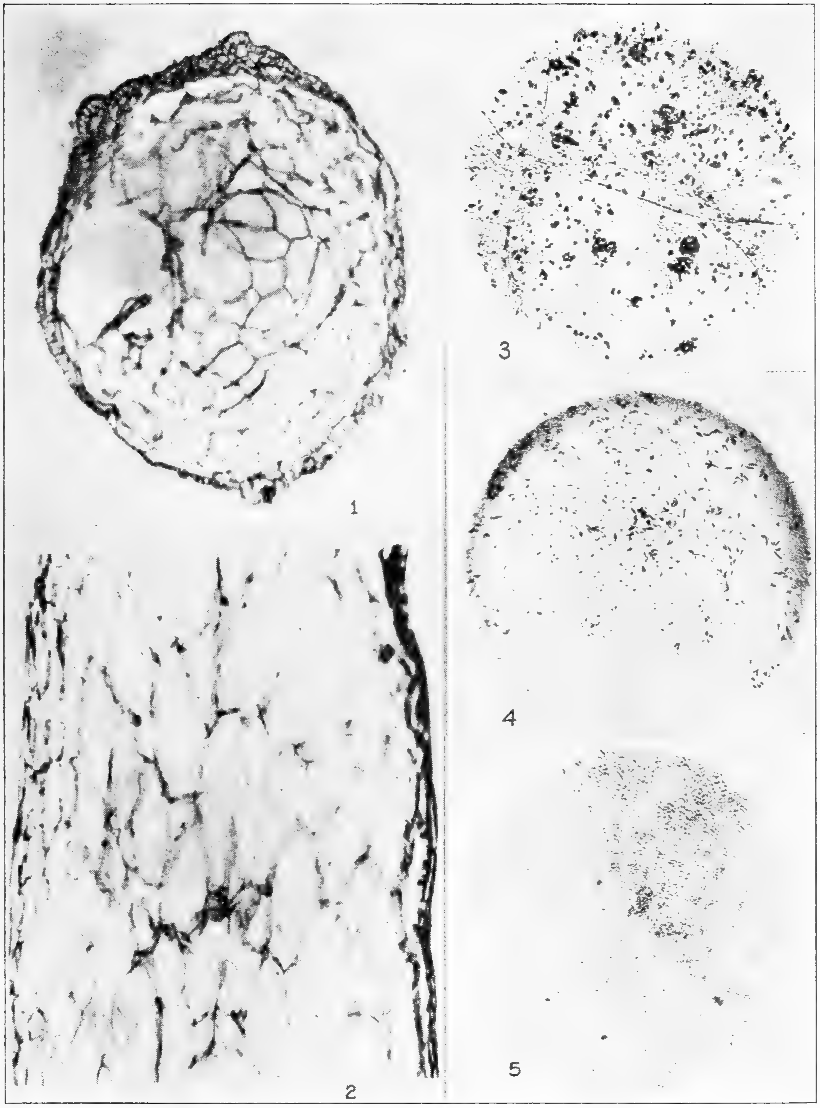



Figure 1.—Juice sac. X Section × 80.
Figure 2.—Juice sac. L Section × 80,
Figure 3.—King orange. Chromoplasts × 440.
Figure 4.—Satsuma orange. Chromoplasts × 440.
Figure 5.—Grapefruit. Elaioplasts ? × 440.

orange, three varieties of kumquats and the numerous varieties of the sweet orange. In the second are the spindle-shaped plastids of the satsuma, tangerine, mandarin, calamondin, rangpur lime, and the Sampson tangelo. The third group includes the colorless type as found in the grapefruit, bittersweet, sour orange, lemon, acid lime, *Citrus trifoliata,* citron (Etrog, Parish and commercial), Siamese pummelo and citrange. The Indian Red Pummelo is an exception in that it contains in addition to elaioplasts, pink crystals which appear at times to be surrounded by a pink stroma. Figures 3, 4 and 5 illustrate the three respective types of plastids.

These observations are presented at this time in the hope that some one will see fit to carry the studies further.

ENTOMOLOGY.—*A new ant from Porto Rico.*[1] WM. M. MANN, U. S. National Museum.

Among ants received by the U. S. Department of Agriculture for identification occurred the following interesting new species:

**Cerapachys (Syscia) seini,** new species.

Worker. Length 2 mm. (Fig. 1).

Head about one-third longer than broad, as broad in front as behind, with slightly convex sides and strongly excavated posterior border and angulate corners. Antennal scapes extending less than half the distance to occipital corners; rather strongly curved and clavate; first funicular joint a little longer than broad; funicular joints 2 to 7 transverse, increasing in size toward apex; terminal joint as long as the 3 preceding joints together. Eyes lacking. Mandibles stout, acuminate at tips. Thorax in profile very feebly convex, from above nearly three times as long as broad; promesonotal suture discernible though very shallow; sides and posterior border of epinotum narrowly margined, subangulate above; petiole in profile as long as postpetiole with a large and flat anteroventral spine; from above two-thirds as broad as postpetiole; postpetiole in profile considerably deeper than petiole, feebly convex above; from above one and one-half times as broad behind as in front. First segment of gaster two and one half times as long as remaining segments together. Legs short with thick femora and tibiae.

Subopaque.

Head, thorax, petiole and postpetiole coarsely, somewhat rugosely punctate; first segment of gaster with large shallow punctures largest and most dense anteriorly; the surface between sublucid; legs rather strongly punctate.

Head, body and appendages with abundant recumbent white silky hairs and a few longer and coarser sub-erect hairs.

Color light yellowish brown.

*Type:* Cat. No. 43648 U. S. N. M.

*Type locality:* Porto Rico Insular Experiment Station, Rio Piedras, P. R.

[1] Received August 15, 1931.

This species is described from a series collected by Francisco Sein in soil about the roots of sugar cane.

Although the type locality of this species is Porto Rico and it is the first record of an ant of this subgenus in the New World, I believe it very probable that it is endemic to New Guinea and has been introduced into Porto Rico in soil with sugar cane. The other species of *Syscia* occur in Australia, Malaya and Ceylon, with the exception of *silvestrii* Wheeler, which was described from Hawaii. I think it possible that the latter species also will later be found endemic to New Guinea.

*C. seini* is one of the smallest of the species; the promesonotal suture is more distinct than in the other known forms and the punctation of the gaster finer and shallower with the area between smooth instead of rugulose. *C. silvestrii* is larger and has the head larger in proportion to its width and the antennal scapes longer, stouter and less curved.

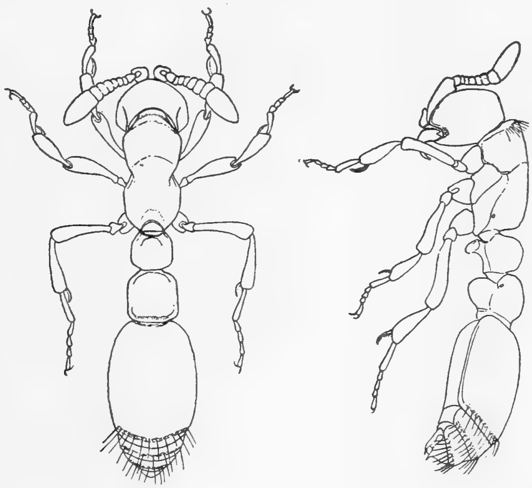


Fig. 1. *Cerapachys* (*Syscia*) *seini*, n. sp., worker. Drawn by ELEANOR A. CARLIN.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## THE ACADEMY

### 239TH MEETING

The 239th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on Thursday, March 19, 1931, Vice-President CURTIS presiding. About 200 persons were present.

*Program:* JOHN C. MERRIAM, President of the Carnegie Institution of Washington: *The unity of nature as illustrated by the Grand Canyon.*—The speaker described the educational features provided at the Grand Canyon for the purpose of assisting visitors in a critical study of the formation and structure of the canyon walls.

## 240TH MEETING

The 240th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on Thursday, April 16, 1931, Vice-President CURTIS presiding.

*Program:* O. E. BAKER, Bureau of Agricultural Economics, U. S. Department of Agriculture: *Changes in diet affect agriculture.*—The economic depression during 1930 resulted in a downward trend in the consumption of several foods by the American people toward the standards that prevailed during the war years and the years immediately preceding.

The World War caused changes in the diet of the American people. The principal change after the war was a notable decline in the use of bread, of corn meal, and other cereal foods and an increase in the consumption of milk, of meat, of sugar, of fresh vegetables, and of fruit. Apparently the higher wages and salaries of city people since the war has enabled them to eat more of the expensive foods.

During the five war years, 1914 to 1918, the average consumption per person of wheat, corn, oats, rye, buckwheat and barley for human food totaled about 310 pounds a year, whereas during the last five years 1924–1928 it was only about 230 pounds. This is a decrease of 80 pounds, or over a fourth. On the other hand, the average American was eating until recently nearly a third more sugar, probably a fourth more milk and dairy products, nearly a fifth more meat, possibly a fifth more vegetables, and a tenth more fruit.

These changes in diet have had a marked effect upon the need for farm land. If man could live on sugar alone it would require only about one-third of an acre of sugar beets to provide the amount of energy in the food of the average American for a year, but it would require three-fourths of an acre of corn or potatoes, an acre and a half of wheat or tomatoes, two to three acres of crops if he lived on milk alone, about the same acreage of corn and other crops if he ate only pork and lard, and 12 to 16 acres of crops if he lived wholly on beef and veal.

This comparison of acreage required to produce an equal quantity of food, measured in calories, shows that much more land is required to produce a diet based largely on meat than one based on wheat, corn or the other cereals. It now requires over two acres of crops to feed the average American, but only one acre to feed the average German, one-half acre to feed a Chinaman, and one-fourth an acre, a Japanese. This is owing largely to the difference in diet, except that the difference between China and Japan is owing to much higher crop yields in Japan.

The decrease in the United States since the war years in consumption per person of cereal foods, principally wheat flour and corn meal, has reduced the area of these crops needed to feed a person by about one-twelfth of an acre; while the increase in consumption of milk, vegetables, fruits, and of meat prior to 1929 increased the area per person needed to produce these products by a quarter of an acre. Nearly all the increase in sugar consumption has come from Cuba, Porto Rico, Hawaii and the Philippines, so it has not been included in the estimate. The net result, therefore, of this change in diet was an increase in crop land needed to feed each person of about one-sixth of an acre. Meanwhile, the population of the United States increased from 95 million to 120 million, which, after allowing for the change in diet, indicates that about 50 million acres more crop land would be needed to feed our people than during the war, provided no changes occurred in production per acre. But the fact is that there are only about 6 million more acres of crops used to produce the nation's food than were used during the war. What has produced this result?

First, the use of the automobile and the tractor has reduced the number of horses and mules in the United States by over seven million and released for other uses probably 20 to 25 million acres of crop land formerly used to feed these horses and mules that have disappeared. Most of this land thus released is used to feed meat and milk animals.

Secondly, there has been a great improvement in the amount of meat and milk produced per unit of feed consumed.

Thirdly, there has been a shift from the less productive classes of animals per unit of feed consumed to the more productive classes,—notably from beef cattle to dairy cattle and hogs.

Fourthly, there has been a shift from the less productive crops to the more productive.

Fifthly, there has been a little increase in the yield per acre of many of the crops.

In brief, the application of science to agriculture, which has taken place more rapidly since the War than ever before, has enabled the American farmer to provide a more expensive diet to an increasing number of people from a practically stationary acreage of crop land. (*Author's abstract.*)

### 241ST MEETING

The 241st meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on Thursday, May 21, 1931, at 8:15 p.m., President COBB presiding. About 125 persons were present.

*Program:* E. D. MERRILL, Director, New York Botanical Garden: *Plants and animals of the Philippines and neighboring islands—How they came to be where they are.*—Introductory to a general discussion of the present-day geographic distribution of plants and animals in the Philippines and in neighboring islands, the speaker discussed in general terms the relative sizes of the geographic areas involved, geologic history of the region, hydrography, climate, wind, and rainfall. The bearing of endemism on the general subject was stressed, indicating that those areas still covered by primary forests were most important, and that much of the present-day vegetation in the settled areas represents introduced elements. In the plant kingdom the percentage of endemism in the primary forest exceeds 80 per cent while in the settled areas and secondary forests it scarcely exceeds 10 per cent.

Attention was called to the fact that man has been a most important disturbing factor in reference to the distribution of both plants and animals in Malaysia. In drawing conclusions as to biogeographic relationships, emphasis was placed on the importance of assembling data covering all groups of plants and animals, for the reason that distributional data appertaining to one group frequently shows entirely different biogeographic relationships as compared with other groups. As an illustration, if one studies the Dipterocarpaceae, one would conclude that the Philippine flora was dominently western Malaysian in origin, but if one studied the Myrtaceae, one would conclude that it was dominently Australian. For purposes of discussion three areas were indicated; western Malaysia or Sundaland (Borneo, Sumatra, Java, etc.); eastern Malaysia or Papualand (New Guiana and adjacent islands); and Wallacea, the region between Wallace's and Weber's lines separating Sundaland from Papualand. Data were presented covering the present known geographic distribution of various groups of insects, fresh-water and land molluscs, fresh-water fishes, batrachians, reptiles, birds, mammals, and plants. In general there is a close correlation in the present distribution in all of these groups as between the Philippines and both eastern and western Malaysia or Papualand and Sundaland. Asiatic types are found to diminish rapidly in numbers and in importance as one proceeds eastward, and Australian types similarly decrease as one proceeds westward and northward in Malaysia. The apparently anomalous distribution of plants and animals in Malaysia and the Philippines, with much stronger Australian elements in the Philippines than in Java and the other Sunda Islands, was explained by the probable existence during Pleistocene and Pliocene times of two more or less stable continental areas represented by the two great continental shelves as delimited by the present 200-meter line. To the west the Sunda Islands (Java, Sumatra, and Borneo, including the Palawan-Calamian group in the Philippines) were at times connected with Asia, and New Guiana had the same history with relation to Australia.

Between these two stable areas there was apparently an unstable constantly archipelagic area which has existed since Tertiary times, the practical absence of mammals in Australia indicating no direct connections between Asia and Australia since the mammals attained dominance as a group. This insular area has inhibited direct east and west intermigration of both plants and animals in Malaysia as a whole. This area, called "Wallacea," is approximately delimited on the west by Wallace's line and on the east by Weber's line. These two "lines," originally proposed as delimiting or separating the Asiatic and Australian faunas, are approximately the eastern boundary of Sundaland and the western boundary of Papualand, where the two old continental areas impinge on the intermediate unstable insular area. Wallacea includes all of the Philippines (except the Palawan-Calamian group), Celebes, Moluccas, Lesser Sunda Islands and Gilolo.

The two stable areas, Sundaland and Papualand, are characterized by the presence of vast continental shelves with a very even submarine topography, the water averaging less than 100 meters in depth in these great shelf seas. In contrast to this, Wallacea has an entirely different submarine topography, being characterized by the presence of numerous great deeps, with depths as great as 5000 to 6000 meters, these deeps being more or less parallel to the rows of raised islands as pointed out by Molengraff. Intermigration has apparently been in general north and south within Wallacea rather than east and west across it. Thus many Australian types were able to reach far to the north in the Philippines, but few were able to reach western Malaysia, although Java is much closer to Australia than is the Philippine group. There was apparently a similar north and south migration of both eastern and western Malaysian types via the Philippines, and some from each area succeeded in negotiating the two longer sides of this hypothetical triangle rather than east and west across its comparatively narrow base, which is represented by the Lesser Sunda Islands.

In closing, the speaker discussed Dr. Lam's application of Wegener's theory of continental shift to the genetic phytogeography of the Malay Archipelago. According to this theory the Australian region shifted northward, coming into collision with the Asiatic continent in the Pleistocene. After the collision the two continents commenced exchanging plants and animals. Dr. Lam considers that the theory of an intermediate unstable insular area of long geologic duration is unsatisfactory in that it gives no real explanation of the principal problem involved; that is why two regions having such remarkably different floras and faunas as Australia and Asia lie so close together in present geography. (*Author's abstract.*)

CHARLES THOM, *Recording Secretary.*

## BIOLOGICAL SOCIETY

### 757TH MEETING

The 757th meeting was held in the New Assembly Hall of the Cosmos Club January 24, 1931 at 8:10 p.m., with President WETMORE in the chair and 130 persons present. New member elected: EDMUND MCNALLY.

A. A. DOOLITTLE exhibited two hermetically sealed jars containing growing algae and mosses, which had been sealed in 1924.

E. P. WALKER reported four nests with eggs of black-crowned night herons in the large open flight cage at the Zoological Park.

*Program:* A. H. HOWELL: *Exhibition of paintings of Florida birds.*—The speaker showed a number of water-color and oil paintings by F. L. JAQUES of the American Museum of Natural History, which will be used to illustrate his forthcoming book on the birds of Florida.

VERNON BAILEY: *General features of the Upper Mississippi River Wild Life and Fish Refuge.*—The Upper Mississippi River Wild Life and Fish Refuge, including the island flood lands and waters of the Mississippi River Valley from Lake Pepin, in southern Minnesota, to near Rock Island, Illinois, about 300 miles of irregular, scattered, and broken areas of land and water, was set aside by Congress for a great experiment in conservation and wild life study. Money was appropriated for purchase of the cheaper bottom lands not suitable for agriculture but well adapted to game and native wild life. Up to date about half of the land needed for the refuge has been secured, enough to start some experiments in restocking and building up the native fauna. The general plan is to keep many extensive areas as absolute sanctuaries, enough to maintain abundance of native life for the whole region, but outside of these areas to allow enough hunting and trapping to remove the excess of each species so they will not overpopulate and destroy their supply of food and cover. The refuge is on one of the greatest migratory highways of waterfowl in the country.

To study the present condition of its native life Mr. and Mrs. BAILEY spent the summer of 1930 at various points along the length of the refuge. Mr. BAILEY grew up in the Upper Mississippi Valley, so its general life has been familiar to him for many years. He saw it first from a covered wagon in 1869, but this part of the valley was a well settled country then and his father had to go 30 miles north of Minneapolis before finding a homestead of choice land. The changes in bird and animal life and the possibilities of the region as a sanctuary were described. (*Author's abstract.*)

F. M. UHLER: *Waterfowl and reptile life of the Upper Mississippi River Wild Life and Fish Refuge.*—The Bureau of Biological Survey conducted preliminary biological investigations in the Upper Mississippi River Wild Life Refuge during the summers of 1926, 1927, and 1928. Two biologists worked together from a headquarters boat each year. The principal purpose was to determine the type, abundance, and distribution of waterfowl foods, and factors affecting their development throughout the Refuge. Fluctuating water levels were found to be the most important single factor in retarding the development of waterfowl foods.

During the course of this work about 400 species of plants (principally aquatic and moist-soil types) were studied. Notes on the water-fowl indicate that the once rare wood duck is now the most abundant of 14 species of ducks recorded in the Refuge during the nesting season; 41 species and races of reptiles and amphibians have been recorded from the counties which the refuge traverses; 90 species and races of fishes and 1 lamprey have been taken in the refuge, and 27 additional fishes and 1 more lamprey have been recorded in adjacent tributary streams. Sixty kinds of mussels and five species of crayfishes have been recorded from this area.

The Refuge will probably be greatly altered in the near future by the construction of a series of dams to facilitate navigation in the Upper Mississippi River. The final effects of that program are problematic. (*Author's abstract.*)

### 758TH MEETING

The 758th meeting was held in the New Assembly Hall of the Cosmos Club February 7, 1931 at 8:15 p.m., with President WETMORE in the chair and 96 persons present. New members elected: H. C. BRYANT, THEODORE KOPPANYI, W. C. MANSFIELD.

W. B. BELL reported that the musk oxen recently introduced into Alaska were adapting themselves readily to the new environment and gaining in weight.

A. WETMORE announced that it was planned to open the new reptile house at the National Zoological Park on February 28.

*Program:* T. GILBERT PEARSON: *Adventures in bird protection.*—The speaker gave his first public address on the subject of bird protection just 27 years ago in Washington, D. C. From this point the history of bird protection here and abroad was sketched.

In Europe bird protection usually means the protection of game on large estates. The first known organization to take up bird protection was in France and was for the purpose of controlling wolves. It dates back to the time of Charlemagne.

The present International Committee on Bird Protection has on its agenda consideration of such problems as the protection of song birds, oil pollution, sizes of "leads" to be used in shooting, and others. Game birds are frequently abundant on estates but the protection of song birds usually is a county matter, the protected species being listed on schedules, and one given protection in one county may not receive it in another. In Scotland no public shooting is permitted except between tides. England has a Royal Society for the Protection of Birds, with volunteer "watchers" who accumulate much useful information. France also has a Society for Bird Protection and last year the speaker attended the celebration at the establishment of their 1000th sanctuary. These are nothing more than plots of land privately owned where the owner agrees to protect the birds. Hawks are very scarce in Europe, being killed at every opportunity. Small song birds are not accorded legal protection, and in one year in Belgium, according to official figures, between three and four million were killed for food.

Referring to American efforts at wild life protection, the speaker gave first the history of Pelican Island, Florida, established by order of President Roosevelt in 1904. Pelicans have at times suffered heavily both at the hands of nature and man. During the war their destruction was urged as a conservation measure but an investigation showed that their food was almost 100 per cent menhaden, fish of no value as human food.

The speaker also dealt with the efforts to establish a national park in the Everglades, the efforts to preserve the Heath Hen on Martha's Vineyard, Massachusetts, and the success achieved in establishing the Paul J. Rainey Wild Life Sanctuary in Louisiana and the Antelope Refuge in Nevada.

H. W. TERHUNE: *Wild life protection in Alaska.*—The Alaska Game Commission is badly hampered through lack of wardens and operating funds. During its five years' operations, the revenues from sale of licenses, fines and forfeitures have increased from $19,000 in the fiscal year 1926, to $53,000 in 1930, while funds appropriated for the work have increased from $55,000 in 1926 to $97,000 in 1930. Starting with a force of 5 field wardens the Commission now has 10, 3 having been added during the present year. In addition to this force of regularly appointed full time men, there are about 90 licensed guides who are ex-officio wardens. The enforcement work of the guides, however, is largely preventative, as they are not authorized to incur expenses chargeable to the enforcement appropriation. Seven wardens with a district of over 90,000 square miles each, during the fiscal year 1930, travelled 55,000 miles in the course of enforcement. The Alaska Game Commission is encouraged in the work by the Courts meting jail sentences in addition to heavy fines in nearly fifty per cent of convictions.

Game conditions, generally, are improving. Since 1915 game has increased in nearly every section of the territory. There are no grounds for the present hysteria over the depletion of the large brown bears of Alaska, as they also are increasing. Some apprehension is felt, however, regarding the mountain sheep, in whose range the coyotes are rapidly advancing. Increasing reports of the scattering of some of the herds of sheep by coyotes are viewed with alarm. Incidentally, recent reports state that two coyotes were taken in the winter of 1929–30 near Point Barrow, the top of the continent.

Furs constitute one of the principal resources of Alaska, standing fourth in exports. Fur exports for 1929, amounting to $4\frac{1}{2}$ millions, were exceeded only by fisheries products with $46\frac{1}{2}$ millions, copper $8\frac{1}{2}$ millions, gold 7 millions. A study of the records of furs shipped from Alaska during the past 18 years indicates a well defined cycle of plenty and scarcity. (*Author's abstract.*)

## 759TH MEETING

The 759th meeting was held in the auditorium of the New National Museum February 28, 1931 at 8:10 p.m., with Vice-President JACKSON in the chair and 280 persons present.

*Program:* R. L. DITMARS: *Motion picture studies of reptiles* (illustrated)—The speaker sketched the advances in the last thirty years in the classification of snakes and in the treatment of snake poisoning. He then showed three reels of excellent moving pictures taken at the New York Zoological Park, illustrating (1) tortoises and lizards; (2) harmless snakes; and (3) poisonous lizards and snakes, accompanying the pictures with a running account of the animals' habits.

## 760TH MEETING

The 760th meeting was held in the New Assembly Hall of the Cosmos Club March 7, 1931 at 8:10 p.m., with President WETMORE in the chair and 90 persons present.

Frank Thone exhibited several recently published books on biological subjects including Skene's *School botany,* Wheeler's *Demons of the dust,* Hornaday's *Thirty years' war for wild life,* Kudo's *Handbook of protozoology,* and Fuertes' *Abyssinian birds and mammals.*

W. M. Mann stated that the newly-opened reptile house has been visited by a large number of people.

E. P. Walker mentioned a recent shipment of Canada geese, white-tailed deer, and three fine buck antelope, received from the Biological Survey.

*Program:* C. H. Townsend: *A recent expedition to the Galapagos Islands and studies of Galapagos tortoises.*—The speaker has been interested for several years in an attempt to save from extermination the tortoises of the Galapagos Islands. For many years these tortoises furnished food to whalers, as well as to many other vessels. Examination of log books of whalers at New Bedford indicates that Baur's estimate that ten million tortoises were taken from the islands is very likely not too large. Tortoises were practically gone from the accessible islands by the last quarter of the last century. They were also harried by hunters from Ecuador who killed them for the oil. In 1928 a vessel of the Bureau of Fisheries, acting with funds furnished by the New York Zoological Society, visited the Galapagos Islands to secure tortoises for zoological gardens. On Duncan Island none were found, but on Albemarle they were still found in numbers. Altogether 180 specimens were brought back, some of which were kept at New York while others were widely distributed to zoological gardens in the southern tier of States and in Bermuda, Honolulu, and Australia. No specimens weighing more than 80 pounds were brought back owing to difficult conditions of transport on the islands, and most of them were very much smaller. In general, it was found that in captivity they doubled or more than doubled their weight in two years. A specimen kept by the speaker at his home would go every evening to a corner of the yard next to a fence or log, scratch off the grass, and lie down on the raw earth. This practice was no doubt safe in its natural home, but was not so in the much cooler climate of New York. Consequently every evening for two weeks the turtle was driven into the garage where he burrowed into a pile of straw. At the end of that time he learned to do this for himself. In 1930 the speaker, with other naturalists, accompanied Vincent Astor on an expedition to the Galapagos Islands on which other specimens were collected. Photographs of the tortoises in the wild state and in captivity were shown, and moving picture films taken on the Vincent Astor Expedition.

### 761st meeting

The 761st meeting was held in the New Assembly Hall of the Cosmos Club March 21, 1931 at 8:15 p.m., with Vice-President Jackson in the chair and 63 persons present.

C. W. Stiles gave a brief resumé of the results of a 5000-mile trip through the southern States in search of hookworm. Newspaper reports that hookworm has been eradicated in the United States are incorrect. The pupils of 97 schools in seven States were examined. Infection varying from 1.4 per cent to 98 per cent was found, with an average of 32 per cent. Deplorable conditions of poverty and destitution were met in many places.

F. Thone exhibited several recent publications: P. Eipper's *Animals looking at you* and *Animal children,* and W. S. Bronson's *Fingerfins* and *Paddlewings,* the two latter, describing the life of a sargassum fish and the Galapagos penguin respectively, being written for children.

*Program:* ELIE CHEVERLANGE: *Exhibition of paintings of fishes of Tahiti.*—The speaker exhibited a series of colored paintings he had recently made and described his method of work. As far as possible, the fish were caught and kept alive in aquaria in order to observe their natural colors, which in many cases change greatly after death. He also studied them under water and made sketches there. By taking in his mouth a tube two or three fathoms long, supported by a float, through which he breathed, and with a clothespin on his nose, he found it possible to stay under water for half an hour without ill effects.

D. E. BUCKINGHAM: *The fish poison Derris.*—*Derris elliptica* is one of the several varieties of poisonous plants employed by the natives of the Malaysian Archipelago as a fish poison. The root of the plant is bruised and thrown into a stream where fish abound; within a few minutes, the fish are stimulated and swim in a frightened manner; then they appear on the surface either stunned or apparently dead. This method of fishing is illegal but is carried on secretly with success.

In other tropical countries, including South and Central America, the plant Cube (*Lonchocarous nicou*), as well as many other plants, produces this poisonous effect on fish. The active principle of Derris and Cube is rotenone, a white crystalline compound, having the formula $C_{22}H_{22}O_6$. It is insoluble in water, but soluble in acetone, chloroform, and many other organic solvents. Rotenone is extremely toxic to fish, one part in twenty million parts water killing gold fish in three hours; it is also highly toxic to insects and is effective both as a contact and as a stomach insecticide.

Derris extract has been used as an arrow poison by the head hunters of Borneo and the Amazon River. Because of its reputation as a poison used by uncivilized tribes, the writer has made many experiments to determine its effect on domestic animals when administered by the mouth.

The usefulness of rotenone as well as the extract of Derris as an insecticide would be seriously curtailed if it were markedly toxic to warm blooded animals; if, for instance, its action were similar to that of curare, strychnine, or similar drugs. The ideal insecticide is one that is toxic to insects but harmless to domestic animals.

Both rotenone and Derris extract have been proved, conclusively, to be non-poisonous to all domestic animals in any reasonable dose. Remarkable effects have been noted when Derris extract, in three per cent dilution in talcum, is applied as an insecticide on dogs and cats for fleas, lice, and ticks. Rotenone and Derris extract are proved to be valuable new insecticides, in both agriculture and veterinary medicine.

There is a large annual production of cultivated crops of Derris in Sumatra and the Malay States. The roots mature full toxicity in twenty months. An American market is sure to follow the fine results obtained with rotenone as well as the toxic extract of Derris. (*Author's abstract.*)

R. E. TARBETT: *Control over mosquito breeding.*—Different species of mosquitoes differ greatly in habits, on which methods of control must be based. The fundamental point is the elimination of water, the breeding place, as far as possible, and the control of the remainder with oil. For the author's purpose, mosquitoes are divided into four groups—malarial, domestic, woodland, and temporary pool species. Of three species of *Anopheles* in the southeastern states only *A. quadrimaculatus* is important. It breeds only in quiet waters, feeds only after dark, has a flight range of about a mile, and appears to have a homing instinct in connection with egg laying. Like some other species, it will enter a house through the chimney but can be kept out by hanging up a bag of naphthalene balls. The larvae feed on the surface of water and can be killed by a light dust of paris green (1 pound per acre). The principal domestic mosquitoes are *Culex* sp. and in the South *Aedes aegypti.* The former breed in any foul water, even in underground water containers which may be difficult to find or to reach; the latter only in man-made utensils in or around inhabited dwellings. The woodland species breed in open water and their habits vary greatly. The species breeding only in temporary pools lay their eggs in depressions where they remain dormant until rain. Development takes only a few days. Control measures in a given area usually do not extend far enough to reach the species of this group. In conclusion the speaker showed a film illustrating the life cycle of *Aedes aegypti.*

### 762ND MEETING

The 762nd meeting was held in the New Assembly Hall of the Cosmos Club April 4, 1931 at 8:10 p.m., with Vice-President JACKSON in the chair and 42 persons present.

J. M. ALDRICH stated that during a trip in the West last summer he found that in one locality bluebirds were nesting in about one-half the drop-front mail boxes.

*Program:* H. S. DAVIS: *Progress in experimental fish culture.*—In this country fish culture has been confined to the propagation of game fish and goldfish. At present emphasis is laid on the planting of older fish than formerly, in proper situations, and on making lakes more productive. Trout are grown for market in large numbers, and other fish may be later. There is an experimental station devoted to trout in Vermont, one devoted to pond culture in Iowa, and another in West Virginia devoted to both. Pictures were exhibited showing hatcheries and also work in the sloughs in the Upper Mississippi Refuge.

Discussed by E. P. WALKER.

C. R. LUCAS: *Commercial fish farming in the United States.*—There are over 1,000 nurseries and hatcheries in the United States, 455 of which are governmental. The value of their product is over $2,000,000 annually. The first hatchery for trout was established in 1864, and there are now over 100 establishments; that for goldfish shortly after 1878 (now 44 establishments); that for pond fish in 1929 (now 11).

H. B. HUMPHREY: *The relation of trees and other vegetation to stream flow.*—The speaker presented the results of observations on the rate of discharge of a small stream near his home at Cabin John, Maryland, made last autumn and subsequently. These observations show that there was an immediate relationship between sunlight and stream discharge, and that after the trees and other vegetation lost their foliage the discharge increased greatly. During 36 hours of continuous observation on 27–29 September, it was found that vegetation exerted an increasing pull on the water supply from about 10 a.m. until late afternoon, and that no water was running from about 3 p.m. to 7 p.m. (Full report in Monthly Weather Review **58**: 397–398. 1930.)

In discussion, R. M. LIBBEY stated that owing to the small amount of fresh water in the Potomac, crabs had been common last summer nearly up to Alexandria.

### 763RD MEETING

The 763rd meeting was held in the New Assembly Hall of the Cosmos Club April 18, 1931 at 8:10 p.m., with Vice-President STILES in the chair and 75 persons present. New member elected: LOUISE W. COCKE.

*Program:* W. A. HOFFMAN: *A consideration of educational, especially biological, progress in China, prefaced by some general remarks on the country and its people* (illustrated).—The speaker described the general features of Chinese geography, language, and customs. Lingnan University (formerly Canton Christian College) is now 43 years old. It is more Chinese than the other fifteen Christian colleges and gives a typical Chinese education. It includes a university (with 300 pupils, including 50 girls), high school, primary, and kindergarten, with a total of 1100 pupils. Two thirds of the college staff of 75 are Chinese. The university has specialized in science and has the largest herbarium in China and large zoological collections. Like other Chinese universities, it is greatly hampered by the lack of published literature. The scientific organizations of China were mentioned and discussed briefly, and an account given of the explorations of Lingnan University in Hainan.

M. K. BRADY: *The Breeding of Salamanders* (illustrated).—This paper will appear in full in the Novitates of the American Museum of Natural History.

### 764TH MEETING

### 52ND ANNUAL MEETING

The 764th regular and 52nd annual meeting was held in the Assembly Hall of the Cosmos Club May 2, 1931 at 8:15 p.m., with Vice-President JACKSON in the chair and ten persons present. New member elected: S. W. GEISER.

The minutes of the last annual meeting were read and approved. The reports of the Recording Secretary and Corresponding Secretary were read and ordered placed on file. The recommendation of the Council that the Treasurer's report and the report of the Auditors be postponed until the first fall meeting was approved.

Dr. OBERHOLSER for the Board of Trustees stated that the status of the Permanent Fund is unchanged.

Mr. WALKER made an oral report for the Committee on Communications.

Messrs H. C. FULLER and W. H. BALL were appointed Tellers, and the election took place, resulting as follows.

*President,* H. H. T. JACKSON: *Vice-Presidents,* C. E. CHAMBLISS, C. W. STILES, T. E. SNYDER, H. C. FULLER; *Recording Secretary,* S. F. BLAKE; *Corresponding Secretary,* W. H. WHITE; *Treasurer,* F. C. LINCOLN; *Members of Council,* W. R. MAXON, A. A. DOOLITTLE, I. HOFFMAN, E. P. WALKER, T. H. KEARNEY.

S. F. BLAKE, *Recording Secretary.*

## SCIENTIFIC NOTES AND NEWS

DR. HILMAR ØDUM, of the Geological Survey of Denmark, Copenhagen, was in Washington during part of September studying Eocene and Upper Cretaceous fossils at the National Museum and the organization and methods of the ground water division of the Geological Survey.

DR. ALEXANDER WETMORE has been elected a member of the California Academy of Sciences.

The first trial expedition of Aeroarctic in the arctic utilized the *Graf Zeppelin* during a six-days' flight of 8,000 miles leaving Berlin July 25 and returning July 30. The course was approximately Friedrichshafen, Leningrad, Archangel, Franz Josef Archipelago, Northern Land, Taymir, Novaya Zemlya, and return to Archangel and Friedrichshafen. LJUNGDAHL of Sweden, SMITH of the United States Coast Guard, and Lincoln Ellsworth representing the American Geographical Society took part in the magnetic observations which were in charge of LJUNGDAHL, the other two men assisting. There were 92 determinations of magnetic horizontal intensity obtained with the double-compass supplied by the Department of Terrestrial Magnetism and eight observations of declination with a Thomson compass. All reports indicate the trial expedition to have been an extremely satisfactory one and ECKENER has already assured the General Secretary of the Society of his desire to have the longer flight as originally proposed realized, if possible, next year.

For its International Polar Year Expedition the Canadian Meteorological Service has already received a special grant to apply this year for the purchase of instruments and for the preliminary arrangements. The main magnetic station will be at Chesterfield Inlet. Four or five other stations will be established principally for meteorological work.

The earth-current photographic registrations started at Tucson in March with the cooperation of the American Telephone and Telegraph Company, the Mountain States Telephone and Telegraph Company, the Coast and Geodetic Survey and the Department of Terrestrial Magnetism are continuing very satisfactorily.

The first of the coded messages regarding auroral display and intensity which are now a regular part of the daily URSIGRAM was received from College, Alaska, August 15 as applying to the date August 13.

The *Nautilus* of the Wilkins-Ellsworth Trans-Arctic Submarine Expedition left Bergen August 5 and arrived at Spitzbergen August 15. Owing to the lateness of the season it was not possible to cruise in the arctic ice longer than about three weeks. The vessel returned to Spitzbergen and after repairs proceeded to Norway. In the scientific staff were B. VILLINGER who spent some three weeks with Dr. VENING-MEINESZ in the study of the gravity apparatus, Dr. SVERDRUP of Bergen and F. M. SOULE of the Department of Terrestrial Magnetism.

Dr. and Mrs. JOHN C. MERRIAM after spending the greater part of the summer in Europe returned to Quebec August 26 and proceeded directly to California.

J. M. STAGG of the British Meteorological Office came to Washington July 25 to visit the Department of Terrestrial Magnetism and discuss matters pertaining to the International Polar Year. He left July 31 to return home by way of Toronto. A letter written after he returned states that despite the unfavorable economic conditions he finds everyone is quite optimistic as regards the program of the International Polar Year.

Dr. J. E. I. CAIRNS who has recently received his degree at Trinity College resumed his work in the Department of Terrestrial Magnetism, June 29.

## OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcements of Meetings

| | |
|---|---|
| Tuesday, October 20 | The Anthropological Society |
| Wednesday, October 21 | The Washington Society of Engineers |
| | The Medical Society |
| Saturday, October 24 | The Philosophical Society |
| Wednesday, October 28 | The Geological Society |
| | The Medical Society |
| Saturday, October 31 | The Biological Society |
| Tuesday, November 3 | The Botanical Society |
| Wednesday, November 4 | The Washington 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.**

## OFFICERS OF THE ACADEMY

*President:* N. A. Cobb, Bureau of Plant Industry.
*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
*Treasurer:* Henry G. Avers, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings



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# WASHINGTON ACADEMY OF SCIENCES



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## 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 semimonthly, 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.

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*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. 21 NOVEMBER 4, 1931 No. 18

POPULATION ANALYSIS.—*The extinction of families*—II.[1] ALFRED J. LOTKA, New York.

Let $C_N$ be the probability, at the moment of his birth, that a random male shall eventually have just $N$ sons. Then, as has been shown by H. W. Watson,[2] and independently by J. F. Steffensen,[3] the probability that the progeny of this male, in direct line of male descent, shall comprise just $k$ males in the s-th generation is given by the coefficient of $x^k$ in the $s$-th iteration[4] $f_s(x)$ of $f(x)$, where

$$f(x) = C_0 + C_1 x + C_2 x^2 + . . . \tag{1}$$

To carry out the successive iterations of the function $f(x)$, as required according to this formula, for any considerable number of generations, would be an excessively laborious task in the general case in which the coefficients $C_N$ may have any arbitrary values. Actually, the work is greatly simplified by the fact that the numerical coefficients $C_1, C_2, \ldots$ as computed from actual statistics (United States, white males 1920), are found to approximate the simple law of geometric progression. This is shown in Fig. 1, in which the numerical values of the $C_N$ are plotted on a logarithmic scale against the values of $N$ on an arithmetic scale. It will be seen that for $N = 1, 2, 3, \ldots$, the points thus plotted fall approximately on a straight line. It is true that for the higher members of the set, notably $C_9$

[1] Received September 23, 1931. For Part I see this JOURNAL **21**: 377-380 1931.

[2] Published in *Natural Inheritance* by Francis Galton, 1889, p. 242.

[3] Matematisk Tidskrift 1930, p. 19.

[4] The notation $f_s(x)$ and its designation as the $s$-th iteration of f(x) is to be understood as follows:

$$f_1(x) = f(x)$$
$$f_2(x) = f\{f_1(x)\}$$
$$f_s(x) = f\{f_{s-1}(x)\}$$

In counting generations, the original ancestor must be reckoned as the zero generation, his sons as the first, and so on.

and $C_{10}$, there is a systematic departure from linearity. But these higher coefficients are relatively unimportant, since families comprising a large number of sons are rare. Accordingly a straight line was fitted by the method of least squares to the logarithms of the values of $C_1$, $C_2$, . . . determined by the process described in Part I (this JOURNAL, October 4, 1931, p. 377) with the results shown in Fig. 1

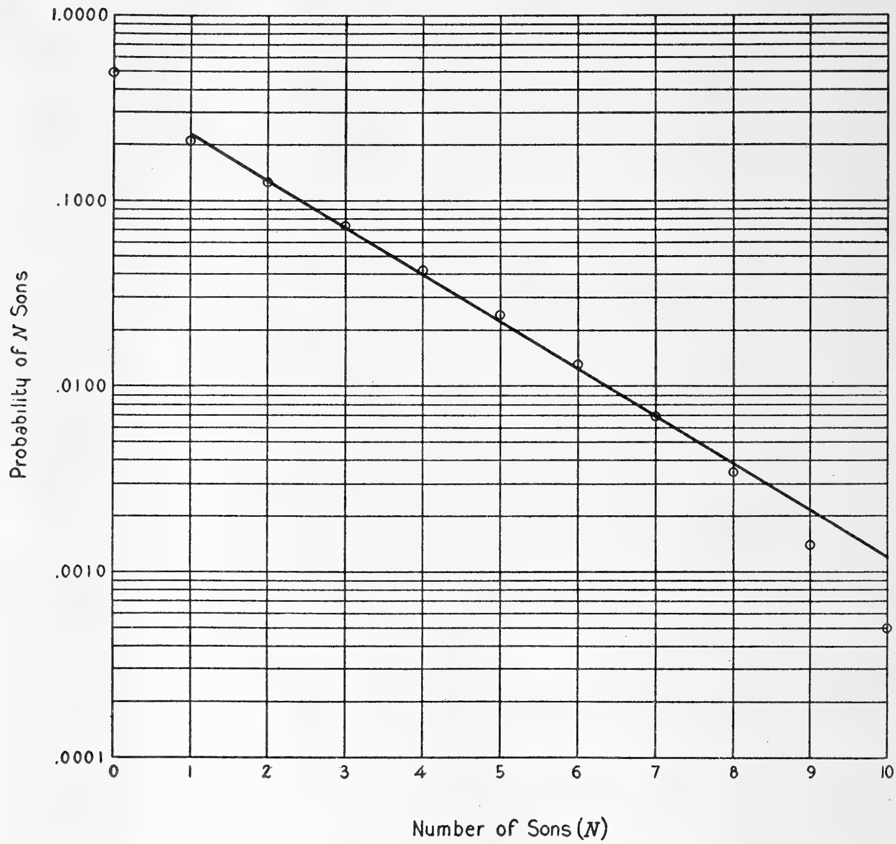



Figure 1. Probability $P$ (*1*, $N$) that a new-born male shall have $N$ male descendents (sons) in the first generation. Based on statistics for white males, U. S., 1920.

and Table 1 in which the "smoothed" values for $C_1$, $C_2$ . . . $C_{10}$ are those given by the least square fit

$$C_N = .4099 \times (.5586)^N \tag{2}$$

It should be noted that $C_0$ is not included among the series of coefficients defined by (2). If it had been included, the set of coefficients would in general fail to satisfy the condition $\sum_{1}^{10} C_N = 1$. Accordingly $C_0$ was determined separately, by the relation

$$C_0 = 1 - \sum_{1}^{10} C_N = .4828 \qquad (3)^5$$

after the "smoothed" values of $C_1, C_2 \ldots C_{10}$ had been determined as indicated above.

TABLE 1. VALUES OF COEFFICIENTS $C_N$

| N | Crude | Smoothed[a] |
|---|---|---|
| 0 | .4981 | .4828 |
| 1 | .2103 | .2289 |
| 2 | .1270 | .1279 |
| 3 | .0730 | .0714 |
| 4 | .0418 | .0399 |
| 5 | .0241 | .0233 |
| 6 | .0132 | .0125 |
| 7 | .0069 | .0070 |
| 8 | .0035 | .0039 |
| 9 | .0015 | .0022 |
| 10 | .0005 | .0012 |

[a] Least squares straight line fit to logarithms of $C_1, C_2, \ldots C_{10}$,
$C_N = .4099 \times (.5586)^N$

The function $f(x)$, using the smoothed values of the coefficients $C_N$, is of the form of a constant term plus a geometric series. It can, accordingly be written in finite form

$$f(x) = .07294 + \frac{.40986\,[1 - (.55860x)^{11}]}{(1 - .55860x)} \qquad (4)$$

In actually carrying out this iteration, the labor can be greatly reduced, with but little loss in accuracy,[6] if the geometric series is summed to infinity, instead of stopping at the term in $C_{10}$. The equation (4) then reduces to

$$f(x) = \frac{.4828 - .04074x}{1 - .55860x} \qquad (5)$$

[5] In equation (3) it does not very greatly influence the result whether we carry the summation to $C_{10}$ or to $C_\infty$, the former alternative giving $C_0 = .4828$, the latter $C_0 = .4813$, while the unsmoothed data give $C_0 = .4981$.

[6] The retention of the higher terms implies that we are including a contingent of very large families. But the coefficients $C_N$ become so small, i.e., the theoretically very large families are so rare, that the error introduced is small.

With the function $f(x)$ thus expressed in finite form, the determination of successive iterations is now a matter of simple arithmetic, the results being obtained primarily in finite form, and being then expanded in series in order to determine the required coefficient of $x^k$.

The results thus obtained are shown in Table 2 and in Fig. 2. This latter has been drawn as a three-dimensional model and shows on a vertical logarithmic scale the probability $P(s,N)$ that the $s$-th generation shall comprise just $N$ sons, the corresponding values of $s$ and $N$ being read on arithmetic scales running respectively from left to right and from the back face forward out of the plane of the paper. The values of this probability for $N = 0$ and for successive generations fall on a separate curve shown near the top on the rear face of the diagram. The values of the probability $P(s,N)$ for all other values of $s$ and $N$ fall on a family of straight lines which themselves fall on a ruled surface, the outstanding feature of the diagram.

TABLE 2. THE PROBABILITY $P$ $(s.N)$ PER 1,000 THAT A NEWBORN MALE SHALL HAVE $N$ MALE DESCENDANTS IN THE $s$-TH GENERATION

| $N$ / $s$ | None | One or More | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 482.80 | 517.20 | 228.95 | 127.89 | 71.44 | 39.91 | 22.29 | 12.45 | 6.95 | 3.88 | 2.17 | 1.21 |
| 2 | 634.16 | 365.84 | 98.29 | 72.12 | 52.92 | 38.83 | 28.49 | 20.90 | 15.33 | 11.25 | 8.25 | 6.05 |
| 3 | 707.65 | 292.35 | 53.97 | 44.19 | 36.18 | 29.62 | 24.25 | 19.85 | 16.25 | 13.30 | 10.89 | 8.92 |
| 4 | 750.74 | 249.26 | 33.80 | 29.36 | 25.50 | 22.15 | 19.24 | 16.71 | 14.51 | 12.60 | 10.94 | 9.50 |
| 5 | 778.83 | 221.17 | 22.95 | 20.68 | 18.63 | 16.79 | 15.13 | 13.63 | 12.28 | 11.07 | 9.97 | 8.98 |
| 6 | 798.45 | 201.55 | 16.48 | 15.22 | 14.06 | 12.99 | 12.00 | 11.09 | 10.24 | 9.46 | 8.74 | 8.07 |
| 7 | 812.80 | 187.20 | 12.29 | 11.56 | 10.87 | 10.22 | 9.61 | 9.04 | 8.50 | 7.99 | 7.51 | 7.06 |
| 8 | 823.68 | 176.32 | 9.46 | 9.01 | 8.59 | 8.19 | 7.80 | 7.43 | 7.08 | 6.75 | 6.43 | 6.13 |
| 9 | 832.13 | 167.87 | 7.41 | 7.13 | 6.86 | 6.60 | 6.35 | 6.11 | 5.88 | 5.66 | 5.45 | 5.25 |
| 10 | 838.81 | 161.19 | 5.90 | 5.73 | 5.56 | 5.40 | 5.24 | 5.08 | 4.93 | 4.78 | 4.64 | 4.50 |

*Graphic iteration of the function $f(x)$.* It is worth noting that the operation of constructing successive iterations of $f(x)$ is very easily carried out graphically, as follows:

In the diagram, Fig. 3, the lowermost curve represents the function $y = f(x)$ to be iterated. Draw the line OP at 45 degrees to the coordinate axes. Take any point Q on the given curve. From Q draw a perpendicular QR, and a horizontal QS meeting OP in S. From S draw a perpendicular ST meeting the curve in T. From T draw a horizontal TU meeting QR in U. Then U is a point on the (second) iteration $f\{f(x)\} = f_2(x)$. Point by point the graph of $f_2(x)$ can thus be constructed, and from it, by a repetition of the process, the graph of $f_3(x)$ and so on. Or, in view of the relation

$$f_2\left\{f_2(x)\right\} = f_4(x) \tag{6}$$

the fourth iteration can be obtained directly from the second, the eighth from the fourth and so on.

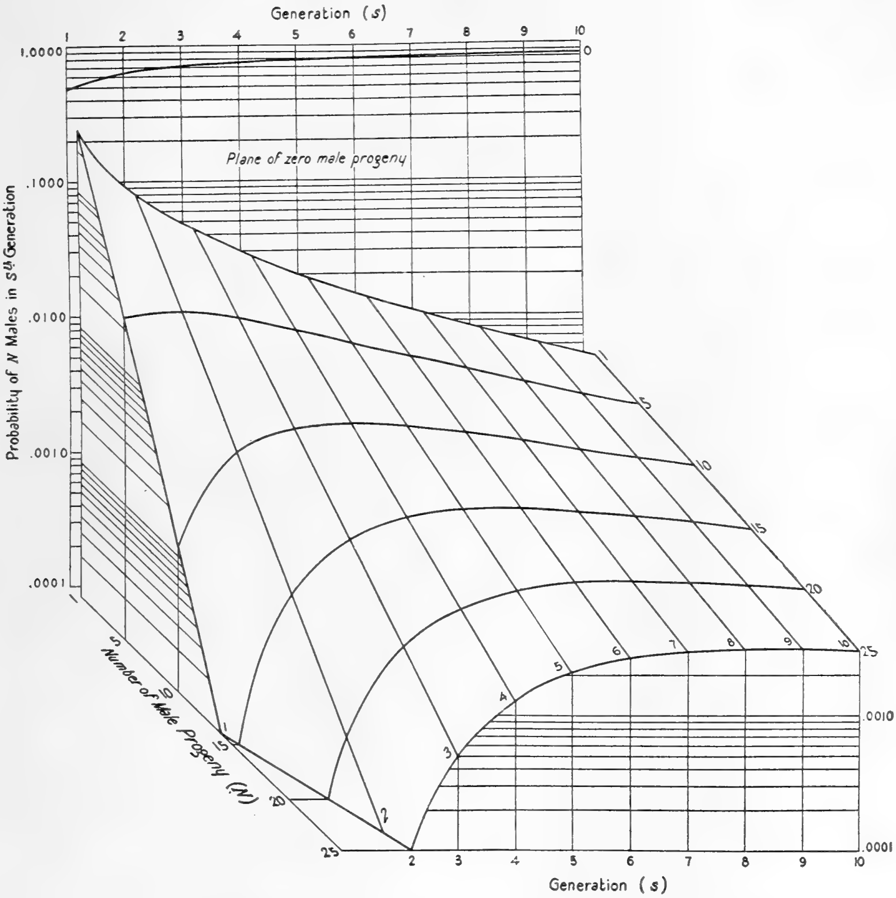



Figure 2. Probability $P(s, N)$ that a new-born male shall have $N$ male descendents in the $s$-th generation. Based on statistics for white males, U. S., 1920.

The process is very simple and easily carried out. It must be remembered, however, that we require not merely the graphs of these iterated functions, but the coefficients of the terms in their expansion in power series. Unfortunately, for the determination of these coefficients with any satisfactory degree of accuracy the graphs are not adequate. They do, however, bring out clearly certain points of interest. So, for example, it will be seen that the graphs for all the iterated functions pass through the points corresponding to the roots of the equation

$$x = f(x) \tag{7}$$

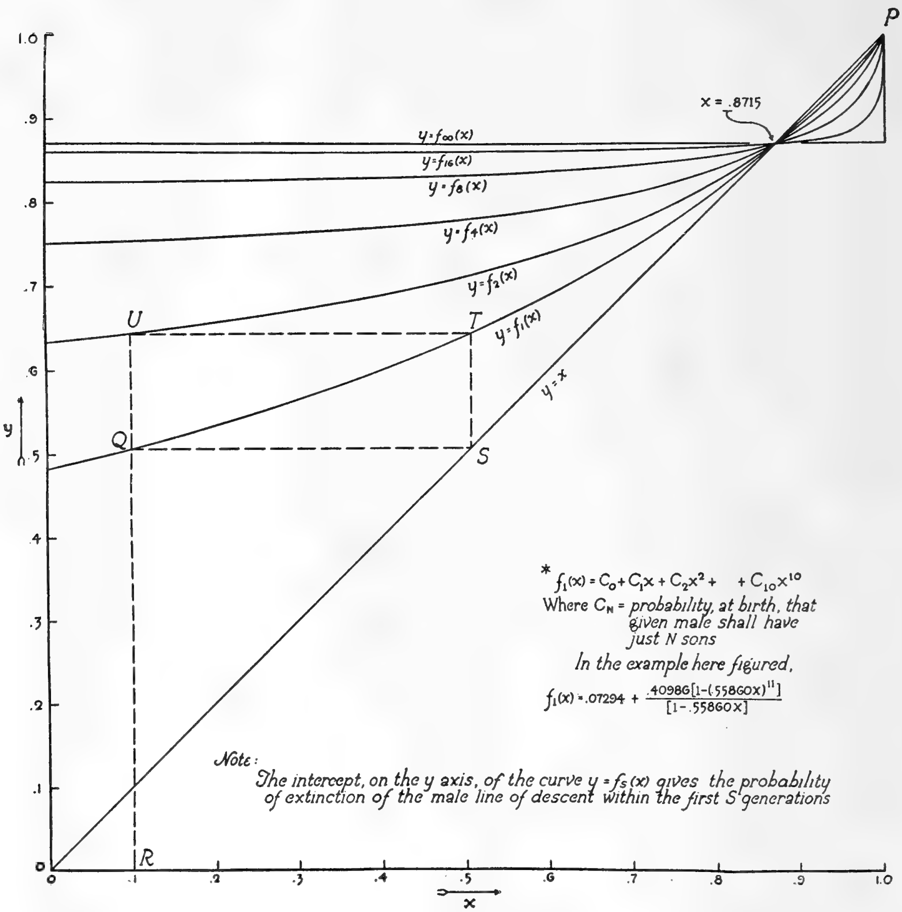



Figure 3. Iterations of $y = f_1(x)$* and illustration of the graphic method of construction.

these roots being common also to the equation

$$x = f_s\{f(x)\} \tag{8}$$

for all values of $s$.

Another point of interest to note is that the successive iterated curves ultimately approach a curve consisting of two straight lines forming a right angle.

*Roots of equation* (7). In Part 1 of this article the root, inferior to unity, of (7) was found to be .8797 on the basis of the original unsmooth values of the coefficients $C_N$. This required solving by the method of successive approximations an equation of tenth degree, with terms of all degrees from the first to the tenth actually present.

It is to be noted that when the smoothed values of the coefficients $C_N$ are employed, the solution of (7) is greatly simplified. The first approximation is found very easily by the quadratic equation

$$\mathrm{x} = \frac{.48280 - .04074x}{1 - .55860x} \tag{9}$$

$$= .8724 \tag{10}$$

The further approximations are then very easily computed with retention of the term in $x^{11}$ in the expression (4) for $f(x)$, since there is always only one term of higher than second degree present. There is thus found, ultimately, for the required root,

$$x = .8715 \tag{11}$$

which, as will be seen, does not differ very greatly from the value .8797 obtained with use of the unsmoothed coefficients $C_N$. In fact, the errors of observation in the statistics underlying the values of $C_N$ are probably greater than the difference between the crude and the unsmoothed values of these coefficients, and accordingly no significance can be attached to the difference by less than one unit in the second decimal between the values .880 and .872 obtained as above by the use of the crude and of the smoothed coefficients respectively.

PALEONTOLOGY.—*Concerning the authorship of the "Preliminary notice of the lamellibranch shells of the upper Helderberg, Hamilton and Chemung groups, etc., Part 2"*[1] G. A. COOPER, U. S. National Museum (Communicated by J. B. REESIDE, JR.).

During the course of bibliographic studies of the Devonian Pelecypoda in connection with a projected bibliography of the Devonian invertebrates under the direction of Dr. E. M. Kindle of the Canadian Geological Survey the writer has had to refer to a paper reminiscent of the turbulent days at Albany in the Hall régime when the great *Pale-*

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 24, 1931.

*ontology of New York* was being conceived. The following remarks relate to the *Preliminary notice of the lamellibranchiate shells of the upper Helderberg, Hamilton and Chemung groups, with others from the Waverly sandstones, Part 2,* published anonymously in 1869 and 1870. Although many writers have accredited the publication to James Hall, evidence points strongly towards a joint authorship with R. P. Whitfield. This claim of Whitfield to joint authorship with Hall has apparently been recognized by a few writers only. In the interest of bibliographic stability it is the writer's purpose to settle permanently the question of authorship of the *preliminary notice, No. 2,* dates of genera and species described therein, and the status of the two generic names, *Modioconcha* and *Nyassa.*

The publication under discussion appeared in two forms, the first an 80-page edition distributed in December 1869 and the other an enlarged edition of 97 pages, published one month later, January 1870. Hall[2] explains the circumstances surrounding the distribution and composition of the pamphlets:

> In 1869 the writer printed and published "Preliminary Notice No. 2, of the Fossil Lamellibranchiate Shells of the Upper Helderberg, Hamilton, Portage and Chemung groups," etc., to the number of eighty pages, issued in December of that year. One hundred copies in this form were distributed. In January following the printing was resumed, and sixteen additional pages were printed. The pamphlet thus augmented, with a supplementary page stating the fact that the descriptions of other species were in type, was distributed to the public.

Hall states further that the paper was to have appeared in the 23rd Annual Report of the New York State Cabinet of Natural History "with a preparatory [sic] note making due acknowledgements for sources of aid and information . . . ." The *Preliminary notice, No. 2* did not appear in the 23rd Annual Report and by way of explanation Hall adds, "this report (23) [rd Annual Report] was, however, not published till 1872. In the meantime the burning of the State printing establishment destroyed the material in the hands of the printer (leaving some proof-sheets only in the hands of the author)." In the same preface he gives the reason for the appearance of *preliminary notice, No. 2* in advance of No. 1 as follows: ". . . because the investigations upon the genera there included in No. 2 were farther advanced; while comparatively little had been done in arranging the

[2] JAMES HALL. *Preliminary notice of the lamellibranchiate shells, etc.*, Part 1. Ann. Rept. N. Y. St. Mus. **35:** 215, 216. 1884.

groups preceding those described." Referring to the *preliminary notice, No. 2* Hall makes the statement that he "was very efficiently aided by Mr. R. P. Whitfield, then an assistant in the Museum, to whom he expresses his obligations."

After the distribution of the 80-page edition, the pamphlet was noticed in the American Journal of Science for March, 1870[3] in which the authorship was accredited to James Hall. The publication of the paper was also recorded in the Proceedings of the American Association for Advancement of Science[4] and likewise attributed to Hall. The Neues Jahrbuch[5] in noticing the second edition, accredited the paper to James Hall.

The basis of Hall's title to sole authorship of the paper appears to rest on the presence of a printed slip inside the cover of the 97-page edition[6] which bears the words "With Compliments of James Hall;" the presence of the name Hall inserted after two of the generic names[7] used in the pamphlet for the first time; the use of the first person singular in some of the descriptions;[8] his many references in later literature[9] to the genera proposed in the *preliminary notice, No. 2* as his own; and the fact that some bibliographers[10] have accredited this anonymous paper to Hall on the above superficial evidence.

In the course of his bibliographic studies the writer came upon the late Dr. C. D. Walcott's copy of the 97-page edition which bears valuable notes dealing with the authorship of the pamphlet. Finding Walcott's notes of such great importance the idea suggested itself that additional copies owned by other paleontologists might likewise yield valuable information. Accordingly requests were sent to several

[3] Page 276.

[4] Proc. Amer. Asso. Adv. Sci. **18**: 282. 1869.

[5] Neues Jahrb. für Min., Geol. & Pal. 1871, p. 988.

[6] Recently the writer purchased an unused copy of the 97-page edition from the University of Chicago which shows clearly the method used by Hall in distributing this edition of the paper in question. Inside the cover is pasted a slip bearing the following printed words: "With compliments of James Hall, N. Y. State Museum Natural History, Albany, N. Y., U. S. A." This was a common method of distribution of New York State Museum publications.

The writer does not know if such a slip appeared with the 80-page edition since the copies seen were without covers. James D. Dana's copy bore "With the respects of James Hall" in Hall's writing. These "compliments" and "respects" of James Hall do not necessarily imply authorship by Hall, as was evidently assumed by the American Journal of Science for March, 1870.

[7] *Nyassa*, p. 28; *Pholadella*, p. 63.

[8] See under *Modioconcha*, p. 27; also pages 34, 44, and 62.

[9] *Pal. N. Y.* V, Lam. I & II, 1884 & 1885, resp.

[10] S. A. MILLER. *North American Geology and Paleontology*, II, 1889; SCUDDER. *Nomenclator zoologicus*, U. S. Nat. Muss. Bull. **19**. 1882.

universities and museums. Dr. Charles Schuchert of Yale University loaned his personal copy of the 97-page edition and James Dwight Dana's copy of the 80-page edition, both of which carried valuable notes. Through Dr. R. Ruedemann the New York State Museum loaned Dr. John M. Clarke's copy of the 97-page edition. The writer extends his thanks to Drs. Schuchert and Ruedemann and the New York State Museum for their kindness.

Whitfield's first printed claims known to the writer appear in the *Geology of Wisconsin, Part III, Paleontology*, 1882, pp. 335–337, and the *Annals of the New York Academy of Science*, volume II, no. 8, 1882, pp. 201, 216, 233, and 244. In these reports Whitfield cites the *Preliminary notice, No. 2* giving Hall and Whitfield as authors and states that the pamphlet was "distributed without author's name." In his faunal lists Whitfield cites a species[11] described in the *Preliminary notice, No. 2* as "H. & W."

Whitfield's claim was brought to public attention prior to the publication of the *Geology of Wisconsin, Part III, Paleontology* by C. A. White[12] who cites the pamphlet as "Anon [Hall and Whitfield]" and in addition makes the following remarks:

> This memoir was noticed in the *Am. Journ. Sci.*, vol. xlix, 2d series, p. 276, and attributed to James Hall, although the work itself bears the name of no author. It does not appear that Prof. Hall has anywhere claimed sole authorship; but, on the contrary, Prof. Whitfield has claimed the authorship to be jointly with Prof. Hall and himself. See *Ann. Rep. Wisconsin Geol. Surv.* 1878, p. 51, and *Paleontology of Wisconsin* (now in press), pp. 136, 137, and 138.— . . . .

White's reference to Whitfield's claim in the *Annual Report of the Wisconsin Geological Survey* for 1878 and the *Paleontology of Wisconsin* have been checked by the writer. The first reference is evidently an error by White since Whitfield's claim does not occur in this report, nor in the reports for 1877 and 1879. In the *Geology of Wisconsin, Part III, Paleontology*, Whitfield's indications of joint authorship with Hall appear on pages 335–337, not the pages cited by White. It is possible that Whitfield informed White of his intention to publish his claims to joint authorship with Hall, or White may have seen the manuscript or proof-sheets of the *Annual Report* for 1878 above cited but the claim never appeared because of deletion or some other reason. Whitfield continued these claims in later publications[13] and

[11] *Geol. Wis.* **1**: 369. 1883.

[12] Bull. U. S. Geol. & Geog. Surv. Terr. **5** (1): 144. 1879.

[13] Ann. N. Y. Acad. Sci. **5**: 523, 545, 559, 561, 604, 614. 1891; **12** (8): 140, 185, 186; *Geol. Ohio* **7**: 422, 437, 438, 440, 451, 453, 494. 1893.

the fact that they were ignored by so many writers is doubtless because the case was never thoroughly investigated.

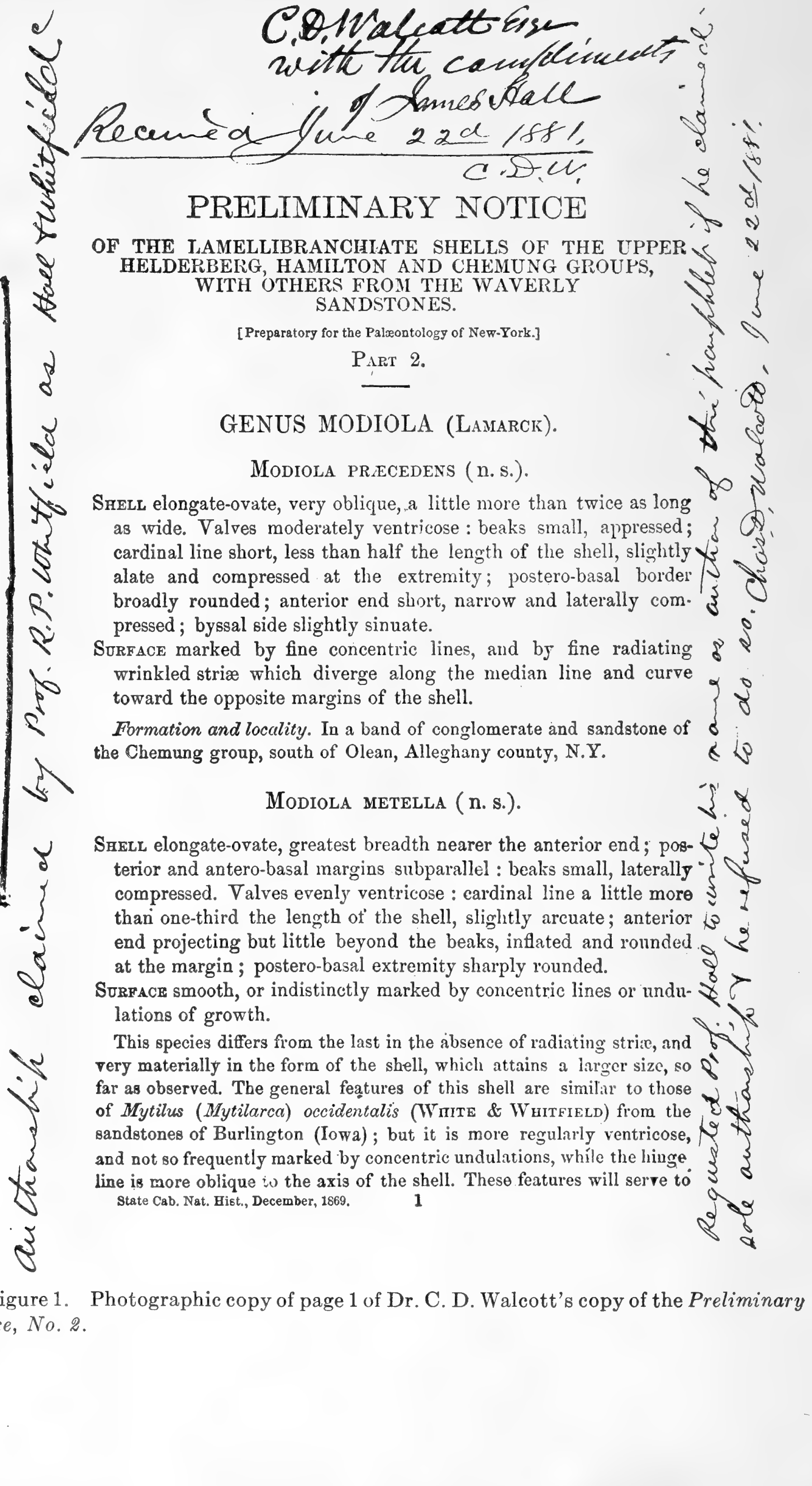
There are certain points of evidence in the paper which strongly substantiate Whitfield's claim to joint authorship with Hall. There is an occasional use of the word "we," and the appearance of Whitfield's initials[14] on pages 84, 91, and 93. These Hall evidently failed to delete during the apparently hurried proof-reading of that part of the paper. To this oversight may be added another of Hall's which appears in the legend to plate 14, figure 7, of the *23rd Annual Report of the New York State Cabinet of Natural History.* In this legend the species, *Microdon tenuistriatus,* described as a new species in the *Preliminary notice, No. 2,* page 32, is cited under the authorship of "H. & W.", the initials clearly indicating Hall and Whitfield. In support of Whitfield's claim also is the oral statement of Dr. Edwin Kirk of the United States Geological Survey who says that, in conversations with Whitfield, the former associate of Hall declared that he (Whitfield) wrote the *Preliminary notice, No. 2* and was to have received joint authorship with Hall.

Still more conclusive than the evidence cited above is that contained in a note written by Dr. C. D. Walcott on the first page of his copy of the sconnd edition. This copy, presented to Walcott by Hall, bears the notation "With compliments of James Hall" in Hall's hand writing. Walcott, evidently aware of Whitfield's claim, asked Hall to write his name as author if he claimed *sole* authorship to the pamphlet, but Hall refused to sign his name (see fig. 1). Hall's refusal to assume sole authorship of the *Preliminary notice, No. 2* places him in the peculiar position of substantiating Whitfield's claim. James Dwight Dana's copy of the 80-page edition also bears evidence, for, in his own handwriting, Dana attributes the authorship to Hall and Whitfield.

The fact that Hall and Whitfield's names are associated together in other papers prepared at this time shows that an agreement of joint authorship with Whitfield was not entirely distasteful to Hall. Three of these papers[15] actually appear in the *23rd Annual Report of the State*

[14] Whitfield calls attention to the appearance of his initials in the *Preliminary notice, No. 2* in the Ann. N. Y. Acad. Sci. **12** (8): 140. 1899.

[15] *Descriptions of new species of fossils from the Devonian rocks of Iowa,* pp. 223–239; *Notice of three new species of fossil shells from the Devonian of Ohio,* pp. 240, 241; *Notice of two new species of fossil shells from the Potsdam sandstone of New York,* pp. 241, 242. The last two papers are without an author's name but are included under article (F) along with the first. The legends to plates 9–12 accompanying these articles attribute all of the species to Hall and Whitfield.



C. D. Walcott Esq
with the compliments
of James Hall

Received June 22d 1881.
C. D. W.

# PRELIMINARY NOTICE

## OF THE LAMELLIBRANCHIATE SHELLS OF THE UPPER HELDERBERG, HAMILTON AND CHEMUNG GROUPS, WITH OTHERS FROM THE WAVERLY SANDSTONES.

[Preparatory for the Palæontology of New-York.]

PART 2.

### GENUS MODIOLA (LAMARCK).

MODIOLA PRÆCEDENS (n. s.).

SHELL elongate-ovate, very oblique, a little more than twice as long as wide. Valves moderately ventricose : beaks small, appressed; cardinal line short, less than half the length of the shell, slightly alate and compressed at the extremity; postero-basal border broadly rounded; anterior end short, narrow and laterally compressed; byssal side slightly sinuate.

SURFACE marked by fine concentric lines, and by fine radiating wrinkled striæ which diverge along the median line and curve toward the opposite margins of the shell.

*Formation and locality.* In a band of conglomerate and sandstone of the Chemung group, south of Olean, Alleghany county, N.Y.

MODIOLA METELLA (n. s.).

SHELL elongate-ovate, greatest breadth nearer the anterior end; posterior and antero-basal margins subparallel : beaks small, laterally compressed. Valves evenly ventricose : cardinal line a little more than one-third the length of the shell, slightly arcuate; anterior end projecting but little beyond the beaks, inflated and rounded at the margin; postero-basal extremity sharply rounded.

SURFACE smooth, or indistinctly marked by concentric lines or undulations of growth.

This species differs from the last in the absence of radiating striæ, and very materially in the form of the shell, which attains a larger size, so far as observed. The general features of this shell are similar to those of *Mytilus* (*Mytilarca*) *occidentalis* (WHITE & WHITFIELD) from the sandstones of Burlington (Iowa); but it is more regularly ventricose, and not so frequently marked by concentric undulations, while the hinge line is more oblique to the axis of the shell. These features will serve to

State Cab. Nat. Hist., December, 1869. 1

Authorship claimed by Prof. R. P. Whitfield as Hall Whitfield

Requested Prof. Hall to write his name as author of this pamphlet if he claimed sole authorship, he refused to do so. Chas. D. Walcott, June 22d/81.

Figure 1. Photographic copy of page 1 of Dr. C. D. Walcott's copy of the *Preliminary notice, No. 2.*

*Cabinet of Natural History*, the publication that was to have contained the *Preliminary notice, No. 2*.

The question of bibliographic stability rather than of justice to Whitfield has impelled the writer to revive this claim of Whitfield's to joint authorship in the *Preliminary notice, No. 2*. Although some writers have credited Hall with sole authorship, White, Dana, Walcott, and Etheridge[16] considered it a joint publication of Hall and Whitfield. The pamphlet as distributed from the New York State Museum was an anonymous paper and as such has no standing; its contents could be ignored and all of the genera and species contained therein dated from 1883 when the *Palaeontology of New York*, vol. V, part 1, *Lamellibranchiata*, Plates and Legends appeared. This however, would lead to a great deal of confusion. It would seem preferable to affix to the anonymous paper the same of the senior author, who was directing the researches embraced by the pamphlet, and the name of the junior author who obviously had a large share in its preparation. It is recommended therefore, as a move towards stability, that subsequent bibliographers recognize the authors of the *Preliminary notice, No. 2* as Hall and Whitfield. This procedure will be followed in the forthcoming bibliography of Devonian invertebrates.

The establishment of authorship is not the sole problem connected with the *Preliminary notice, No. 2*; there are, among other points, the questions of dates for genera and species and the status of certain genera and species. The question of dates arises from the fact that there were two editions of the pamphlet, the second edition containing 17 pages more than the first. The genera and species in the first, or 80-page edition, take the date December 1869, and those described on pages 81–96 of the second or 97-page edition date from January 1870. On page 97 several new species of *Schizodus* and *Lunulacardium*, a new genus *Mytilops*, and a new subgenus of *Pinna*, *Palaeopinna*, are mentioned but are unaccompanied by descriptions; these are therefore *nomina nuda* and have no standing. The species and genera[17] mentioned on this page are properly indicated in *Palaeontology of New York*, volume V, Part 1, *Lamellibranchiata* (*plates and legends*), 1883 and must

[16] R. JUN. ETHERIDGE. Rec. Austral. Mus. **11** (10): 223. 1917. Cites *Modiomorpha* correctly as Hall and Whitfield, 1869.

[17] *Cardiola ventricosa*, nom. nud., in the *Preliminary notice, No. 2* is not mentioned in Pal. N. Y. **5**, pt. 1, Lam. (Plates and legends) 1883, but appears in Pal. N. Y. **5**, pt. 1, Lam. 2, 1885, p. 417, pl. 69, figs. 1, 2. In Pal. N. Y. **5**, pt. 1, Lam. (Plates and legends), 1883, pl. 69, figs. 1, 2, the very same figures bear the name *Cardiola? elevata*. Evidently the latter name has priority.

date from the publication of that volume. The species *Schizodus quadrangularis* (n. s.), page 96, also must stand as a *nomen nudum* because its description is incomplete. This species is adequately indicated in the "*Plates and legends*" 1883.

It will be of interest to mention several miscellaneous points, as follows: a). Although the name *Cimitaria* is used in the *Preliminary notice, No. 2* for the first time, it is not designated as a new genus, probably due to oversight. b). Whitfield's claim that Hall's name was inserted after *Pholadella*[18] without his knowledge can not be recognized. "*Pholadella* (Hall n. g.)" must stand as written, for, once it is agreed that the paper is a joint product of Hall and Whitfield, it must be accepted as published. *Pholadella* is to be cited, therefore, as "*Pholadella* Hall 1869, in Hall and Whitfield 1869." c). Under the heading "Genus *Schizodus* King," the synonyms of the genus are given, and are followed by the name "*Curtonotus*" in small capitals. It is not clear if *Curtonotus*, a *Schizodus*-like genus created by Salter, is to be regarded as a subgenus of *Schizodus* because it appears in no other place and furthermore all the species are listed as *Schizodus*. d). The familiar names *Palaeoneilo* and *Palaeanatina* are spelled in this paper "*Palaeaneilo*" and "*Palanatina*," probably an example of inadequate proofreading, of which there are many more obvious ones throughout the pamphlet. The current spelling is correct and will be continued.

The case of *Modioconcha* versus *Nyassa* is interesting because the two genera rest on the same genotype. *Modioconcha* has never been favored by use but *Nyassa* on the other hand, has been in general use since it was first proposed. On page 27 of the *Preliminary notice, No. 2* remarks on several genera are concluded with a paragraph in which the subgeneric name *Modioconcha* is proposed for a pelecypod thought by the "authors" to have a close relationship to *Modiolopsis*. The type of the proposed subgenus is given as *Nyassa arguta*. Following the characterization of the new subgenus *Modioconcha*, is the heading "Genus *Modiolopsis*" with the subheading "Subgenus *Nyassa* (Hall)." These headings are followed by descriptions of four species of *Nyassa*, the first species being *N. arguta*. Although this is the first use of the word *Nyassa*, except for its mention as the genotype of *Modioconcha* referred to above, there is no description of the subgenus *Nyassa* and no type is designated. However it is clear that the two genera are synonyms, *Modioconcha* having *N. arguta* as type, and *Nyassa* having *N. arguta* as its first species.

[18] Ann. N. Y. Acad. Sci. **2** (8): 233. 1882; **5**: 609. 1891; Geol. Ohio **7**: 494. 1893.

Later, in 1882, Whitfield published the first characterization of the genus (subgenus) *Nyassa* and stated that the generic description had been omitted from the *Preliminary notice, No. 2*.[19] Whitfield selected *N. arguta* as the genotype. Since *Modioconcha* and *Nyassa* are to be regarded as having been proposed simultaneously the life of either depends on the first reviser who has the privilege of selecting one of these two genera.[20] Whitfield, as first reviser, selected *Nyassa* and named *N. arguta* as the type of the genus, and ignored the obscure *Modioconcha*. Further the writer holds that it is desirable to retain *Nyassa* as a genus in preference to *Modioconcha* because the latter has been totally ignored. Scudder[21] does not list *Modioconcha*, and Hall in the final copies of the *Paleontology of New York*, volume V, *Lamellibranchiata*, recognizes the name *Nyassa* only. The single mention of *Modioconcha* known to the writer in the literature subsequent to 1870 is by Beushausen[22] who lists the name in his synonymy of *Nyassa* but fails to use it. On this basis then *Modioconcha* Hall and Whitfield becomes a synonym of *Nyassa* Hall and Whitfield 1869. In the *Preliminary notice, No. 2* the name "(Hall)" is inserted after *Nyassa* on page 28 but is not followed by the usual "n. g.". For this reason it is suggested that Whitfield's name accompany Hall's as author of the genus.

[19] Ann. N. Y. Acad. Sci. **2** (8): 216, 244; **5**: 558, 1891; *Geol. Ohio* **7**: 451.

[20] See Article 28, *International rules of zoological nomenclature*, Proc. Biol. Soc. Washington **39**: 82.

[21] Scudder. *Nomanclator zoologicus*. U. S. Nat. Mus. Bull. **19**: 1882.

[22] Abhandl. königl. preuss. geol. Landesanst., n. f., Heft 17, p. 29, 1895.

ZOOLOGY.—*On the status of the nemic genera* Aphelenchus *Bastain,* Pathoaphelenchus *Cobb,* Paraphelenchus *Micoletzky,* Parasitaphelenchus *Fuchs,* Isonchus *Cobb and* Seinura *Fuchs.*[1] G. STEINER, Bureau of Plant Industry.

About a year ago, while examining diseased gladiolus corms from New Egypt, New Jersey, and again in looking over some diseased Irish potatoes from South Africa, nemas were found closely resembling that described by Cobb in 1913 as *Isonchus radicicolus.* In the gladiolus corms a single such male was seen, together with numerous females, while many males were found in the potatoes. These males were specifically identical with the associated females,—which were, beyond doubt, *Aphelenchus avenae.* A detailed study supports this view in every way. The male of *Aphelenchus avenae* is thus identified as Isonchus of Cobb. In 1927 Goodey called attention to the close resemblance of the head end of *Isonchus radicicolus* to that of the female *Aphelenchus avenae.* The proposal by Cobb of a new genus mainly on the basis of the male characters is good evidence that the male of *A. avenae* is utterly different from the males hitherto assigned to Aphelenchus. This difference is so great that the two types cannot reasonably be placed in a single genus. Seemingly, it would be most logical to retain Isonchus as the generic name for what has been called *Aphelenchus avenae.* Unfortunately the rules of nomenclature prevent this. According to Stiles and Hassal (1905), Bastian through correspondence made *avenae* the type of *Aphelenchus.* Nevertheless the portion of the genus which is thought of by every nematologist when the generic name is used is that which includes *A. parietinus, A. fragariae, A. olesistus, A. ritzema-bosi,* etc., all quite different from *avenae.* The usual generic diagnosis was chiefly shaped after these species, since males were known for these species only. The absence of a bursa in the male, a character which is general in all these forms, was always considered one of the main generic features, especially in contrast with Tylenchus. Even Bastian himself does this by default. However, the generic name Aphelenchus Bastian, according to the rules of nomenclature, must be connected permanently with *A. avenae,* because this form was selected by Bastian as the type of the genus. This makes the reclassification of the former genus more complex. It was an unfortunate choice to designate this species, of which the male was unknown at the time, as the type, when another

[1] Received September 30, 1931.

species like *A. parietinus,* with both sexes known, could have been designated. This is even more deplorable because, as before mentioned, one of the main generic characters—the absence of a bursa—was based on the male of *A. parietinus.*

It is evident that the whole classification of what has been called Aphelenchus must be revised, even though the genus has included a number of economically important parasitic species recorded in an extensive literature, so that the renaming must create confusion.

Under the rules of zoological nomenclature, *Aphelenchus avenae* Bastian remains as the type species of the genus Aphelenchus. Aphelenchus must be synonymized with the genus Isonchus Cobb.

Thus the forms placed in the genera Aphelenchus, Isonchus and Paraphelenchus now fall as follows:

1. *Aphelenchus,* with four or, more probably, two species, namely: *A. avenae, A. agricola* de Man (if it is different from *avenae*), *A. radicicolus-Isonchus radicicolus* (if it is different from *avenae*) and *A. Cylindricaudatus* Cobb (Steiner 1926).

*Diagnosis:* Aphelenchus, nemas resembling Tylenchus but differing in the following characters; spear without basal swellings (knots); posterior portion of oesophagus not distinctly set off from the intestine, which apparently begins just behind the middle bulb; the latter well developed, oval, with valvulae; dorsal salivary gland emptying in front of, subventral behind, these valvulae. Female with a more or less reduced posterior branch of the uterus; male with a gubernaculum and a well developed bursa with several bursal ribs.
Type: *A. avenae* Bastian 1865.

2. *Pathoaphelenchus* (Cobb), (Syn. Parasitaphelenchus Fuchs) proposed in 1928 as a subgenus of the formerAphelenchus, to include forms like *A. parietinus* etc., which do not have a bluntly rounded, but conical or even filiform tail end. It is proposed to give Pathoaphelenchus generic standing and to include in it the forms Cobb placed in his subgenus.

*Diagnosis:* Pathoaphelenchus, nemas similar to Aphelenchus but the males without bursa and without a gubernaculum. Spear mostly with basal swellings (knots) or furcated at its proximal end. Type: *P. parietinus* Bastian. The subgeneric division proposed by Cobb would be retained:

subgen. Pathoaphelenchus with the spear with basal swellings (knots), not furcated posteriorly. Type: *P. parietinus* (Bastian) 1865.

subgen. Schistonchus with the spear furcated posteriorly. Type: *S. caprifici* (Gasparrini) Cobb 1928.

subgen. Seinura (Fuchs) emend with the spear as in subgenus Pathoaphelenchus but without basal swellings or knots. Type: *S. mali* Fuchs.

This last subgenus was proposed as a new genus by Gilbert Fuchs in 1931, and characterized as resembling Aphelenchus but having a spear without basal swellings or knots and an elongated tail. Considering that an earlier described Pathoaphelenchus (*P. demani*) has also an elongated tail, the only remaining differentiating character would be the absence of swellings or knots on the spear. This, however, we cannot consider as of generic importance, and propose Seinura as of subgeneric standing.

Recently Fuchs created the genus Parasitaphelenchus to include a large number of new species. Unfortunately he gives no diagnosis. The genus as he describes it cannot be distinguished from Pathoaphelenchus. It is therefore thought best to consider it synonymous with the latter. Possibly later some of the forms he referred to it may be placed to advantage in one or several new genera, their generic diagnosis being formulated anew. But some at least of the new species of Fuchs would have to remain with Pathoaphelenchus, its generic diagnosis applying fully to them. This matter is more fully discussed in a recent paper (Steiner, in press).

3. *Paraphelenchus* Micoletzky. This is a good genus. Its standing and the forms belonging to it are discussed in another paper (Steiner and Cassidy, in press).

*Diagnosis:* Paraphelenchus, nemas resembling Aphelenchus but with a posterior (post-bulbar) oesophageal portion, which is distinctly set off from the intestine; males with a gubernaculum but without a bursa, their tail being short, more or less obtuse and having a number of irregularly arranged papillae.

Type: *P. pseudoparietinus* Micoletzky 1922.

### APHELENCHUS AVENAE Bastian

Syn.: *Aphelenchus agricola* de Man, 1885

This species has been discussed by a number of authors. Goodey (1927, 1928 and 1929) added perhaps most to our knowledge, and first called attention to its close resemblance to *Isonchus radicicolus*, which may prove to be synonymous. As far as can be seen at present, they differ in no way. The male of *A. cylindricaudatus* (syn. *Tylenchus cylindricaudatus*) can hardly also be distinguished from it; here, however, the female exhibits some differentiating characters.

It has long been an open question as to the synonymy of *A. avenae* and *A. agricola*. The only marked difference between the two species is the striation of the lateral fields described for *A. agricola* but not mentioned by Bastian for *A. avenae*. However, Bastian may well have overlooked them. In fixed material it is often difficult, even impossible, to observe them, although they are rather plain in all living specimens. This is true too for the caudal papillae as described by de Man for the female tail of *A. agricola.* Sometimes they are very faint or are not seen at all.

*A. avenae* seems to be a very polyphagous species since it has been discovered on a great variety of plants. From January to July 1931 it was seen by the writer as follows:

| | | | |
|---|---|---|---|
| In | Irish potatoes | from | South Africa (2) |
| “ | “ “ | “ | England (4) |
| “ | “ “ | “ | Canada (7) |
| “ | “ “ | “ | Argentina |
| “ | “ “ | “ | Denmark |
| “ | “ “ | “ | Finland |
| “ | “ “ | “ | Egypt |
| “ | sweet “ | “ | New Jersey |
| “ | carrot | “ | Brazil |
| “ | “ | “ | South Africa |
| “ | “ | “ | Germany |
| “ | onion | “ | Greece |
| “ | “ | “ | Egypt |
| “ | “ | “ | Italy |
| “ | “ | “ | Germany |
| “ | narcissus | “ | Virginia (2) |
| “ | “ | “ | New Jersey (2) |
| “ | “ | “ | New York |
| “ | “ | “ | Mississippi |
| “ | “ | “ | Illinois |
| “ | “ | “ | Holland (2) |
| “ | iris | “ | Holland (2) |
| “ | anemone | “ | New York (2) |
| “ | cactus | “ | Germany |
| “ | Caryopteris sp. | “ | France |
| “ | strawberry | “ | Massachusetts |
| “ | “ | “ | Oregon |
| “ | peony | “ | Ohio |
| “ | cotton seedlings | “ | South Carolina |

Not only is the variety of plants with which it is found associated apparently large, but its geographical distribution also seems to be worldwide. Little is known as to its closer relationship to the various plants. It is perhaps one of the species with facultative parasitism, that is, it can live as a true parasite but does not necessarily have to do so, being able also to support itself in a saprophytic mode. Its parasitism may be ecto- or endo-parasitism. In gladiolus the nemas were found in brownish spots all through the corms and were located by cutting the latter into pieces. There is a certain phaenotypical difference in the specimens from the various hosts, those from potato tubers, carrots and similar rich food being relatively larger and fatter.

Few facts are to be added to the morphology of the female. The number of the striae on the lateral fields, if counted in the middle region, is most often 12. The number, however, diminishes toward both ends of the body. These striae are crenate according to the cuticular annulation. The latter, however, stops at these lateral fields. In the male these structures are the same. A careful comparison of the sexes reveals this to be true for all morphological characters common to both. Figure 1, A represents the anterior end of a male. If compared with Figure 3 and the description given by Goodey (1929) and others, complete similarity is seen. Special stress is laid upon the fact that the oesophageal glands have not only the same arrangement but also the same order of outlets in the oesophageal bulb.

Most striking is the male copulatory apparatus. It somewhat links conditions as seen in Rhabditis with those of Tylenchus. The spicula resemble somewhat those of Rhabditis in that they have ventrally a semicircular protuberance. The proximal end is slightly capitate. In a side view (fig. 1,G) the gubernaculum appears to be almost lineate and of about half the length of the spiculum. Seen ventrally (fig. 1,F) however it appears to be a broad but flat piece. Most interesting is the bursa, the presence of which so widely separates this form from all those of the genus Aphelenchus as hitherto conceived. From the Tylenchus bursa it differs by the multiple bursal ribs, which, if this is, as it seems, a generic character, brings the genus Aphelenchus near to Rhabditis. One rib is located slightly in front of the anus, the three others on the second half of the tail, being separated from each other by about equal distances. The bursa encloses the tail end. The presence of some bursal muscles anterior to the bursa itself is probable. A retractor spiculi was seen in the usual position. The testis is reflexed (fig.1,D). In the material from South Africa which contained a larger number of male specimens, a female with a definite copulatory mark on its vulva was seen (fig. 1,C). Such marks are not infrequently seen in the bisexual Rhabditis species. In the present case it shows that copulation may take place. It is, however, assumed by most writers that *Aphelenchus avenae* is a syngonic species. What significance then has the sporadic appearance of males? They seem to be fully functional, at least to judge from the above mentioned copulation mark. There are no explanations available based on experimental or other evidence. However, reference may be made to similar conditions in some of the Rhabditis species. Under certain circumstances, probably of external character, males appear in some of these normally

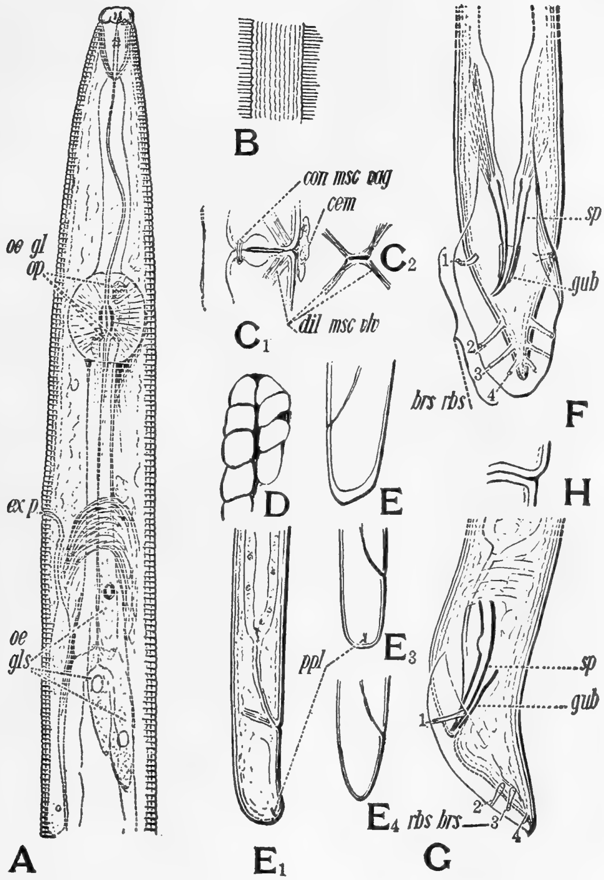



Fig. 1.—*Aphelenchus avenae* Bastian. A. Head end of male. *ex p*, excretory pore; *oe gls*, oesophageal glands; *oe gl op*, openings of oesophageal glands; about × 533. B. Structure of lateral field. $C_1$. Side view of vulva and vagina; *cem*, cement left from copulation, *con msc vag*, circular constrictor vaginae; *dil msc vlv*, dilatator muscle of vulva. $C_2$. Front view of vulva with obliquely placed dilatator muscles. D. End portion of testis reflexed. E,$E_{1,3,4}$. Various types of tail ends. F. Ventral view of male tail end; *gub*, gubernaculum; *sp*, spiculum; *rbs brs 1–4*, bursal ribs; about × 533. G. Side view of male tail end; legend same as in Fig. F; about × 533. H. Side view of vulva to show the sudden contraction behind the vulva.

syngonic species, exceptionally even in considerable number. The mechanism of their appearance, however, is unknown. The resemblance of *A. avenae* to Rhabditis along this more physiological line is rather significant.

Finally attention should be called to the fact that in the present species the tail of the female exhibits a certain variation; forms with the typical cylindrical tail (fig. 1, $E_3$) were seen, besides forms with a tail like that in Figure 1,$E_1$ and the one in Figure 1, $E_{3,4}$. A certain variation exists also in regard to the profile line of the vulva, which usually represents conditions as drawn in Figure 1,H where a sudden constriction occurs just back of the vulva. Figure 1,$C_1$ represents an exception to this, the constriction being absent. The latter figure and Figure 1, $C_2$ give the arrangement of the dilatatores vulvae, four in number and attached diagonally at each corner of the vulva. There seems to exist also a circular constrictor vaginae (fig. 1, $C_1$).

*Measurements:*

Male from gladiolus corm

$$\frac{1.9 \quad 12. \quad 14. \quad M. \quad 96.8}{1.9 \quad 2.9 \quad 3.1 \quad 3.5 \quad 2.4} \quad .748 \text{ mm.}$$

Specimens from parsnips

$$\frac{2.2 \quad 11. \quad 16. \quad M. \quad 97.1}{2. \quad 2.9 \quad 3.2 \quad 3.8 \quad 2.2} \quad .74 \text{ mm.}$$

$$\frac{1.5 \quad 10.6 \quad 12. \quad 80. \quad 97.}{1.5 \quad 2.5 \quad 2.6 \quad 3.5 \quad 2.2} \quad .82 \text{ mm.}$$

## THE SPECIES OF THE GENUS APHELENCHUS AS KNOWN AT PRESENT

As stated above, *Isonchus radicicolus* Cobb 1913 is undoubtedly a member of the genus Aphelenchus as here conceived; the same is the case for *Tylenchus cylindricaudatus* Cobb (Steiner 1926). Both species are extremely similar to *A. avenae*, especially in the male and a revision of their characters seems to be necessary for a final ascertainment of their taxonomic position. On the basis of data available at present, the following diagnoses may be given:

*A. avenae* Bastian, type species (Syn. *A. agricola*)

*Diagnosis:* Aphelenchus with the characters of the genus; lateral fields in the middle region of the body with about twelve longitudinal striae, crenate according to the annulation. Four bursal ribs; female tail cylindroid or obtuse conical.

*A. cylindricaudatus* (Cobb) (Steiner 1926)

*Diagnosis:* Similar to *A. avenae* but lateral wings well developed, crenation irregular, not conforming with the cuticular annulation. (Lateral fields without longitudinal striae?). Female tail somewhat finger-shaped, its base conical, next portion cylindrical, end portion somewhat swollen and bluntly rounded.

⊥*A. radicicolus* (Cobb 1913)

*Diagnosis:* Characters of *A. avenae* but a single lateral wing (apparently without lateral fields and longitudinal striae!). Male bursa with 5 ribs.

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## SCIENTIFIC NOTES AND NEWS

F. M. SOULE of the Department of Terrestrial Magnetism, who was one of the scientific staff on board the *Nautilus*, arrived in Washington, D. C., October 14, bringing with him the magnetic and depth data obtained. Despite the necessary curtailment in the cruise because of lateness of the season valuable data were secured in physical and chemical oceanography, terrestrial magnetism, gravity, and marine biology.

ANDREW THOMSON, formerly director of the Apia Samoa Observatory, who recently returned from eight months' meteorological studies in Europe is temporarily engaged at the Department of Terrestrial Magnetism in the reduction and discussion of the 171 pilot-balloon series over the Pacific Ocean obtained on the *Carnegie.*

Dr. L. E. Loveridge of the University of California reported September 28 at the Department of Terrestrial Magnetism to assist in the high-voltage laboratory.

The United States Geographic Board on October 7, 1931, adopted a resolution naming a crater in Coconino County, Ariz., "Merrill Crater," in honor of the late Dr. George P. Merrill, who was the first scientist to investigate and describe Meteor Mountain, which is in the vicinity of the newly named Merrill Crater.

The staff of the Division of Mollusks of the National Museum has been increased by the appointment of Mr. Horace G. Richards of the University of Pennsylvania, to the position of Aid.

## Obituary

James Williams Gidley, Assistant Curator of Mammalian Fossils in the U. S. National Museum and a member of the Academy, died September 25, 1931, at Washington after a protracted illness. Dr. Gidley was born in Winneshiek County, Iowa, on January 7, 1866. He obtained his professional training at Princeton University, where he took a master's degree, and at George Washington University, where he received the doctorate. He was attached for some years to the American Museum of Natural History, transferring in 1905 to the National Museum and remaining with that institution until his death. Dr. Gidley chose the study of the fossil mammals as his special field and attained distinction in it. His earlier work concerned the Eocene mamals, but in later years he dealt chiefly with the later faunas. His most recent work was with the late extinct fauna of Florida, which is associated with human remains, and with an older fauna of the late Pliocene of Idaho.

# OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcements of Meetings

| | |
|---|---|
| Thursday, November 5 | The Entomological Society |
| Friday, November 6 | The Geographic Society |
| Saturday, November 7 | The Philosophical Society |
| Tuesday, November 10 | The Electrical Engineers |
| Wednesday, November 11 | The Geological Society |
| | The Medical Society |
| Thursday, November 12 | The Chemical Society |
| Friday, November 13 | The Geographic Society |
| Saturday, November 14 | The Biological Society |
| Tuesday, November 17 | The Anthropological Society |
| | The Historical Society |
| Wednesday, November 18 | The Washington Society of Engineers |
| | The Medical Society |
| Thursday, November 19 | The Academy |

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## CONTENTS

ORIGINAL PAPERS



This JOURNAL is indexed in the International Index to Periodicals

VOL. 21 NOVEMBER 19, 1931 No. 19



# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES



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# JOURNAL

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# WASHINGTON ACADEMY OF SCIENCES

VOL. 21 NOVEMBER 19, 1931 No. 19


BOTANY.—*Four new species of Myrsinaceae from China.*[1] E. H. WALKER, National Museum. (Communicated by WILLIAM R. MAXON).

The following four new species have been recognized during the examination of a large number of specimens of Myrsinaceae from eastern Asia in various American Herbaria. They are here described preparatory to a revision of the Chinese, Japanese, and Formosan members of this family.

**Ardisia scalarinervis** Walker, sp. nov.

Repent undershrub, about 40 cm. high, the branches ascending, densely fuscous-tomentose; leaves clustered at ends of branches, the petiole about 4 cm. long, fuscous or ferruginous-tomentose or villose, the blade 20 to 30 cm. long, 7 to 8 cm. wide, obovate or oblanceolate, tapering toward the narrowly rounded base, rather broadly acute or sub-acuminate at apex, closely erose-dentate (the teeth apiculate), prominently elevated-punctate near margin and apex on both sides, glabrous and dark green above, sparingly and minutely puberulent and fuscous beneath; midrib prominent beneath, densely shaggy with long ferruginous villose crisped hairs, the lateral nerves forming a right or obtuse angle with the midrib; inflorescence 2 to 3 cm. long, a subterminal or axillary, pubescent cluster of several peduncled umbels each about 7-flowered, the peduncles short, the pedicels slender, about 1.5 cm. long; flowers 4 mm. long; sepals shortly united at base, triangular-ovate, 1.5 mm. long, ferruginous-puberulent, minutely ciliate, not punctate; petals ovate or oblong-ovate, acute glabrous, black punctate at apex; stamens somewhat shorter than petals, the filaments very short and broad, the anthers large, sagittate, acute or submucronate; pistil with globose, hairy ovary, the style very slender, about as long as petals, the stigma punctiform; fruit a globose berry with horny endocarp, 5 to 7 mm. in diameter, reddish, minutely puberulent or glabrous, not punctate, one-seeded.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 28, 1931.

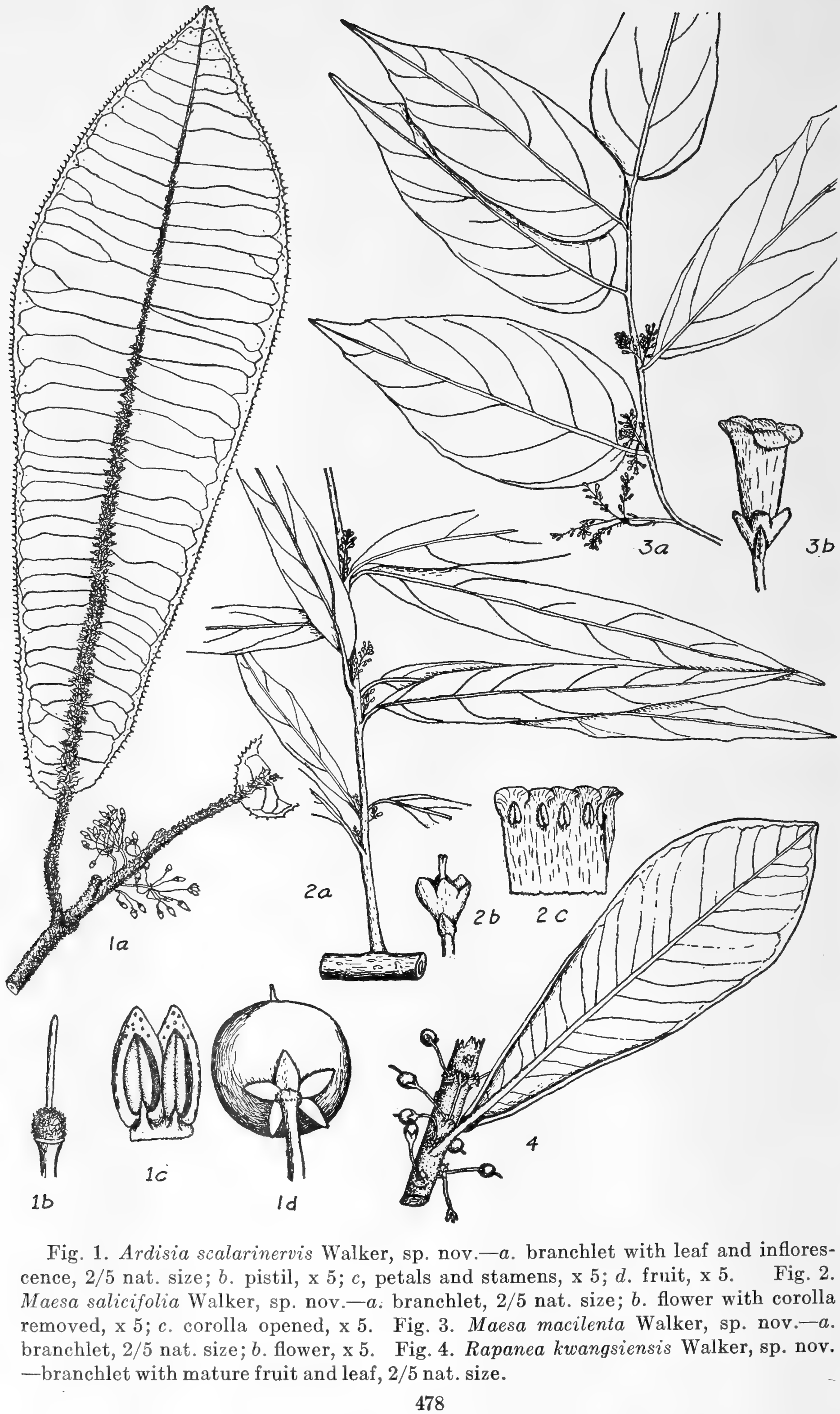


Fig. 1. *Ardisia scalarinervis* Walker, sp. nov.—*a.* branchlet with leaf and inflorescence, 2/5 nat. size; *b.* pistil, x 5; *c,* petals and stamens, x 5; *d.* fruit, x 5. Fig. 2. *Maesa salicifolia* Walker, sp. nov.—*a.* branchlet, 2/5 nat. size; *b.* flower with corolla removed, x 5; *c.* corolla opened, x 5. Fig. 3. *Maesa macilenta* Walker, sp. nov.—*a.* branchlet, 2/5 nat. size; *b.* flower, x 5. Fig. 4. *Rapanea kwangsiensis* Walker, sp. nov. —branchlet with mature fruit and leaf, 2/5 nat. size.

Type in the U. S. National Herbarium, no. 458,790, collected at Szemao, Yunnan, China, by A. Henry (no. 12,021).

This species, known only from the type, is very distinct in its oblanceolate or obovate leaves with densely shaggy midrib and in the ladderlike arrangement of the lateral nerves, which are divergent at a right angle from the midrib.

**Rapanea kwangsiensis** Walker, sp. nov.

Small tree or shrub, 6 meters high, the branchlets thick; leaves petiolate (1 to 2 cm.), the blade coriaceous, 11 to 14 cm. long, 4 to 5 cm. wide, obovate, gradually tapering to an acute base, broadly acute to obtuse or almost rounded at apex, entire, dark green above, paler beneath, glabrous, not punctate, except obscurely so beneath at margin; inflorescence few-flowered, developing 1 to 3 fruits, umbellate on short, densely scaly spurs or knobs, axillary, among the leaves or above the rather prominent leaf scars on older portions of the branch, the scales obtuse, entire, sometimes fringed; flowers 5 to 6-merous on slender pedicels; sepals 2 mm. long, united one-third to one-half their length, ovate, acute, entire, sometimes finely papillose on margin, otherwise glabrous, not distinctly punctate; petals united one-third their length, about 4 mm. long, narrowly oblong-lanceolate, rounded or acute at apex, punctate on back, papillose on margin and within; stamens with short filaments attached at or just above the throat of corolla tube, the anthers in pistillate flowers shorter than petals, sagittate, apiculate; pistil with ovoid ovary, the style very short, the stigma about as long as or slightly longer than the petals, flattened-ligulate, sometimes cleft at apex; fruit globular, 4 to 5 mm. in diameter, purplish, longitudinally lined with elongate, glandular punctations, the pedicels slender, 5 to 8 mm. long.

Type in the U. S. National Herbarium, no. 1,273,486, collected at "Lanlow, E. Lin Yen," Kwangsi, China, 1,500 meters altitude, August 2, 1928, by R. C. Ching (no. 6,657).

This species, known only from the type, may be easily distinguished from other Chinese species of the genus by its thicker stems, its clearly obovate large leaves having a gradually tapering base, and its fruits with longer pedicels. The type specimen, though in fruit, bore a few dried pistillate flowers from which the above flower description was drawn. It was collected on the expedition sent into Kwangsi in 1928 by the Metropolitan Museum of Natural History, Nanking, China.

**Maesa macilenta** Walker, sp. nov.

Shrub, 1.5 to 2 meters high, the branchlets slender, glabrous or minutely puberulent; leaves short-petiolate (5 mm.), the blade thin-membranous, 10 to 20 cm. long, 3.5 to 5 cm. wide, ovate to elliptic-lanceolate, acute or rounded at base, long-acuminate at apex, subentire or minutely sinuate-dentate, dull green on both sides, glabrous, glandular-striate, the lateral nerves 7 or 8 pairs; inflorescence 1 to 2.5 cm. long, racemose or sparingly branched-paniculate, very minutely puberulent, the bracts subulate, nearly equaling the short pedicels; flowers 2 mm. long, the bracteoles ovate to oblong; sepals shortly united at base, ovate, obtuse, entire, sometimes very minutely ciliate, not conspicuously glandular; corolla tubular-campanulate, the tube twice as long as the sepals, 2 to 3 times the length of the ovate, rounded, irregularly margined lobes, longitudinally lined; staminate flowers unknown; stamens in pistillate flowers minute, included, the anthers ovate; pistil shorter than the corolla tube, the free part of the semi-inferior ovary conical, the style slender, less than 1 mm. long, the stigma obscurely lobed; fruit unknown.

Type in the U. S. National Herbarium, no. 458,604, collected at Szemao, Yunnan, China, by A. Henry (no. 11,704A). An additional specimen is *Henry* 11,704, in the herbarium of the New York Botanical Garden.

This species is related to *Maesa japonica* (Thunb.) Moritz in its characteristic relatively long corolla tube. However, it may be distinguished from that species by its thin, membranous leaves, its small inflorescence and flowers, and its ovate bracteoles, which are not broad and clasping. From the following new member of this group with long corolla tubes it is distinguished by its ovate or elliptic-lanceolate (not narrowly lanceolate) leaves, these thin and membranous, not coriaceous and rugose, and by its ovate bracteoles.

**Maesa salicifolia** Walker, sp. nov.

Erect shrub, 2 meters high, glabrous throughout, the branchlets rather slender, grayish-brown; leaves with channeled petiole (5 to 8 mm.), the blade coriaceous, 10 to 18 cm. long, 1.5 to 2 cm. wide, narrowly oblong-lanceolate, obtuse at base, long-acute or acuminate at apex, strongly revolute, entire, not punctate, rugose, the midrib and the 5 to 7 pairs of lateral, curved, ascending nerves appearing deeply impressed above, correspondingly ridged beneath, the veinlets inconspicuous; inflorescence axillary, solitary or 2 or 3 together, 1.5 to 2 cm. long, racemose or paniculate, the few branches near the base; flowers 3 to 4 mm. long, slightly longer than the pedicels, the floral parts mostly longitudinally glandular-striate, the bracteoles broadly ovate, obtuse, sometimes broadly so; sepals about 1 mm. long, imbricate, shortly united, below, broadly ovate to suborbicular, broadly obtuse or rounded, the margin thinner; corolla tubular or tubular-campanulate, the tube 3 to 4 mm. long, about 3 times the length of the sepals, the lobes short-ovate, rounded, scarcely spreading; stamens in staminate flowers included, attached at about the middle or above the middle of the corolla tube, 1 mm. long, anthers oblong-ovate, rounded at apex, about equaling the slender filaments; pistil in pistillate flowers with free part of semi-inferior ovary conical, the style slender, scarcely reaching height of anthers, the stigma slightly dilated; or obscurely lobed; fruit globose, 4 mm. in diameter, reddish longitudinally striate-punctate wrinkled, the persistent sepals approximate about the more or less persistent style.

Type in the herbarium of the New York Botanical Garden, collected on Teng Woo Mountain, Kwangtung Province, China, by C. O. Levine and G. W. Groff, Nov. 18, 1916 (Canton Christian College no. 45). Additional specimens are: *C.C.C.* 13,242 and *H. T. Ho* 60,026, both from the type locality, Teng Woo Mountain.

In its long corolla tube this species is related to *Maesa japonica,* from which, however, as well as from the preceding new species, it may be readily distinguished by its narrowly lanceolate, entire, rugose leaves. In floral characters it is at present indistinguishable from *Maesa japonica.*

ZOOLOGY.—*A new agouti from Costa Rica.*[1] E. A. GOLDMAN, Biological Survey.

Among interesting mammals recently obtained by the well known field naturalist, Mr. C. F. Underwood, in western Costa Rica, is an agouti which seems to represent a hitherto unrecognized geographic race. It is here named for the collector who has been making notable contributions to knowledge of the fauna of Costa Rica for many years.

**Dasyprocta punctata underwoodi** subsp. nov.
Costa Rican Agouti

*Type.* From San Geronimo, Pirris, western Costa Rica. No. 256459, ♂ adult, U. S. National Museum, collected by C. F. Underwood, June 1, 1931.

*General characters.*—An orange buff and yellow subspecies without distinctly banded pelage; longer hairs on rump reaching about 95 millimeters, mainly dusky below light orange yellow tips about 20 millimeters in length. Similar to *Dasyprocta punctata punctata* and *D. p. richmondi*, but pelage of upper parts in general much less distinctly banded, the longer rump hairs nearly uniformly dusky below light orange yellow tips (narrowly banded to base in *punctata* and *richmondi*). Very similar in color arrangement to the geographically more distant form *D. p. dariensis* of eastern Panama, but upper parts more extensively orange buff or orange yellowish; and skull lighter in structure. Differing notably from *D. p. nuchalis* of western Panama in the absence of the black nape.

*Color.*—*Type:* Top of head, nape, shoulders, sides of body and outer surfaces of limbs coarsely mixed black and light orange yellow; middle of back heavily overlaid with rich orange buff, the under color blackish; long hairs of rump blackish basally but tipped with light orange yellow in contrast with orange buff of back; under parts in general mixed brownish and pale yellowish buff, the buff becoming purer along the median line of abdomen and inguinal region; fore feet blackish; hind feet with short black and yellowish hairs on metatarsus.

*Skull.*—Closely resembling those of *D. p. punctata* and *D. p. richmondi* but vertical portion of maxilla between jugal and antorbital vacuity narrower in the type, more encroached upon by jugal; nasals very broad and expanded anteriorly.

*Measurements.*—*Type:* Head and body, 511 mm.; tail, 22; hind foot, 115. *Skull* (type): Greatest length, 114.2; condylobasal length, 103.7; zygomatic breadth, 51.8; interorbital constriction, 31.3; length of nasals, 41.5; maxillary toothrow (alveoli), 17.8.

*Remarks.*—The agoutis of the *D. punctata* group subdivide in Middle America into several closely allied, but fairly well marked geographic races. *D. p. underwoodi* is based on a single specimen which appears to be quite distinctive, as shown by comparison with neighboring forms including specimens assumed to be near typical *D. p. punctata*, the type of which probably came from western Nicaragua (See Goldman, Proc. Biol. Soc. Washington, vol. 30, p. 114, May 23, 1917).

[1] Received October 18, 1931.

ZOOLOGY.—*A new kinkajou from Mexico.*[1] E. W. NELSON and E. A. GOLDMAN, Biological Survey.

In reviewing the kinkajous of Mexico (*Potos flavus* group) the writers have noted characters which seem to warrant the recognition by name of the geographic race inhabitating the region of the Yucatan peninsula. The new form is described as follows:

**Potos flavus campechensis** subsp. nov.

Campeche Kinkajou

*Type.*—From La Tuxpeña, Champoton, Campeche, Mexico. No. 181266, ♀ adult, U. S. National Museum (Biological Survey collection), collected by Percy W. Shufeldt, February 12, 1913. X catalogue number 10234.

*Distribution.*—Campeche, Tabasco, northern Guatemala and probably all of Yucatan peninsula; limits of range unknown.

*General Characters.*—A light-colored, medium-sized subspecies, very similar in general to *Potos flavus chiriquensis* of western Panama, but lighter in color, the head, and front and sides of legs and feet less shaded with dusky; skull narrower and differing in detail. Similar in general size to *P. f. guerrerensis* of western Mexico, but upper parts less overlaid with dusky; cranial characters distinctive. Differing from *P. f. aztecus* of the Gulf slope in Vera Cruz mainly in decidedly smaller size and lighter color.

*Color.*—*Type:* Upper parts in general near clay color (Ridgway, 1912), purest on face, flanks, and outer sides of limbs, the top of head and back thinly overlaid with brown; under parts, including inner sides of limbs and under side of tail near ochraceous buff, becoming brownish abruptly along a narrow median line on the abdomen and a spot immediately behind the naked gular patch; ears thinly clothed with light buffy hairs; feet about like outer sides of limbs, not distinctly dusky as usual in the group; tail above about like back, becoming more brownish toward tip.

*Skull.*—Similar in general form to that of *P. f. chiriquensis,* but braincase narrower; frontal region rising similarly high anteriorly but somewhat more depressed behind postorbital processes; postorbital processes more compressed or flattened antero-posteriorly, less rounded and peg-like; bullae usually larger, more inflated anteriorly; dentition very similar. Compared with *P. f. guerrerensis* the skull is relatively narrower, more elongated; frontal region higher anteriorly, more depressed behind postorbital processes (frontal profile more evenly arched in *guerrerensis*); audital bullae much less inflated. Differing from *aztecus* in decidedly smaller size.

*Measurements.*—*Type:* Total length, 997 mm.; tail vertebrae, 513; hind foot, 90. *Skull* (type): Greatest length (median line), 95.4; condylobasal length, 88.2; zygomatic breadth, 60.8; interorbital breadth, 20; postorbital constriction, 18.8; breadth across mastoid processes, 47.2; breadth of braincase, 37.8; upper toothrow, front of canine to back of last molar (alveoli), 25.8.

*Remarks.*—In general combination of cranial characters *P. f. campechensis* tends to bridge the gap between *P. f. chiriquensis,* of which over 20 specimens have been available for comparison, and the more northern representatives of the *Potos flavus* group. The skull is more slender, however, than usual in the nearly related forms, and the lighter coloration appears to be distinctive.

[1] Received October 18, 1931.

Pallid coloration, apparently associated with general aridity, characterizes a considerable number of the animals of the Yucatan peninsula region and the representative there of *P. flavus* is, apparently, no exception.

*Specimens examined.*—Total number, 4, as follows:

Campeche: La Tuxpeña (type locality), 1.

Tabasco: Las Minas, 1 (skull only)

Guatemala: Perdida, Peten, 1 (skull only); northern Guatemala (without definite locality), 1.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## THE ACADEMY

### 242D MEETING

The 242d meeting of the ACADEMY was a joint meeting with the Society of Sigma Xi, and was held in the Auditorium of the Interior Department Building, F. Street, between 18th and 19th Streets, on Monday, October 26, 1931. About 400 persons were present. President N. A. COBB called the meeting to order at 8:30 P.M., and made the introductory remarks, then turned over the chairmanship to Dr. P. R. HEYL who introduced Professor WILLEM DE SITTER, Director of the Observatory at Leyden, Holland and Past President of the International Astronomical Union, who delivered an address on *The origin of the planetary system*:

The solar system shows many features that cannot be due to chance but must have an explanation in the origin of the system. All the planets move around the sun in planes that are inclined at very small angles to each other. They all move in the same direction. The satellites move around the planets in planes which again have small inclinations with the planes of their families and also in the same direction. The axial rotations of the planets and of the sun itself are in the same direction and the equatorial planes have again small inclinations from the orbital planes. All the orbits are nearly circular. The masses of the planets are small as compared with that of the sun. The masses of the satellites are small compared with those of the planets. The only two notable exceptions are our own moon of which the mass is as much as 1/80 of the mass of the earth and the rings of Saturn which are a formation that is unique in the solar system. Other exceptions, large inclinations and revolutions in the opposite direction, occur only at the very outskirts of the system or in subordinate systems. All these irregularities call for an explanation which must be found in the origin of the system.

The well known hypothesis, known by the names of Kant and Laplace, has held the field for over a century. It really consists of two hypotheses, namely, that the sun and the planets were formed by condensation from a gaseous nebula and that the planets were separated from the sun as a result of the centrifugal force due to rotation of this nebula. There are several objections to this hypothesis. In its original form it is supposed that by the rotation, a ring of matter somewhat similar to the rings of Saturn was thrown off from the equator of the rotating sun and that the planets were formed by condensation of matter constituting this ring, in one point of it. It has been shown by Darwin that this is impossible. But even omitting the ring as an intermediary stage, the hypothesis was shown to be untenable. Mathematical analysis proves that rotation can give rise to only two configurations, namely, either a double star or a spiral nebula, both of which exist in the stellar universe in many and great numbers. But rotation can never produce a stellar system consisting of one central body attended by a number of relatively small planets.

Another theory which was already suggested by Babinet in 1861 is that the planets were thrown out of the body of the sun by the attraction of another celestial body passing at a very short distance. The first result of an encounter of this kind would be that a filament of matter was drawn out from the sun towards the passing star. This filament, after the star had passed away, would break up into different fractions some of which would be large and constitute the planets, while a considerable part of the mass of the filament would either fall back on to the sun or be dissolved into a medium of gaseous molecular constitution, which would in the course of time partly fall down on the sun and planets and partly be dissolved into space. The effect of this medium on the motion of the planets would be to make the orbits circular as the result of friction. Those parts which would fall back on the sun would impart to the sun the momentum acquired from the passing star and thus produce the rotation of the sun in the same direction as the revolution of all the planets. The orbits of the planets would be very elliptical in the beginning and only be reduced to circles gradually due to the effect of the resisting medium and only at first perihelion passage in the elliptical orbit, the satellites would be drawn out from the planet by the action of the sun in the same way as the planets were drawn out from the sun by the star.

This theory thus explains all the major features of the solar system. It explains why all motions are in the same direction and in the same plane and why all the orbits are nearly circular. The rotation of the sun and planets in the same direction and in the same plane is explained by matter falling back on them. In working it out numerically, Dr. Harold Jeffreys has found that on the whole the theory is very satisfactory, and in particular, the time required for the resisting medium to reduce the eccentricity of the orbit of Mercury to its present value agrees approximately with the age of the earth as derived from geological evidence. There is one difficulty, however, and that is that the momentum of the matter falling back is not sufficient to explain the rotation of the sun and the planets. Jeffreys, therefore, about two years ago, suggested that the encounter was not only a near approach but an actual collision between two suns, the shortest distance between the centers being of the order of 4/5 of the sum of the diameters. This would provide a sufficient explanation for the rotation while the other results from the theory would be very little changed. (*Author's abstract.*)

CHARLES THOM, *Recording Secretary.*

## OFFICIAL COMMUNICATIONS

### THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

#### Announcements of Meetings

| | |
|---|---|
| Friday, November 20 | The Geographic Society |
| Saturday, November 21 | The Helminthological Society |
| | The Philosophical Society |
| Wednesday, November 25 | The Geological Society |
| | The Medical Society |
| Friday, November 27 | The Geographic Society |
| Saturday, November 28 | The Biological Society |
| Tuesday, December 1 | The Botanical Society |
| Wednesday, December 2 | The Washington Society of Engineers |
| | The Medical Society |
| Thursday, December 3 | The Entomological Society |
| Friday, December 4 | 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.**

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*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
*Treasurer:* Henry G. Avers, Coast and Geodetic Survey.

## CONTENTS

### Original Papers



### Proceedings




This Journal is indexed in the International Index to Periodicals

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OF THE

# WASHINGTON ACADEMY OF SCIENCES



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# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES

Vol. 21 December 4, 1931 No. 20

BOTANY.—*Notes on yagé, a drug plant of southeastern Colombia.*[1] C. V. Morton, U. S. National Museum. (Communicated by E. P. Killip.)

The National Museum has recently received from Mr. Guillermo Klug, of Iquitos, Peru, a large collection of plants obtained by him in the Putumayo region of southeastern Colombia. Mr. Klug became especially interested in various drug plants used by the natives as stimulants, and included herbarium specimens of these in his collection. Three of the plants, known to the Indians under the general name of *yagé*, belong to the genus *Banisteriopsis* C. B. Robinson (Family Malpighiaceae), subgenus *Eubanisteriopsis* Morton, nomen novum (*Banisteria* subgenus *Eubanisteria* Niedenzu). The necessity for using the name *Banisteriopsis* for this genus has been discussed by the author in a former paper.[2] The type of the genus (and subgenus) is *Banisteriopsis argentea* (Kunth) Robinson & Small.

**Banisteriopsis inebrians** Morton, sp. nov.

Sect. *Camptostylis*, Subsect. *Cosmiothamnus.* Liana altissima plus quam 30 m. scandens, ramulis jam hornotinis demum usque 4 mm. diametro fuscesentibus glabratis teretibus striatis lenticellis numerosis instructis, internodiis 5–6 cm. longis; lamina foliorum oppositorum late elliptica basi rotundata obliqua apice solum acuta, ca. 11 cm. longa, 6.5 cm. lata, supra laevis nitida olivaceo-viridis, subtus concolor mox utrinque glabrata (pilis perpaucis persistentibus exceptis), margine paullo revoluta subcoriacea, nervis mediis primariisque supra depressis subtus elevatis prominentibusque, utrinque jam demum dense strigosis, nervis primariis utrinque 4 vel 5 valde decurrentibus, basi nervorum infimorum glandulas 2 magnas nigras gerentibus, nervis

[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 28, 1931.

[2] "A new *Banisteria* from Brazil and British Guiana," Proc. Biol. Soc. Wash. 43: 157. 1930.

secundariis inter se parallelis vix prominulis; petiolus 10–12 mm. longus, ca. 1.5 mm. crassus, supra valde canaliculatus strigosus eglanduliferus; stipulae ad glandulas pubescentes magnas demum deciduas reductae; flores non suppetunt; inflorescentia axillaris, fructu vix ultra 5 cm. longa, paullulum composita, rhachi 4–9 umbellas gerente, umbellis ipsiis 4-floris, pedunculo inflorescentiae 6–14 mm. longo, pedunculis umbellarum 12–14 mm. longis, pedicellis sessilibus 13–14 mm. longis, sicut pedunculis persistente pubescentibus; sepala ovata obtusa puberula ca. 4 mm. longa, incurva, glandulas 8 oblongas ca. 2 mm. longas gerentia; styli recti apice orbiculari-capitati, anticus 3.5 mm. longus rectus 2 posticis crassior longior; samarae nuce densissime sericeae, ceterum demum parce strigosae; nux nigro-fusca oblonga, uno latere solum reticulato-rugosa, altero in alulas vel aculeos biseriatos ad 2 mm. longos excrescens, areola ventrali orbiculari 5–5.5 mm. diametro concava; ala dorsalis fere verticalis, late semiobdeltoidea, ca. 3.5 cm. longa, basi ca. 7 mm. lata, infra apicam ca. 16 mm. lata, margine antico incrassato recto basi vix appendiculato, margine postico curvato crenulato.

*Banisteriopsis caapi*[3] diversa esse patet: petiolis subgracilibus apice 2 glandulis magnis instructis, stipulis minutis subulatis, laminis foliorum longe acuminatis, majoribus (usque 17 cm. longis, 6–9 cm. latis), nervis mediis et primariis demum glabris, inflorescentia valde majore, pedunculis umbellarum subnullis, stylo antico 2 posticis breviore, et ala samarae oblique oblongo-obovata. *B. quitensis*[4] a nostra differs videtur: foliis longe acuminatis, fere eglanduliferis, stipulis parvis, inflorescentia terminali (?), magna 3 dm. longa, stylo antico 2 posticis breviore, lateribus nucis leviter solum tuberculatis fere laevibus, et alis minoribus (2.5 cm. longis, 11 mm. latis), obliquo-oblongis.

Type in the U. S. National Herbarium, no. 1,517,293, collected at Umbría, 0° 54′ N, 76° 10′ W, Comisaría del Putumayo, Colombia, in forest, alt. 325 meters, Jan.-Febr., 1931, by G. Klug (no. 1964).

Mr. Klug's note reads, "1964. '*Yagé del monte.*' From root to tip, more than 30 meters long. It takes 6 men to drag the lower half when cut. I estimate that this half weighs more than 500 kg." Over 60 herbarium sheets of this plant were prepared by Mr. Klug, all of which have been examined in preparing the above description.

The related species *Banisteriopsis caapi* and *B. quitensis* are also powerful drug plants. The former is more closely related, differing in having the petioles bi-glandular at apex, the stipules minute and subulate, long acuminate leaves with glabrous midvein and nerves, the inflorescence much larger, the peduncles of the umbels very short, the anterior style shorter than the two posterior, and the samara wing obliquely oblong-obovate. *B. quitensis* has quite differently shaped samaras from those of our species. It is however perhaps much more nearly related to *B. caapi* than its disposition by Niedenzu would

[3] *Banisteriopsis caapi* (Spruce) Morton, nomen novum. (*Banisteria caapi* Spruce; Grisebach in Flora Brasiliensis 12[1]: 43. 1858.)

[4] *Banisteriopsis quitensis* (Ndzu.) Morton, nomen novum. (*Banisteria quitensis* Ndzu. in Ind. lect. Lyc. Brunsverg p. hiem. 1900–1901: 10. 1900.)

indicate. The character which he stresses, namely the long-decurrent primary veins, is a variable one, being found in all three of the species here discussed. The length of the decurrent portion is apparently far from constant and is probably of no diagnostic value.

The following notes on the use and effect of the drug *yagé* are kindly supplied by Mr. Klug. The *yagé cultivado* referred to (*Klug* 1934) is apparently *Banisteriopsis quitensis*, but the specimen is sterile and the determination therefore doubtful. The specimens of *oco yagé* or *chagro panga* (*Klug* 1971) also are sterile. The leaves however appear to be very like those of *Banisteriopsis rusbyana*,[5] of which two sheets of the type collection[6] are in the U. S. National Herbarium.

"One of the most interesting plants found in the region of the upper courses of the Putumayo and Caquetá Rivers is the *yagé*. The Indians make a beverage from either the wild or cultivated *yagé*, boiling it in a large earthenware vessel an entire day until there is formed a sort of liquid, like the syrup of sugar cane. They add to the *yagé* the leaves and the young shoots of the branches of the *oco yagé* or *chagro panga* (no. 1971), and it is the addition of this plant which produces the "bluish aureole" of their visions. These are like cinematograph views, and occur after about a half liter of the drink has been consumed in portions an eighth of a liter each at intervals of half an hour. Thereafter, the Indian falls into a profound sleep during which he is in a state of complete insensibility and anesthesia. During this period the subconscious activity acquires enormous intensity. The dreams follow each other with extraordinary precision and clearness. giving to the intoxicated person, according to the observations of missionaries, the power of double vision, and of seeing things at a distance, like certain mediums in their trances. Upon awakening, he retains clearly the hallucinations and fantastic visions which he experienced in unknown regions. Perhaps this drug has the property of developing the psychic faculties. In 1919 Dr. Zerda Bayon, specialist in the chemistry of plants, gave this plant the name *Telepatina.*

"Prof. Barriga Villalba experimented upon animals with the yageina, which he succeeded in isolating, with the following results: If a horse has a weak dose of a few centigrams per kilogram of its weight injected into it an extreme excitation is produced, and the animal runs in all directions. The body begins to tremble and the animal maintains its equilibrium with the greatest difficulty. With a larger dose, something like twenty centigrams per kilogram, the yageina becomes a real poison, and the animal loses its equilibrium, cries, falls into convulsions, its temperature is lowered, and anesthesia becomes

[5] *Banisteriopsis Rusbyana* (Ndzu.) Morton, nomen novum (*Banisteria rusbyana* Ndzu. in Ind. Lect. Lyc. Brunsberg. p. aest. 1901: 19. 1901).

[6] Beni River, Bolivia. July, 1886, *Rusby* 2171; distributed as *Hiraea.*

general. The same results were obtained with dogs, in which complete anesthesia without loss of vision or sense of smell was proved.

"The small doses which Barriga Villalba tried upon himself produced a profound sleep and certain sensations of well-being. But this was very far from being the effect on the savages, for which reason Professor Muñoz, of Colombia, employed 30 to 40 grams of the drink, prepared according to the manner of the natives. Effect: At first there was a slight stimulation of the nerves, similar to that of caffein, then a slight dilation of the pupils. All exterior objects acquired a strange appearance, aureoled and of a blue color. Then came the most extraordinary hallucinations, resembling those of hashish, very magnificent, very terrifying. These are due without doubt to the excitation of the cerebral centers of vision, the sensibility of which is such, that the person who has taken *yagé* is capable of *seeing objects in the midst of the most complete obscurity.*

"In Umbría I have had occasion to converse with persons of education who have told me of taking yagé, prepared by the savages (but without the addition of the leaf of *chagro panga* or *oco-yagé*) for the cure of malaria from which they suffered, and they have assured me that with three drinks of this (about 150 grams) they have been cured completely, and that for several years they have not suffered further from this illness."

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## GEOLOGICAL SOCIETY

### 478TH MEETING

The 478th meeting of the Society was held in the Assembly Hall of the Cosmos Club, April 22, 1931, President O. E. MEINZER presiding.

*Informal communications:* H. D. MISER described certain small anticlines exposed in the Cason shale at the Cason manganese mine near Batesville, Arkansas, and ascribed them to compaction of the shale above an irregular buried topography. The Cason shale rests unconformably on the Fernvale limestone, the relief of the surface of unconformity being about one foot. Above each buried hill the shale is folded into an anticline and above each valley it is folded into a syncline. The folds are not aligned and they die out about 3 feet above the top of the limestone. The shale contains fossil algae that are normally spherical but that are so flattened in the Cason shale that their present minor diameters are about one-third their original lengths. The major diameters are parallel to the bedding of the shale. It is believed, therefore, that the shale has been compacted to about one third its original thickness. Miser pointed out that some believe such folds yield part of the petroleum in the mid-Continent oil fields.

*Regular program:* C. N. FENNER and A. L. DAY: *Borehole investigations in the geyser basin of Yellowstone National Park.*—For a number of years the Geophysical Laboratory of the Carnegie Institution of Washington has been making a comprehensive study of the geysers and hot springs of Yellowstone Park. In connection with this study exploratory boreholes have been put down to a depth of several hundred feet at two sites in order to determine the underground conditions on which the surface manifestations of geyser activity are dependent. The first hole was drilled in 1929 in Old Faithful Basin, and the second in 1930 in Norris Basin. At both sites the holes were in hot areas not far from active vents.

At Old Faithful the drill penetrated beds of indurated sand and gravel to a depth of 220 feet. These sediments apparently had been accumulated in basins overdeepened by glacial scour. The component material is rhyolite, now much altered by the circulating hot water and consolidated by the deposition of secondary minerals. From 220 feet to the bottom of the hole at 405 feet, rock in place was penetrated. This bedrock was likewise rhyolite, either glassy or lithoidal. The temperature in the hole increased progressively though somewhat irregularly to a maximum of 180°C. at the bottom. Steam which contained small amounts of hydrogen sulphide and carbon dioxide was encountered, the maximum pressure being 57 pounds to the square inch.

In both the sediments and in the underlying rock there were numerous small seams and fissures in which opaline silica, quartz, chalcedony, adularia, calcite, and the zeolites analcite and clinoptilolite had been deposited together with other secondary minerals. Even the unfractured rock was likewise impregnated with these minerals.

In the second hole, drilled in the Norris Basin, sedimentary beds such as were found at Old Faithful were lacking, and rhyolite in place was encountered just below the surface. This rock has been considerably altered, with the formation of quartz, adularia, and tridymite. Hydrogen sulphide was evidently more abundant than at Old Faithful and consequently pyrite is a fairly abundant secondary mineral. In the Norris hole the maximum temperature was 205°C.

In the borehole in the Norris basin steam pressure as great as 300 pounds to the square inch was encountered. This is the highest pressure on record for such drilling projects, and it increased the difficulties enormously. The bedrock was found to be much fissured, and there was apprehension that it might be uplifted bodily and a great crater formed. Drilling operations were slowed down greatly, and finally when the hole was 265 feet deep, a break developed in the casing, probably produced by the abrasion of the grit carried by the uprushing steam. No means of repairing the casing was found, and it brought operations to a close at a less depth than had been contemplated. Difficulties such as those encountered in drilling this hole must be contended with in any attempt to tap underground sources of power under similar conditions, or to put down holes for investigative purposes.

It is believed that the data on rock texture and underground temperatures that were obtained in these holes will permit amplification of Bunsen's theory of geyser action in a number of respects, and will explain various manifestations visible at the surface. Detailed petrographic and chemical studies of the drill cores are still in progress. (*Author's abstract.*)

Discussed by Messrs. Johnston and Shenon.

W. H. Bucher: *The mobile belts of the earth.*—The structural features of the face of the earth result from the deformation of the crust. Two mutually incompatible views as to the physical character of this crust are being held by geologists at present. One assumes that the acid and basic materials of the crust differ so much in strength that the acid materials can maintain their form in pushing laterally through the basic materials and also in extending downward into levels of higher temperature. The other view assumes that the strength of both materials is of the same order of magnitude. In the second case the base of the crust, that is, the zone in which the strength reaches zero, is a fairly smooth surface from 30 to 100 miles below the earth's surface.

A number of observations have convinced the writer that the first view is untenable. Two of these are: (1) If there were an essential difference between the strength of basic and acid materials, it should result in corresponding differences in surface forms produced by structural deformation. This does not seem to be true. Essential features of what are commonly called "grabens" for instance, are seen to be identical on continents and on sea bottoms. (e. g. Bartlett Trough; Tanganyika Trough, etc.) (2) Shepherd and Greig have demonstrated experimentally that the temperature at which rocks of granitic composition would flow is much lower than for basalt.

Adopting the second view, we think of the crust as a definite shell which is capable of transmitting stresses. The presence of long linear structural features points to stresses which acted on the crust at large. The most striking features of this type are the long belts of mountain *folding* (e. g. Antillean system and the Alpine Mountains of Europe, N. Africa, and Asia) and of graben *faulting* (e. g. African fault belts of which rift valleys are a conspicuous part). This paper deals with the relation between these two extreme types of linear crustal deformations.

The chief structural features of the fault belts are believed to owe their existence to tensional stresses. Besides these, however, there are indubitable evidences of compressive stresses. This is reflected in a curious way by the fact that the same series of hypotheses of origin have been suggested for three conspicuous examples: the Rhine graben, the African rift valleys, and the Great Basin. ("Key-stone" theories of Elie de Beaumont, Gregory, and Le Conte, 1878; tensional theories of Suess and Le Conte, 1888; compressive wedge theories of Andreae, Wayland, and Link).

The writer believes that these three typical regions originated under tensional stresses and were modified by subsequent compressive stresses. The distinctive feature of these belts is that under compressive stresses they developed a minimum of mobility. The writer, correspondingly, designates them as "fracture belts of low mobility."

Such regions as the areas of Saxonian folding in northern Germany and the Coast Ranges of California of post-Franciscan time display a curious combination of fault-block pattern and rock folding. The writer contends that the fault dislocations took place under tensional stresses in epochs of general crustal expansion and that they were modified by compression in epochs of crustal contraction. This is the same sequence as that inferred for the fracture belts of low mobility. In this second case, there is much greater mobility, but it is localized due to the mosaic arrangement of the fault blocks. The writer designates this type "heterogeneous mobile belts."

The true "mobile belts," such as the Appalachian and Alpine systems, are characterized by intensive folding, essentially without normal faulting. Their history involves a major problem which is apt to be overlooked. The folding always follows a period of "geosynclinal" sinking, but at least during long intervals of these "geosynclinal" epochs, sinking took place without upward movements of one or both margins. This is shown by the very thick series of pure limestone which are so characteristic of such "geosynclinal" belts. ("Hochgesbirgskalk" of the Alps; Cambro-Ordovician limestones of the Appalachians). The writer knows of no adequate explanation of the origin of such long, relatively narrow troughs that sink continuously for long intervals of time without any mountain-making movements. The analogy of the "fracture belts of low mobility" and of the "heterogeneous mobile belts" suggests that these "homogeneous mobile belts" likewise owe their origin to tensional crustal stresses which create the geosynclines while later compressive stresses throw them into folds. It seems reasonable to assume that just as folding takes place with all signs of a much greater mobility than is displayed in the other two types, so the yielding under tension owes its peculiar "homogeneous" character to greater "mobility." The writer, then, suggests that these three types of major linear elements of structure form a gradational series that are produced by the same alternation of crustal tension and compression, and that differ merely in the manner of their reaction to these stresses.

One characteristic common to all three types is frequently overlooked; namely, that later belts may intersect earlier ones at any conceivable angle. This independence of later from earlier mobile belts is very difficult to understand unless just such an alternation of tension and compression in the crust is assumed, as seems to be indicated by the structural history of the belts themselves. (*Author's abstract.*)

Discussed by Messrs. MOORE, FERGUSON, RUBEY, and G. R. MANSFIELD.

CARLE H. DANE and A. M. PIPER, *Secretaries.*

## SCIENTIFIC NOTES AND NEWS

The Innsbruck meetings of the International Commission on the Polar Year were held September 23, 25, and 26. Among the many resolutions passed one provided that there should be no postponement of date since so many governments were participating.

Five meetings of the International Commission of Terrestrial Magnetism and Atmospheric Electricity were held at Innsbruck September 21, 22, and 23.

Observations made on the Graf Zeppelin's arctic flight last July indicate that sea fog in the arctic is a relatively thin blanket varying from a few hundred to one thousand feet that can be easily surmounted in aerial navigation.

A general meeting of Aeroarctic is to be held in Berlin, November 7, 8, and 9.

The International Electrical Congress will meet at Paris in July 1932.

The recently formed Section of Hydrology of the American Geophysical Union announces the organization of a Committee on the Hydrology of Glaciers, composed of the following men: STEPHEN R. CAPPS, Senior Geologist, Alaska Branch, U. S. Geological Survey: Dr. HARRY FIELDING REID, Professor Emeritus of Dynamic Geology, Johns Hopkins University; G. L. PARKER, District Engineer, Water Resources Branch, U. S. Geological Survey; CARL P. RICHARDS, Chairman of the Research Committee of the Mazamas, Portland, Ore.; R. H. SARGENT, Senior Topographic Engineer, Alaska Branch, U. S. Geological Survey; Dr. WALLACE R. ATWOOD, Assistant, Branch of Research and Education, National Park Service; François E. Matthes, Senior Geologist, Section of Glacial Geology, U. S. Geological Survey, Chairman. The functions of the committee correspond in general to those of the Glacier Commission appointed by the Section of Scientific Hydrology of the International Geodetic and Geophysical Union in Europe and will consist principally in securing systematic records of the annual variations of American glaciers.

Kenneth D. Lohman, A. M. 1930, California Institute of Technology, has been appointed Assistant Geologist in the Geological Survey.

J. P. Marble, recently instructor at Harvard University, is making determinations of the age of certain uranium minerals, by means of their lead-uranium ratios, in the chemical laboratory of the Geological Survey.

Charles Milton, Ph. D. 1929, Johns Hopkins University, has been appointed a geochemist in the Geological Survey.

Prof. Kanzaemon Kukuchi, in charge of the Department of Biology, Toyama High School, Toyama, Japan, has come to the National Museum for the purpose of examining its collections of oriental invertebrates. He is particularly interested in crustacea and mollusks, and is determining a number of specimens that he has gathered in the course of his Japanese faunal studies. He expects to be in Washington for some weeks.

Dr. Teiichi Kobayashi of the Geological Institute, Imperial University, Tokyo, Japan, accompanied by his wife, has arrived at the National Museum with large collections of early Paleozoic fossils. He intends to remain here for perhaps a year and a half to study these fossils where related forms are available for comparison. These collections are mainly from South Korea which is practically a virgin territory from a geological standpoint.

## OFFICIAL COMMUNICATIONS

### THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

#### Announcements of Meetings

| | |
|---|---|
| Saturday, December 5 | The Philosophical Society |
| Tuesday, December 8 | The Electrical Engineers |
| Wednesday, December 9 | The Geological Society |
| | The Medical Society |
| Thursday, December 10 | The Chemical Society |
| Friday, December 11 | The Geographic Society |
| Saturday, December 12 | The Biological Society |
| Tuesday, December 15 | The Anthropological Society |
| | The Historical Society |
| Wednesday, December 16 | The Washington Society of Engineers |
| | The Medical Society |
| Thursday, December 17 | The Academy |
| Friday, December 18 | The Geographic Society |
| Saturday, December 19 | The Helminthological 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

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*Corresponding Secretary:* Paul E. Howe, Bureau of Animal Industry.
*Recording Secretary:* Charles Thom, Bureau of Chemistry and Soils.
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## CONTENTS

ORIGINAL PAPERS



PROCEEDINGS



This JOURNAL is indexed in the International Index to Periodicals

VOL. 21 DECEMBER 19, 1931 No. 21



# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES



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## 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.

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VOL. 21 DECEMBER 19, 1931 No. 21

PHYSICS.—*Certain aspects of Henry's experiments on electromagnetic induction.*[1] JOSEPH S. AMES, Johns Hopkins University. (Communicated by L. H. ADAMS.)

I regard it as a great honor to be invited to give the first of a series of lectures before the Washington Philosophical Society, to be known as the Joseph Henry lectures, established in honor of the founder and the first President of the Society.

I think it is undoubtedly proper for me to choose as the topic of this first lecture one which is related to the life of Joseph Henry, partly because of the association of his name with the lectureship, but also because this year is recognized as the one hundredth anniversary of the discovery of the phenomena of electromagnetic induction, a discovery with which the name of Joseph Henry will always be associated.

This discovery of electromagnetic induction marked the beginning of the modern era of electricity and in fact of the modern era of physics, and it is therefore most fitting that a celebration of the centennial anniversary of the discovery should take place. Last month such a celebration was held in London at the Royal Institution, to commemorate the part Michael Faraday played in the discovery. Although he was anticipated in this by Joseph Henry, so far as both mutual induction and self induction are concerned, Faraday will always be regarded, properly I think, as their real discoverer because he was the first to publish the results of his investigations and pointed out at the time of his first announcement the possibility of making practical application of them. Joseph Henry, himself, although he deeply regretted the fact that he had delayed publication of his investigations, always gave

[1] An address delivered before the Philosophical Society of Washington on October 24, 1931. Received November 12, 1931.

full credit to Faraday and was scrupulously careful to refer to him as the discoverer. The newspapers, magazines and scientific periodicals have called attention repeatedly during the past two months to the work of Faraday and to his greatness as an experimenter and as a philosopher of nature. Rather scant notice has been given to the work of Joseph Henry, one writer saying that he "probably anticipated" Faraday; and my real reason for selecting the topic I have for this evening is my desire to impress upon all of you who listen to me the essential facts of Henry's great discoveries. Certainly whenever an American physicist hears the words, induced currents, the first thought that should come to his mind is "Joseph Henry discovered these."

It will indeed be superfluous for me to give a sketch of the life of Henry or to refer in detail to the long series of his brilliant investigations in the varied fields of physics or to his great contributions to the scientific life of this country. Anyone who is interested in these matters should read the address by Professor William B. Taylor which was read before this society fifty-three years ago this month and which was published by the government in a volume devoted to the life and scientific work of Henry, and especially the excellent article by Professor Magie in the October number of *Reviews of Modern Physics.*

I intend to confine myself this evening to the question of induced electric currents and, even more narrowly, to the original experiments of Henry, calling attention particularly to the dates at which his discoveries were made. I must begin, however, by making as the background of my paper a statement concerning the scientific knowledge available at the time Henry began his experiments and also a description of Henry's environment, so that you may understand more clearly the stimulus which animated him and the difficulties under which he labored.

In 1819 Oersted made the discovery that an electric current flowing in a conductor exerted a force upon a magnet and this great event was, of course, followed at once by investigations all over Europe. In the following year Schweigger devised his multiplier consisting of an arrangement by which a magnetic needle came under the influence of several turns of wire, and thus perfected a rather sensitive instrument for the detection of an electric current. In this same year, 1820, Arago and Davy discovered independently that a steel needle placed axially inside a helix of wire became magnetized when an electric current was passed through the helix. In this experiment of Arago's the wire was uncovered and was wrapped in a loose helix around a glass tube, the needle being placed inside this tube. In the same year also Ampère began his brilliant series of studies on the action of currents on magnets and of currents on currents, resulting in the discovery of phenomena which form the basis of electrodynamics. In these experiments Ampère used single turns of bare wire. In 1825 William Sturgeon of Woolwich, England really developed the electromagnet by winding uncovered wire around an iron bar, which was insulated from the wire, the iron bar itself being bent into the shape of a horseshoe so that an armature could be placed across its two ends. In this electromagnet Sturgeon used eighteen turns, loosely coiled. These were the essential facts concerning the relations between electricity and magnetism known to the scientific world at the time Henry began his studies.

In 1826 Joseph Henry was elected Professor of Mathematics and of Natural Philosophy at the Albany Academy. This was one of the outstanding High Schools of the State of New York and the work done there compared favorably with that characteristic of some of the colleges of that day. He was twenty-seven years old at the time of his appointment and his interests were already centered in the study of natural philosophy, his attention having been called to the subject when he was fifteen years old by the chance reading of a book which he had found left on a table by a man boarding with his mother. This book, Dr. G. Gregory's *Lectures on Experimental Philosophy, Astronomy and Chemistry*, made a great impression upon the boy's mind, and it is recorded that the owner gave it to him and that he kept it with him throughout his entire life. It aroused his intellectual curiosity and inspired him with a desire to answer questions dealing with nature. He set to work at once to perfect himself for this life of investigation, and after some years of study, teaching and tutoring, during which time he presented several papers before the local Scientific Society, the Albany Institute, he was chosen unanimously to fill the position I have mentioned. Albany at that time was a small city practically on the frontier, remote from centers of scholarship or of study, but the Albany Academy was a very worthy institution. It occupied a large building in the center of the city, consisting of classrooms and one good sized hall in its center, used for general purposes. There was no laboratory, of course, as such, and no apparatus of any kind; consequently Henry had to do everything with his own hands except so far as he could call upon a blacksmith to help. Schools in those days were rather serious-minded institutions and Henry was kept fully occupied with his classes as long as the school was operating, which was for practically ten months of the year. The sessions began the first of September and during all the time Henry was professor in the Academy the only opportunity he had for experimental investigations was during the summer vacations, and practically for only one month, the last part of July and the first part of August. When the vacation began Henry would set up his apparatus in the main hall of the building and he could work with it until in August the time came for the building to be cleaned and gotten ready for the classes which met, as I have said, the first of September.

I must ask you to consider this situation and to contrast it with that of the investigators in Europe, especially of Faraday. Here was a man evidently full of ideas, evidently eager to add to knowledge and to test his theories by experiments; but he had no apparatus, he had no means to buy any even if it had been available and he had at his disposal only a few weeks of the year in which he could devote himself to what was really the purpose of his life. When one considers these circumstances it is extraordinary indeed that Henry should have been able to advance as far as he did.

Henry read with eagerness everything that was published in regard to the connection between electricity and magnetism and as soon as he became a professor at the Albany Academy he began to make plans for the continuation of the experimental work of which he had read. The first thing he planned to do, naturally, was to repeat the work of others so as to convince himself of its accuracy and to become more familiar with the phenomena. In thinking over the experiments done by others he believed that he could increase the sensitiveness of the apparatus and could magnify the forces by an extremely simple device, which apparently had not occurred to anyone else. This was to use coils of insulated wire in place of single turns, and in October, 1827 he demonstrated before the Albany Institute the various experiments of Ampère and others using coils and thus magnifying the effect greatly. In order to super-impose one layer of the coil upon another layer, thus forming a bobbin, it was obviously necessary to insulate the wire itself, which he did by wrapping the wire "with silk," as he says. I have heard from the family that "the silk" used by Henry in making some of his first coils was really a series of ribbons of silk obtained by the sacrifice on the part of his wife of her white silk petticoat. An electromagnet made by Joseph Henry and used in his experiments is still in existence, being treasured in the museum at Princeton University, and one can still see the white silk ribbons used in its construction, so I believe the story I have heard is true.

One can hardly overestimate the importance of this device of Henry's. No one up to this time had thought apparently of using insulated wire coiled in layers, and immediately after Henry described his apparatus all the investigators of Europe adopted the idea. Faraday in his original apparatus, used when he made his discovery of electromagnetic induction, wound bare wire on an insulated iron ring, the separate coils being kept apart by winding between them a long twine, the separate layers being kept apart by pieces of non-conducting cloth. One cannot tell by reading Faraday's papers whether this idea was original with him or whether it was adopted after having seen Henry's published paper. As a matter of fact, in no one of Faraday's papers is there any reference to the experimental work of Joseph Henry.

Henry's first application of this new principle of coiling long wires into a number of layers was in the construction of a small electromagnet which he exhibited before the Albany Academy in June, 1828; and, having found how successful it was, he made another more powerful one the following year, which he exhibited in March, 1829. He then had a new idea in regard to the winding of magnets and in the latter part of the same year made one in which he had two independent windings over the whole length of the iron core, so that he could join these two in parallel. Then in order to make a magnet which could be used for many experimental purposes, in August, 1830 he wound one in a distinctly novel way, producing a magnet by far the most powerful then in existence. He wound the core of this magnet with nine separate coils, each coil occupying a space of about two inches. The terminals of each coil extended out from the side so that he was able to join the nine coils either in series or in parallel. This offered him a great variety of experimental possibilities. He investigated in connection with this magnet the effect of using a number of voltaic cells arranged in parallel or in series and he emphasized the effect of having the cells when in series joined with the coils of his magnet also in series and similarly the effect of having either one cell or all the cells in parallel joined with the coils of his magnet when these were in parallel. He made a study of what we would today call Ohm's law so far as the effect of the internal resistance of batteries is concerned and also performed many other experiments, some of which I will refer to later. All this was in August, 1830. In November of the same year he saw in

*Brewster's Edinborough Journal* an account of some work done by the Dutch physicist, Moll, in regard to electromagnets and thought it best to write an account of his work up to that time upon the same subject. This he did in November and submitted it for publication in *Silliman's Journal.* It was published in January, 1831 and was Henry's first scientific publication in a recognized scientific journal. It was characteristic of Henry for many years not to publish his results as soon as he had obtained them, but rather to wait until he had tested and investigated the various ideas which were in his mind on any one subject so that he would be convinced that he had exhausted the possibilities of that particular line of thought. This quality of his mind resulted naturally in the fact that so far as publication was concerned he was anticipated often and he was in several cases persuaded by his friends to write brief accounts of what he had done after the publication by others of their work.

I refer above to experiments which Henry made with his final form of magnet, and these he did not include in his paper in *Silliman's Journal,* which was confined simply to a description of his magnets. His reason for not publishing some of these experiments which were made in August, 1830 was because he intended to continue these further, and during August, 1831 he was very busy preparing some new apparatus one portion of which was a large reel containing a mile of wire and another was a much more powerful electromagnet. In a letter of November 6, 1831 he says that he had been making this apparatus "for some contemplated experiments in the identity of electricity and magnetism." In another letter he says that he had to stop his work on this new apparatus because the room in which he was working was wanted for the classes of the Academy. It is clear, therefore, that in August, 1831 he had been occupied with the construction of apparatus with the idea of continuing some of the work which he had begun in August, 1830 and which he had not thought to be sufficiently advanced to justify publication.

Immediately after the discovery of the fact that an electric current through a coil of wire would magnetize a piece of iron and in fact that a coil of wire carrying an electric current had magnetic properties, many investigators felt that there should be some way by which an electric current could be produced by means of a magnet and experiments of various kinds were tried. Among others, Michael Faraday of the Royal Institution, London, occupied himself with the problem for some years and on August 29th, 1831 began a series of experiments which finally solved the problem. He reported the essential features of his experiments to the Royal Institution and also to the Royal Society and preliminary accounts were published in the spring of 1832. Henry saw these probably in June of that year and thought it best to publish at once his preliminary investigations on the same subject, so that the first published account of his work appeared in the July, 1832 number of *Silliman's Journal.* In this account he describes experiments on the production of electric currents by varying the magnetic field through a coil of wire and also an observation which he had made some years before concerning the spark which is produced when an electric circuit is broken. He noted further that these two phenomena were evidently due to the same fundamental cause. I shall describe later the details of these experiments, but I wish at this time to call attention to the probable dates at which they were performed. In view of what I have said above I do not think there can be any doubt but that his observations of induced electric currents due to a varying magnetic field were carried out in August, 1830 when he was working with his new magnet. In fact, he says explicitly that the observations were made by using this magnet. When he observed the spark produced at the breaking of a circuit and studied the effect on this spark of various forms of the circuit it is quite impossible to say. It certainly was an early observation and the date has been set by Joseph Henry's daughter, Miss Mary Henry, as in 1829. This is extremely probable and the claim, I think, is supported by various considerations. Miss Henry says that she often talked with her father concerning the early history of electromagnetic induction and that he always spoke as if he had discovered induced currents in 1830 and made his first observations of self induction in 1829. I think it is very reasonable to believe that it was his observation of the electric spark on breaking a circuit and certain other phenomena to which I shall refer later, these being made in August, 1829, that led him to undertake the experiments which culminated in the discovery of induced currents in August, 1830 after he had completed his new magnet. In any case he saw so much ahead of him in August, 1830 calling for the construction of new apparatus that he thought it best not to publish his preliminary studies, so that August, 1831 found him busy making the apparatus which he felt necessary to have available to continue his investigations. Then again, he was stopped in his work by the opening of the school session and probably he would not have published any full account of his studies until after August, 1832 if it had not been for the fact that he saw that Faraday had already made some of the discoveries with which he was familiar as the result of his own investigations.

After Henry saw the brief notes concerning Faraday's work he took up the problem anew, repeating some of Faraday's work and extending his own, although the latter was very complete and convincing.

Having made his powerful electromagnet, which I have described above (early in the summer of 1830), he wound a coil of wire around the armature of the magnet and led the terminals of the wires to an instrument for indicating current. He noticed that when he turned on the magnetizing current there was immediately a fling of the galvanoscope needle and that when he broke the magnetizing current there was a fling in the opposite direction. He further observed that when he turned the magnetizing current off and detached the armature there was also a fling of the galvanoscope needle, the amount of which varied according to the distance he moved the armature. Finally, he observed that when the armature was in place on the magnet and he varied the magnetizing current there was also a fling. So he felt justified in drawing the conclusion that there was an instantaneous current in one or the other direction in a helix of copper wire surrounding a piece of soft iron accompanying every change in the magnetic intensity of the iron. No statement concerning the production of induced electric currents could be any clearer than this.

His observation of certain phenomena of self induction, probably made in 1829, was equally important. Having noticed this fact of the appearance of a spark which may have been and probably was a chance observation owing to some break in an electric circuit, he studied the effect of having the circuit consist of a short wire or a long one and also the effect of coiling a conductor into a spiral or helix, noting the increased effect when the latter was done.

We have seen that in the summer of 1831 Henry was busy making a new magnet and new apparatus for experimental purposes. In 1832 he was elected Professor of Natural Philosophy at the College of New Jersey, now Princeton, and he moved there with his family in November of that year. The first few years of his incumbency were occupied with the immediate duties of his chair and he did not have an opportunity to continue his studies until 1834. In November of that year Faraday published an account of his discovery of the phenomena of self induction and Henry's friends persuaded him that it was his duty to publish at once an account of what he had done on the same subject up to that time. This he did. He gave an oral account of his work before the American Philosophical Society in Philadelphia at its meeting of January 16, 1835 and wrote a fuller account, which was published in *Silliman's Journal.* He had extended the observations to which I have referred above by investigating not alone the spark produced on breaking the circuit, but also the currents and the shock which accompanied the break. He had also studied the effect of introducing iron into a helix and had really made great progress. From this time on Henry worked fairly continuously and, apparently having learned his lesson in regard to publication, communicated his results as soon as he was convinced that they were definite. He had been elected a member of the American Philosophical Society in 1834 and thereafter he communicated his results to this Society and they were published in its *Transactions* or *Proceedings.*

He continued for some years his study of the phenomena of self induction and other effects of electromagnetic induction; in fact there was a constant series of publications on the subject till his election as Secretary of the Smithsonian Institution in December, 1846.

In one series of experiments he investigated the effect of a discharge of a Leyden jar through his primary coil in producing induced currents in neighboring conductors and was ultimately led to the proof that such a discharge was oscillatory. (Conviction that this was the character of the discharge had been expressed previously in 1827, by Savaray, but this fact was not known by Henry.) He was able to prove also that this inductive action produced by discharges through a primary conductor was felt at considerable distances, certainly as far as two hundred feet. This is the first experiment on record of electromagnetic waves (in 1842).

One of his most important studies dealt with the effect of introducing sheets of conductors between his primary and secondary coils (in 1838). One of the main interests in this study lies in the fact that Henry's observations were quite contrary to those announced by Faraday. Henry showed that the introduction of a plate of copper cut off completely the inductive action, whereas Faraday had found that there was no shielding effect. The explanation of the discrepancy, which Henry, himself, was able to make, lies in the fact that Henry's observations were on what we nowadays call electromotive force, whereas Faraday in his investigations was concerned with the quantity of induced current. This fact emphasizes the difference in the experimental equipment of the two investigators. Henry had practically no measuring apparatus and had to content himself with such observations as sparks and the shocks received when discharges were passed through his body; Faraday, on the other hand, had a well equipped laboratory. It is extremely interesting as one reads the papers by the two great physicists to see how they express themselves without having the benefit of the knowledge which came when Ohm's law was known. I think of the two men Henry had perhaps a clearer understanding of the essential features of induced currents, but I could not give conclusive proof of this. Both men were aware of the fact that there was one quality of the current which depended upon the rate at which the magnetic field is changed, this being what determines the shock in the muscles and the distance at which a spark will occur in a broken circuit, and that there was another property of the current depending upon the total change in the field, which determined the fling of the galvanometer needle. The former was independent of the material of the conductor, while the latter varied with it. It was not, however, until the work of Lenz and of Neumann that all the difficulties were removed and all the phenomena expressed in one simple equation.

One interesting experiment of Henry's in this connection was to show that although there were differences in the shock produced in the secondary coil when the current was made or broken in the primary, there was no difference at all in the fling of the galvanometer needle. This observation led him to a very careful study of the phenomena associated with making and breaking a circuit.

The discrepancies between the observations of Henry and of Faraday, dependent upon the fact that the former was observing as a rule electromotive force while the latter was measuring the quantity of current, reminds one very much of the discrepancies which existed in the early history of mechanics, discrepancies which were only cleared up by the mathematical work of D'Alembert. Mechanics had its origin, as is known to you all, in the work of Galileo, Newton and Huyghens, and in the century that followed their first publications a controversy as to the proper measure of those agencies in nature which produce the changes in velocity of a body. One school of writers insisted that the proper measure of the effect of such agencies was to be found in the difference in the squares of the velocities of the body at the beginning and the end of the action. Another school insisted equally vehemently that the effect should be measured by the difference in the velocity. If this dispute were stated in modern language it would be somewhat as follows: Is the effect to be measured by the change in the kinetic energy or by the change in the momentum? It was D'Alembert who first showed that neither one of them was the proper measure, because the change in the kinetic energy is equal to the product of the force by the distance through which the body moves under the action of the force, while the change in the momentum is equal to the product of the force by the time during which the body is under the action of the force. Or, it may be said, if one wishes to, that both schools were right and that they were looking at the two sides of the shield as in the ancient fable. Something of the same kind may be said in regard to work of Henry and Faraday. Their research work was absolutely trustworthy, but their interpretation of this could not be completely satisfactory until the work of Ohm was appreciated and until the mathematicians had completed their study.

I can add but little to what is well known concerning Henry's qualities as an investigator and administrator. As one reads the various papers contributed to the memorial volume devoted to his life, one is struck by the universal admiration for his broad philosophy, his accuracy of observation, his brilliant intuitions and his devotion to the cause of science in its widest interpretation. He was unselfish to a marked degree. He was not interested the faintest in personal advancement or in advancing claims for discoveries or inventions. His sole purposes in life were to interpret nature and to diffuse knowledge among men. Beyond any doubt he is the outstanding figure in the history of the scientific life of America.

## GEOLOGY.—*Seven coastal terraces in the southeastern States.*[1] C. WYTHE COOKE, U. S. Geological Survey.

In two recent papers[2] I called attention to the horizontality of the shore lines that bound the marine Pleistocene terraces of the eastern and southeastern United States and interpreted it as due to the stabil-

[1] Received November 17, 1931. Published by permission of the Acting Director of the U. S. Geological Survey.

[2] C. WYTHE COOKE. *Pleistocene seashores.* This JOURNAL 20: 389–395. 1930. *Correlation of coastal terraces.* Jour. Geol. 38: 577–589. 1930.

ity of the land on which a fluctuating sea had cut its marks at various levels. The fluctuations of sea level were attributed primarily to the varying quantities of water contained in the waxing and waning continental ice caps, sea level having been low during times of greater glaciation and high when there was less ice. Under this hypothesis, the shore line of each coastal terrace was formed during an interglacial stage.

I also pointed out the obvious facts that fluctuations of sea level are not local but are world-wide and that contemporaneous beaches stand at nearly the same level on all lands that have not moved since the sea lay upon them but that the beaches may vary somewhat in altitude because of local differences of tidal range. As many lands have presumably remained rigid and undisturbed throughout Quaternary time, it may be possible to detect abandoned beaches along their margins at the same altitudes as those along the southeastern part of the United States. When they are found a ready means will be at hand to establish exact correlations between the interglacial Pleistocene deposits of the eastern United States and those of other continents. Anthropologists and archeologists may be able to date the stages in the evolution of man and his cultures in terms of an intercontinental chronology, and glacialists may eventually tie in the complex history of the advances and retreats of the ice sheets of North America with those of other lands.

In the papers cited I recognized only six Pleistocene shore lines at altitudes about 25, 65, 95, 160, 215, and 265 feet above the present sea level, but mentioned the possibility that there might be more than the six enumerated. The altitudes assigned to these shore lines were intended to indicate the approximate position of mean sea level when each terrace was formed, and were therefore purposely made a little lower than the highest water marks of the time, which presumably were produced by high tides and storms. In the present paper attention is called to a seventh shore line which was overlooked in earlier work, the altitudes of the beaches are revised (the average former high-water mark rather than former mean sea level being chosen although the datum of reference is present mean sea level), the distribution of each terrace in the southeastern States is sketched, and recommendations are made as to what name should be applied to each terrace. The altitudes of the seven shore lines now recognized and the preferred names of the terraces corresponding to them are as follows:

270 feet (82 meters), Brandywine terrace.
215 feet (66 meters), Coharie terrace.
170 feet (52 meters), Sunderland terrace.
100 feet (30 meters), Wicomico terrace.
70 feet (21 meters), Penholoway terrace.
42 feet (13 meters), Talbot terrace.
25 feet (8 meters), Pamlico terrace.

It should not be forgotten that points on a terrace are ordinarily lower than the corresponding shore line and may be almost as low as the next lower shore line. Thus, the Sunderland terrace (if no intermediate terraces have been overlooked) may range in altitude from 170 feet above sea level at its former shore line to 100 feet above sea level at its outer edge.

All of the terraces above listed are, in my opinion, recognizable in the eastern United States at least as far north as Maryland and are interpreted by me to indicate marine or estuarine shore lines throughout their extent. According to another interpretation recently published[3] marine terraces in the Potomac basin are recognized only below 100 feet elevation and all deposits above that level are considered to belong to an alluvial fan laid down on land by the Potomac River.

*The Brandywine terrace.*—The type locality of the Brandywine terrace may be considered to be the same as that of the Brandywine formation, about which there can be no question. Clark[4] wrote as follows: "The name Brandywine is proposed for this formation as the deposits are extensively and typically developed in the vicinity of Brandywine, Prince Georges County, Maryland . . . . Brandywine . . . . is located on the slightly-eroded surface of the old Brandywine terrace not far from the center of the largest tract still preserved intact. . . . . The formation attains its maximum thickness in the general area in which Brandywine is situated. No section of the formation is exposed at Brandywine since it is situated on the uneroded surface of the formation, but the adjacent ravines both to the east and west cut through the formation, exhibiting the gravels, sands, and loams characteristic of the formation."

[3] M. R. Campbell. *Alluvial fan of Potomac River.* Geol. Soc. Am. Bull. 42: 182. 1931.

[4] W. B. Clark. *The Brandywine formation of the Middle Atlantic Coastal Plain.* Am. Jour. Sci. (4th. ser.) 40: 499, 505. 1915.

As Clark included in the Brandywine formation some deposits that are now known to be older and others that are younger than those at Brandywine, the formation should be restricted so as to include only those gravels, sands and loams that were laid down in the Brandywine sea and in the contemporaneous estuaries and rivers. As the shore of the sea and estuaries during Brandywine time appears to stand about 270 feet above the present sea level, that altitude may be assumed to represent the upper limit of the Brandywine formation and the 270-foot contour line may be assumed to mark approximately the landward margin of the Brandywine terrace except where the land has been cut back by later erosion. If, however, a shore line between 233 feet (the altitude of Brandywine) and 270 feet should be discovered, the formation and terrace would need to be further restricted.

Several remnants of the Brandywine terrace in Virginia are shown on the map of Washington (D. C.) and vicinity, notably the ridge between Baileys Crossroads and Theological Seminary and along the Fairfax Road south of Back Lick Run. Part of the so-called "Lafayette" terrace of North Carolina represents the Brandywine. In the mapped parts of South Carolina and Georgia the Brandywine terrace is considerably dissected, but farther south in Georgia it is represented by large flat areas. The name "Hazlehurst" which I applied to it in 1925 should be discarded in favor of Brandywine, which has priority.

The Brandywine terrace does not appear on any published topographic maps of Florida because the areas mapped are too low, but it probably fringes the highlands of western Florida and of Dade County which rise above 270 feet.

*The Coharie terrace.*—The typical Coharie terrace[5] is crossed by Great Coharie Creek in Sampson County, North Carolina, and is shown on the Coharie quadrangle. The prevailing altitude of the plain in this region is between 180 and 190 feet, although it rises to 210 feet above sea level in the northwestern corner of the quadrangle. The shore of the Coharie sea does not cross the Coharie quadrangle, but is faintly shown in the western part of the Four Oaks quadrangle, which adjoins it on the north, where there is a rise from 215 feet to 230 feet within a quarter of a mile. The shore is more plainly visible on the Orangeburg (South Carolina) quadrangle, where a scarp rises from about 215 feet to 270 feet in half a mile. Although these slopes

[5] L. W. Stephenson. North Carolina Geol. Survey 3: 273. 1912. The Coharie terrace, as mapped by Stephenson, included a large part of the Brandywine.

would appear insignificant in a hilly country, they are much steeper than the normal slope of the undissected terrace plain.

The "Claxton" terrace of Georgia, as shown on the Claxton quadrangle, stands at the same altitude as the typical Coharie, and is evidently the same terrace. The name Coharie has many years' priority. Part of a large outlier of Coharie terrace (an island in the Sunderland sea) is shown on the Arredondo quadrangle north and northwest of Gainesville, Fla. In Virginia, the Coharie terrace is considerably dissected, but many flat patches of it remain, such as that 2 miles east of Fredericksburg (Stafford quadrangle and map of Fredericksburg and vicinity) and at Arlington (map of Washington and vicinity). In the District of Columbia, the Coharie terrace (estuarine facies) is well developed at Meridian Hill Park and in the Mount Pleasant section of Washington. In Maryland, the uplands in the southern part of the Brandywine quadrangle are part of the Coharie terrace.

*The Sunderland terrace.*—The name of the Sunderland terrace is derived from the hamlet of Sunderland, Calvert County, Maryland (Prince Frederick quadrangle). This place is not very suitable for a type locality, for it appears to lie between two outliers of the Coharie terrace, but the Sunderland terrace is further defined by Shattuck[6] as being limited by an ancient sea cliff at Charlotte Hall (Wicomico quadrangle), the foot of which he said is 170 feet above sea level. This definition is quite satisfactory. However, in later work[7] Shattuck included in the Sunderland much that falls within the Coharie and other terraces as now defined, with the result that the surface and the shore line of the composite Sunderland terrace appeared to be warped. The name Sunderland should be restricted to the terrace that is bounded by the shore line at or near 170 feet above sea level.

The shore of the Sunderland sea appears to have lain against or near the crystalline rocks of the Piedmont from Wilmington, Del., to Baltimore; thence it trended southward to the vicinity of Mechanicsville, St. Marys County, Md., lying several miles west of Patuxent River south of Bowie. There was a wide embayment up the Potomac Valley to Washington. In Virginia, the shore gradually approached the Piedmont, which it reached near Richmond and followed to the North Carolina line. The shore can be traced across the Kenly (North Carolina) quadrangle at an altitude apparently a little above 170 feet,

[6] G. B. Shattuck. Am. Geol. 28: 102–103. 1901.
[7] Maryland Geol. Survey. Pliocene and Pleistocene. 1906.

although the large contour interval and the lack of detail in the map do not permit one to locate it very accurately. In the mapped part of South Carolina, the shore is rather faint, but it can be traced at an altitude between 170 and 175 feet above sea level from the south fork of Edisto River near Bamberg past Allendale to the former estuary of Savannah River (Bamberg, Olar, Allendale, and Peeples quadrangles). In Georgia, the Sunderland terrace has been called the "Okefenokee" plain or terrace, but the name Sunderland has priority.

*The Wicomico terrace.*—Wicomico River in St. Marys and Charles counties, Maryland, suggested the name of the Wicomico terrace. According to Shattuck[8] in southern Maryland the base lies about 40 or 50 feet, and the top, where it borders its ancient sea cliff, about 90 feet above sea level. The only area within these limits in the neighborhood of Wicomico River shown on the much-generalized map of the Wicomico quadrangle is about 1 square mile southwest of Cooksey that lies between the 80 and the 100-foot contour lines. This area may be regarded as the type locality of the Wicomico terrace.

Ninety feet appears to be somewhat lower than the Wicomico shore line. Even 95 feet, which I assigned to the Wicomico in a recent paper, is a little too low. One hundred feet (30 meters) above sea level is generally considered as the upper limit of the Wicomico, and that altitude appears to be about right.

In Maryland, the Wicomico terrace is best developed on the Eastern Shore, where it forms the crest of the divide in Kent and Queen Anne counties, but strips of it are found along most of the estuaries west of Chesapeake Bay. The Capitol at Washington is built on it and Capitol Hill was mentioned by Shattuck as an example of the terrace. In Virginia, the Wicomico seashore followed the Surry scarp,[9] the foot of which lies about 100 feet about sea level (Surry and Ivor quadrangles), but estuarine reentrants of the terrace extend to the Fall Line along some of the streams. In North Carolina, part of the shore line is shown on the Falkland quadrangle south of Fieldsboro at an altitude of about 100 feet. It shows on the Manning and Pineland quadrangles (South Carolina) at the same level. On the Glennville (Georgia) quadrangle, the Wicomico shore can be traced along or near the 100-foot contour line southward for two-thirds the length of the map and

[8] G. B. Shattuck. Am. Geol. 28: 103. 1901.

[9] C. K. Wentworth. *Sand and gravel resources of the Coastal Plain of Virginia.* Virginia Geol. Survey Bull. 32: 55. 1930.

westward up the former seven-mile-wide estuary of the Altamaha River. In Florida, the Wicomico terrace, called "Newberry" by Matson, covers much of the Cambon quadrangle. Its shore lay along Trail Ridge on the adjoining Macclenny quadrangle and on the Lawtey quadrangle. Here, too, the altitude of the shore line is very close to 100 feet above sea level.

*The Penholoway terrace.*—The type locality of the Penholoway terrace is shown on the Hortense (Georgia) quadrangle.[10] This area lay back of a low barrier island on which Browntown and Winslow (Everett City quadrangle) stand and apparently was partly covered by tidal marshes, to judge from the pattern of the present drainage. High tides reached 70 feet above present sea level or possibly a foot or two higher. Seventy feet (21 meters) may be taken as the altitude of the shore of the Penholoway sea.

In Florida, a terrace standing within the limits of altitude of the Penholoway and probably equivalent to it has been called by Matson the "Tsala Apopka" terrace, but its type locality shows so much evidence of underground solution that the position of its shore line is problematical. The name Penholoway is therefore preferred although Tsala Apopka has priority.

The shore of the Penholoway sea can be easily traced at an altitude of about 70 feet across the Walterboro (South Carolina) quadrangle. Summerville and Pinopolis are built on a long spit or island that separated the Penholoway sea from the mainland. Ridgeville stands on a barlike island at the mouth of the bay back of it (Summerville and Ridgeville quadrangles). The seashore of the Penholoway terrace forms the southern part of the Kinston (North Carolina) quadrangle. In Virginia most of the seaward-facing part of the Penholoway terrace has been destroyed, but there are a few areas (notably south of Yorktown) which lie within its altitudes. Several remnants of the estuarine part of the Penholoway terrace border Potomac River in Arlington County, Virginia. College Park, Md., (map of Washington and vicinity) is built near the head of a Penholoway estuary. A ridge of clay that rises to an altitude of about 70 feet above sea level near the Mount Vernon Memorial Highway near Fort Hunt, Va., (Indian Head quadrangle) is interpreted as having been deposited during Penholoway

[10] C. WYTHE COOKE. *Physical geography of Georgia.* Georgia Geol. Survey Bull. 42: 24. 1925.

time by the Potomac estuary across the entrace to an old drowned meander curve cut by the Potomac River at some stage of Pliocene time.[11]

*The Talbot terrace.*—According to the original definition by Shattuck,[12] the 45-foot contour line marks the shore of the Talbot sea. As the actual shore line seems to be three or four feet lower than this, the altitude adopted in this paper is 42 feet, or 13 meters. The name is taken from Talbot County, Maryland. Shattuck included in the Talbot not only the Talbot terrace as here restricted, but everything between its shore and the Recent terrace that is now forming. Stephenson, in describing the Pleistocene deposits of North Carolina, divided the composite Talbot terrace into two parts, an upper "Chowan" terrace, which has the same shore line[13] as the typical Talbot, and a lower Pamlico terrace. It seems preferable to retain the name Talbot for the upper terrace and to discard the newer name "Chowan."

In Delaware and Maryland the ocean extended inland 12 or 15 miles beyond the present seashore during Talbot time. A low seaward-facing scarp above the 40-foot contour line on the Pittsville quadrangle shows its former margin. Elsewhere in Maryland, including Talbot County, the Talbot terrace was covered by Chesapeake Bay and its tributary estuaries. In Virginia, most of the seaward-facing part of the Talbot terrace has been destroyed, but the terrace is developed along many of the estuaries. The foot of an unusually fresh-looking eastward-trending scarp facing the James in the southeastern part of the Toano quadrangle a quarter of a mile north of B. M. 22 stands 41 feet above sea level. The sharpness of this scarp may have been accentuated by artificial grading.

In the mapped parts of South Carolina little of the original shore of the Talbot sea remains, although there were many islands of Talbot terrace in the succeeding Pamlico sea. In the *Physical geography of Georgia,* I pointed out[14] what is probably a remnant of the Talbot terrace between Hinesville and Canoochee River (Hinesville quadrangle) but interpreted it as a bench cut while the sea stood at a higher level.

[11] Wentworth (op. cit., page 77) interprets this oxbow as having been cut off and partly silted up in late Talbot time.

[12] G. B. SHATTUCK. Am. Geol. 28: 104. 1901.

[13] Stephenson did not define the "Chowan" terrace by reference to a shore line although he states (op. cit., page 283) that "the surface of the [Chowan] formation forms a plain which slopes up from elevations of about 25 to 40 feet above sea level along its eastern margin to elevations of about 50 feet along the foot of the escarpment separating it from the Wicomico plain above."

[14] Georgia Geol. Survey Bull. 42: 32. 1925.

The Talbot shore line is better shown along the East Coast of Florida, where it follows the 40-foot contour line from the forks of Black Creek on the Middleburg quadrangle southeastwardly across the southwestern corner of the Orange Park quadrangle. It is even more conspicuous on the Interlachen quadrangle, at the same altitude. Leverett[15] has traced this shore line down the eastern side of the Peninsula at an altitude of about 40 feet and referred it to the "Pensacola" terrace.

*The Pamlico terrace.*—The name Pamlico is derived from Pamlico Sound in eastern North Carolina, away from whose shores the Pamlico terrace extends as broad, nearly level stretches of lowland. The plain is also present on both sides of Pamlico River and covers the greater part of Pamlico County.[16] According to Stephenson, the terrace nowhere in North Carolina is higher than 25 feet above sea level. The Pamlico terrace may therefore be defined as the terrace having a shore line approximately 25 feet above sea level.

In Maryland the Pamlico seashore lay near the present Atlantic coast. Traces of it can be seen on the Snow Hill quadrangle. The estuarine facies of the terrace borders Chesapeake Bay from a few miles below Havre de Grace to Baltimore and covers a broad expanse on the Eastern Shore below Chestertown.

From the North Carolina line almost to Charleston, S. C., the shore of the Pamlico sea appears to have been cuspate and almost continuous, but from Charleston to Savannah there were many irregular islands like the Sea Islands of today.

In Georgia the Pamlico shore consists of two broad cusps broken by several bays and inlets. Almost everywhere in the area covered by topographic maps it is marked by a moderately high scarp, the foot of which lies about 25 feet above sea level. The terrace was excellently described by Otto Veatch[17] under the name "Satilla coastal lowland or Satilla plain" in a book which bears a date of publication a year earlier than that of Stephenson's description of the Pamlico although the letter of transmittal of the North Carolina report is dated four months earlier than that of the Georgia report. The name Pamlico is preferred because it has gained wider acceptance than "Satilla."

In eastern Florida the Pamlico terrace is backed by a scarp whose

[15] Frank Leverett. *The Pensacola terrace and associated beaches and bars in Florida.* Florida Geol. Survey Bull. 7: 9–17. 1931.

[16] L. W. Stephenson. North Carolina Geol. Survey 3: 286. 1912.

[17] Otto Veatch. Georgia Geol. Survey Bull. 26: 36–38. 1911.

base lies below the 30-foot and above the 20-foot contour lines on the Boulogne, Hilliard, Cambon, Orange Park and Palatka quadrangles. In western Florida it stands at the same altitude on the War Department's fire-control map of Pensacola. Leverett[18] places the height of the "Pensacola" sea at Pensacola about 25 feet above present sea level.

Matson[19] described the "Pensacola terrace" as "a broad plain, rising less than 40 feet above sea level, and apparently including two divisions, one being less than 20 feet above, and the other from 20 to 40 feet above sea level." The lower of these two divisions is the Pamlico terrace; the upper is the Talbot. Frank Leverett, in searching for evidence of deformation of the "Pensacola" shore line,[20] overlooked the shore line of the lower of these two divisions in the east and the shore line of the upper of the two in the west. Therefore, in correlating the 40-foot (Talbot) shore in eastern Florida with the 25-foot (Pamlico) shore at Pensacola, he finds a gentle slope toward the west which he ascribes to tilt due to the increasing weight of the delta of Mississippi River. As further indication of this downwarp he says: "In the vicinity of Baton Rouge, on the east side of the Mississippi, the base of a scarp is down to about 15 feet." The foot of the scarp to which he referred, which is the one adjacent to Bayou Fountain on the Baton Rouge, La., quadrangle, slopes southeastward from about 30 feet at Baton Rouge to an altitude below 10 feet at the edge of the quadrangle, and apparently closely approaches sea level in the unmapped area farther east. It seems to have been the Recent shore of the Gulf before the Mississippi Delta was built up in front of it. The slope is that of the surface of the delta and is not due to tilting. Another scarp near Baton Rouge, shown by the closeness of the 40- and 50-foot contour lines, may mark either the Pamlico or the Talbot shores, or possibly both, for the Mississippi River is able to deposit sediment upon both the Pamlico and the Talbot terraces (raising them above their natural level) because high water at Baton Rouge, according to the map, is 41 feet above sea level.

No topographic maps showing the shores of Pamlico Sound have been published. The Belhaven quadrangle, however, which lies only a few miles north of Pamlico River, includes a large area of Pamlico

[18] FRANK LEVERETT. Florida Geol. Survey Bull. 7: 24. 1931.

[19] G. C. MATSON. *Geology and ground waters of Florida.* U. S. Geol. Survey Water-Supply Paper 319: 34. 1913.

[20] FRANK LEVERETT. Op. cit., pp. 26–29.

terrace and shows a short stretch of its shore line in the northwestern corner at an altitude of very nearly 25 feet. The Pamlico shore line can be easily traced across the Edenton, Beckford, and Suffolk quadrangles into Virginia, where it lies at the foot of the Suffolk Scarp.

Wentworth[21] has recently proposed to substitute for the Pamlico terrace of Virginia two terraces, an upper, which he calls the "Dismal Swamp" terrace, and a lower or "Princess Anne" terrace. If a marine terrace be defined by reference to the shore line of the tidal waters in which it was formed, it can not be divided, for a terrace can have only one shore line, although its supposed width may be restricted by the discovery of another shore line within the areal limits that had been assigned to it. As the "Dismal Swamp" terrace has identically the same shore line as the Pamlico,[22] the name Pamlico, which has many years priority, should be retained. The "Princess Anne" terrace was separated from the "Dismal Swamp" because of the presence of a low scarp above 12 feet in the neighborhood of Norfolk and elsewhere in Virginia. Although no one can dispute the existence of this scarp, for it is plainly shown on the Cape Henry quadrangle, opinions may differ as to whether it is really a sea cliff formed at a stage of the sea about 12 feet above the present sea level. The evidence at present appears to be inconclusive.

## BOTANY.—*A crown-rot of hollyhocks caused by* Phytophthora megasperma *n. sp.*[1]

CHARLES DRECHSLER, U. S. Department of Agriculture.

On May 15, 1931, a specimen of diseased hollyhock, *Althaea rosea* Cav., from a garden in the District of Columbia and reported to be illustrative of a trouble that had led to the loss of other plants in the same plot, was submitted to the writer for examination. Additional specimens were received during the ensuing two weeks. Early in June, perhaps because of the advent of drier weather conditions, but more probably because all the diseased plants had by that time succumbed, the destruction came to a halt in the garden referred to, though on June 5 a dying specimen from a small experimental planting

[21] C. K. WENTWORTH. Virginia Geol. Survey Bull. 32. 1930.
[22] C. K. WENTWORTH. Op cit., pp. 67–69.
[1] Received November 16, 1931


Fig. 1. A.—Hollyhock plant affected with crown-rot, as collected in Washington, D. C. showing decay throughout short over-wintered stem and in the discolored proximal portions of the fleshy roots, $\times\frac{2}{5}$. B.—Longitudinal section of hollyhock crown attacked by *Phytophthora megasperma*, showing sharp line of demarcation between decayed and healthy parts at bases of new shoots, $\times\frac{2}{5}$. Photographed by Lillian A. Guernsey.

of hollyhocks at Arlington Experiment Farm, Rosslyn, Va., was found to be affected with the same disease. While definite information as to the distribution of the malady is not available, there is reason to believe that it is fairly widespread, a grower in the vicinity of Racine, Wis., for example, stating that he had lost his entire planting of hollyhocks during the early part of June 1931, the destruction evidently having taken precisely the same course as was observed in the District of Columbia.

As the seat of the malady is very largely in the underground parts (fig. 1, A), the trouble makes itself manifest at the beginning sometimes through poor growth of the new shoots, but in other instances, as notably in the specimen at Arlington Experiment Farm, a dozen robust shoots between 1.5 and 2.0 meters high may be produced before any sign of abnormality is noticeable. Ordinarily no premonitory changes in coloration or turgidity of leaves or stalks are apparent when one after another the shoots fall to the ground, where they soon wither and die. In the course of a few days the entire aerial growth from a well developed crown may be killed. The manner of destruction thus shows a strong similarity to that pertaining to the foot-rot of various species of *Lilium* by the fungus generally designated as *Phytophthora cactorum* (Leb. & Cohn) Schroet., or to the foot-rot of rhubarb caused by *P. parasitica* Dast.

When the overwintered underground parts of a dying plant are examined, the short stem is usually found to be completely involved in a decay that extends downward into many if not into all of the large fleshy roots, often for distances of from 5 to 10 cm. and sometimes for distances of from 15 to 20 cm. Outwardly the decay is evidenced in a buff or sepia or darker brown discoloration, while internally the tissues, in addition to being more or less discolored, are softened to such a degree that the fibrous and woody elements are readily separated into longitudinal shreds. The decay is found usually to extend only a very short distance from the overwintered stem into the new shoots, the line of demarcation between diseased and healthy tissues being here rather sharply marked by a darkly discolored marginal zone (fig. 1, B). Apparently the shoots obtain water for a considerable period through the vascular elements of the completely killed overwintered parent stem, and fall to the ground only when the supporting tissues are weakened mechanically in such measure as no longer to be capable of supporting the weight of the aerial structures.

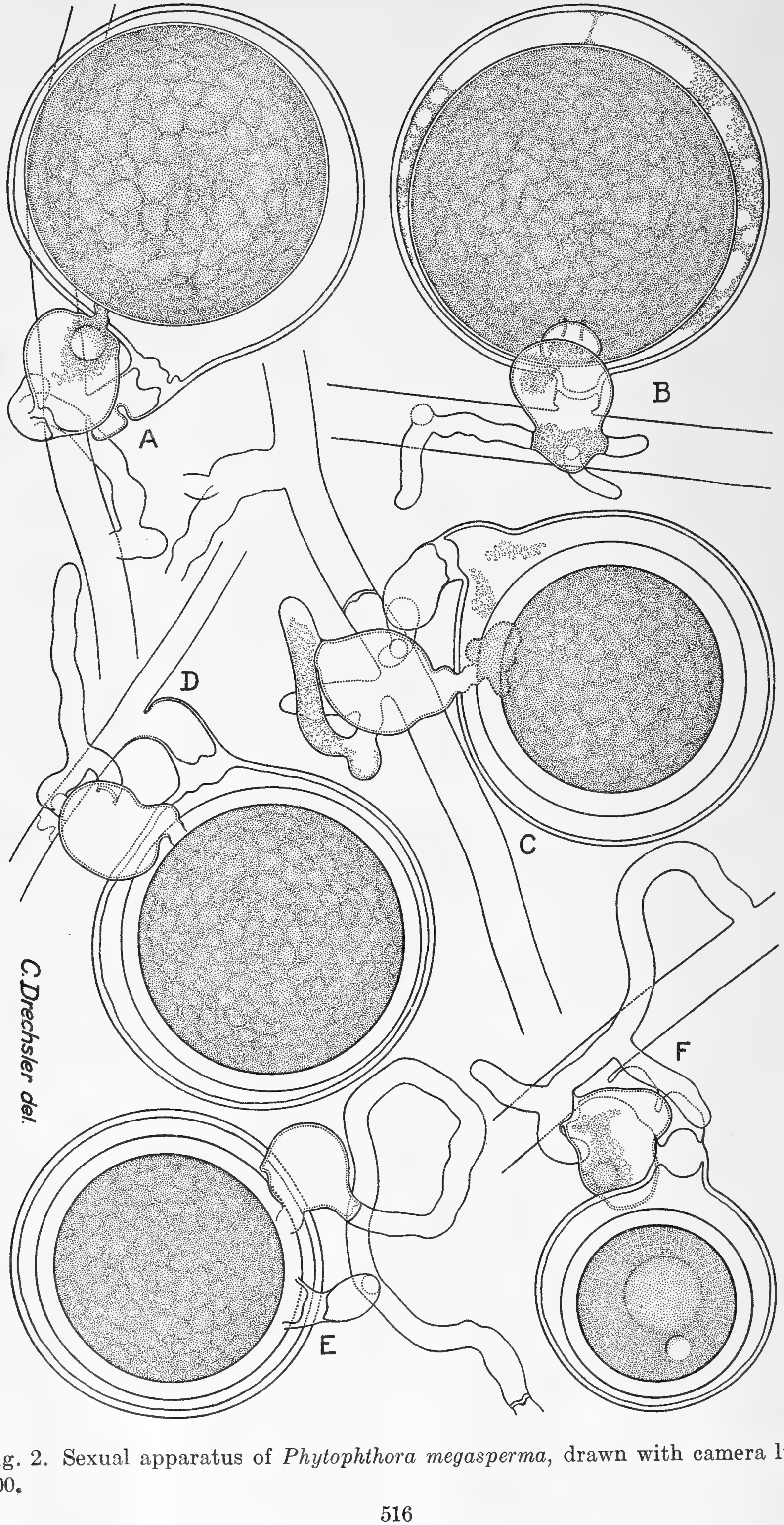


Fig. 2. Sexual apparatus of *Phytophthora megasperma*, drawn with camera lucida, ×1000.

In the greater bulk of the decaying tissues of the diseased hollyhock plants examined was found a moderate quantity of intercellular mycelium, which being usually devoid of protoplasmic contents, could not usually be made to yield new growth. New growth and subsequently pure cultures on artificial media were obtained fairly readily from pieces of newly invaded tissue from the margins of the diseased parts by employing the method set forth in an earlier paper (4), and with very satisfactory regularity when the washing of the infected material was continued until the gelatinous substance oozing in extraordinary quantity from the irrigated hollyhock tissue had been largely removed.

The fungus thus obtained displays in its mycelium the vegetative features generally associated with species of *Phytophthora*. Its staring, openly branching habit and the substantial appearance of the granular contents of its hyphae at once indicate a member of that genus rather than of the related genus *Pythium*. As in many other species of *Phytophthora* and, indeed, in various species of *Pythium*, septa make their appearance in the originally continuous hyphae with the withdrawal of the granular contents. In completely evacuated mycelium the rather thick cross-walls are present usually in considerable number.

A high degree of distinctiveness attaches, however, to the sexual apparatus, which is produced promptly and abundantly on nearly all substrata ordinarily employed (figs. 2–4). Aside from its ready production, the sexual apparatus is distinguished by the unusually large dimensions of oogonium and oospore. Thus 200 oogonia produced on maize-meal agar plates and chosen at random 10 to 15 days after planting, yielded measurements of diameters distributed according to values expressed to the nearest micron as follows: 33$\mu$, 1; 34$\mu$, 1; 37$\mu$, 1; 39$\mu$, 2; 40$\mu$, 3; 41$\mu$, 5; 43$\mu$, 6; 44$\mu$, 7; 45$\mu$, 19; 46$\mu$, 24; 47$\mu$, 28; 48$\mu$, 19; 49$\mu$, 27; 50$\mu$, 24; 51$\mu$, 17; 52$\mu$, 8; 53$\mu$, 3; 54$\mu$, 2; 56$\mu$, 2; 57$\mu$, 1. Measurements of the diameters of the 200 oospores contained within these oogonia yielded values distributed as follows: 26$\mu$, 1; 28$\mu$, 1; 30$\mu$, 1; 32$\mu$, 1; 33$\mu$, 2; 34$\mu$, 3; 36$\mu$, 2; 37$\mu$, 6; 38$\mu$, 2; 39$\mu$, 17; 40$\mu$, 32; 41$\mu$, 26; 42$\mu$, 26; 43$\mu$, 30; 44$\mu$, 22; 45$\mu$, 13; 46$\mu$, 8; 47$\mu$, 5; 49$\mu$, 1; 52$\mu$, 1. These values from which averages for diameter of oogonium and diameter of oospore of 47.4$\mu$ and 41.4$\mu$ respectively were computed, may presumably be regarded as fairly representative of the species, having been obtained from material in which the bodies in question were present

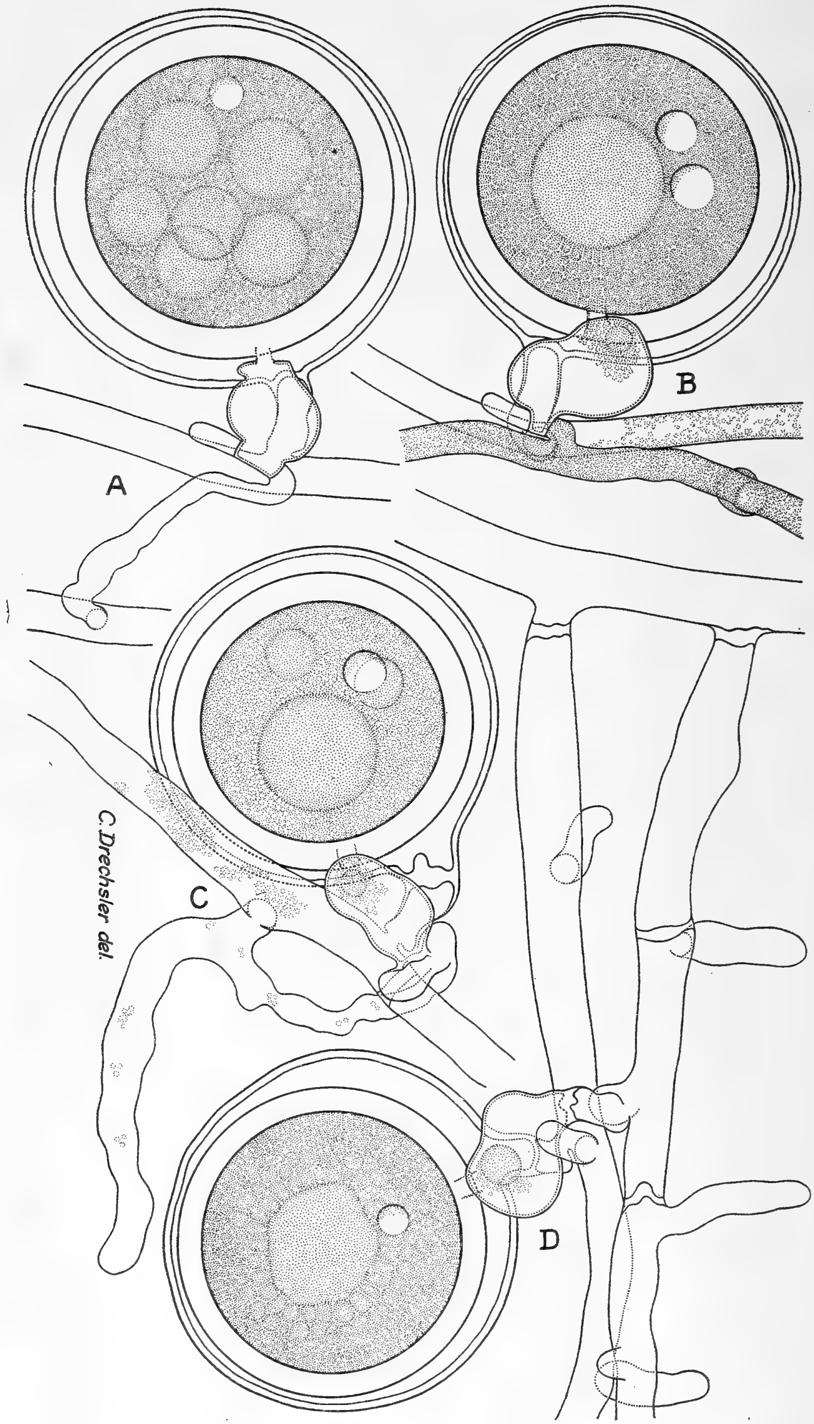


Fig. 3. Sexual apparatus of *Phytophthora megasperma* drawn with camera lucida, ×1000.

in large number and showed practically no tendency toward degeneration. The oospores in substantially all cases showed the structure normal for the stage of maturity in which they were found. Naturally more extreme values not included in the ranges found in the course of the random selections came under observation. Thus in the sex apparatus shown in Figure 4, E, among the smallest seen in an irrigated lima-bean agar preparation, in which somewhat smaller dimensions are wont to prevail then in dry maize-meal agar plate cultures, the oogonium measures only 16 $\mu$ in diameter, while the oospore measures only 11 $\mu$; and again the very largest oogonium seen in any maize-meal agar culture was found to measure 61 $\mu$ in diameter, and contained an oospore 54 $\mu$ in diameter.

The pertinent literature contains few records of oogonia and oospores equalling or closely approaching in size those of the hollyhock parasite. In a recently published comparative study of the genus *Phytophthora,* Tucker (9) states that the oogonia and oospores of *P. erythroseptica* Pethyb. with average diameters of 36.3 $\mu$ and 31.4 $\mu$ respectively, and hence fully 10 $\mu$ smaller in these dimensions than the hollyhock fungus, exceed in size those of any congeneric form, and held this superiority in size to be diagnostic for that species. In this connection it must be mentioned that Tucker reports that on transferring sterile mycelium of *P. erythroseptica* to Petri's mineral solution he found after one week a few large oogonia measuring 30.1 to 64.3 $\mu$ (average 45.1 $\mu$) in diameter. As, however, oospores were not observed in these oogonia there were, indeed, excellent grounds for not regarding the large structures as representative of the species. Somewhat similarly disturbing considerations pertain to Petri's report (7) of the production of oogonia varying in diameter from 57 to 62 $\mu$ and oospores "non ancora ben differenziate" measuring between 50 and 56 $\mu$ by *P. cambivora* (Petri) Buism. grown on carrot-agar acidulated with malic acid, when previously (6) oospores of the chestnut parasite in the tissues of the diseased host had been found to measure only 20 to 27 $\mu$. Ashby (2) more recently reported the discovery of several oogonia and oospores in a pure culture of *P. cambivora,* which with respect to size more nearly approximated those of the hollyhock parasite. It is to be noted that whereas the antheridia of both *P. erythrospetica* and *P. cambivora* developing in pure culture have always been found to be of the amphigynous type, those of the hollyhock fungus are predominantly paragynous.

A really close approximation to the hollyhock parasite in size of oogonium and oospore is to be inferred from Alcock's summary (1) of the morphological features of the fungus held by her to be responsible for the "Lanarkshire strawberry disease" prevalent of late years in Scotland and England: "Oogonia average about $46\mu$ to $47\mu$ in diameter; oospores average about $33\mu$ to $47\mu$ diameter; oospore wall about $4\mu$ thick; sporangia about $50\mu$ by $30\mu$." Antheridia of the amphigynous type were stated to have been made out in the cells of the host in a few instances, failure to obtain the fungus in pure culture having precluded more complete observations of the sexual apparatus. According to a later note (3) of somewhat indefinite authorship, presumably the same parasite is "characterized by a large sporangium, by oospores of the two types and as far as has been ascertained is similar to *Phythophthora cinnamomi*." It is not certain whether the latter quotation is to be interpreted as implying that the strawberry parasite produces large globose resting bodies of the type described by Rands (8) for his *P. cinnamomi*; but assuredly no bodies of such type have ever been seen in cultures of the fungus isolated from diseased hollyhocks.

As has been mentioned the antheridia of the hollyhock fungus are predominantly paragynous. In plate cultures of maize-meal agar approximately 99 out of every hundred sexual units exhibit a paragynous relationship of the male organ (figs. 2, A-F; 3, A-D; 4, A-C), the amphigynous relationship occurring only rather rarely. On irrigated lima-bean agar preparations useful in the study of asexual reproduction the proportion of amphigynous antheridia (fig. 4, D-F) is much larger, varying often between 25 and 35 in every hundred. The fungus is very obviously homothallic, for in many instances when it is neither too remote nor leads into one of the knotted hyphal tangles present here and there, the mycelial connection between antheridium and oogonium may be readily traced. In some cases (figs. 2, D; 4, C) the combined lengths of antheridial branch, oogonial stalk and intervening portion of hypha is not in excess of $40\mu$. The usual somewhat irregularly orbicular or broadly elliptical shape of the antheridium is sometimes modified by the presence of a distal protuberance or lobe (figs. 2, B, C, D; 4, B) by which contact with the oogonium is established.

In its asexual reproduction the hollyhock parasite is rather similar to *Phytophthora cryptogea* Pethyb. & Laff., *P. cinnamomi* and *P. cambivora*. The sporangium is as a rule ovoid (fig. 5, A-F) but frequently the development of a distal lobe or protuberance (fig. 5, K, L, N, O) brings

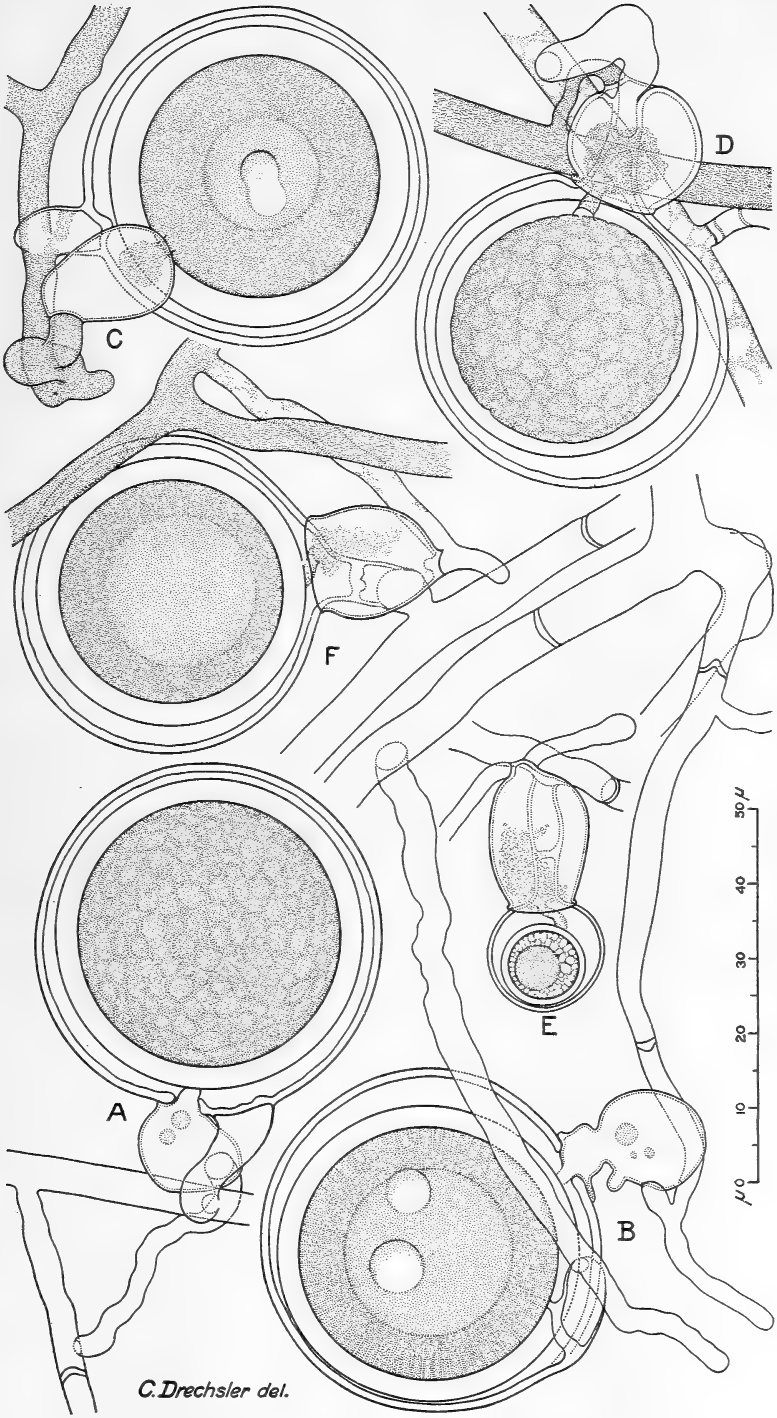


Fig. 4. Sexual apparatus of *Phytophthora megasperma* drawn with camera lucida, ×1000.

about a modification in its outward form suggesting the distal modifications sometimes present on antheridia. A papilla of dehiscence protruding beyond the apical contour is not produced, although quite obviously the wall at the apex of the sporangium becomes transformed into a noticeably thickened refringent cap through the yielding of which discharge is effected. Dehiscence is accompanied by a perceptible shrinkage of the sporangial envelope, as may be seen by a comparison of Figure 4, F with Figure 4, E, the contraction apparently being only in part accounted for by the relaxed contour of the empty membrane. The hypha supporting the sporangium is proliferous, so that a second or a third sporangium may be borne on the same axis, either within the empty envelope of the primary one, or beyond the latter, depending on the lengths of the intervening increments of growth of the sporangiphore (fig. 5, G-M).

The sporangia obtained in irrigated preparations are too variable for profitable statistical metric treatment. Those formed earliest in a fresh preparation measure usually from 35 to 60$\mu$ in length by 25 to 45$\mu$ in diameter. The larger individuals like the one shown in Figure 5, A, yield between 35 and 45 zoospores; slightly smaller examples like those shown in Figure 5, B, C, yield between 30 and 35; the medium-sized specimen represented in Figure 5, E, yielded 18 by accurate count; the small one shown in Figure 5, D, was seen to deliver 6 zoospores. As the preparations become older and in part exhausted, the sporangia decrease in size until specimens make their appearance with minimum dimensions; that is, with the length between 15 and 20$\mu$, and width between 6 and 8$\mu$. Such diminutive structures as, for example, the

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Fig. 5. Asexual reproductive structures of *Phytophthora megasperma*, drawn with camera lucida, $\times$500. A, B, C.—Fully grown primary sporagnia. D. E.—Sporangia immediately preceding dehiscence. F.—Empty envelope of sporangium shown in E. G, H, I, J, K, L, M.—Sporangia and supporting hyphae showing proliferation. O, P.—Evacuated sporangial envelopes within which are retained empty cyst walls with membranous parts of papillae of dehiscence, and in P, in addition, some encysted zoospores without evidence of repetitional development. Q.—Sporangium after frustrated dehiscence showing one zoospore cyst wall evacuated by means of a papilla of dehiscence, one discharged miniature sporangium on a germ sporangiophore perforating the wall of the primary sporangium, and 10 zoospores in various stages of repetitional development by production of miniature germ sporangia. R, *a-i*.—Zoospores after rounding up. S.—Two zoospores each giving rise to a germ sporangium, *a* showing beginning of development, *b* showing miniature sporangium delimited by basal septum. T, *a-f*.—Zoospores, each provided with a papilla of dehiscence. U, *a-h*.—Evacuated cyst membranes after escape of zoospores in second swimming stage. V, *a-c*.—Zoospores germinating by vegetative germ tubes. W.—A zoospore in motile stage.

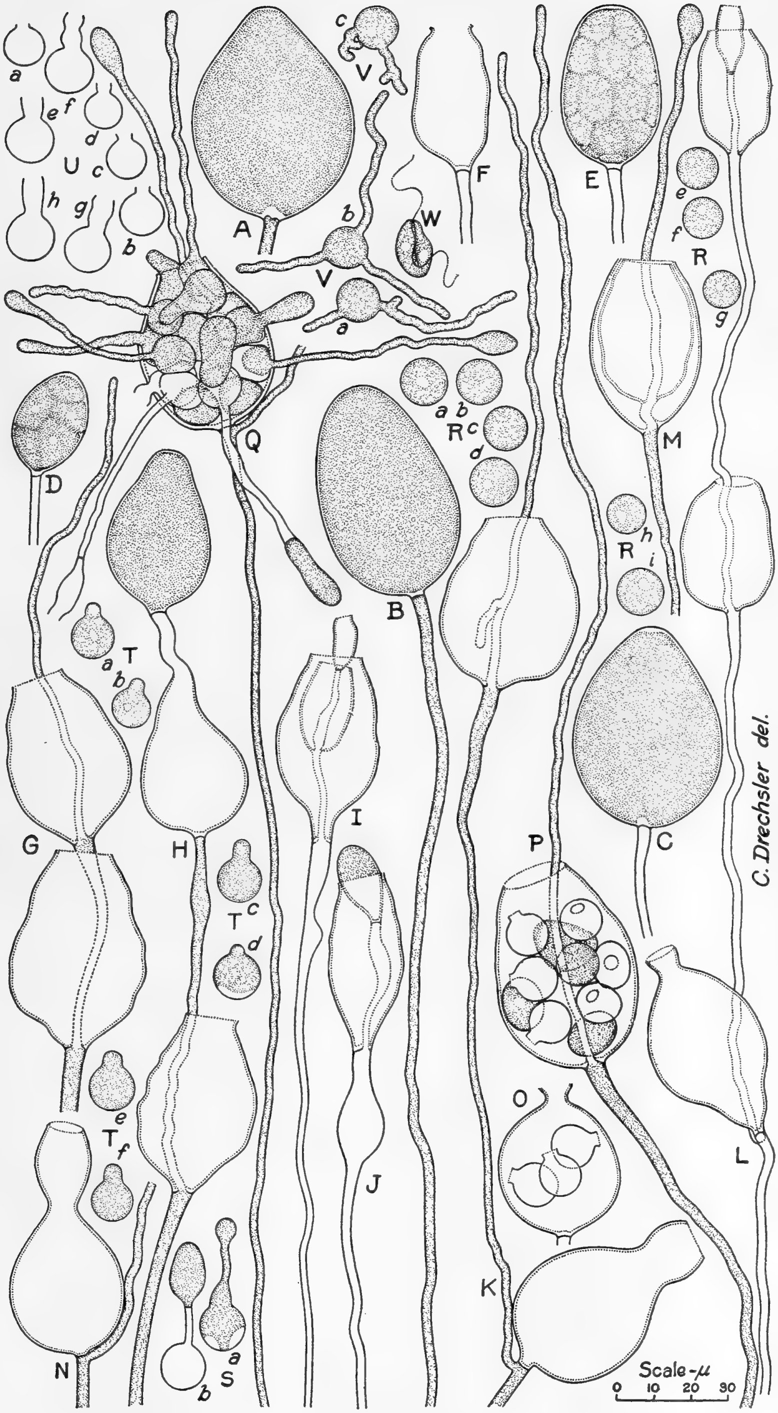


Fig. 5. *Phytophthora megasperma.* For explanation see page 522.

tertiary sporangium shown in Figure 5, I, give rise to only a single zoospore.

The zoospores are of the biciliate, longitudinally grooved, reniform type usual in the genus (fig. 5, W), which after a period of swarming round up (fig. 5, R, *a-i*). A second period of motility frequently ensues, this being accomplished through both of the courses of repetitional development set forth for a number of congeneric forms in an earlier paper (5). In most instances the encysted zoospore produces a wide papilla (fig. 5, T, *a-f*) which ultimately yields at the apex to liberate the full-fledged secondary swimming spore. Usually the cylindrical modification on the evacuated cyst wall is relatively short (fig. 5, U, *a-d*) but in some instances modifications of more considerable lengths (fig. 5, U, e-h) remain behind as evidence of exceptionally long papillae. This type of development prevails also among zoospores retained in relatively small number within sporangia (fig. 5, O, P) the dehiscence of which has been partially frustrated. In fewer instances a properly liberated zoospore gives rise to the second swimming stage by the production of a miniature sporangium on a delicate germ sporangiophore (fig. 5, S, *a*, *b*). Yet in cases where the dehiscence of the ordinary large sporangia has been frustrated more nearly completely, so that the imprisoned zoospores are packed rather closely within the containing envelopes, the escape of the protoplasts in this species as in congeneric forms is usually acomplished through the latter type of repetitional development (fig. 5, Q).

As far as the writer is aware the literature contains no record of any species of *Phytophthora* combining oogonia and oospores having dimensions approaching those characteristic of the hollyhock parasite with predominantly paragynous antheridia, proliferous, non-papillate sporangia and the absence of large globose "chlamydospores." The fungus under consideration is therefore described as a new species for which a specific term descriptive of the large oospore is deemed appropriate.

**Phytophthora megasperma** n. sp.

Mycelium intercellular in tissues of host; on artificial substratum of somewhat radiating aspect, composed of freely branching hyphae from 3 to 8$\mu$ in diameter; continuous in actively growing stage, later, on becoming evacuated, developing numerous, rather thick septa; producing aerial growth in small or moderate quantity; under aquatic conditions extramatrical growth meager.

Sporangium regularly formed terminally on a long, simple or sparingly branched, extramatrical filament measuring mostly $50\mu$ to 2 mm. in length and 2 to $2.5\mu$ in diameter, though often expanding in the distal portion to a diameter of 3 to $5\mu$; later often coming into a lateral position through continued elongation of the supporting filament from immediately below the delimiting septum; regularly ovoid, but occasionally bearing distally a protuberance or lobe of variable size; measuring 6 to $45\mu$ in transverse diameter by 15 to $60\mu$ in length; on dehiscence opening broadly at apex without formation of an outwardly protruding papilla; after evacuation proliferous in moderate measure, both by formation of sessile or nearly sessile secondary or often tertiary sporangia within primary one and by repeated growth of the supporting filament through the orifices of the empty envelope to produce additional sporangia externally. Zoospores produced from 1 to 45 in a sporangium; reniform, longitudinally grooved, biciliated, after rounding up measuring 10 to $13\mu$ in diameter; individually germinating by germ-tubes usually 1 to 3 in number, or often, whether properly liberated or retained within the sporangial envelope owing to frustrated dehiscence, often giving rise to a secondary zoospore,—the repetitional development taking place either by direct discharge of contents through an evacuation tube 3.5 to $5.5\mu$ in diameter and 1 to $10\mu$ in length, or by the production of an elongated miniature sporangium mostly 6 to $10\mu$ in diameter and 16 to $22\mu$ in length on a germ sporangiophore mostly $1.5\mu$ in diameter and 10 to $60\mu$ in length.

Oogonium borne terminally on a stalk usually 5 to $15\mu$ in length; smooth, subspherical, measuring 16 to $61\mu$, mostly 42 to $52\mu$ (average $47.4\mu$) in diameter; provided with a wall 0.5 to $1.7\mu$ (average $1.2\mu$) in thickness. Antheridium single; irregularly orbicular or prolate ellipsoidal, sometimes provided with a distal protuberance or lobe; measuring usually 10 to $18\mu$ in diameter by 14 to $20\mu$ in length; in some (1 to 35 out of 100) cases amphigynous, but more often paragynous, in latter event usually applied near base of oogonium and often in intimate contact with oogonial stalk; borne laterally or terminally or in intercalary relationship on a branch mostly 5 to $50\mu$ in length, the branch sometimes arising from a hypha not demonstrably connected with the oogonial hypha, but sometimes having close mycelial connection with the oogonium, the total length of filamentous parts between the septa delimiting the sex organs occasionally not exceeding $40\mu$. Oospore colorless or more often distinctly yellowish; smooth, subspherical, measuring 11 to $54\mu$, mostly 37 to $47\mu$ (average $41.4\mu$) in diameter; provided with a wall 0.8 to $4.6\mu$ (average $3.6\mu$) in thickness, and containing a reserve globule measuring at early maturity 6.5 to $24.0\mu$ (average $17.6\mu$) in diameter.

Causing a destructive decay of the stem and roots of *Althaea rosea* Cav. in Washington, D. C. and at Rosslyn, Va.

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# BOTANY.—*The Genus* Chikusichloa *of Japan and China.*[1] 

Y. L. Keng,[2] U. S. National Herbarium. (Communicated by A. S. Hitchcock.)

In 1925 *Chikusichloa* was described with a single species and was regarded as an endemic genus in Japan. This grass, however, was recently found in China and a second species as well. The new species is from the Kwangsi collection of Mr. R. C. Ching in 1928, the other from my Kiangsu (I-shing) collection in 1929.

Chikusichloa Koidz. Bot. Mag. Tokyo **39**: 23. 1925. A single species, *C. aquatica* Koidz., is described from Japan.

Spikelets perfect, 1-flowered, somewhat laterally compressed or subterete, the disarticulation a short distance below the lemma, the spikelets falling with a stipe attached; glumes wanting; lemma lanceolate, attenuate into a terminal awn or acuminate, membranaceous, strongly 5-7-nerved; palea a little shorter and thinner than the lemma, 2-3-nerved; styles distinct, the stigmas laterally exserted; stamen 1, the anther linear; lodicules 2, minute; grain hard, fusiform, the pericarp adnate to the mealy seed. Aquatic peren-

[1] Received November 13, 1931.

[2] Fellowship student of the Rockefeller Foundation, from the National Central University, Nanking, China.

nials with simple culms, narrow blades, and terminal panicles.—Species 2, one in Japan and Southeastern China, the other in Southwestern China.

A. Spikelets awned, the stipe 2-4 mm. long, usually longer than the branchlet below the joint....................................1. *C. aquatica.*
AA. Spikelets awnless, the stipe 1-2 mm. long, equaling or shorter than the branchlet below the joint...............................2. *C. mutica.*

This genus belongs to the tribe Oryzeae, but approaches the American genus *Zizaniopsis,* which is differentiated from Oryzeae by the unisexual spikelets. Though the spikelets in *Chikusichloa* are all alike, those in the upper part of the panicle are usually more fruitful than those in the lower. Moreover, there seems to be a tendency toward reduction in the size of the anthers in the spikelets of the lower part of the panicle, suggesting a trend toward two kinds of spikelets, one pistillate, the other perfect. The perfect stipitate spikelets recall those of *Hygroryza,* but in that the stamens are 6, and the plant is floating, with inflated sheaths, short broad blades, and small panicles. In the original description of *Chikusichloa* the stipe remaining attached to the lemma is considered to be the elongated lower joint of the rachilla. Since here, as well as in *Hygroryza,* the glumes are wanting, it is not certain whether the stipe is an elongated rachilla-joint or the summit of a pedicel which disarticulates some distance below the spikelet. Such pedicels are characteristic of *Thysanolaena* and *Polypogon,* and are found in some species of *Trisetum,* where the presence of glumes at the apex of the stipe shows conclusively that the stipe is part of the pedicel.

CHIKUSICHLOA AQUATICA Koidz. Bot. Mag. Tokyo **39:** 23. 1925

Culms tufted, erect, 0.8–1.5 meters tall, subcompressed, 3–5 mm. thick, 5-noded, the lower nodes remote, the upper ones approximate; sheaths loose, compressed-keeled, much longer than the internodes; blades 45–60 cm. long, 8–14 mm. wide, acuminate, flat or folded, deep green, rather flaccid; panicle lanceolate, erect, half to one third the length of the plant, the branches slender, ascending, up to one third the length of the panicle; spikelets dull green, 3–5 mm. long, terminating in a slender awn 3–6 mm. long, hispidulous along the nerves; stipe 2–4 mm. long, or rarely shorter, hispidulous; anther 1–1.5 mm. long; grain 2–2.5 mm. long, dark or brownish.—Shady sides of mountain streams, Japan and Southeastern China.

CHINA: Kiangsu, I-shing, *Keng* 2496.

One Japanese specimen, collected from Satsuma by Masamune in 1925, has been examined. It differs in having a stipe as much as 6 mm. long, but is similar otherwise to that of China.

**Chikusichloa mutica** Keng, sp. nov.

Culmi caespitosi, erect, circ. 75 cm. alti, 3 mm. crassi, subcompressi, glabri; vaginae laxae, compresso-carinatae, internodiis longiores; ligula firma, glabra, 3–5 mm. longa; laminae erectae, saepe conduplicatae et falcatae, 15–40 cm.


Fig. 1. *Chikusichloa aquatica* Koitz. For explanation see page 529.

longae, expansae 10–16 mm. latae, acuminatae, firmae, glaucae, costa media superne obscura, inferne prominente; panicula contracta, linearis, 20–30 cm. longa, ramis tenuibus, alternis, erectis vel appressis, usque 7 cm. longis; spiculae anguste lanceolatae, 4 mm. longae, acuminatae, muticae, lacteae, inter nervos validos hispidulos glabrae et interdum plicatae; stipes 1–2 mm. longus, hispidulus; stamen unum, anthera usque 2 mm. longa; styli distincti, stigmatibus multo breviores.

Culms tufted, erect, about 75 cm. tall, 3 mm. thick, subcompressed, glabrous; sheaths loose, compressed-keeled, the upper ones crowded on the approximate nodes; ligule firm, glabrous, 3–5 mm. long; blades erect, usually folded and falcate, 15–40 cm. long, 10–16 mm. wide, acuminate, firm, glaucous, the midrib obscure above, prominent beneath; panicle contracted, linear, 20–30 cm. long, the branches slender, appressed, up to 7 cm. long; spikelets narrowly lanceolate, 4 mm. long, acuminate, awnless, rarely mucronulate, creamy-white, glabrous and sometimes folded between the hispidulous strong nerves; stipe 1–2 mm. long, hispidulous, equaling or more frequently shorter than the glabrous branchlet below the joint; stamen 1, the anther up to 2 mm. long; styles distinct, much shorter than the stigmas.

Type in the Herbarium of the Metropolitan Museum of Natural History, Academia Sinica, Nanking, China, collected by the side of a stream in ravine, Seh Fing Dar Shan, Nanning, Kwangsi, altitude 600 meters, October 24, 1928, by *R. C. Ching* (no. 8200). Duplicate type in the U. S. National Herbarium (no. 1501590).

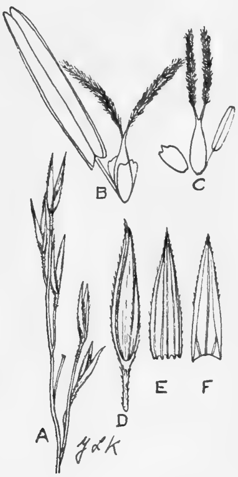


Fig. 2. *Chikusichloa mutica* Keng. A. Part of a panicle branch, ×2. B. Stamen, pistil, and lodicules, drawn from a spikelet on the upper part of the panicle, ×10. C. Same from a spikelet near the base of the panicle, ×10. D. Spikelet and its stipe, ×5. E-F. Lemma and palea, ×5.

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Fig. 1. *Chikusichloa aquatica* Koidz. A. Plant, ½ natural size. B-C. Fruitful spikelets and stipes, ×5. D. The articulation showing the branchlet persistent below the joint, ×5. E-F. Caryopsis and its section showing the pericarp adnate to the mealy seed, ×5. G. Young spikelet on the lower part of the panicle, with its lemma removed, ×10.

This species is closely related to *Chikusichloa aquatica*, from which it differs chiefly in the awnless cream-white spikelets, shorter stipes, linear panicles, and in the glaucous firm blades. The specimens seen consist of the upper part of the plant, about 60 cm. long, with 4 leaves crowded above and the lower internodes 7–11 cm. long.

MAMMALOGY.—*Six new white-footed mice* (Peromyscus maniculatus *group*), *from islands off the Pacific Coast.*[1] E. W. NELSON and E. A. GOLDMAN, U. S. Biological Survey.

In *Revision of the mice of the American genus Peromyscus* (North Amer. Fauna, No. 28, pp. 96–98, Apr. 17, 1909) Osgood referred specimens from the islands of San Miguel, San Nicolas, Santa Barbara, and Santa Rosa of the Santa Barbara group, off the coast of southern California, to *Peromyscus maniculatus clementis* which was originally described from San Clemente Island. Those from Santa Cruz Island were assigned to *P. m. catalinae,* of Santa Catalina Island. Specimens from Natividad Island and San Martin Island, off the coast of Lower California, were referred (l. c., p. 100) to *P. m. geronimensis,* typical on San Geronimo Island.

More than 20 years have passed since the fine monograph mentioned was published. In commenting upon material examined from the various islands the author pointed out in several instances characters which he regarded as too slight to afford a basis for satisfactory separation. Finer distinctions are being made by many workers at the present time, and it seems to us probable that if the same reviser were reviewing this part of his work his viewpoint would be somewhat altered. Some of the islands are separated by 50 miles or more of open sea, while others lie somewhat nearer together. San Miguel and Santa Rosa Islands, with a comparatively narrow passage between them, appear to be inhabited by the same form. Study of the fairly ample material available has shown that although the characters presented in varying combinations from island to island are relatively slight they are maintained with rather remarkable constancy. Such characters are, as in many other similar places, the expression of genetic factors resulting through isolation and response to environmental influences favoring their perpetuation. These insular forms, with ranges sharply

[1] Received November 19, 1931.

definable, are more readily and satisfactorily segregated than would be the case with many similarly differentiated mainland forms with ranges merging almost imperceptibly. We believe they should be recognized as interesting and tangible steps in the evolutionary process involved in the development of species.

New subspecies are described as follows:

### **Peromyscus maniculatus streatori** subsp. nov.

San Miguel Island Mouse

*Type.*—From San Miguel Island, off coast of southern California. No. 34631/46716, ♂ old adult, U. S. National Museum (Biological Survey collection), collected by C. P. Streator, June 24, 1892. Original number 1861.

*Distribution.*—San Miguel and Santa Rosa Islands.

*General characters.*—A dark subspecies, similar to *Peromyscus maniculatus clementis* of San Clemente Island, but darker and browner, less buffy; general size about the same but ears usually slightly smaller; skull more slender in structure. Closely resembling *P. m. catalinae* in color; general size similar, but tail longer; ears slightly smaller; cranial characters, especially the smaller braincase, distinctive.

*Color.*—*Type*: Upper parts in general near wood brown (Ridgway, 1912) with a dull cinnamon suffusion on cheeks, shoulders, and along sides, the top of head and back moderately mixed with black; underparts in general dull white; a small ochraceous buffy area at base of tail; forelimbs and hind feet white; ears dusky, indistinctly edged with white; tail bicolor, brownish above, white below.

*Skull.*—Similar to that of *P. m. clementis* but of slenderer proportions, the rostrum narrower, more attenuate; interorbital region narrower; interparietal smaller (shorter antero-posteriorly). Compared with that of *P. m. catalinae* the skull differs notably as follows: Braincase smaller, less inflated; interorbital region narrower; interparietal smaller (shorter antero-posteriorly).

*Measurements.*—*Type*: Total length, 170 mm.; tail vertebrae, 80; hind foot, 20. Average of 10 adult topotypes: 175 (160–185); 82 (77–86); 21 (21–22). *Skull* (type): Greatest length, 25.7; condylobasal length, 23.5; zygomatic breadth, 13.2; interorbital breadth, 4; interparietal, 9.1 × 2.1; length of nasals, 10.5; maxillary toothrow, 3.7.

*Remarks.*—*P. m. streatori* is one of the smaller forms of *P. maniculatus* inhabiting the Santa Barbara group of islands. It is larger and darker-colored and scarcely requires close comparison with *P. m. gambeli*, of the adjacent mainland. Specimens from Santa Rosa Island appear to be inseparable from those from San Miguel Island.

*Specimens examined.*—Total number, 38, as follows:

California: San Miguel Island (type locality), 25; Santa Rosa Island, 13.

**Peromyscus maniculatus santacruzae** subsp. nov.

Santa Cruz Island Mouse

*Type.*—From Santa Cruz Island, off coast of southern California. No. 47449, ♀ old adult, U. S. National Museum (Biological Survey collection), collected by C. P. Streator, July 13, 1892. Original number 1923.

*Distribution.*—Known only from Santa Cruz Island.

*General characters.*—A large dark subspecies, closely allied to its geographic neighbor *Peromyscus maniculatus streatori*, of San Miguel Island, but usually decidedly larger with very noticeably longer tail; color about the same. Similar to *P. m. catalinae*, of Santa Catalina Island, but tail longer, ears usually smaller, and cranial details distinctive. Differing from *P. m. clementis* as follows: General size larger, tail decidedly longer; color somewhat duller, more brownish, less suffused with buff; buffy lateral line less distinct.

*Color.*—*Type:* Upper parts near wood brown, suffused with cinnamon buff on cheeks, shoulders, flanks, and outer surfaces of limbs, the top of head and back moderately overlaid with brownish black; under parts dull white; ears dusky, indistinctly edged with white; tail bicolor, brownish above, whitish below.

*Skull.*—Closely resembling that of *P. m. streatori*, but larger and heavier; interparietal small as in *streatori*. Similar to that of *P. m. catalinae*, but braincase somewhat smaller, less fully inflated; interorbital region usually narrower; interparietal smaller (shorter antero-posteriorly). Compared with that of *P. m. clementis* the skull is similar in general form, but larger; interparietal smaller (shorter antero-posteriorly).

*Measurements.*—*Type*: Total length, 207; tail vertebrae, 99; hind foot, 22. Average of 10 adult topotypes: 194 (184–214); 96 (88–105); 22 (21–23). *Skull* (type): Greatest length, 27.7; condylobasal length, 25.7; zygomatic breadth, 14.4; interorbital breadth, 4.2; interparietal, 8.7 x 2.6; length of nasals, 11.2; maxillary toothrow, 3.9.

*Remarks.*—*P. m. santacruzae* is a large subspecies interposed in geographic range between the smaller form, *P. m. streatori* of San Miguel and Santa Rosa Islands and the still smaller mainland animal, *P. m. gambeli*. It differs conspicuously from the latter not only in larger size, but in darker color. The smaller ears of specimens from Santa Cruz Island, compared with typical *P. m. catalinae* was pointed out by Osgood (l. c. p. 98).

*Specimens examined.*—Twenty-five, all from Santa Cruz Island.

**Peromyscus maniculatus exterus** subsp. nov.

San Nicolas Island Mouse

*Type.*—From San Nicolas Island, off coast of southern California. No. 92098, ♀ old adult, U. S. National Museum (Biological Survey collection), collected by H. A. Gaylord, May 23, 1897.

*Distribution.*—Known only from San Nicolas Island.

*General characters.*—One of the smaller of the California insular races, very similar to *Peromyscus maniculatus streatori* of San Miguel Island, but ears larger; color paler, more cinnamon buffy, less brownish or dusky, especially on posterior part of dorsum. Similar to *P. m. clementis*, but lighter buff, and cranial details quite distinctive. Decidedly smaller in general than *P. m. santacruzae*, but with slightly larger ears; color brighter, more buffy, less brownish, the lateral line more distinct. Differing from *P. m. catalinae* in lighter, more buffy instead of brownish color, the lateral line more evident; skull exhibiting a departure in detail.

*Color.—Type:* Upper parts cinnamon buff, purest on cheeks, shoulders, lateral line and interfemoral area, the top of head and back moderately overlaid with brownish black; under parts white; ears dusky, faintly edged with white; outer sides of forearms cinnamon buffy; outer sides of ankles dark brownish; tail bicolor, brownish above, white below.

*Skull.*—Closely similar to that of *P. m. streatori*, but upper outline highest near anterior border of frontals (highest near posterior border in *streatori*); braincase slightly larger; interparietal short (antero-posteriorly) as in *streatori*. Compared with that of *P. m. clementis* the skull is slenderer, with narrower and slightly flatter frontal region; nasals narrower; outer wall of antorbital foramen narrower, as viewed from the side; interparietal smaller (shorter antero-posteriorly). In contrast with *P. m. catalinae* the braincase is smaller, less fully inflated; interorbital region narrower; interparietal smaller (shorter antero-posteriorly). Differing from that of *P. m. santacruzae* mainly in smaller size.

*Measurements.—Type:* Total length, 183; tail vertebrae, 88; hind foot (dry skin), 20. Average of 10 adult topotypes: 177 (171–187); 82 (76–88); 20 (19.5–21). *Skull* (type): Greatest length, 25.7; condylobasal length, 23.5; zygomatic breadth, 23; interorbital breadth, 4; interparietal, 8.2 x 1.9; length of nasals, 10.3; maxillary toothrow, 3.8.

*Remarks.—P. m. exterus* inhabits the outermost of the Santa Barbara group of islands. Cranial characters indicate closer relationship to *P. m. streatori* of the islands of San Miguel and Santa Rosa to the northwest than to *P. m. clementis* of San Clemente Island, nearly equidistant to the southeast. In paler, more buffy coloration, however, it tends toward *clementis* which in turn is paler as compared with *P. m. catalinae.* The somewhat lighter coloration of the mice on these farther off shore islands suggests the presence of some differential influence. Many animals from within the fog belt along the Pacific coast are well known to exhibit dark colors. Possibly fog is less prevalent on San Nicolas and San Clemente, which are 50 miles or more off shore, than on the other islands all of which are considerably nearer the coast.

*Specimens examined.*—Twenty-four, all from San Nicolas Island.

### **Peromyscus maniculatus elusus** subsp. nov.

Santa Barbara Island Mouse

*Type.*—From Santa Barbara Island, off coast of southern California. No. 92049, ♂ adult, U. S. National Museum (Biological Survey collection), collected by H. A. Gaylord, May 16, 1897. X catalogue number 1095.

*Distribution.*—Known only from Santa Barbara Island.

*General characters.*—A dull brownish subspecies similar to *Peromyscus maniculatus clementis* but upper parts darker, the general tone brownish instead of buffy; skull differing in detail. Approaching *P. m. catalinae* in color, but ears smaller, and cranial characters distinctive. Closely resembling *P. m. santacruzae*; color about the same; size smaller; tail decidedly shorter; skull slightly different. Similar to *P. m. exterus* of San Nicolas Island, but darker, duller, more brownish in color; ears slightly smaller; skull diverging in minor features.

*Color.—Type:* Upper parts in general near wood brown, moderately mixed with black on top of head and over back; lateral line pinkish buff, but rather indistinct; under parts dull white; ears dusky, faintly edged with white; outer sides of forearms and hind legs buffy brownish; tail bicolor, brownish black above, white below.

*Skull.*—Very similar to that of *P. m. clementis*, but interparietal smaller (shorter antero-posteriorly); frontal region slightly flatter, with a less distinct longitudinal median groove or trough. Compared with *P. m. catalinae* the braincase is smaller, flatter, less inflated, and the interparietal is smaller. Slightly broader and heavier than *P. m. streatori* or *P. r. exterus*; rostrum and interorbital region broader; parietal with antero-external angle forming a less acute point. Differing from *P. m santacruzae* mainly in smaller size and slightly rounded, instead of acutely pointed, antero-external angle of parietal.

*Measurements.*—*Type:* Total length, 166; tail vertebrate, 70; hind foot (dry skin), 20. Average of six adult topotypes: 174 (165–190); 75 (67–88); 20 (20–21). *Skull* (type): Greatest length, 26; condylobasal length, 23.3; zygomatic breadth, 12.6; interorbital breadth, 4.3; interparietal, 9.3 x 2; length of nasals, 10.3; maxillary toothrow, 3.8.

*Remarks.*—Specimens from Santa Barbara Island have hitherto been referred to *P. m. clementis* which was originally described from San Clemente Island. A difference in color, however, while not striking is quite appreciable, especially when the series from the two islands are placed side by side; and the slight cranial characters are distinctive. In color *P. m. elusus* more nearly resembles *P. m. santacruzae*, and the skulls are not widely different, but it averages decidedly smaller, and the slightly rounded, instead of acutely pointed, antero-external angle of the parietal is quite constant.

*Specimens examined.*—Twenty, all from Santa Barbara Island.

### **Peromyscus maniculatus martinensis** subsp. nov.

San Martin Island Mouse

*Type.*—From San Martin Island, off west coast of Lower California, Mexico. No. 138979, ♀ adult, U. S. National Museum (Biological Survey collection), collected by Nelson and Goldman, August 13, 1905. Original number 17726.

*Distribution.*—Known only from San Martin Island.

*General characters.*—A large medium-colored (neither very light nor very dark) insular subspecies, distinguished from its near relatives by a combination of slight but fairly constant cranial details. Very similar to *Peromyscus maniculatus geronimensis* of San Geronimo Island; size and color about the same, but differing especially in the broader, less tapering rostrum and more projecting supraoccipital region. Decidedly paler than *P. m. dubius*, of Todos Santos Island, and skull differing in minor features. Paler than *P. m. gambeli* and darker than *P. m. coolidgei*, and larger, more robust, than either of these mainland forms.

*Color.*—*Type:* Upper parts cinnamon buff, purest on cheeks, shoulders, and distinct lateral line, moderately mixed with black on top of head and over back; under parts in general dull white, the basal color plumbeous except on throat and lips where the short hairs are white to roots; a small buffy area at base of tail; fore limbs whitish; outer sides of hind legs dull buffy, becoming whitish on feet; ears brownish dusky, narrowly and inconspicuously edged with white; tail brownish above, white below. Some of the topotypes are lighter and others darker above than the type.

*Skull.*—Very similar in size and general form to that of *P. m. geronimensis*, but frontal region slightly more arched, less flattened anteriorly; rostrum usually broader, nasals broader, less tapering anteriorly; supraoccipital with a more prominent posteriorly projecting median angle, this portion of the cranium extending farther over the foramen magnum beyond the plane of the condyles; palatal pits larger. Not very unlike that of *P. m. dubius*, but interparietal smaller; nasals usually narrower.

*Measurements.—Type:* Total length, 184; tail vertebrae, 82; hind foot, 23. Average of three adult topotypes: 182 (178–185); 81 (75–87); 22.5 (22–23). *Skull* (type): Greatest length, 27; condylobasal length, 26.3; zygomatic breadth, 12.8; interorbital breadth, 4.2; interparietal, 9.8 x 2.3; length of nasals, 10.3; maxillary toothrow, 4.

*Remarks.*—In size and external appearance *P. m. martinensis* closely approaches *P. m. geronimensis* to which the specimens upon which it is based were referred by Osgood (l. c., p. 100). The greater average width of the nasals, as compared with typical *geronimensis* was pointed out by him, and this together with the other differential cranial features mentioned here are regarded by us as sufficiently distinctive to warrant a separate name.

*Specimens examined.*—Fifty, all from San Martin Island.

## **Peromyscus maniculatus dorsalis** subsp. nov.

Natividad Island Mouse

*Type.*—From Natividad Island, off west coast of Lower California, Mexico. No. 80857, ♀ adult, U. S. National Museum (Biological Survey collection), collected by A. W. Anthony, August 4, 1896. Original number 96.

*Distribution.*—Known only from Natividad Island.

*General characters.*—A large subspecies similar to *Peromyscus maniculatus geronimensis*, of San Geronimo Island, but less buffy, the face usually paler and the posterior part of back and rump in contrast more heavily overlaid with black; minor cranial features distinctive. Differing from *P. m. cineritius*, of San Roque Island, in darker color.

*Color.—Type:* Head and anterior part of back grayish or light buffy brownish in contrast with posterior part of back and rump which is pinkish buff heavily overlaid with black; flanks buffy brownish; under parts dull white; fore limbs whitish; outer sides of hind legs buffy brownish becoming white on feet; ears dusky externally, thinly clothed internally and narrowly edged with white; tail bicolor, brownish above, white below.

*Skull.*—Size and general form about as in *P. m. geronimensis*, but nasals usually broader, less tapering anteriorly; outer wall of antorbital foramen broader, the anterior margin more rounded and projecting (more squarely truncate in *geronimensis*) as viewed from the side. Compared with that of *P. m. coolidgei* of the adjacent mainland the skull is larger, more robust, and differs in detail about as from *geronimensis*.

*Measurements.—Type:* Total length, 177; tail vertebrae, 73; hind foot (dry skin), 22.5. Average of three adult topotypes: 176 (174–183); 79 (75–83); 23 (22.5–23.5). *Skull* (type): Greatest length, 26.1; condylobasal length, 3.3; zygomatic breadth, 23.5; interorbital breadth, 24.2; interparietal, 9.3 x 2.8; length of nasals, 9.8; maxillary toothrow, 4.

*Remarks.*—*P. m. dorsalis* lacks the richer cinnamon buffy tones of *P. m. geronimensis.* The head and anterior part of the back are paler and grayer while the posterior part of the back and rump, suffused with lighter buff, becomes rather abruptly more heavily overlaid with black. No specimens of *P. m. cineritius*, of San Roque Island, are at hand for direct comparison, but that animal is described as pale grayish drab and apparently quite unlike the present form. *P. m. dorsalis* requires no close comparison with the smaller, paler subspecies, *P. m. coolidgei*, of the adjacent mainland.

*Specimens examined.*—Twenty-one, all from Natividad Island.

ZOOLOGY.—Neotylenchus abulbosus *n. g., n. sp.* (*Tylenchidae, Nematoda*) *the causal agent of a new nematosis of various crop plants.*[1] G. STEINER, Bureau of Plant Industry.

During the last two years the nemic plant parasite, *Neotylenchus abulbosus* n. g., n. sp., has been observed in strawberry plants affected by so-called "yellows" or "xanthosis," received from Mr. Harold E. Thomas of California; in strawberry plants from Wisconsin and from Germany; in potatoes in ships' stores from England, Holland, Norway, and New Brunswick, Canada; and in carrots from England and Sweden. The form at first sight resembles *Tylenchus dipsaci*, and it is probable that it has sometimes been mistaken for it. The present paper gives the result of a single experiment, and a summary of observations, and morphological and taxonomic data concerning the new genus and species.

In strawberry plants this nema occurs in the bud,—between the folded leaves and stems,—and also in the developed stems and leaves, and is undoubtedly an endoparasite. In the above mentioned California plants, the nemas were extremely numerous in brownish, blackish or yellowish spots of the leaves. We have not yet been able experimentally to produce such spots, but the single negative experiment is not conclusive.

The Wisconsin strawberry plants, were somewhat dwarfed and looked abnormal, without exhibiting very special symptoms; they contained this nema only in small numbers. A lot of strawberry plants imported from Germany seemed to be 100% infested; they had, however been packed close together in transit. The few old leaves present exhibited brown spots or decayed parts. Young tender leaves had developed, though they were not completely unfolded. Nemas were found in their tissues, and in the bud between developing leaves. Some of the leaf stems seemed to be slightly swollen, apparently because of the infestation. It is therefore impossible at the present time to describe satisfactorily clear-cut symptoms of this nemic disease on the strawberry plant.

The carrots seen exhibited sunken areas, which, however, were filled with decay; no green parts have been available for study. The potato tubers also were too decayed when received to allow specific symptoms to be recognized, though the appearances seem much like those pro-

[1] Received November 20, 1931.

duced by *Tylenchus dipsaci*. Certain areas were sunken and the tuber tissues exhibited a mealy appearance.

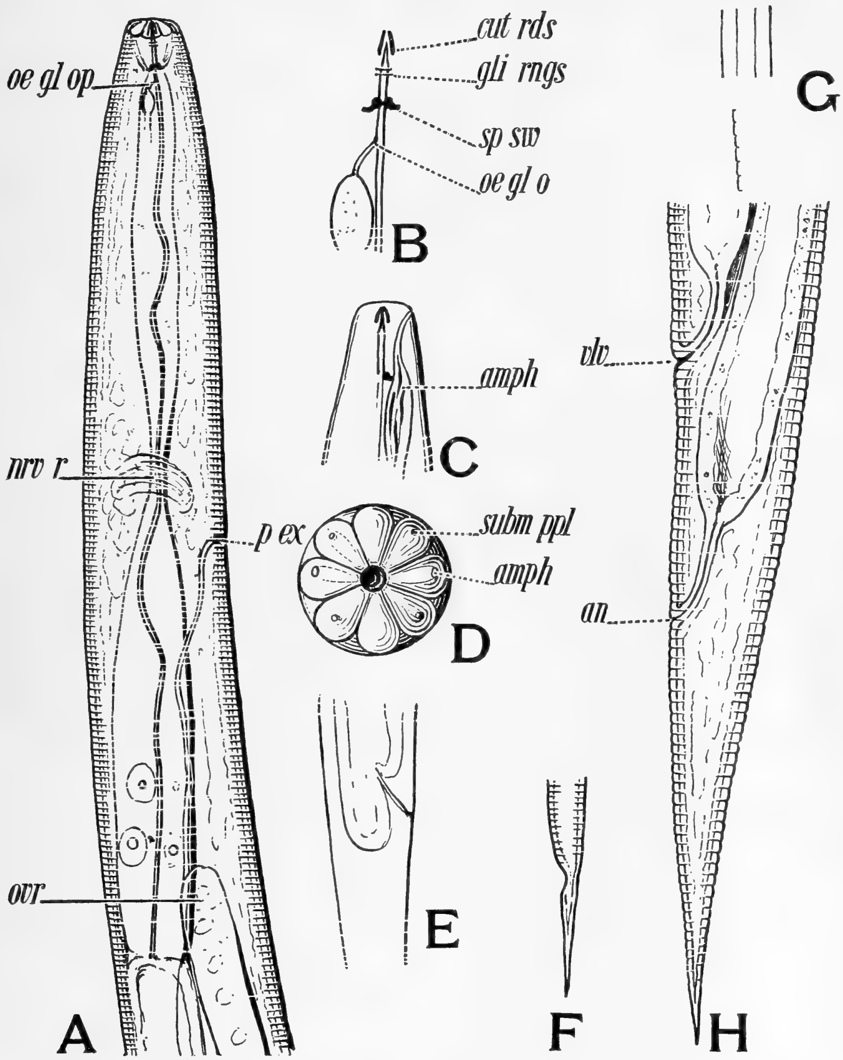


Fig. 1. *A*. Sketch of the anterior end; *B*, of the spear; *C*, amphid; *D*, head on end; *E*, anal region of a specimen with caecal extension of the intestine; *F*, tail end; *G*, lateral wings showing nature of crenation; *H*, posterior end. All ×530 except "D" which is ×1075. The abbreviations are mostly self explanatory; *oe gl op*, opening of dorsal oesophageal gland; *cut rds*, cuticular rods of the framework in the lip region; *gli rngs*, gliding rings of the spear; *sp sw*, swellings at base of the spear.

It is considered probable that this nema has a wide geographical distribution; but it appears at present to be a temperate zone species.

## **Neotylenchus** n. g.

*Diagnosis.* Genus very similar to Tylenchus, but differing in the complete absence of a median oseophageal bulb, the oesophagus having a pronounced central constriction encircled by the nerve-ring, the anterior portion being somewhat spindle-shaped, the posterior one somewhat sugarloaf-shaped. Head, seen from in front, divided into eight sectors (instead of six as in *Tylenchus, Paraphelenchus, Aphelenchus, Pathoaphelenchus,* etc.,)—a dorsal, a ventral, two lateral and four submedial. Male unknown. Type species:

## **Neotylenchus abulbosus** n. sp.

Fig. 1

*Diagnosis.* Neotylenchus with the characters of the genus; swellings or knots at the base of the spear with short, outward-pointing, curved processes.

*Further notes on the species.* The female is very similar to that of *Tylenchus dipsaci.* It is, however, noticeably thicker (compare formula below). The cuticle is annulated. The lateral wings are four in number, crenate in harmony with the cuticular annulation and arranged as shown in fig. 1G. The head end is not set off, as it is in *Tylenchus dipsaci,* and is more obtuse and broader; the tail is similar, sharply pointed, the terminus varying somewhat (figs. 1F and H). In spite of the presence of eight sectors on the front of the head, there seem to be only four submedial papillae. Fig. 1C shows a sketch of the profile view of an amphid. The spear is not strong, and is rather short; its basal swellings or knots are very characteristic, each having a small, outward-pointing, curved process for the attachment of protrudor muscles (Fig. 1B). In the lip region proper the spear is surrounded by short, longitudinal, cuticularized rods forming a kind of guiding frame. The species is easiest determined by the basal swellings of the spear. As in the true *Tylenchus* species, there is a dorsal outlet of the oesophageal glands into the oesophageal canal just back of the spear. It seems that the oesophageal cells lie within the oesophageal tissus, the posterior portion of the oesophagus being quite swollen. The oesophageal canal seems to be continuous, without any valvulae. No cardia was seen. The posterior end of the intestine sometimes forms a short blind sac, extending a little behind the anal opening (fig. 1E). The excretory pore is just behind the nerve-ring. A long canal leads inward and backward, the renette cell apparently being quite a distance behind the beginning of the intestine. *Neotylenchus abulbosus* is prodelphic, the ovary extending sometimes as far forward as the excretory pore. *Neotylenchus abulbosus* is apparently a syngonic species.

*Measurements*: Average of three females that showed very slight variations.

$$\frac{1.4}{2.0}\quad\frac{9.3}{3.7}\quad\frac{18.}{4.1}\quad\frac{\overset{67.}{-85.}}{3.7}\quad\frac{90.5}{3.0}\quad 0.76\text{ mm.}$$

# MALACOLOGY.—*A new volutid marine mollusk,* Aurinia schmitti.[1]

PAUL BARTSCH, U. S. National Museum.

Dr. Waldo L. Schmitt, Curator of our Marine Invertebrates, while collecting Crustacea in 1930 under the auspices of the Carnegie Institution at the Marine Biological Station, Tortugas, Florida, made a number of hauls with a 30-foot otter trawl south of Tortugas. In one of these hauls in 80 fms. he secured two specimens of an *Aurinia*, which differ from any heretofore secured; these are here described.

**Aurinia schmitti,** n. sp.

Fig. 1.

Shell large, spindle-shaped, exterior covered by an olivaceous periostracum which dehisced upon drying. When the periostracum is removed the general color of the shell is pinkish chalky with the exception of the nucleus, which is pale buff. There are also rows of chestnut-brown spots, which are arranged in spiral series. Two of these occur between the summit and the suture of the turns. The last whorl shows five of these interrupted bands; the first much less developed than the rest, being at some little distance anterior to the summit of the whorl; the next and fifth band are of about equal width, while the third and fourth are fully twice as wide as the second and fifth. The base of the columella is also brown. The front of the shell from the inner columellar edge to the left side of the shell and the same area of the proceeding whorl, are covered with a soiled, smoky gray, somewhat nacreous callus. Inside of outer lip salmon-colored, showing the two heavy interrupted bands, and the rest by transmitted light. The nucleus consists of about one turn, which forms a smooth mammilated apex. Postnuclear whorls appressed at the summit, marked by obsolete, rather broad, irregular, axial ribs, which are absent on the first and last turns. They show best on the second and third. The entire postnuclear part of the shell is marked by rather strong incremental lines, particularly so behind the edge of the outer lip. The spiral sculpture consists of numerous fine raised threads, which are of almost equal strength and spacing on the early whorls, but become less so on the later whorls; on the last they are a little stronger on the basal half than on the posterior portion thereof. Aperture elongate-oval, strongly channelled anteriorly and feebly so at the posterior angle; outer lip thin at the edge, somewhat sigmoid, being protracted in the middle, columella with two strong oblique folds.

*Type.*—The type, U.S. N. M. No. 382779, has five postnuclear whorls, and measures: Height, 115 mm.; greater diameter, 35 mm.; length of aperture, 78 mm.

The present species resembles *Aurinia robusta* Dall in the shouldering of the last turn at the posterior angle of the aperture, which is even more strongly emphasized here. The spotting, too, is obscure as in that species. It also resembles it in the callus formation of the front of the last turn. In general shape, excepting the posterior angle of the aperture, it resembles *Aurinia*

[1] Published by permission of the Secretary of the Smithsonian Institution. Received November 10, 1931.

*dubia* Broderip more closely than *Aurinia robusta* Dall, but it is at once distinguished from it by the absence of the polished surface and brilliant spotting.

Figure 1. *Aurinia schmitti* Bartsch.

# INDEX TO VOLUME 21

An * denotes the abstract of a paper before the ACADEMY or an affiliated society

## PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES



## AUTHOR INDEX

# SUBJECT INDEX

# OFFICIAL COMMUNICATIONS

## THE WASHINGTON ACADEMY OF SCIENCES AND AFFILIATED SOCIETIES

### Announcements of Meetings

| | |
|---|---|
| Wednesday, December 23 | The Medical Society |
| Saturday, December 26 | The Biological Society |
| Wednesday, December 30 | The Medical Society |
| Friday, January 1 | 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.**

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## CONTENTS

### ORIGINAL PAPERS



### INDEX TO VOL. 21



This JOURNAL is indexed in the International Index to Periodicals.