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# JOURNAL

## OF THE

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No. 1

BOTANY.—*Ceroxylon ferrugineum* André, the Salento waxpalm.<sup>1</sup> MIRIAM L. BOMHARD, U. S. Forest Service.

The waxpalms (*Ceroxylon*)<sup>2</sup> grow in the Andean region of northwestern South America from Caracas in Venezuela to southern Peru, or possibly into Bolivia. In some areas waxpalms occur in such numbers that they dominate the landscape, forming forests of ivory columns, known as "palmares." These palms are extremely beautiful—the graceful pinnate leaves crown a usually tall, slender trunk, which is covered with wax. The resinous wax can be scraped from the trunk and fashioned into candles and matches. The leaves are used for thatch and the trunks for construction. The outer wood is very hard.

The genus is justly celebrated. Certain of the species are unique among living palms—they are the tallest, grow at the highest altitudes, and endure the coldest temperatures of any palms in the world.<sup>3</sup> The most renowned waxpalms, which were first made known by Alexander von Humboldt, are those of the Quindío region in the Central Cordillera of Colombia. *C. quindiuense* (Karst.) Wendl. (= *Klopstockia quindiuensis* Karst.) is the very tall (60 meters, or about 200 feet) species that grows on the eastern slope at elevations from 2,000 to 3,000 meters (nearly 10,000 feet) and endures temperatures just above freezing. The very different species on the western slope has apparently been without a botanical designation; a valid name for it, published with a brief description in 1879,

has escaped the attention of botanists. It is the purpose of this paper to bring to light that the name *C. ferrugineum* André<sup>4</sup> applies unmistakably to this species and can refer to no other palm.

Although *Ceroxylon* was established in 1807,<sup>5</sup> founded upon a single species, *C. andicola* Humb. and Bonpl., the genus is even now not well understood botanically. It is stated that Humboldt found this palm in the most elevated part of the Andes (the Quindío region), which separates the valley of the Magdalena River from that of the Cauca; more specifically, "It is found between the snow-capped summits of Tolima, San Juan, and Quindío . . . between 1750 and 2825 meters." This is a roughly triangular area on the eastern slope of the Quindío Pass and must be considered as the type locality of *C. andicola*. The *Ceroxylon* described in such glowing terms by Humboldt himself in his *Vues des Cordillères*<sup>6</sup> is probably not the one figured in connection with the formal description of the species by Bonpland in 1807. In fact, Bonpland states on page 4 of *Plantes Equinoxiales* that "Humboldt drew this plant on the spot; but the size of the drawing being smaller than that of the fascicles which we are going to publish under the name of *Plantes equinoxiales*, we have been obliged to make a larger drawing from it: it is this which I present here. It was made by Monsieur Turpin, who combines the eminent knowledge of a botanist with the talent of a skillful artist." The species is

<sup>1</sup> Received October 9, 1942.

<sup>2</sup> The genera *Klopstockia* Karsten and *Beethovenia* Engel are at present referred to *Ceroxylon* Humb. & Bonpl.

<sup>3</sup> BOMHARD, MIRIAM L. *The waxpalms*. Smithsonian Inst. Ann. Rept. 1936: 303-324, 4 pls., 2 figs. 1937. Spanish translation: *Las palmeras de cera*. Bol. Soc. Geograf. Colombia 6(4): 250-273, 3 pls. 1940.

<sup>4</sup> ANDRÉ ÉDOUARD. *L'Amérique équinoxiale (Colombie-Équateur-Pérou)*. Le Tour du Monde 37(945): 101. Feb., 1879.

<sup>5</sup> HUMBOLDT, A., and BONPLAND, A. *Plantes équinoxiales* 1: 1-6, pls. 1a, 1b. Paris, 1807.

<sup>6</sup> HUMBOLDT, A. *Vues des Cordillères*, pp. 13-19, pl. 5. Paris, 1810.

characterized by a single spathe and violet-colored fruits; the inner perianth (corolla) consists of three separate petals. The habit figure shows a bulge in the trunk.

No palm answering to the description and illustration of the type species has ever again been encountered. It is true that vast regions where the genus abounds still remain to be explored. Although *C. andicola* has not yet been rediscovered in Colombia, the figure and description may one day prove to belong to a waxpalm of Ecuador, where species with a bulged trunk do exist.<sup>7</sup> As early as 1856,<sup>8</sup> Hermann Karsten, who described a new waxpalm genus, *Klopstockia*,<sup>9</sup> stated that he had been unsuccessful in locating Humboldt's *C. andicola* on the eastern side of the Quindío, nor had he seen any waxpalms that agreed with the description of the genus. In 1858,<sup>10</sup> therefore, he published *K. quindiuensis* (transferred to *Ceroxylon* by Wendland) for the waxpalms he found "in the Quindío at the foot of Tolima, altitude from 2200 to 2280 meters." All the palms he saw had tall straight trunks (not ventricose), there were several spathes as in other members of *Klopstockia*, the fruits were coral-red, and the corolla was partly united below.

Humboldt appears to have been somewhat in error concerning the altitudinal limits for palms on the eastern slope. It is known that he crossed the Quindío divide and was then forced to camp for several days because of rains, but there is no indication that he noted the different character of the waxpalms surrounding him then on the western slope.

In March, 1876, however, Édouard André, traversing the Quindío trail from east to

<sup>7</sup> *C. ventricosum* Burret is bulged and has grouped leaf segments. *C. utile* (Karst.) Wendl. was described by Karsten as having aggregate leaf segments but he made no mention of a ventricose trunk. It is of interest that Richard Spruce listed a palm in Ecuador as being *C. andicola* (*Notes of a botanist on the Amazon and Andes . . . during the years 1849-1864*, vol. 2: 268, 1908).

<sup>8</sup> KARSTEN, HERMANN. *Plantae Columbianae*. *Linnaea* 28: 251-255. 1856.

<sup>9</sup> KARSTEN, HERMANN. *Die Vegetationsorgane der Palmen*. *Phys. Abh. Königl. Akad. Wiss.* Berlin, 1847: 73-235, pls. 1, 2. 1849. Also KARSTEN, *Linnaea*, 1856: 251.

<sup>10</sup> KARSTEN, HERMANN. *Florae Columbiae* 1: 1-2, pl. 1. Berlin, 1858.

west, that is, from Ibagué to Cartago, and following the exact route that Humboldt took in October, 1801, at once observed that a different species occurred on the western side. André headed a scientific expedition (mission) to Colombia, Ecuador, and Peru, having sailed from St. Nazaire on November 7, 1875. He returned to Europe at the end of September, 1876. His official report<sup>11</sup> enumerates his extensive collections of herbarium specimens, seeds, living plants, insects, minerals, and other specimens of scientific interest. His travel and exploration account was published in a series of articles, *L'Amérique équinoxiale*, which appeared intermittently in *Le Tour du Monde*, from 1877 to 1880. This weekly journal is well printed and excellently illustrated. It was devoted to accounts of travel and exploration.

The name *Ceroxylon ferrugineum* was first published by André, with a brief description (amounting to a contrast of this palm with that on the eastern slope which he continues to refer to *C. andicola*), in *Le Tour du Monde*, vol. 37, no. 945, p. 101, 1879. It might be well to quote at some length from page 101. André states:

On the faith of Humboldt and other voyagers, I indicated in a study of *Ceroxylon andicola*\* that the altitude where they grow is between 1750 and 2825 meters. I am today correcting these figures from my own observations. On the eastern slope of the Quindío, I have not encountered this tree before 2,000 meters altitude and I have followed it up to 3,000 meters. The most abundant "palmares" are situated in the vicinity of Las Cruces between the elevations of Toché and La Céja. In going towards Ibagué, one encounters the palm until near Mediacion. The zone where it abounds only extends 15 to 20 kilometers, as a bird flies, north and south from the mesa of Herveo to the massif of the Quindío. . . . I have vainly searched the oak forests (*Quercus Humboldtii*) which the celebrated German traveler said accompanied the wax palm. The oaks, which scarcely go beyond 1800 meters and which I had already noted . . . belong to a

\* See *Illustration horticole*, 1874, p. 9, with figure.

<sup>11</sup> ANDRÉ ÉDOUARD, in *Archives Missions Scientifiques* 5 (sér. 3): 49-83. 1879. On p. 55 André reports that he sent specimens of the Quindío waxpalms to Paris; also that many points concerning Humboldt's *C. andicola* remain obscure and that he hopes he will be able to clarify them.

temperate, not a cold, country. These reasons make me believe that Humboldt has confused the true *Ceroxylon andicola*, that of Las Cruces, with another species, smaller, as yet little known (*C. ferrugineum*). It is characterized especially by the rough surface of its berries, and it abounds in the Andes, principally on the west of the Central Cordilleras and almost into the Republic of Ecuador.

After crossing the crest (3,485 meters), André observed that the vegetation was at first quite similar to the unimpressive high-altitude flora of the opposite side. Continuing his descent toward Salento and the Cauca valley, he remarks, on page 106: "But as soon as the barometer indicated 2800 meters altitude and large trees dominated, then giant oaks appeared, this time intermingled with the other species of wax palm of which I spoke previously, *Ceroxylon ferrugineum*." He states further, on page 108, that the waxpalms disappeared along his route on the western slope at 1,800 meters.

Baron von Thielmann, in *Vier Wege durch Amerika* (1879), says on page 374 that he arrived at the lower limit of the waxpalm at 1,750 meters, near the Río Quindío (western slope). His footnote to this remark is worth quoting:

According to the statements of the latest plant explorer in this region, Ed. André, these wax palms at the western base of the Quindío were not identical with those of the eastern slope, but belonged to the related species, *Ceroxylon ferrugineum*. The wax palm of Humboldt in the narrow sense, *Ceroxylon andicola*, inhabits according to André only the eastern slope of the Cordillera between 2,000 and 3,000 meters.

Interestingly enough, the name *Ceroxylon ferrugineum* has appeared in botanical literature but not ascribed to André. This may be due to the fact that André's name was published in a journal devoted to travel. Indeed, this name has been variously listed as being of horticultural origin,<sup>12</sup> or credited

<sup>12</sup> KERCHOVE (DE DENTERGHEM), OSWALD. *Les palmiers*. Paris, 1878. On p. 238 of the *Index Général*, *Ceroxylon ferrugineum* (sic) Hort., is listed as an invalid name, being in boldface type which he uses to indicate invalid species. The origin of *C. ferrugineum* as a horticultural name, and this appears to be the earliest printing of it, can only be surmised. André was himself especially interested in ornamentals. He returned from South America in 1876 and had sent large quanti-

ties to Regel,<sup>13</sup> to Wallis,<sup>14</sup> or to Linden.<sup>15</sup> The entry as a valid name given in *Index Kewensis* is as follows: "ferrugineum, Regel, *Gartenfl.* (1879) 163. t. 977.—N. Granat."

In this brief article (June, 1879) Regel makes known three palms that were collected by G. Wallis somewhere in tropical America. Regel states that the name *Ceroxylon ferrugineum* seems to have been given only provisionally by Wallis to this palm. There is no description. Figure 3 of plate 977 consists of three elements: a habit sketch of some feather-leaved palm (there are no spathes, nor is it discernible whether the pendant inflorescences are in fruit or in flower), a fruit with burst pericarp, and a seed showing the micropyle. The fruit and seed may possibly belong to some *Ceroxylon*; the habit sketch is unidentifiable. Dr. Max Burret<sup>16</sup> is eminently correct in consigning this name to "nomina delenda"; that is, insofar as Regel's *Gartenflora* is concerned. But this is not the first date of

ties of palm and other seeds, living plants, etc., to J. Linden's horticultural establishment in Ghent, as mentioned on p. 70 in his official report (*Archives Missions Scientifiques*, 1879). There was ample time for the name to be known among horticulturists between André's return and his publication of it. If it did not originate with him—and this seems unlikely—at least he is the first to have given characters to the different palm on the western slope of the Quindío.

Dr. Burret also cites the name as a horticultural one. See footnote 16 as well as footnote 14 (Dahlgren's *Index of American palms*).

<sup>13</sup> REGEL, EDUARD. *Gartenflora* 28: 163–164, pl. 977, fig. 3. June, 1879.

<sup>14</sup> REGEL, EDUARD. *Op. cit.* 389. In the index the name appears as follows: "Ceroxylum (sic) ferrugineum Wallis 163." See also DAHLGREN, B. E., *Index of American palms*. Bot. Ser. Field Mus. Nat. Hist. 14: 86. 1936. The entry on this page as an invalid name is "ferrugineum Hort. Wallis, Regel *Gartenfl.* . . . nomen . . ."

<sup>15</sup> LINDEN, J. *Plantes introduits et mises pour la première fois dans le commerce par l'établissement J. Linden*. Illus. Hort. 28 (sér. 4, no. 1): 15–16. 1881. It has previously been mentioned that André sent some of his South American material to J. Linden for introduction. The entry on p. 16 of Linden's palm list reads, under *Ceroxylon*: "ferrugineum, Lind., Colombie."

<sup>16</sup> BURRET, M. *Die Gattung Ceroxylon Humb. et Bonpl. Notizbl. Bot. Gart. u. Mus. Berlin-Dahlem* 10 (98): 853. 1929. The name is listed under the heading "Species nimis imperfecte notae vel nomina delenda" as follows: "*Ceroxylon ferrugineum* Hort. in Regel *Gartenflora* XXVIII (1879) 163, tab. 977, fig. 3." He suggests that the species be looked upon as a "Species delenda."

publication of *C. ferrugineum*. Inasmuch as vol. 37 (the first semester of 1879) of *Le Tour du Monde* begins with no. 939, there seems to be little question that no. 945 appeared in the third week of February, 1879. (The even earlier horticultural nomen in Kerchove may be disregarded. See footnote 12.)

André collected herbarium specimens of 4,300 species, with one to ten duplicates for each number.<sup>17</sup> His herbarium collection numbers reached 3,175 by the time he arrived at Pasto (this includes his trip over the Quindío). Two waxpalm specimens collected by André (nos. 2426 and 2563) are deposited in the herbarium of the New York Botanical Garden. The labels bear the designation, "*Mission scientifique de Ed. ANDRÉ. HERBARIUM AMERICAE AEQUINOCTIALIS.*" Specimen no. 2426 was collected on March 9, 1876, between Las Cruces and Quindío, that is, on the eastern slope. It consists of portions of two glabrous spadices, one with some male flowers. The date of collection for specimen no. 2563 is March, 1876; the locality, "Quindío-Salento-Tambores." Tambores does not appear on recent maps of the area, but it is clearly indicated on André's map no. 5 (his route from Quindío to Cartago, thence south to Buga) about two-thirds of the distance from Salento toward Cartago.<sup>18</sup> This specimen consists of the upper portion of a fruiting spadix to which, unfortunately, no fruits are attached. The axis and branches are clothed with a rusty-brown scurf—the obvious ferruginous character on which André based his very appropriate name, *ferrugineum*.<sup>19</sup> Fig. 1, *F*, shows a small branch of André's specimen.

<sup>17</sup> ANDRÉ ÉDOUARD, in *Archives Missions Scientifiques*, 1879, p. 69.

<sup>18</sup> ANDRÉ, ÉDOUARD. *Le Tour du Monde* 37: (945): 99. 1879.

<sup>19</sup> Examination of this and later collections of *C. ferrugineum* shows that this covering is rather remarkable in character. Although the spadix appears at first glance to be clothed with rusty tomentum, it is clear under a lens that there are no trichomes. The scurf that clings to the surface appears to have been developed from numerous papillae or crater-like projections which occur on the basic surface of the spadix axis. The scurf is not easily rubbed off with the fingers. It ignites quickly when touched off with a match and the odor emanating from it in burning is similar to that when the wax on the trunk is ignited.

It is likely that fruits accompany other specimens of *André 2563*. André mentions, on page 100 of vol. 37 (*Le Tour du Monde*), in connection with the felling of a tree of "*C. andicola*" (east slope of the Quindío), that the thousands of berries, some leaves, spathes, and trunk sections that he sent to Europe had become the property of the Muséum d'Histoire Naturelle in Paris. It is reasonable to suppose that adequate material of *C. ferrugineum* was also collected by him.

He specifically stated, however, that the fruits were characterized by their roughness, thus differing from those of the species on the eastern slope. Specimens of this smaller palm from the western slope of the Quindío, collected by E. P. Killip, of the Smithsonian Institution, and Dr. T. E. Hazen, of Columbia University, in 1922, have berries whose surface is roughened by small pustules.<sup>20</sup> There are two sheets in the U. S. National Herbarium of *Killip 9049*, collected July 25–31, 1922, near Salento in the Department of Caldas, between 1,700 and 1,900 meters altitude. One consists of an upper section of a leaf; the other, of a portion of fruiting spadix, with the fruits in an attached pocket. A photograph of the palm is also affixed to the sheet. A single sheet of *Killip 9049* in the New York Botanical Garden consists of a similar leaf portion, section of spadix, and pocket of fruits. Two mounts comprise the U. S. National Herbarium specimen of *Hazen 10149*, collected August 25–28, 1922, in the Quindío valley, toward Río Boquío, between 1,600 and 1,700 meters. Part of a leaf is mounted on one sheet; a spadix section with several fruits attached and a pocket of fruits make up the other. The spadices of these specimens, with rather stout zigzag branches, are unmistakably ferruginous; the surface of the spherical fruits, buff-colored when dry is definitely pustulate or "pebbly." These specimens were collected in the same region as André no. 2563 and are undoubtedly *C. ferrugineum*.<sup>21</sup>

<sup>20</sup> BOMHARD, MIRIAM L. *Op. cit.*: 315.

<sup>21</sup> On the eastern slope of the Quindío, *Killip & Hazen 9525* was collected on August 2, 1922, between La Céja and Agua Bonita, at 2,500 to 3,100 meters altitude. This specimen consists of only a portion of a leaf; a photograph is also

The most recent, and at the same time the most complete, collection of the Salento waxpalm that I have seen was made by Dr. David Fairchild, July 11, 1941, on the extensive ranch of Dr. J. F. Galloway, at 1,828 meters. The ranch, on which there are hundreds of waxpalms, is situated on the Quindío River above Salento. *Killip 9049* was also collected on the Galloway place. Dr. Fairchild not only collected seeds for plant introduction but also made a special effort to secure herbarium material (*Fairchild 1023*). I have been privileged to examine parts of a leaf, an entire fruiting inflorescence with spathes, fruits, seeds, and sections of the trunk. In a letter to Dr. Walter T. Swingle, Dr. Fairchild wrote from Bogotá, July 14, 1941: "They are magnificent palms in a setting so beautiful that you want to stay there forever . . . I saw no palm that I thought was quite 200 feet. One that had fallen Dr. Galloway stepped off and it was only 43 paces long. It was a smallish example, I think. Dr. Galloway promised to measure one accurately and let me know. I shall be surprised if any go over 200 feet and most of them I wager will measure under that. This fact does not detract from their amazing beauty and the marvelous character of this organism, which can stand up perfectly

affixed. It is probably, from the locality at least, *C. quindiuense*. It is unfortunate that there are no fruits. The segments of this part of the leaf (probably taken from below the middle) are about 68 cm long and 4 cm wide. They are whitish-scaly on the under surface; the rachis is also whitish-scaly below and on the sides as well. The leaf is apparently much more robust than in *C. ferrugineum*.

Mr. Killip collected *Ceroxyton* specimens on March 27 and 28, 1939, along the new Quindío highway, between Cajamarca and the summit of the Divide (eastern slope), at 2,438 meters. The highway more or less parallels the old Quindío trail, which has now fallen into disuse, but runs 7 to 10 miles south of it. His specimen no. 34540 consists of part of a spadix, which appears to be glabrous but is actually faintly scurfy (puberulous where the scurf seems to have rubbed off), and fruits, which are deposited in the separate fruit collection of the U. S. National Herbarium. They were a reddish color when fresh but are gray when dry; superficially, they are quite smooth. It is almost surely *C. quindiuense*, or very closely related to that species. The seeds are black as in *C. quindiuense*. One of these fruits and a cross-section of the seed are shown in Fig. 1, A and B, for comparison with *C. ferrugineum*.

straight in the winds of some considerable violence—60 km per hour would be a maximum I think—that blow down the pass."

A complete description of the Salento waxpalm can not form a part of this paper. Knowledge of the flowers is lacking, but arrangements made with Dr. Galloway should soon provide flowering material. Certain measurements are also lacking. There is need of an adequate description of the living trees.<sup>22</sup> A very general account of *Fairchild 1023*, which is not offered as a technical description, is given below.<sup>23</sup>

<sup>22</sup> To be fully understood botanically, palms are best studied by investigators who have frequent and ready access to them in their native habitat. Fortunately, Dr. Armando Dugand, director of the Instituto de Ciencias Naturales of the Universidad Nacional de Colombia, with headquarters at Bogotá, has become interested in palms. Among several papers already published toward a comprehensive survey of the Colombian species, a preliminary list, *Palmas de Colombia*, appeared in *Caldasia* 1: 10–84, 1940. For *Ceroxyton*, see pp. 37–39 of this article.

<sup>23</sup> The following account is being given to serve as a partial record of *Fairchild 1023* (*C. ferrugineum*), since it seems worth while to set down any data that may add to the knowledge of a species. This specimen was collected close to the type locality of André. The trunk is at least 40, and not more than 60 meters tall. It measures about 30 cm in diameter toward the base, tapering gradually to 15 cm or less near the summit. The leafscars, which are waxy, do not completely encircle the trunk (see pl. 2, Smithsonian Inst. Ann. Rept. 1937). Five turns bring the ninth scar directly above the first. The vascular elements stand out on a section as stiff black bundles.

The reduplicate segments, with strong midrib, of the large pinnate leaves are placed uniseriately, without a pulvinus, at rather regular intervals on either side of the rachis. The segments toward the apex of the leaf, closely spaced, are nearly opposite, whereas those near the middle, at 2–2.5 cm intervals, are subopposite or alternate. (The lowest section of the "blade" of material I have examined apparently comes from a smaller leaf than the rest of the material. However, in it the 5 or 6 lowest segments are shorter, narrower, and grouped closely together at the base of the "blade.") The longest segments of the sections I have seen measure 75 cm; these are widest (about 3.5 cm) some distance above their point of insertion, tapering toward the apex, which is cleft. The relatively soft, lax segments are glabrous and green above; whitish-scaly beneath. The slender rachis is also glabrous (perhaps somewhat resinous) above; the lower face is similar to the under surface of the leaves in its whitish- or grayish-scaly indument; the sides are glabrous. A portion of the leaf, taken from the section where the segments are longest, shows the rachis, which is 2 cm wide at this point, to advantage. There is a shallow groove on the upper face; the lower is rounded-convex. A cross-section of the rachis is

It seems evident from his treatment of *Ceroxylon*<sup>24</sup> that the eminent palm specialist Dr. Max Burret is, unfortunately, aware neither of André's publication of *C. ferrugineum*, inasmuch as he gives only the Regel citation, nor of his herbarium speci-

rectangular or, better, vertebra-shaped, rather than triangular as in so many pinnate palm leaves. The sides of the rachis slant downwards at only a slight angle from the upper to the lower face. The margins of the upper and lower faces are somewhat extended in phlange-like fashion (probably slightly emphasized in the dry material); the insertion of the segments, therefore, appears to be partially concealed in the shallowly U-shaped sides of the rachis.

The paniculately branched fruiting spadix is about 24 dm long including the peduncle, which measures 15 dm. It is covered with ferruginous scurf throughout. The axis of the spadix is about 2.5 cm across at its base. There are about 75 primary branches including the smallest ones at the apex. These branches are comparatively stout; strongly thickened where they arise from the main axis. The longest, 20 cm above the base, measures 60 cm. The secondary branches have the zigzag, tendril-like appearance of other *Ceroxylon* specimens I have seen, but the undulations seem to be more angular. The short thick pedicels of the fruits are set at the undulation angles. (The flowers are, of course, solitary.) Fig. 1, *F*, showing a branch of André 2563, should make this clear.

I hesitate to describe the spathes, which, although still attached to the fruiting peduncle in this specimen, are already somewhat lax and spent owing to age, and furthermore, are so fragile that they shatter rather easily. Moreover, the character of the spathes can best be seen when a palm is in flower. The measurements here given are only approximate and provisional. Dr. Fairchild specifically mentioned that there were three spathes, covered with grayish pubescence. However, I find remnants of a fourth partial spathe or bract, which opens from the main axis 30 cm below the body of the spadix. Assuming that the peduncle of this specimen, which, like the spathes, is covered with rufous almost velvety scurf, was severed fairly close to the trunk, then the first spathe (15 dm long) comes from near the base; the second (about 18 dm in length) arises about 5 cm above the first; and the third (about 19 dm long) comes off 15 cm above the second, is 8 or 9 cm wide, and strongly folded near the tip.

According to Dr. Fairchild the fruits were "deep orange color" when fresh. They fade to a buff yellow on drying. These are 16 mm in diam. and 17 mm in height (Fig. 1, *C*). The position of the three stigma remains may be noted to one side of the base of the fruit, where the perianth persists. The outer, rather thin-leathery exocarp is rather friable; mucilaginous when placed in water. The papery, gray endocarp adheres lightly to the seed. The seeds (there is one in each fruit) average 12-12.5 mm in diameter and 13 mm or slightly more in height. They are chestnut-brown

mens. It may be assumed that he believes *C. andicola* occupies the Quindío region from Ibagué all the way to Cartago. Furthermore, apparently owing to the fact that a *Ceroxylon* specimen collected by August Fendler, in Venezuela but with no other data,<sup>25</sup> came to his attention, Dr. Burret has added the ferruginous character to the spadices of *C. andicola*.<sup>26</sup> He has published the

and have a roughish surface. The point of attachment is knoblike and the micropyle is prominent just to the side of the knob. The albumen is equable and the embryo subbasilar (Fig. 1, *D* and *E*).

<sup>24</sup> BURRET, M. Notizblatt 10(98), 1929. See the key, pp. 841-842; the discussion of *C. andicola*, pp. 842-844, and *C. quindiuense*, pp. 845-846, in which it is stated that *C. quindiuense* has been mainly mistaken for *C. andicola*.

<sup>25</sup> Thus far I have examined two *Ceroxylon* specimens bearing the label "PLANTAE VENEZUELANAE. Prope coloniam Tovar legit A. Fendler." That in the New York Botanical Garden is dated 1854-55; the other, in the herbarium of the Academy of Natural Sciences of Philadelphia, is dated 1856-57. There are no additional data. Three other specimens in the Gray Herbarium, all dated 1854-55, are undoubtedly of the same collection as that in New York. Although it is true that the spadices of all are ferruginous and the fruits rough, the latter are mainly twinned, smaller than those of *C. ferrugineum*, and the surface is much more uneven—verruucose with crater-like projections. Moreover, the sides of the rachis—and therefore the appearance of the insertion of the leaf segments—is quite unlike that of specimens of *C. ferrugineum*. From all accounts, it seems practically certain that Fendler did not travel in Colombia. Dr. H. W. Rickett, bibliographer of the New York Botanical Garden, wrote me in a letter of April 26, 1941, that Fendler took up residence in Colonia Tovar, a small colony 35 miles west of Caracas, Venezuela, in 1853. Except for the winter of 1855-56 spent in the United States, he seems to have been in the general region of Colonia Tovar, collecting many plant specimens, until 1858. No doubt, there are *Ceroxylon* species with ferruginous spadices and rough fruits which await investigation in parts of South America other than the western slope of the Quindío.

<sup>26</sup> BURRET, M. *Palmae neogaeae*. Notizbl. Bot. Gart. u. Mus. Berlin-Dahlem 11(105): 319-320. 1932. In this later note concerning *Ceroxylon andicola*, Dr. Burret refers to his treatment of the genus in Notizblatt, 1929, and again mentions the Fendler specimen. He states that in the light of specimens Killip 9049, Hazen 10149, and Killip & Hazen 9525, which were sent him for determination, he is puzzled, especially since no. 9525, collected at the higher altitude, appears to be *C. quindiuense*, whereas those of the lower altitude seem to him to be *C. andicola*. He has determined no. 9525 as *C. quindiuense* with a question and adds that it is perhaps *C. andicola*. He determined the other two as *C. andicola*.

Dr. Burret himself previously pointed out

name *C. furfuraceum* with Latin description for the Fendler specimen but has placed it under his discussion of *C. andicola*. I can find no indication in Bonpland's description

(1929) that *Triana 720*, with its male flowers, is doubtless *Klostockia quindiuensis*. The Triana material is thought to have been collected with Karsten, who later described *K. quindiuensis*. I have examined *Triana 720* and *723*, collected between 1851-57. A section of leaf and a spadix branch (no. 720 has two branches mounted) make up these specimens. The male spadices are apparently glabrous (actually somewhat puberulous under a lens) and glaucous or waxy. The flowers agree perfectly with Karsten's fig. 4, plate 1, *Florae Columbiae*; the spadix also shows tertiary branching. Moreover, the male spadices of the Triana specimens are strikingly similar to the male spadix of *André 2426*, collected on the eastern slope, except that the latter, although glaucous, is not puberulous. Dr. Burret further states

or figures that the spadices of this species are other than glabrous, nor is there any statement in the comparatively detailed description of the fruits that the surface is verrucose.

that it is impossible to imagine that male and female plants of the same species would differ in the very striking indument of the spadices. I might add that *Ceroxylon* is described by Bonpland as polygamo-monoecious, whereas Karsten's *Klostockia* is dioecious, polygamo-dioecious, or monoecious.

It would be enlightening to know the character of the specimen in the Humboldt herbarium in Paris purported to be the type of *C. andicola*, but without exact locality. Although a clear photograph of it is in the U. S. National Herbarium, Mr. Killip's negative no. 365, the branches of the spadix section are so dense that I am unable to glean much concerning its character.

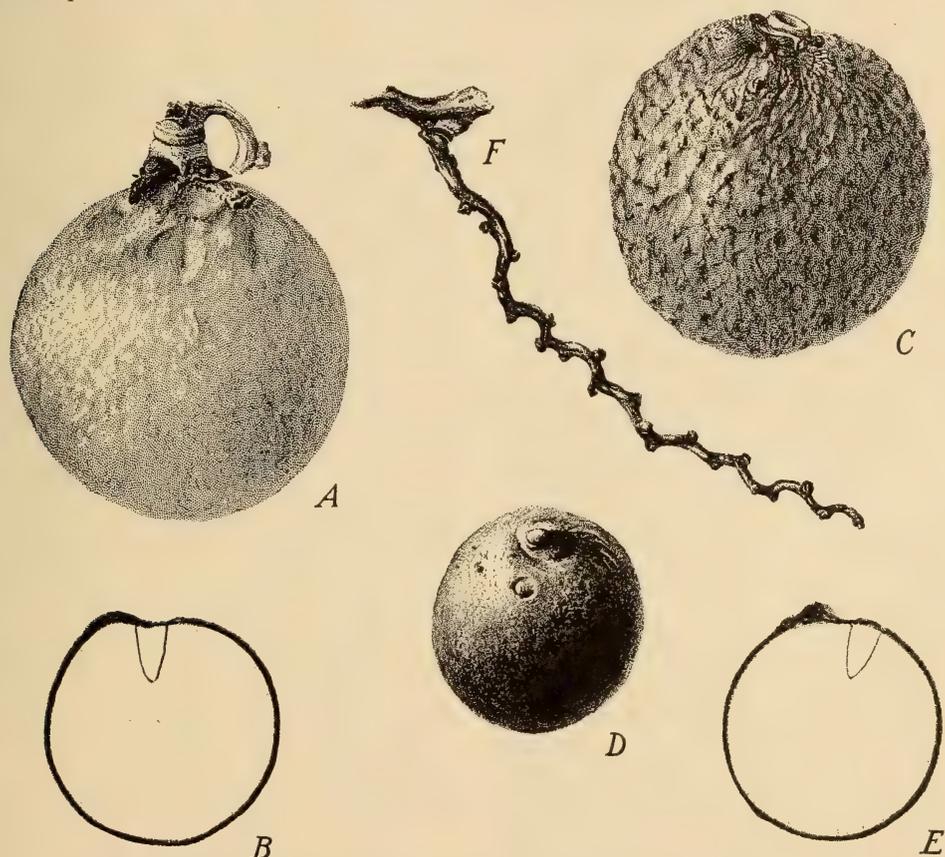


Fig. 1.—A, Glabrous fruit of Killip 34540, *Ceroxylon quindiuense* or near this species; collected on the new Quindío highway between Cajamarca and the summit of the Divide, at 2,438 meters. The position of the three persistent stigmas to one side of the base of the fruit is indicated. B, Longitudinal section of seed showing position of the embryo. C, Pustulate fruit of *C. ferrugineum*, Killip 9049. D, Outer view of a seed, showing the position of the micropyle in relation to the hilum. *C. ferrugineum*, Fairchild 1023. E, Longitudinal section of seed D, with position of embryo indicated. F, Branchlet of ferruginous spadix, André 2563. Drawn by Leta Hughey. (All  $\times 2\frac{1}{2}$  except F, which is natural size.)

Dr. Burret does cite André in *L'Illustration Horticole*, 1878, as to his observations concerning Humboldt's altitudinal data. This excerpt from the *Le Tour du Monde* articles, although quoted, is not quite identical with the statements that appeared in that journal in February, 1879, inasmuch as André withholds the name of the species on the western slope of the Quindío. This portion of the excerpt reads, "another species, smaller, as yet little known, of which I shall speak later."<sup>27</sup> Dr. Burret also cites Baron von Thielmann's *Vier Wege durch Amerika*, but appears to have overlooked André's name, mentioned in a footnote.

<sup>27</sup> ANDRÉ, ÉDOUARD. *Les palmiers de Cerroxylon andicola en Colombie*. *Illust. Hort.* 25: 176. 1878.

Recognition of André's publication establishes the botanical identity of the distinct species of waxpalm that occurs on the western slope of the Quindío, in the region of the town of Salento and of the rivers Boqufo and Quindío. The full extent of its range is unknown. The elevations at which it grows may be placed, from available data, at 1,600 to 2,800 meters. The material thus far collected in the Salento area is quite uniform in character. André's brief description,<sup>28</sup> substantiated by his own and later collections, appears to be sufficiently adequate to validate the name *Cerroxylon ferrugineum* André.

<sup>28</sup> The description seems to meet the requirements of articles 36 and 37 of the International Rules.

BOTANY.—*New names in Quercus and Osmanthus*.<sup>1</sup> ELBERT L. LITTLE, JR., U. S. Forest Service. (Communicated by WILLIAM A. DAYTON.)

New names for four natural hybrids in *Quercus* and validation of a combination in *Osmanthus* are needed for the revision of the *Check list of the forest trees of the United States*, now nearing completion. The four names in use in *Quercus* all must be rejected as later homonyms under Articles 60 (3) and 61 of the International Rules of Botanical Nomenclature (Ed. 3. 1935). As no other names are available, new epithets are desired under Article 69. Two of the names were used earlier for fossils, which are not included in indexes of living plants. However, the rules of botanical nomenclature apply to recent and fossil plants alike (Article 9).

Though it may be questioned whether it is useful or necessary to give hybrids binominal names like species, as permitted by Article 31, this established custom is followed here for uniformity. In genera of many species that cross readily, the number of natural and artificial hybrids may exceed the total number of species. For example, the number of named natural hybrids of *Quercus* in the United States, already more than 70 and still growing, is greater than the number of native arborescent species of the genus. Experimental evidence of the

origin and parentage has been presented for very few of these supposed oak hybrids. Muller (*Amer. Midland Nat.* 27: 478. 1942) has recently suggested that some so-called hybrids of *Quercus* may be only miscellaneous variations unworthy of names.

- × *Quercus asheana* Little, nom. nov. ASHE OAK
- Quercus cinerea* Michx. × *Quercus laevis* Walt.
- Quercus cinerea* × *catesbaei* Ashe, *Journ. Elisha Mitchell Sci. Soc.* 11: 88. 1894; *Small, Bull. Torrey Bot. Club* 22: 76, pls. 234, 235. 1895.
- Quercus brevifolia* × *catesbaei* Sudw., U. S. Dept. Agr. Div. Forestry Bull. 14: 170. 1897.
- × *Quercus ashei* Trel. (*Q. catesbaei* × *cinerea*), *Proc. Amer. Phil. Soc.* 56: 48. 1917; *nomen nudum*. Sarg., *Man. Trees North Amer.* ed. 2, 254. 1922; *nomen nudum*.
- × *Quercus ashei* Trel., *Mem. Nat. Acad. Sci.* 20: 13, 156, 200. 1924. Non *Quercus ashei* Sterrett, *Journ. Elisha Mitchell Sci. Soc.* 37: 178. 1922.

A new name is needed for the hybrid between *Quercus cinerea* Michx. (*Hist. Chênes Amér.* no. 8, pl. 14. 1801) and *Quercus laevis* Walt. (*Fl. Carol.* 234. 1788; *Q. catesbaei* Michx.) because × *Quercus ashei* Trel. is a later homonym

<sup>1</sup> Received October 17, 1942.

dating from 1924 instead of 1917 (Article 45).  $\times$ *Quercus ashei* Trel. (Proc. Amer. Phil. Soc. 56: 48. 1917) founded only upon "*(Q. catesbaei*  $\times$  *cinerea*)," without description or citation of a previous one, must be rejected as a *nomen nudum*, because under Article 31 the name of a hybrid is subject to the same rules as names of species. Mention of the two supposed parent species without description would not be valid publication of a hybrid binomial under Articles 37 and 44.

Before the name  $\times$ *Quercus ashei* Trel. was properly published in 1924 by reference to Ashe's early description, *Quercus ashei* Sterrett had been validly published in 1922 for another oak. *Quercus ashei* Sterrett was renamed *Quercus similis* Ashe (Journ. Elisha Mitchell Sci. Soc. 40: 43. 1924), which is to be rejected under Article 60 (1) as superfluous, and was also reduced to a synonym of *Quercus stellata* f. *páludosa* Trel. (Mem. Nat. Acad. Sci. 20: 104, 105. 1924). Thus, *Quercus ashei* Sterrett is a synonym, and *Quercus ashei* Trel. is a later homonym. The new epithet for the hybrid, the range of which is recorded as Georgia, also honors the discoverer of this oak, the late William Willard Ashe.

$\times$ *Quercus burnetensis* Little, nom. nov.

BURNET OAK

*Quercus macrocarpa* Michx.  $\times$  *Quercus virginiana* Mill.

$\times$ *Quercus coloradensis* Ashe, Bull. Torrey Bot. Club 49: 268. 1922.

Non *Quercus coloradensis* Lesq., Mus. Comp. Zool. Bull. 16: 46. 1888 (fossil, Eocene, Colorado).

The later homonym  $\times$ *Quercus coloradensis* Ashe, named for a river in Texas, is a hybrid between *Quercus macrocarpa* Michx. (Hist. Chênes Amér. no. 2, pl. 2, 3. 1801) and *Quercus virginiana* Mill. (Gard. Dict. Ed. 8, *Quercus* no. 16. 1768). This hybrid was discovered by Ashe along the Colorado River above Marble Falls in Burnet County, Tex., from which county the new name is taken.

*Quercus coloradensis* Lesq. is a fossil species from the Tertiary (Eocene epoch, Denver formation) at Golden, Colo. It was described by Lesquereux from two specimens collected in 1883, but Knowlton (U. S. Geol. Surv. Prof. Paper no. 155: 54. 1930) later could locate only one specimen, which was so fragmentary that

it was not worth figuring. Trelease (Mem. Nat. Acad. Sci. 20: 27. 1924) cited *Quercus coloradensis* Lesq. among the fossil oaks of America but did not mention  $\times$ *Quercus coloradensis* Ashe, which was published just two years before Trelease's monograph. Camus (Les Chênes 2: 754. 1939) noted that Ashe's hybrid was a later homonym but did not rename it.

$\times$ *Quercus cravenensis* Little, nom. nov.

CAROLINA OAK

*Quercus cinerea* Michx.  $\times$  *Quercus marilandica* Muenchh.

$\times$ *Quercus carolinensis* Trel. (*Q. cinerea*  $\times$  *marilandica*), Proc. Amer. Phil. Soc. 56: 48. 1917; *nomen nudum*. Sarg., Man. Trees North Amer., ed. 2, 266. 1922; *nomen nudum*.

$\times$ *Quercus carolinensis* Trel., Mem. Nat. Acad. Sci. 20: 14. 1924. Non *Quercus carolinensis* Muenchh., Hausvater 5: 254. 1770. Non *Quercus caroliniensis* Young [Young, William, Jr.], Cat. Arbr. Arb. Pl. Herb. Amer. 53. 1783; *nomen subnudum*.

*Quercus cinerea*  $\times$  *nigra* Ashe, Journ. Elisha Mitchell Sci. Soc. 11: 91. 1894.

The hybrid between *Quercus cinerea* Michx. (Hist. Chênes Amér. no. 8, pl. 14. 1801) and *Quercus marilandica* Muenchh. (Hausvater 5: 253. 1770) should be given a new name, as  $\times$ *Quercus carolinensis* Trel. is a later homonym.  $\times$ *Quercus carolinensis* Trel. was published in 1917 as a *nomen nudum* based merely upon "*(Q. cinerea*  $\times$  *marilandica*)" and without description. In 1924 it was validly published by reference to Ashe's earlier description of *Quercus cinerea*  $\times$  *nigra*. The new name  $\times$ *Quercus cravenensis* is based upon the same description by Ashe (Journ. Elisha Mitchell Sci. Soc. 11: 91. 1894), though the parent species formerly known as *Quercus nigra* now bears the name *Quercus marilandica*. The hybrid has been recorded from Craven County, N. C., from which the new epithet was taken, and from Georgia and Texas.

Strangely,  $\times$ *Quercus carolinensis* Muenchh., which was not included in the *Index Kewensis*, has not been mentioned by recent authors, though it was validated as a binomial in the same rare work with three other pre-Linnaean species. These three important species of eastern United States are *Quercus marilandica* and

*Q. palustris*, published by Muenchhausen on the preceding page, and *Q. coccinea*, published after *Q. carolinensis* on the same page.

As the identity of *Quercus carolinensis* Muenchh. is not clear, it seems best to pass over it as a *nomen dubium* (Article 63). No useful purpose would be served by adopting it and adding to the confusion among the old names of the genus already replacing other names and used with different meanings. *Quercus carolinensis* Muenchh. was based entirely upon *Quercus Caroliniensis*, *virentibus venis muricata* of Catesby (Nat. Hist. Car. Fla. Bahama Is. 1: 21, pl. 21, fig. 1. 1731), who in turn compared it with a slightly different, earlier species, *Quercus Virginiana rubris venis, muricata* of Plukenet (Alm. Bot. 309. 1696; Phytogr. pl. 54, fig. 5. 1691). Linnaeus (Sp. Pl. 996. 1753) cited, as synonyms of his variety *Quercus rubra*  $\beta$ , both Catesby's and Plukenet's species, but Muenchhausen without explanation asserted that *Q. carolinensis* was different from *Quercus rubra*. It was suggested by Valekenier Suringar (Rijks Herbarium Leiden Meded. 56: 11. 1928) that probably Linnaeus had not seen Catesby's and Plukenet's plants but referred to their drawings instead. Linnaeus's variety  $\beta$  was designated later as *Quercus rubra subserrata* Lam. (Encycl. Méth. Bot. 1: 720. 1785), with Catesby's and Plukenet's names as synonyms. Sargent (Rhodora 17: 38. 1915; 18: 46. 1916) interpreted Catesby's figure of a single leaf and an acorn to represent the northern red oak. When he proposed that *Quercus rubra* L. be rejected as a *nomen ambiguum*, Rehder (Journ. Arnold Arb. 19: 283-284. 1938) indicated also that Catesby's name apparently was referable to the northern red oak. Svenson (Rhodora 41: 522. 1939), in advocating the name *Quercus rubra* L. (emend. Du Roi) for the northern red oak, mentioned "the very crude figure by Catesby." Though *Quercus carolinensis* Muenchh. possibly might be interpreted as an available name for the northern red oak, it is hoped that this name of uncertain identification will not be adopted for any species.

*Quercus caroliniensis* Young, published in a commercial catalog with a very brief, indefinite French description, should be rejected as it is scarcely more than a *nomen nudum* and is not recognizable. It was not listed in the *Index Kewensis*.

× *Quercus filialis* Little, nom. nov.

VARILEAF OAK

*Quercus phellos* L. × *Quercus velutina* Lam.

× *Quercus inaequalis* Palmer and Steyermark, Ann. Missouri Bot. Gard. 22: 521. 1935. Non *Quercus inaequalis* Watelet, Descr. Pl. Foss. Bass. Paris 136, pl. 35, fig. 8. 1866 (fossil, Eocene, France).

× *Quercus filialis* is a new name for the hybrid between *Quercus phellos* L. (Sp. Pl. 994. 1753) and *Quercus velutina* Lam. (Encycl. Méth. Bot. 1: 721. 1785). × *Quercus inaequalis* Palmer and Steyermark must be rejected for this hybrid because it is a later homonym of the fossil species, *Quercus inaequalis* Watelet, from the Tertiary (Eocene epoch) in Belleu, France. (Incidentally, Watelet's fossil species was reduced to a synonym of *Pasaniopsis retinervis* Sap. and Mar. by Fritel, Journ. de Bot. 22: 160. 1909.) The range of this hybrid, according to Palmer and Steyermark, is from southeastern Missouri to Arkansas and Louisiana. The new epithet refers to the hybrid origin as the filial generation or offspring of a cross between parents of different species.

Sargent (Silva North Amer. 8: 180, pl. 436. 1895) interpreted × *Quercus heterophylla* Michx. f. (Hist. Arb. Amér. 2: 87, pl. 16. 1812) as a hybrid between *Quercus phellos* and *Quercus velutina*, the supposed parents of × *Quercus filialis*. However, Hollick (Bull. Torrey Bot. Club. 15: 303-309, illus. 1888) concluded that × *Quercus heterophylla* Michx. f. was a hybrid between *Quercus phellos* and *Quercus rubra* (now *Quercus borealis* var. *maxima* (Marsh.) Sarg.). Later (Sci. Amer. 121: 422, 429-430, 432, illus. 1919), he demonstrated this parentage to be correct by planting acorns of the hybrid and obtaining among the young trees individuals like the two parent species and many intermediate ones. Small (Man. Southeast. Fl. 428, 430. 1933) designated × *Quercus dubia* (without author) as a hybrid between *Quercus phellos* and *Quercus velutina*.

*Osmanthus megacarpus* (Small) Small ex Little, comb. nov. BIGFRUIT OSMANTHUS

*Amarolea megacarpa* Small, Man. Southeast. Fl. 1043, 1507. 1933.

*Osmanthus megacarpa* Small, Man. Southeast. Fl. 1043. 1933; as synonym.

*Osmanthus megacarpa* Small; Gray Herbarium Card-Index, Issue 141; "In synon."

*Osmanthus megacarpus* Small; Hill, Index Kew. Sup. 9: 196. 1938; "in syn."

When he published the new genus *Amarolea* Small (Man. Southeast. Fl. 1043, 1507. 1933), a segregate from *Osmanthus* Lour. (family Oleaceae), Small described one new species, *Amarolea megacarpa* Small, listing at the end

BOTANY.—Notes on American Euphorbiaceae, with descriptions of eleven new species.<sup>1</sup> LEON CROIZAT, Arnold Arboretum of Harvard University. (Communicated by E. P. KILLIP.)

It was my privilege to visit the United States National Herbarium during the summer of 1941, and the descriptions and notes that follow are based largely upon material seen at that time. Herbaria at which the specimens cited in this paper are deposited are indicated thus: AA, Arnold Arboretum; GH, Gray Herbarium of Harvard University; US, U. S. National Herbarium.

#### *Andrachne* L.

Pax and Hoffmann completely misunderstood this genus within the American range. They treat<sup>2</sup> *Andrachne phyllanthoides* Nutt. as a species of *Savia* Willd., a manifest error as the floral morphology of these two genera is very different and they are not even closely related. *Andrachne* is nearest *Phyllanthus* and *Actephila*, whereas *Savia* is consanguineous with *Cleistanthus* and *Amanoa*. Further, these authors place *A. brittonii* Urb. in the section *Phyllanthidea*, which is another error as this species is not close to *A. microphylla* Baill., the standard-species of that section, but is probably nearest to *A. telephioides* L. *Andrachne* ? *cuneifolia* Britton, which is overlooked by Pax and Hoffmann in their account of the American species, is not an *Andrachne* but a species of *Phyllanthus* (see the new combination effected under *Phyllanthus*).

*Andrachne microphylla* (Lam.) Baill. Et. Gén. Euphorb. 577. 1858; Muell.-Arg. in DC. Prodr. 15<sup>2</sup>: 237. 1866; Pax & Hoffm. Pflanzenreich IV. 147. 15: 178. 1922.

of the description and as a synonym the name "[*Osmanthus megacarpa* Small]." This name in *Osmanthus*, just cited as a synonym, was not validly published there under Article 40. The *Gray Herbarium Card-Index* and *Index Kewensis Supplementum* both stated that the name was published in synonymy and thus did not validate it. The combination is published here merely to avoid making it unintentionally.

*Croton microphyllum* Lam. Encycl. Méth. 2: 212. 1786.

*Phyllanthidea microphylla* Didr. Kjöb. Vid. Meddel. 1857: 150. 1857.

So far as I am aware, nothing in the literature indicates that this species has been reported since the time of Dombey. A fragment of the type, generously given me by Professor Humber of the Muséum d'Histoire Naturelle, Paris, shows that here belong (1) *Pennell* 14492—Peru: Depto. Lima: Near Viscas, along Río Chillón, alt. 1,800–2,000 meters (US); (2) *Haught* 39—Peru: Depto. Piura: Prov. Paita: Talara (US; distributed as "Tragia?").

*Andrachne ciliato-glandulosa* (Millsp.) Croiz., comb. nov.

*Phyllanthus ciliato-glandulosus* Millsp. Proc. California Acad. II, 2: 219. 1889.

*Tragia ciliato-glandulosa* M. E. Jones, MS. in sched. (*an tantum?*).

This annual, endemic to Lower California, so closely resembles *A. microphylla* as to be very easily confused with it. Its characters are those of *Andrachne* sect. *Phyllanthidea*, there being a minute pistillode in the female flower. Millspaugh erred in crediting this species to *Phyllanthus* sect. *Menarda*, with which it has no relationship. The occurrence of very similar plants in Peru and lower California is not altogether unexpected, but it is interesting to note that *A. aspera* Spreng., endemic from the Punjab to Morocco, is very closely allied to *A. microphylla* and *A. ciliato-glandulosa*, and that *A. phyllanthoides* from the United States, is near *A. colchica*, from the Caucasus. The distribution of all these species is undoubtedly pre-Tertiary.

<sup>1</sup> Received August 12, 1942.

<sup>2</sup> Pflanzenreich IV. 147. 15: 184. 1922; Nat. Pflanzenfam. 19c: 66. 1931.

**Phyllanthus L.**

**Phyllanthus cuneifolius** (Britton) Croiz., comb. nov.

*Andrachne?* *cuneifolia* Britton, Mem. Torrey Club 16: 72. 1920.

Apparently near *P. orbicularis* H.B.K., as it seems to have the stipitate ovary and the peculiar ♂ disc of that species.

A species published with a question mark as to the genus is not a nomen provisorium.<sup>3</sup>

**Phyllanthus botryanthus** Muell.-Arg. in DC. Prodr. 15<sup>2</sup>: 323. 1866.

*Glochidion botryanthum* Pax & Hoffm. Nat. Pflanzenfam. 19c: 58. 1931.

The two following collections, on comparison with *Plée* 55 and 56 (type material, AA), belong here: (1) *Pittier* 10521—Venezuela: San Martín, Río Palomar (AA); (2) *Pittier* 11914—Venezuela: Miranda: Puente de Turumo, road from Petare to Guatire, "Small tree in forest, up to 4 meters" (AA).

Pax and Hoffmann have an untenable concept of *Glochidion*. This may be retained as a genus only with the understanding that its species form a natural group that it is not possible to define with reference to a set of conventional characters. *Glochidion* is "good" in India, China, Indochina, and Malaysia but is apt to turn "bad" in New Guinea and Oceania, for here its characters merge with those of *Phyllanthus*. Naturally, it is a serious error to introduce *Glochidion* to the floras of America merely because certain species of American *Phyllanthus* have styles that tend to remain connate rather than to expand. These species may exhibit the *technicalities* of the style that are used to circumscribe *Glochidion*, but since they lack a *natural affinity* with this genus they can not be treated under it. I know few other families in which the problems of generic definition are so involved as those of the Euphorbiaceae, a genus under this family more often than not standing or falling on account of considerations that do not immediately bear upon the peculiarity of its floral morphology.

**Phyllanthus L. Sect. Elutanthos**

Croiz., sect. nov.

Foliis fructibusque magnis, inflorescentiis

<sup>3</sup> See Croizat, Journ. Arn. Arb. 21: 499. 1940; op. cit. 22: 137. 1941.

laxe racemosis ramis filiformibus habitu effusis; perianthio utriusque sexus 6-lobo, staminibus saepissime in columnam connatis, disco in ♀ subconnato vel libero, in ♂ libero. Species typica: *Phyllanthus glaucescens* H.B.K. (= *P. adenodiscus* Muell.-Arg.).

Leaves and fruit usually large to very large but these not woody; inflorescence laxly racemose, 10–30 cm long, axillary or pseudoterminal, its axes mostly slender or filiform; flowers ♂ numerous, prevailingly clustered in groups, ♀ fewer, basal or apical; perianth usually 6-lobed, ♂ with 1–3 stamens connate within a staminal column or more seldom free, ♀ with a disk of erect, subconnate, or free glands alternating with the lobes.

Prevailingly Mexican and Central American woody endemics with a striking habit, reminiscent of certain Menispermaceae (e.g., *Hyperbaena* Miers), at first suggesting a genus other than *Phyllanthus* but closely related to classic species of this genus in every technical detail of their floral morphology. Standard-species: *Phyllanthus glaucescens* H.B.K. Nov. Gen. 2: 115. 1817 (= *P. adenodiscus* Muell.-Arg. Linnaea 32: 23. 1863).

The material of this section is insufficient and too imperfect to make an adequate key to the species, at least one, *P. oaxacanus* Brandeg., lacking staminate flowers. The following outline, however, will be of some use in distinguishing them. Two new species described below are included.

## KEY TO THE SPECIES

- Staminal column none; stamens 3, solute. . . . .  
 . . . . . *P. coalcomanensis* Croiz.
- Staminal column present; stamens connate.  
 Anthers 2. . . . . *P. tequilensis* Robins. & Greenm.
- Anthers 6.  
 Male flowers delicate, lobes longer than broad; staminal column slender; axes of inflorescence often squamulose. . . . .  
 . . . . . *P. glaucescens* H.B.K.
- Male flowers delicate; axes of inflorescence bearing flowers from pulvinate buds. . . . .  
 . . . . . *P. huallagensis* Croiz.
- Male flowers not delicate with broadly ovate lobes; staminal column robust; axes of inflorescence not squamulose.  
 Inflorescence long, diffuse. . . . .  
 . . . . . *P. laxiflorus* Benth.
- Inflorescence short. . . . .  
 . . . . . *P. chiapensis* Brandeg.
- Male flowers unknown. . . . .  
 . . . . . *P. oaxacanus* Brandeg.

**Phyllanthus coalcomanensis** Croiz., sp. nov.

Arbor; foliis magnis ad 15 cm longis; inflorescentia laxiflora; floris ♂ perianthio 6-lobo, ca. 6 mm lato, staminibus 3 liberis, glandulis discretis; floris ♀ perianthio 6-lobo, disco e glandulis discretis, ovario globuloso, stylis 3 reflexis. Ad *P. glaucescentem* H.B.K. accedit, at staminibus discretis statim dignoscitur.

A tree or shrub about 3 m high, the older bark reddish, wrinkled and lenticeled, quite glabrous; leaves 5–15 cm long, 4.5–12 cm broad, blackish when dried (only young leaves seen), thinnish, probably slightly glaucescent beneath in life, broadly ovate, very broadly acuminate at the tip, truncate to truncate-cordate at the base, with about six pairs of spreading primaries, widely branching toward the margin of the blade; petiole not over 1 cm long; stipules nearly petaloid in texture at least at the margin, irregularly broad-ovate, entire, much veined, up to 1 cm long, 0.7 cm wide; inflorescence ♂ of effuse, many-flowered sub-filiform lateral and subterminal racemes up to 25–30 cm long, monoecious; inflorescence ♀ perhaps fasciated and axillary but, more likely, occupying the basal part of some or all the ♂ axes; flower ♂: perianth about 6–7 mm broad on a slender pedicel about 6–8 mm long, the lobes 6, hyaline, costate in center, ligulate, rounded at the tip, about 3 mm long, alternating with as many disciform to globose glands (nectaries), these not forming a continuous disk; stamens 3, free, connate merely at the base; filaments fleshy about 1 mm long, the anthers transverse; flower ♀: perianth (not dissected, only one seen) up to 20 mm broad on a pedicel about 15 mm long, the lobes apparently 5, blackish when dry, thinly hyaline at the margin, broadly ovate to rotundate, about 8 mm long and broad; ovary globose, quite glabrous, manifestly sulcate on the keels and commissures, about 4 mm long and wide; styles 3, reflexed, apparently shortly bilobed at the tip, about 1–1.5 mm long; glands as many as the lobes and alternating with them, erect, punctulate at the upper lip, apparently not connate into a close disk.

Type: *Hinton* 15857, Mexico: Michoacán, Distr. Coalcomán, Aquila, 400 meters. "Tree 3 meters high. Flowers white, raceme pendulous, in barranca" (US). Syntype: *Hinton* 15859, same locality and date, "2 meters high.

Flowers purple, racemes pendulous; different from 15857" (US).

*Hinton* 15857 and 15859 are the same species, the collector having been misled by the changing color of the flowers, apparently purple at unfolding or before unfolding, white in full anthesis.

**Phyllanthus huallagensis** Standl. MS. in sched.

Arbor, foliis ad 9 cm longis, subtus glaucescentibus; inflorescentia racemosa ad 25 cm longa; floris ♂ perianthio ca. 4 mm lato, staminibus 3 in columnan connatis, glandulis discretis; floris ♀ perianthio ca. 6 mm lato, glandulis subconnatis, ovario globuloso ad 2 mm lato, stylis 3 brevibus. *Phyllanthum tequilensem* Robins. & Greenm. admet.

A tree, 6 m high, quite glabrous, the older bark much lenticeled and fissured, reddish brown; leaves 4–9 cm long, 3–5 cm broad, brownish when dried, firmly chartaceous, glaucescent beneath in life and slightly so in dried specimens, round-elliptic, shortly and broadly acuminate at the tip, cuneate to round-cuneate, not cordate at the base, with about six pairs of broadly ascending primaries, conspicuous beneath, less so above, the veinlets fairly conspicuous; petiole less than 5 mm long; stipules triangular, small, apparently not long persistent; inflorescences of axillary and subterminal, slender but not filiform racemes up to 20–25 cm long, bearing numerous clustered ♂ flowers arising from manifestly pulvinate buds and many less ♀ flowers, as seen in an apical position; flower ♂: perianth about 4 mm broad, borne on a slender pedicel about 10 mm long, the lobes 6, more or less ovate to elliptic, about 2 mm long and 1.5–2 mm broad, alternating with 6 small glands; stamens 3, fused into a staminal column about 1 mm long; flower ♀: perianth about 5–6 mm broad, borne on a pedicel about 3.5 mm long, the lobes 6, more or less ovate, 1.5–2 mm long, alternating with six suberect curved glands, almost connate to form a continuous disc underneath the ovary; ovary globose, about 2 mm long and broad; styles 3, short, more or less reflexed and cleft at the tip.

Type: *Klug* 4240, Depto. San Martín, Peru: Juan Jui, Alto Río Huallaga, alt. 400–800 meters, in forest, Jan. 1936 (AA).

This is the only species of this section known, so far, from Peru, somewhat reminiscent of *P. tequilensis* Robins. & Greenm. from Mexico and not too far removed from *P. botryanthus* Muell. from Venezuela.

As a further help in sight-identification of species of the section *Elutanthos*, the following ranges are given: *P. coalcomanensis*, Michoacán, Mexico; *P. tequilensis*, Jalisco, Mexico; *P. glaucescens* (including *P. adenodiscus*, which might be retained as a variety in a critical study of this group, but does not impress me as having a clear specific status), the entire eastern coast of Mexico from British Honduras and Yucatan to Tamaulipas, Mexico; *P. laxiflorus*, Guatemala; *P. chiapensis*, Chiapas, Mexico—very near *P. laxiflorus* as far as seen; *P. huallagensis*, Depto. San Martín, Peru; *P. oaxacanus*, Oaxaca, Mexico. These ranges are fairly indicative of the various centers of endemism for the Euphorbiaceae of this region.

**Phyllanthus neoleonensis** Croiz., sp. nov.

Fruticulus ligneus, intricatus; foliis vix 2 cm longis, petiolis quam stipulis brevioribus, vix 2 mm longis; inflorescentia cymulosa, axillari; perianthio floris ♂ ca. 2 mm lato, 6-lobo, staminibus 3 ad basem liberis, glandulis 6 liberis; perianthio floris ♀ ca. 5 mm lato, 6-lobo, stylis brevibus; semine trigono, arillo granuloso scabro. *Phyllanthum galeottianum* Baill. atque *P. liebmannianum* Muell.-Arg. admonet.

A low, woody and much intricate shrub, probably not over 1–2 feet high, the innovations herbaceous or subherbaceous, quite glabrous, the older shoots woody, slender, sometimes zigzag; leaves 1–2 cm long, 0.5–1.5 cm broad, obovate to elliptic, rounded and obscurely mucronate at the tip, more or less rounded to cuneate at the base, pale olive above, grayish or pink-grayish underneath, the primaries obscure, delicate, about 4–5 pairs; petiole less than 2 mm long; stipules 2–3 mm long (that is, longer than the petioles), setaceous towards the tip, irregularly broadened towards the base, venulose, mostly purplish; inflorescences bisexual in axillary cymules; flower ♂: perianth about 2–2.5 mm wide on a slender pedicel about 4 mm long, the lobes 6, elliptic to elliptic-ovate, 1.5 mm long, 0.75 mm broad, alternating with as many roundish

glands: stamens 3, free except at the very base; flower ♀: perianth about 5 mm wide, on a pedicel about 10 mm long: lobes 6, about 2–2.5 mm long, 1.5–2 mm wide, ovate, sometimes acuminate and slightly glandular at the tip, glands 6, erect, curving against the ovary, not connate into a disc; ovary glabrous, 2 mm long and wide or less, sulcate; styles 3, short, barely bilobed at the apex; seed trigonous, 2 mm long, 1.5 mm broad, the testa brown, smoothish, the aril black, as a loose, hard, granular dust on the testa.

Type: *Pringle* 13881 bis, Nuevo León, Mexico: Limestone ledges, Sierra Madre, near Monterrey (GH). Syntypes: *C. H. & M. I. Mueller* 314 & 315, same locality as the type (AA); *Pringle* 10810, Monterrey (GH); *Pringle* 1198, Sierra Madre (GH).

The Muller material was originally determined with doubt as *P. ferax* Standl., a species that *P. neoleonensis* superficially resembles in its vegetative characters but from which it differs in the much more robust habit and in the details of floral morphology. *Phyllanthus galeottianus* Baill., which is in all probability represented by *Pringle* 4443, collected near Guadalajara, Jalisco (GH), is unlike *P. neoleonensis* because of its more robust habit and its stamens being connate to form a staminal column. A plant bearing some resemblance to *P. neoleonensis*, but more delicate and probably not different from *P. liebmannianus* Muell.-Arg., is represented by *Purpus* 2313, Zacuapan and vicinity, Veracruz (GH). Lastly, *Gaumer* 508, *Gaumer* 1817, *Gaumer & Sons* 23543 (all AA), distributed as *P. lathyroides*, are probably conspecific with *P. ferax* Standl. (*Bartlett* 12157, Petén, Guatemala; US).

**Phyllanthus mexiae** Croiz., sp. nov.

Frutex; foliis setaceis, bracteis in ramulis florigeris (vulgo pro foliis laudatis) ad 4 cm longis; inflorescentia cymulosa axillari; floris ♂ perianthio ca. 2 mm lato, staminibus 3 in columnam connatis; floris ♀ perianthio ca. 7 mm lato, 6-lobo, ovario vix 1 mm magno, stylis 3 brevibus.

A shrub, quite glabrous, the innovations smooth and ribbed; leaves (strictly speaking) none, transformed into acuminate stipules 2 mm long or less, marcescent at the axil of the stiffly spreading, leafy-bracteate florigerous

axes; bracts of the florigerous axes ("leaves") 2.5–4 cm long, 2–2.5 cm broad, elliptic-ovate, thinly membranous, greenish above, pale grayish below but probably not glaucescent, very broadly acuminate, sometimes mucronate at the tip, more or less broadly and irregularly cuneate at the base with 5–7 pairs of thin primaries; petiole about 3 mm long; stipules triangular, not over 2 mm long, marcescent or deciduous; inflorescences bisexual in lax clusters in the axils of foliaceous bracts ("leaves"); flower ♂: perianth 2 mm broad or less, on a capillary pedicel 3–5 mm long, the lobes thin, hyaline, the glands 3 surrounding the base of the column formed by 3 connate stamens, about 1.5 mm long; flower ♀: perianth about 7 mm broad on a pedicel about 10 mm long, the lobes 6, ovate-elliptic, 3 mm long, 1.5 mm broad, hyaline, thinly greenish-costate along the middle, alternating with as many erect, incurved, more or less regular glands; ovary glabrous, somewhat depressed, about 1 mm long and wide, with 3 reflexed styles, short and manifestly cleft at the tip.

Type: *Ynes Mexia* 6718, Ecuador, Prov. of Leon, Canton Pajilli: Hacienda Solento, near Santa Rosa, alt. 1,000 meters, "shrub 5 m. high, in forest in cloud belt. Fish-poison," Nov. 1934 (US).

In certain groups of *Phyllanthus* true leaves are present, the florigerous axes being often reduced, bracteate, and, strictly speaking, leafless branchlets (see *P. laxiflorus*). In other groups of the same genus the true leaves are represented only by scales, the aspect and function of foliage being assumed by the bracts of the florigerous axes (see *P. mexiae*). These peculiarities, seldom if ever noticed, are of the utmost importance because they furnish a ready key to the understanding of all the very variable inflorescences of the phyllanthoid alliance. It is worthy of note that true leaves appear on seedlings of species (e.g., *E. niruri* L.) which in their more mature aspect bear only "leafy" florigerous axes.

#### Croton L.

##### *Croton aristophlebius* Croiz., sp. nov.

Ligneus; apicibus brunneo-ochraceis, subargillaceo-tomentosis; foliis elliptico-lanceolatis ad 12 cm longis, venulis venisque valde impressis, primariis ca. 9–12 jugis; perianthio

floris ♀: lobis sub fructu discretis, ca. 6 mm longis, pedicello ca. 15 mm longo, columella ad 7 mm longa.

*Crotonem celtidifolium* Baill. habitu bene simulat at indumento toto caelo discrepat.

A tree or shrub; innovations brown-ochraceous, the indumentum of rough, very persistent, subargillaceous trichomes; leaves 6–12 cm long, 2–5 cm wide, elliptic-lanceolate, acuminate to short-caudate at the tip, round-cuneate at the base, glabrous, dull green, smooth above, with sharply impressed veins and veinlets, underneath pale-ochraceous, the indument compactly scurfy-tomentose, the veins about 9–12 pairs, anastomosing near the entire margin, the tertiary veins sharp; petiole 1.5–2.5 cm long, vestite like the innovations, bearing 2–4 pedicelled, disciform glands at the apex on the abaxial face of the blade; stipules almost none; inflorescence of spicate, bisexual axes, rather slender, up to 15–20 cm long; flower ♂: perianths immature, about 2 mm long; flower ♀ (only the perianth seen after fruiting): calyx about 12–14 mm wide, on an ascending, ultimately recurved pedicel about 14–17 mm long, rather slender, the lobes 5, entire, ligulate to elliptic, short-acuminate to rounded at the tip, nowhere imbricating, 5–6 mm long, 1.5–2 mm wide, not accrescent; petals as setaceous brownish ligulae between the sepals; columella after dehiscence about 7 mm long.

Type: *Bro. Daniel* 1912, Depto. Antioquia, Colombia: Piedras Blancas, July 1938 (US).

A strong species, distantly suggesting *C. celtidifolius* Baill. but with a very different indumentum.

#### Caperonia St.-Hil.

##### *Caperonia chiltepecensis* Croiz., sp. nov.

Herba, indumento delicato interdum glanduloso; foliis elliptico-lanceolatis vel obovatis, nervis primariis ca. 10–14-jugis, haud profunde dentatis; floris ♂ perianthio delicato, sepalis triangularibus ca. 1.5 mm longis, petalis tenuissimis, ligulatis ad 2 mm longis, staminibus ca. 10 in serie duplici dispositis; floris ♀ perianthio ad 5 mm magno, sepalis petalisque cum ♂ sat congruentibus, ovario depresso 1 mm longo, 2 mm lato, dorso processibus 5–7 in cocco quolibet ornato. *Caperoniam zaponetam* Mansf. Peruvianam potius in mentem vocat quam *C. palustrem*, at magis delicata est.

Herb with dimorphic pubescence of short, appressed setulose eglandulose hairs and more or less spreading, delicate glandulose trichomes, these not over 1 mm long; leaves fairly thin, greenish on both faces, 5–8 cm long, 2–4 cm broad, elliptic-lanceolate at the apex of the shoot, more or less regularly obovate at its base, sparingly and weakly setulose on both faces, the indumentum scattered below, mostly restricted to the primaries above, the primaries in 10–14 pairs, thin, ascending the tertiaries manifest, the serration shallow, the teeth barely spreading at their apex, the petiole 5–10 mm long; stipules setaceous, up to 3–4 mm long; inflorescences on slender axillary axes, short-branching or dichotomous, up to 8–10 cm long; flower ♂: perianth delicate, about 3 mm broad; sepals 5, about 2.5 mm long and 1.5 mm wide, triangular; petals very thin, ligulate, about 2 mm long, 1.5–2 mm broad; stamens apparently 10, alternating in two even series, the lower subsessile, the upper borne upon a staminal column 1–1.5 mm long with filaments 0.5–1 mm long; flower ♀: perianth 4–5 mm broad, with a pedicel about 2.5 mm long; sepals 5, elliptic, entire, slightly glandular and cucullate at the apex, somewhat strigulose on the back; petals 5, very thin, white, 2–3 mm long, abruptly produced at the base into a filiform claw about 1 mm. long, otherwise ligulate, rotundate at the apex; ovary depressed, 1 mm long, 2 mm broad, each keel bearing 5–7 triangular processes, fleshy at the base, glandulose at the apex; styles 3 flabellate, irregularly cleft into 5–6 nearly terete branches, about 3–4 mm long.

Type: *Martínez-Calderón* 334, Mexico, Oaxaca: Distr. Tuxtepec, Chiltepec and vicinity, 20 meters, 1941 (US).

Despite its being much more delicate in all its parts this species seems to be most closely allied with *C. Zaponeta* Mansf., from Peru (*Klug* 3954, *GH*). It differs from *C. palustris* St. Hil. in the finer indument, in the less open and spreading serration, in the different epicarp, and in the general outline of the foliage.

### *Jatropha* L.

*Jatropha deutziflora* Croiz., sp. nov.

Stimulosa, folia visa ad 35–27 cm magna, 7-loba, basi optime sinuata; inflorescentia longe pedunculata ca. 40 cm longa; perianthio floris ♀ ca. 10 mm longo, lobis 5 albicantibus, car-

nosulis, calyptratim deciduis; ovario glaberrimo 3 mm longo in disco insidente integro ca. 1 mm crasso, stylis 3, quolibet apice in laciniis 6 diviso. Cum *J. longipede* Pax e descriptione congruere videtur, in sect. *Calyptosolene*.

Probably a large shrub, the specimen consisting only of a leaf, a petiole, and a cyme with ♀ flowers; leaf large, about 27 cm long, 35 cm broad, quite glabrous on both faces, very thin, brittle, greenish on both faces with brownish veins, 7-lobed, the 3 median lobes subsimilar, about 20 cm. long and 8 cm wide, with about 7–9 pairs of broadly spreading primaries and with distant tertiaries often running parallel to the main veins, the margin of the lobes coarsely and not profoundly dentate, lined by numerous stimulose hairs, these not over 1.5–2.5 mm long, inconspicuous, almost parallel with the margin the lateral lobes falcating and shorter, the external 2 hardly more than lobules, 5–6 cm long, about 3.5 cm broad, the base of the leaf cut to form a wide sinus very nearly lined by the excurrent midribs of the outer lobes, the petiole quite herbaceous, ribbed, glabrous; inflorescence a long-peduncled cyme about 40 cm long, armed below with ascending, rather small, stimulose hairs, becoming almost unarmed and finely puberulous at the tip, the flowers much crowded upon short dichotomous branches; perianth ♀ about 10–11 mm long, the 5 lobes about 8 mm long, 3 mm broad, obovate to subspatulate, fleshy, quite whitish, falling off neatly from the persistent greenish base of the perianth; ovary quite glabrous, 3 mm long, 2 mm broad, on a continuous disk about 1 mm thick; styles 3 about 2.5–3 mm long, each divided at the tip into about six branches, these sometimes shallowly cleft or lobed at the apex.

Type: *Martínez-Calderón* 77, Mexico, Oaxaca: Tuxtepec, Chiltepec and vicinity, alt. about 20 meters, July, 1940–February, 1941 (US).

Nearest to *J. longipes* Pax from Colombia. Differs from the Mexican species of sect. *Calyptosolen*, to judge from descriptions, in the glabrous ovary.

### *Manihot* Mill.

*Manihot aesculifolia* (H.B.K.) Pohl, Pl. Bras. Ic. Descr. 1: 55. 1827; Muell.-Arg. in DC. Prodr. 15<sup>2</sup>: 1065. 1866; Pax & Hoffm. Pflanzenreich IV. 147. 2: 58. 1910.

*Janipha aesculifolia* H.B.K. Nov. Gen. 2: 85. pl. 109. 1817.

Pax describes this species as having "limbus membranaceus, basi cordatus, concolor," listing only the type, collected by Humboldt on the Gulf of Campeche. *Bangham* 300, Honduras: San Pedro Sula, 1929 (AA), erroneously distributed as *M. dulcis*, so perfectly agrees with the type-illustration of *M. aesculifolia* in its vegetative and in floral characters that I have little hesitation in referring it to this species, despite its having a leaf that is not "concolor" but strongly glaucescent at the lower face.

*Manihot dulcis* (J. F. Gmel.) Pax, Pflanzenreich, IV. 147. 2: 71. 1910.

*Jatropha dulcis* J. F. Gmel. Onom. Bot. 5: 7. 1772-1778, *vide* Pax.

Three collections from Peru, which very likely represent the same species are: *Killip & Smith* 22722, Depto. Ayacucho: Aina; *Klug* 2662, Depto. San Martín: Pongo de Cainarachi; *Skutch* 5009, Depto. Loreto: Río Ucayali (all AA). In this plant the leaf is almost always 3-foliate, sparingly pubescent to glabrate on the veins, innovations, and floral axes. The *Skutch* collection has a fruit that lacks "wings," which, taken together with all the other characters, identifies the specimens cited as *M. dulcis*, in the sense of Pax. *Killip & Smith* 22722 shows remnants of a fine rufous pubescence and may be *M. dulcis* var. *ferruginea* (Muell.-Arg.) Pax, accepted by Mueller for the subandine regions of Peru (*DC. Prodr.* 15<sup>2</sup>: 1063. 1866, under *M. palmata* (Vell.) Muell.-Arg.), but questioned there by Pax. *Manihot pavoniana* Muell.-Arg., another Peruvian species, agrees so far as the descriptions with the cited collections in some characters, but differs in the glabrous perianth and stamens. *Killip & Smith* 22722 and *Klug* 2662 have been identified as *M. utilissima* Pohl, a determination which the fruit of *Skutch* 5009 now shows to be untenable.

#### *Gymnanthes* Swartz

*Gymnanthes texana* Standl. Proc. Biol. Soc. Washington 39: 135. 1926.

This species is to be excluded from the Euphorbiaceae. Inspection of *Tharp* 3634, the type in the U. S. National Herbarium,

having convinced me that the plant was not of this family, I called it to the attention of E. J. Palmer, of the Arnold Arboretum, and of V. L. Cory, of the Texas Agricultural Experiment Station in Sonora. Both these botanists promptly recognized it as *Forestiera reticulata* Torr., an identification confirmed by the characters of the wood of *Tharp* 3634, which show unquestionable kinship with the Oleaceae. I am deeply indebted to Mr. Cory for the following additional data (*in litt.*, Nov. 24, 1941): "[Tharp's] material is identical with that which I collected on a hillside sixteen miles north of Comstock on August 15 of this year. My study had convinced me that this was *Forestiera reticulata* Torr. Mr. Ernest J. Palmer reports that my material undoubtedly is of that species. The peculiar thing about this plant is the remarkable difference between the pistillate and the staminate aspect. In my limited observation, the former grows to an height of six feet or more, with leaves that are prominently porulose beneath, and the plant is, in appearance, a typical *Forestiera*. On the other hand, the staminate plant, or at least the one I have seen growing, is a foot or less in height with the aspect of a shrubby species of *Croton* and the leaves imperceptibly porulose. I made additional collections from this plant on November 12 and at this time it was easy to take it as a *Forestiera* and not a *surge*."

The following synonymy is consequently affirmed:

*Forestiera reticulata* Torr. U. S. & Mex. Bound. Bot. 168. 1859 = *Gymnanthes texana* Standl. Proc. Biol. Soc. Washington 39: 135. 1926.

#### *Senefeldera* Mart.

The generic name has been spelled *Senefeldera* and *Senefeldera*, and Mueller-Argovienensis has proposed<sup>4</sup> the latter spelling as an alternative to the former. The correct version is *Senefeldera* as given<sup>5</sup> by Pax and Hoffmann, the genus having been named by Martius in honor of Alois Senefelder (1771-1834), a citizen of Munich, and the inventor of lithography. The name of the lithographer of Vellozo, Flora Fluminensis, as shown on the title-page of this work, is Senefelder.

<sup>4</sup> Mart, Fl. Bras. 11<sup>2</sup>: 528. 1874.

<sup>5</sup> Pflanzenreich IV. 147. 5: 23. 1912.

**Senefeldera verticillata** (Vell.) Croiz., comb. nov.

*Omphalea verticillata* Vell. Fl. Flum. 10: pl. 15. 1827.

*Senefeldera multiflora* Mart. Flora 24<sup>2</sup>, Beibl. 2: 29. 1841; Pax & Hoffmann, Pflanzenreich IV. 147. 5: 23. 1912.

Pax and Hoffmann and J. Mueller have placed *O. verticillata* Vell. in the synonymy of *S. multiflora* Mart., failing, however, to effect the combination required under the International Rules. I present this combination here, believing that Vellozo's plate 15 (not 152, as cited by Pax and Hoffmann) is correctly understood by all these authors to illustrate *Senefeldera*, not *Omphalea*.

**Senefeldera macrophylla** Ducke, Arch. Jard. Bot. Rio de Janeiro 4: 113. 1925.

To this species or to a very nearly related one belongs A. C. Smith 2960 (AA), collected on the southern slopes of the Akarai Mountain in the drainage basin of Rio Mapuera, Pará, Brazil, 1938.

**Senefeldera nitida** Croiz., sp. nov.

Arbor; foliis 10–18 cm longis, 6.5–8 cm latis, late ellipticis, apice breviter acuminato-mucronatis, more proprio nitidis, venis primariis ca. 12-jugis; capsula submatura 1.5 cm longa, 2.5 cm lata, laevissima.

A medium-size tree with quite glabrous innovations; leaves 10–18 cm long, 6.5–8 cm broad, very broadly elliptic and very broadly and shortly acuminate-mucronate, coriaceous, brownish, glossy on both faces but especially above, quite entire, very obscurely cordate at the base and here barely glandular, the glands scarlike and inconspicuous; primaries about 12 pairs, all patent, thin but sharp, the anastomoses inconspicuous, the petiole 3–4 cm long; inflorescence seen only in fruit and mostly broken off, typical of the genus, subapical and many-branched, the branches stoutish; only one capsule seen, almost ripe, 1.5 cm long, 2.5 cm broad, manifestly trigonous and depressed, the rounded keels of the cocci thinly grooved, the epicarp quite smooth.

Type: *Krukoff* 7126, Brazil, State of Amazonas: Basin Rio Madeira, Municipality Humayta, on plateau between Rio Livramento and Rio Pixuna, 1934 (AA).

Distributed as *S. karsteniana* Pax & Hoffm., *Triana* 5791–1, in the Colombian National Herbarium, collected at Villavicencio, the classic locality of *S. karsteniana*, and in all probability this species, is certainly different from *Krukoff* 7126. The peculiarly glossy foliage is characteristic.

**Senefeldera skutchiana** Croiz., sp. nov.

Arbor; foliis 15–10 cm longis, 8–3 cm latis, late ellipticis, nervis primariis ca. 10–14-jugis utrinque conspicuis, glandulis nullis vel subnullis, petioli apice atrato; inflorescentia apicali, paniculam decompositam simulante; floribus ♂ vulgo ternatis, staminibus 5–8 in bracteolae axilla ad 2 mm longae, margine hyalino erosae; floribus ♀ bracteis 3 integris lanceolatis circumdatis, ad 2.5 mm longis, interdum flore laterali ♂ auctis, ovario ad 2 mm longo subfusiformi, stylis carnis vix divaricatis.

A medium-sized tree, quite glabrous; leaves 10–15 cm long, 3–8 cm broad, firmly chartaceous to subcoriaceous, greenish when dry, broadly elliptic, short-acuminate to apiculate at the tip, the apex of the blade slightly glandular at the end of the midrib and here somewhat reflexed, broadly cuneate to subrotund at the base, the margins entire, the primary veins about 10–14 pairs, sharp on both faces not all anastomosing, the glands almost wanting, only the apex of the petiole slightly enlarged, blackish when dry, and the base of the blade in certain leaves obscurely spotted above, near the insertion of the petiole, the petiole comparatively slender, 2.5–8 cm long; inflorescence apical, of numerous spiciform stiffish axes, about 20 cm long and wide, appearing as if compound-panicled, the ♂ flowers very numerous, the ♀ fewer and basally borne or tending to be mixed with the staminate on certain axes; flowers ♂ usually borne in 3's in the axil of an ovate to elliptic-ovate scale, 1.5–2 mm long, erose and thin at the margin, the central flower very seldom reaching maturity in the lower part of the florigerous axes but usually evolute and alone in the upper one by abortion of the lateral flowers, the pedicel with a low articulation, about 2 mm long, bearing adaxially a bract, open and holding 5–8 stamens about 1.5–2 mm long; flower ♀: perianth of 3 lanceolate entire imbricate bracts, sometimes glandular at the base inside,

about 1.5–2.5 mm long, with an occasional lateral ♂ flower; ovary 1.5–2 mm long, tapering at both ends with rather fleshy styles not divaricate, as seen, about 3 mm long.

Type: *Skutch* 4967, Peru, Depto. Huánuco, Tingo María, alt. 2,500 feet, a tree 60 feet high with yellowish flowers, August, 1940 (AA). Syntype: *Skutch* 4961, same locality and date, at 2,300 feet, (AA).

A very distinct species, suggesting at first sight some rutaceous plant (for instance, resembling *Evodia*), with comparatively slender and numerous floriferous axes.

### *Pedilanthus* Neck.

I reinstated<sup>6</sup> *Tithymalus* Mill., this being the earlier validly published name for this group, but *Pedilanthus* has subsequently been proposed<sup>7</sup> as a *nomen genericum conservandum* by Wheeler. In view of the existing international situation it is not likely that the Botanical Congress can decide in the near future between *Tithymalus* and *Pedilanthus*. Thus, not to deepen the existing controversy and further to disturb nomenclature, I accept *Pedilanthus* as proposed by Wheeler.

### *Pedilanthus coalcomanensis* Croiz., sp. nov.

Arbor 15-pedalis; innovationibus inflorescentiis lanulosis; bracteis floralibus conspicuis, viosis, ad 2.5 cm longis; cyathio horizontali calcarato 15 mm longo, 10 mm lato; appendice integra ad 10 mm longa, apice callosula, dorso impresso-canaliculata, glandulis 4, lobis superioribus 3 connatis, apice acuminatis, lobis lateralibus 2 apice rotundato-carinatis; floribus ♂ (staminibus) ad 30; flore ♀ (ovario) ad 4 mm longo (ut adest), gynophoro 5–7 mm longo, stylo filiformi ad 13 mm longo, apice breviter trifido, cruribus ad 2 mm longis. Species more proprio bracteata, appendice cyathii integra.

A tree about 5 m high; innovations lanulose, older wood with a grayish smooth bark, glabrous; leaves seen none; inflorescence surrounded by conspicuous bracts of variable length but probably not longer than 2.5 cm and about 1.75–2.25 cm broad, ovate, mucronulate, subcordate at the broadly clasping base, wine-colored at the margins, softly whit-

ish pubescent, indument lanulose; internodes of the cyme scarcely over 1 cm long, all lanulose; cyathium manifestly calcarate, about 15 mm long, and 10 cm broad, the anterior margin rounded, the posterior evidently produced, horizontal or nearly so, wine-colored, on a pedicel about 10–12 mm long, sparingly lanulose; appendix entire, about 10 mm long, that is, shorter than the cyathium, bearing three grooves above, ending in an entire or scarcely lobulate glandular tip; glands four, set under the fornicate appendix, not stipitate, rather small; upper calyx-lobes 3, connate for a longer or shorter tract, about as long as the lateral calyx-lobes, acuminate; stamens (in reality, ♂ flowers) about 20–30, 10–15 mm long; ovary (♀ flower), as seen, about 4 mm long, 2.5 mm broad, glabrous, on a gynophore about 5–7 mm long; style filiform, 10–13 mm long, shortly trifid at the tip, the branches 1.5–2 mm long, slightly cleft to bilobed.

Type: *Hinton* 15765, Mexico: Coalcomán, Michoacán. Sierra Naranjillo 1,550 m, tree 5 m, bracts red, locally known as *candelilla*, in woods, 1941 (US).

The apparently involved morphology of the cyathium of *Pedilanthus* can easily be explained, if only it is realized that this cyathium is homologous with a much coarctate inflorescence of *Dalechampia*, the upper part of the inflorescence, which bears glands and ♂ flower in this genus, being replaced by a chamber with glands in *Pedilanthus*. The lower part of the inflorescence carries three ♀ flowers in *Dalechampia* but only one ♂ flower and numerous ♀ flowers in *Pedilanthus*. It stands to reason that the structural details of the cyathium of *Pedilanthus* have as much taxonomic significance as those of the inflorescence of *Dalechampia* and that, unlike *Euphorbia* and *Chamaesyce*, *Pedilanthus* can readily be keyed on floral characters once the proper position and evolution of these characters is understood.

Millspaugh's fundamental paper<sup>8</sup> keys out the species of sect. *Eupedilanthus* in two groups,<sup>9</sup> one having an appendix entire, the other bipartite. The latter group is once again divided into two lesser divisions, with and without colored floral bracts. *Pedilanthus coalcomanensis* thus belongs to a group of its own,

<sup>6</sup> Amer. Journ. Bot. 24: 703. 1937.

<sup>7</sup> Contr. Gray Herb. no. 124: 47. 1939.

<sup>8</sup> Field Mus. Bot. 2: 353–371. 1913.

<sup>9</sup> *Op. cit.* 354.

having an entire appendix and colored floral bracts. I find no species, either in the herbaria I have visited or in the descriptions I have read, that agree with this new one.

***Pedilanthus personatus* Croiz., sp. nov.**

Frutex ad 10 ped. altus; innovationibus puberulis; cyathio calcarato, horizontali ad 12 mm longo, 8 mm lato, appendice 8 mm longa, acuminata, ad basem imam partita, glandulis 4, quarum 2 in infundibulo sacciformi ex appendice fornicata, 2 in suturis inter lobos superiores lateralesque; lobis superis 3, longe acuminatis vix connatis; floribus ♂ (staminibus) ad 20 vel ultra; flore ♀ (ovario) tomentello ca. 2.5 mm longo, gynophoro optime articulado, stylo ca. 10 mm longo, stigmatibus brevissimis.

A shrub 10 feet high; stems pale green, puberulous at the tips, the inflorescence congested in apical, very short cymes; leaves and bracts not seen; cyathium puberulous, about 10–12 mm long and 8 mm broad, the appendix fully 8 mm long, rather pointed, cleft down to its obscurely saccate base, bearing at the base and on either side 2 stipitate glands; lateral lobes 2, rounded at their apex; upper lobes 3, subconnate and readily separating, about 10 mm long, slightly spatulate at the tip, the lateral 2 bearing each a gland along the line of connation with the adjacent lobes, these two glands being visible from the outside in a characteristic manner (hence the specific name); stamens (♂ flowers) numerous, 20 or more; ovary (♀ flower) finely grayish-tomentellous, about 2.5 mm long, on a gynophore deeply articulate, ca. 10 mm long, the style about 10 mm long, incrassate at the base; stigmas very short, apparently cleft and elobulate.

Type: *J. B. Edwards* 581, Honduras, Comaguaya, in semiarid country, at 1,800 feet, locally called "ditamo real," February, 1933 (A.A.).

Distributed as *P. macradenius* Donn. Smith, an altogether different species. It keys near *P. oerstedii* Kl. & Garcke and *P. aphyllus* Boiss., but it does not agree in the slightest with the latter, as interpreted by Millspaugh<sup>10</sup> and illustrated by *Botteri* 968 (GH). *Pedilanthus oerstedii* is published with an inadequate description, there being a possible question

whether its status is better than that of a *nomen nudum*. Its classic locality is not far from that of *P. personatus* but it may not be the same species if, as it is affirmed<sup>11</sup> by Boissier and by Millspaugh, it is closely related with *P. aphyllus*. The specimen of *P. oerstedii* is now inaccessible.

***Euphorbia* L.**

***Euphorbia crispata* Hornem.** Hort. Bot. Hafn. Suppl. 58. 1819; Link, Enum. Pl. Hort. Berol. Edit. Alt. 2: 15. 1822.

*Euphorbia undulata* Bernh. ex Hornem. Hort. Bot. Hafn. 2: 507. 1815; Willd. (Schlecht.) Enum. Pl. Hort. Berol. Suppl. 28. 1813, *nomen nudum*. Non *E. undulata* M. a B. Fl. Taur.-Cauc. 1: 371. 1808.

*Euphorbia pubescens* Desf. Fl. Atl. 1: 386. 1798 (excl. syn. *Vahlia*); Gussone, Syn. Fl. Sic. 1: 541. 1842, and 2: 828. 1843; Reich. Ic. Fl. Germ. 5: pl. 138, fig. 4769. 1841; Boiss. in DC. Prodr. 15<sup>2</sup>: 134. 1862; Batt. & Trab. Fl. Algér. 795. 1890 (excl. var.); Lojacono-Pojero, Fl. Sic. 2<sup>2</sup>: 333. 1904; Jahand. & Maire, Cat. Pl. Maroc 2: 464. 1932 (saltem p. p.). Non *E. pubescens* Vahl, Symb. Bot. 2: 55. 1791.

With Jacquin,<sup>12</sup> Gussone, and Lojacono-Pojero I believe that Desfontaines and the authors who have followed him erred in their interpretation of Vahl's *E. pubescens*, the whole trend of the evidence standing against Desfontaines's and Boissier's decisions. The correct binomial for the plant called by these authors *E. pubescens* is *E. crispata* Hornem., so far as I may learn from the literature. It is strange that Vahl's species, not to mention misapplications, should have accumulated not less than four probable synonyms, as follows: (1) *E. vahlii* Jacq. Ecl. 1: 99. in not. 1813; (2) *E. vahliana* Guss. Syn. Fl. Sic. 2: 829. in not. 1843; (3) *E. bonae* Mutel, Fl. Franç. 3: 151. (in not.) 1836; (4) *E. cossoniana* Boiss., in DC. Prodr. 15<sup>2</sup>: 135. 1862; Vahl, Mutel, and Boissier practically giving the same descriptions and suggesting the same comparisons with *E. helioscopia* L.

*Martínez* s. n., Chapultepec, near Mexico City, July, 1940, belongs to *E. crispata* Hornem. (*E. pubescens* auct., non Vahl), and is apparently the first record of this Mediterranean plant as an escape in American floras.

<sup>11</sup> DC. Prodr. 15<sup>2</sup>: 6. 1862.

<sup>12</sup> Ecl. 1: 98–99. pl. 66. 1813.

<sup>10</sup> *Op. cit.* 367.

BOTANY.—*Antagonism and parasitism among some oomycetes associated with root rot.*<sup>1</sup> CHARLES DRECHSLER, Bureau of Plant Industry.

Among the many species of *Pythium* that may be isolated, especially in wet seasons, from softened, discolored, or decaying portions of the roots, stems, or basal leaves of herbaceous cultivated plants, some prove ineffective, under ordinary circumstances, for bringing about the root rot, stem rot, or crown rot with which they were found associated. When these relatively innocuous fungi are not attended by more strongly pathogenic forms, their occurrence in diseased plants is usually held to derive from some limited capacity for parasitism whereby they are enabled to attack phanerogamic hosts that have become much weakened, or in part moribund, as the result of unfavorable external conditions. On the other hand, when, as very often comes to pass, an innocuous species is found accompanied by a demonstrably pathogenic form—or, perhaps, even by two or three such forms—there is reason to presume usually that it entered the plant as a secondary invader, and then propagated itself saprophytically by drawing nourishment from tissues already killed by an earlier invader. However, a more complicated system of biotic relationships would seem to obtain in many cases of root rot where any one of the three echinulate species I described under the names *P. oligandrum*, *P. acanthicum*, and *P. periplocum* (9) is present as secondary invader, since on transparent agar media these species freely display destructive parasitism on many root-rotting forms congeneric with them.

When, for example, *Pythium ultimum* Trow and *P. oligandrum* both grow out from a piece of decaying pea (*Pisum sativum* L.) root into a Petri plate of maize-meal-agar culture medium—as, indeed, has often happened in subjecting diseased pea roots from Maryland, Delaware, New Jersey, and New York, to procedure suitable for isolation of oomycetes—the former is attacked by the latter in spectacular manner. The same parasitic development can be brought to

light conveniently by planting the two fungi some distance apart on a maize-meal-agar plate. Along the line where the two growing mycelia meet, the advance of *P. ultimum* is abruptly halted and its hyphae become enveloped in innumerable places by intricately ramifying branches of *P. oligandrum* (Fig. 1). Soon these branches penetrate into the enveloped hyphae and extend prolongations longitudinally within them to assimilate the degenerating protoplasmic contents. Here and there the internal filaments send out ramifications that attack other hyphae of *P. ultimum*. Conidia and young oogonia of *P. ultimum* are also attacked, though apparently with less readiness than young vegetative hyphae. Often the destruction is so rapid and thoroughgoing that in only scattered portions of the *ultimum* mycelium is sexual reproduction permitted to reach a stage where the thick oospore wall affords reliable protection.

*Pythium debaryanum* Hesse and *P. irregulare* Buism. (3), which occur as casual agents of root rot and damping-off almost as frequently as *P. ultimum*, have likewise been observed undergoing violent attack by *P. oligandrum*, not only in dual cultures prepared purposely for such observation, taking place in the transparent medium merely continues the destruction, but also in isolation plate cultures where manifestly the destruction spontaneously begun in such natural substrata as tomato (*Lycopersicon esculentum* Mill.) roots, pansy (*Viola tricolor* L.) roots, sugar-beet (*Beta vulgaris* L.) seedlings, and peach (*Prunus persica* Sieb. & Zucc.) seedlings. *P. mammillatum* Meurs (13), often found in discolored rootlets of field tomatoes in Maryland and Virginia, is attacked by *P. oligandrum* in dual cultures no less severely than the three familiar damping-off species with which it belongs taxonomically as a member of an intimately interrelated series. In the same series must be included also an apparently undescribed species found occurring abundantly during May, 1939, on pansies seriously affected with root rot in the District

<sup>1</sup> Received July 16, 1942.

of Columbia; the fertilization of its large oogonia, which often measured 28 to 33 $\mu$  in diameter, by an antheridium consisting frequently of an adjacent hyphal segment, relating it more particularly to *P. ultimum*. This species, too, is very destructively parasitized by *P. oligandrum* in dual cultures, penetration of its hyphae being accomplished after they have been closely enveloped by ramifications of the spiny form (Fig. 2, A). Again, when *P. splendens* Braun, a species less intimately related to those commonly causing damping-off, is grown in dual culture with *P. oligandrum*, it suffers elaborate envelopment of its hyphae, which then are permeated longitudinally by narrow filaments of the spiny form and expropriated of their degenerating contents (Fig. 2, B). *P. salpingophorum* Drechsl. (9) similarly is attacked with spectacular effect, while *P. butleri* Subr., *P. graminicolum* Subr., and *P. arrhenomanes* Drechsl., as also the three interrelated prolific species I described under the names *P. helicoides*, *P. oedochilum*, and *P. palingenes* (9) suffer less severely in encounters with *P. oligandrum*.

As *Pythium acanthicum* and *P. periplocum* have only occasionally been obtained from softened or discolored roots, isolation plate cultures have afforded little opportunity for observing the behavior of these echinulate species toward the congeneric forms known to cause root troubles. However, when the two species are grown in dual cultures with various congeners pathogenic to phanerogamic plants, parasitic activity similar to that of *P. oligandrum* comes to light: *P. ultimum*, *P. debaryanum*, *P. irregulare*, *P. mammillatum*, *P. splendens*, *P. salpingophorum*, and the *ultimum*-like form found prevalent in pansy roots, being attacked in a most destructive manner, whereas, in general, *P. butleri*, *P. graminicolum*, *P. arrhenomanes*, *P. helicoides*, *P. oedochilum*, and *P. palingenes* incur less ruinous injury. That aquatic congeners are subject to similar adverse action is evident from the readiness with which, in dual cultures, delicate ramifications of *P. acanthicum* (Fig. 2, C, a; D, a) as well as of *P. periplocum* (Fig. 2, E, a) invest the hyphae of

*P. marsipium* (Fig. 2, C, b; D, b; E, b), a species I recently described (12) from decaying leaves of the white waterlily, *Nymphaea tuberosa* Paine.

The three species of *Pythium* thus given to attacking other members of the genus are distinguished, even when growing alone, by a delicate mycelial habit achieved through unusually abundant development of slender branches that arise laterally from axial filaments of moderate width. No such copious production of slender branches suitable for envelopment of alien hyphae occurs in the vegetative growth of *P. megalacanthum* de Bary *sensu* Buisman (3), a form associated with flax (*Linum usitatissimum* L.) scorch in The Netherlands, or of the two closely related American species, similarly provided with large oogonia, which I described (9) as *P. mastophorum* and *P. polymastum*. The separateness of the two spiny series, indicated by marked differences both in make-up of sexual apparatus and in mycelial texture, is further evidenced by ready parasitism of the three delicate species on all three of the coarse species. The parasitism of *P. acanthicum* on *P. mastophorum*, initiated by extensive envelopment of *mastophorum* filaments (Fig. 2, F), has in some instances led to more severe injury than usually eventuates in any of the other eight combinations of host and parasite that are possible between the two series. Since the oogonia of the coarse forms are often invaded even during relatively late stages in their growth, their capacious spiny envelopes often come to surround from three to six alien echinulate oogonia, each usually containing a mature oospore of normal structure.

*Pythium anandrum*, which I originally described from decaying underground buds of rhubarb (*Rheum rhaponticum* L.) in Maryland (9), and which more recently was also found associated with crown rot of rhubarb in California (14), has its oogonia ornamented with tapering protuberances that in general shape resemble the oogonial spines of *P. oligandrum*, but its mycelium lacks any extensive development of fine ramifications, being rather similar in coarseness and manner of branching to the myce-

lium of *P. debaryanum* or of *P. irregulare*. As might be expected, in view of such similarity, the species is attacked by *P. oligan-*

*drum*, though for the most part not with much severity. However, *P. acanthicum* and *P. periplocum* ordinarily show more pro-

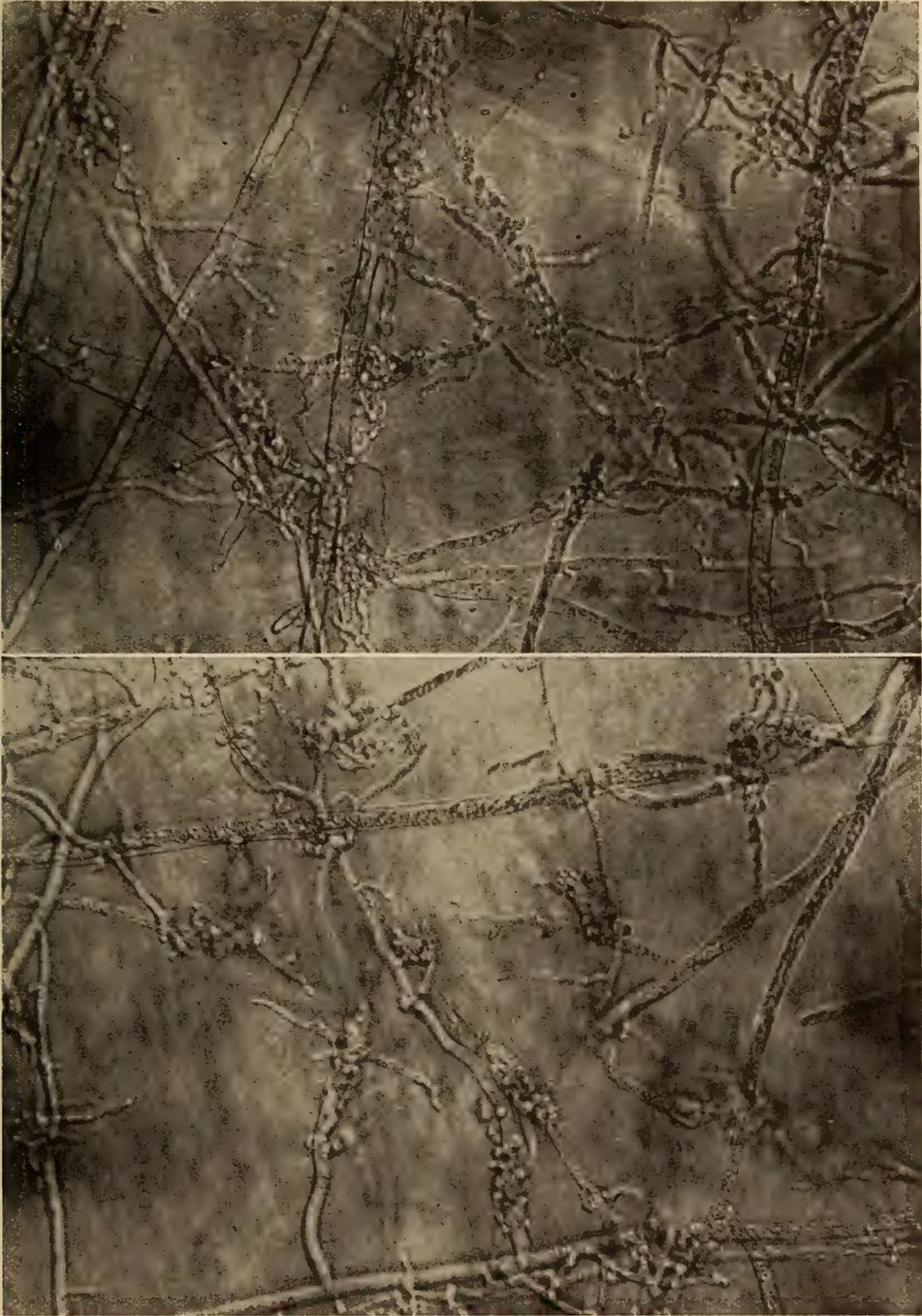


Fig. 1.—*Pythium oligandrum* attacking *P. ultimum* in dual culture on maize meal agar; approximately  $\times 400$ . Photomicrograph taken by Marguerite S. Wilcox.

nounced aggressiveness in their attack on *P. anandrum*, many of the hyphae enveloped by them being subsequently invaded and expropriated of contents. *Pythiogeton autossytum*, a pythiaceus fungus that I isolated and described (10) from softened leaf-sheaths of the common cat-tail, *Typha latifolia* L., also is attacked only feebly by *P. oligandrum*, yet suffers appreciable injury when grown in dual culture with either *P. acanthicum* or *P. periplocum*. Wherever a filament of *P. periplocum* (Fig. 2, G, a; H, a) encounters one of *P. autossytum* (Fig. 2, G, b; H, b) it envelops the latter with branches whose somewhat lobate, rounded tips evidently become affixed by means of an adhesive secretion, after the manner of appressoria.

While *Pythium oligandrum* thus is inimical in varying degree to many pythiaceus fungi, it is itself affected unfavorably by a number of oomycetes found associated with root rot. When grown in dual culture with the congeneric *P. complens* Fischer [= *P. gracile* Schenk *sensu de Bary* (1, 2), *P. gracile* (de Bary) *sensu Ward* (16), *P. torulosum* Coker & Patterson (4)], which occurs widely in the decaying roots of numerous phanerogamic plants, including, for example, pansies, peas, sugar beets, beans (*Phaseolus vulgaris* L.), spinach (*Spinacia oleracea* Mill.), and sugar cane (*Saccharum officinarum* L.), a few of its hyphae are attacked and invaded for short distances (Fig. 3, A). It suffers much more severe injury from *Plectospira myriandra* Drechsl., a saprolegniaceous fungus originally isolated from tomato rootlets (7). A growing mycelium of *P. oligandrum* is abruptly halted in its advance wherever it encounters a growing mycelium of *P. myriandra*. Everywhere in the zone of encounter the hyphae of *P. oligandrum* are elaborately enveloped by ramifications put forth from axial filaments of *P. myriandra* (Fig. 3, B). An increased opaqueness of the enveloped hyphae soon announces the onset of progressive disorganization within them. Some of the affected hyphal parts are penetrated and invaded lengthwise, with consequent disappearance of their degenerating protoplasmic materials; though, on the whole, utilization of

such materials would seem hardly commensurate with the expenditure entailed in enwrapping the *Pythium* filaments.

Injury from encounter with *Plectospira myriandra* is incurred likewise by *Pythium periplocum* and *Pythium acanthicum*, and in varying measure also by many other congeneric species less intimately related to *Pythium oligandrum*, including those most frequently found responsible for damping-off, root rot, stem rot, and fruit rot. Moreover, destructive behavior toward pythiaceus fungi is not limited to *P. myriandra*, but is displayed with equally telling effect by three root-rotting strains of *Aphanomyces* obtained from infected roots,—two of the strains in question having been isolated from discolored roots of flax and spinach, respectively (11), several years before the third was isolated from softened cortex of a pansy root dug up in Arlington, Va., on May 4, 1939. Judging from the origin and positional relationships of their antheridial branches, the flax and spinach strains appear certainly referable to *A. cladogamus*, a species I based originally on cultures obtained from tomato rootlets (8); and the pansy strain, despite some aberrance, would seem better referable to this species than to any other hitherto described. At all events the three strains, when grown in dual culture with numerous species of *Pythium*, show decided parallelism in their strongly antagonistic behavior. Thus, when the spinach strain encounters the pythiaceus form from decaying waterlily leaves, which, owing to its production of very large globose intramatrical reproductive bodies, appears identical with the form that Dissmann (6) assimilated to *P. undulatum* Pet., it puts forth elaborate ramifications to envelop and destroy the alien hyphae (Fig. 3, C) much after the same manner in which the pansy strain puts forth elaborate ramifications to envelop and destroy hyphae of *P. dissotocum* Drechsl. (Fig. 3, D), a species causing important damage to sugar cane under unfavorable conditions (15).

Less aggressive antagonism is usually displayed by *Aphanomyces cochlioides* Drechsl., a water mold often causing damping-off and root rot of sugar beets in wet fields (8).

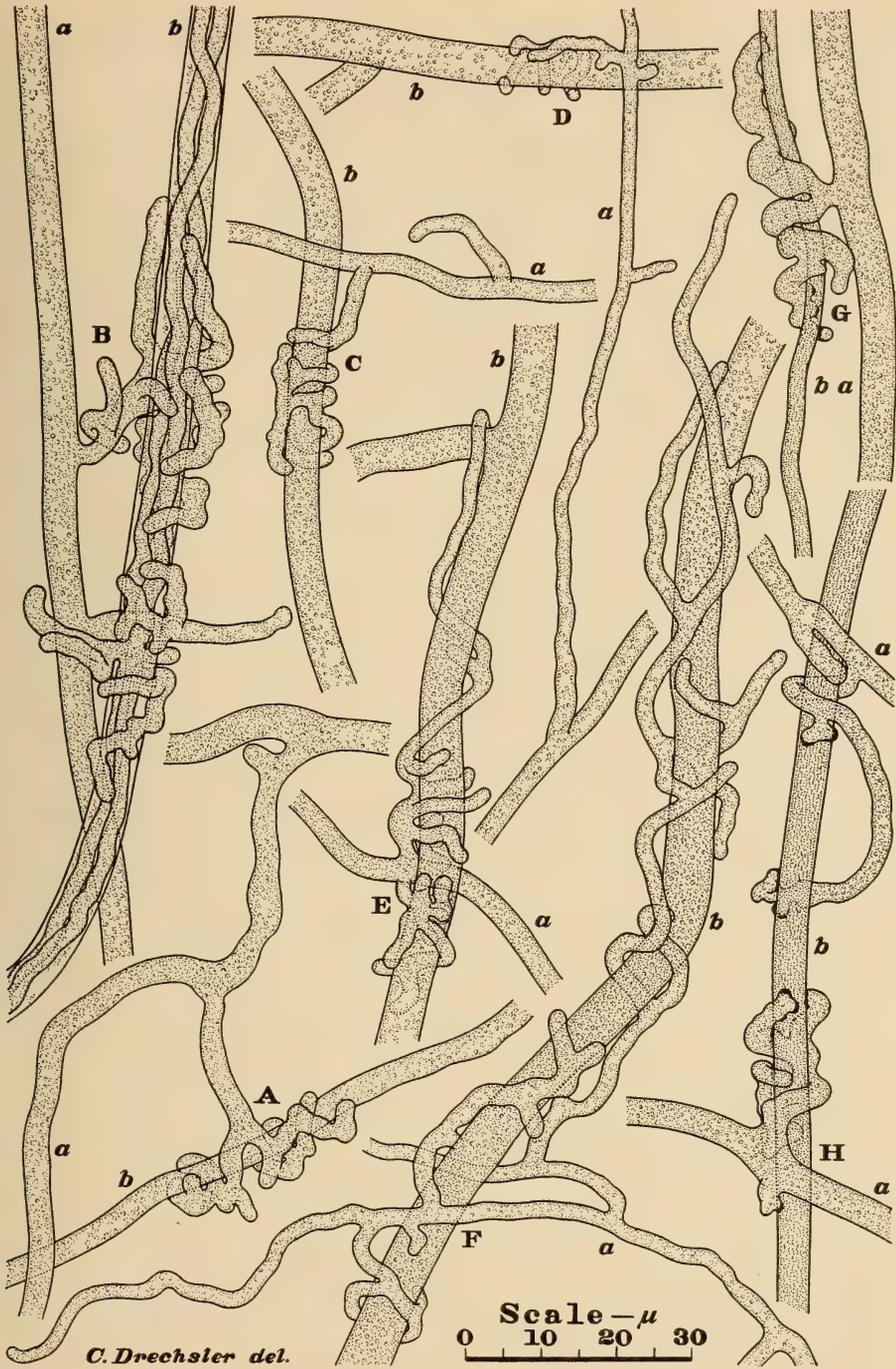


Fig. 2.—Attack of three echinulate species of *Pythium* on several pythiaceous fungi in dual cultures; all parts drawn to a uniform magnification with the aid of a camera lucida;  $\times 1000$ . A, *Pythium oligandrum*, a, enveloping a filament of an *ultimum*-like congeneric species from pansy roots, b. B, *P. oligandrum*, a, enveloping and invading a filament of *Pythium splendens*, b. C, D, *Pythium acanthicum*, a, enveloping *Pythium marsipium*, b. E, *Pythium periplocum*, a, enveloping a filament of *P. marsipium*, b. F, *Pythium acanthicum*, a, enveloping a filament of *Pythium mastophorum*, b. G, H, *Pythium periplocum*, a, enveloping *Pythiogeton autossytum*, b.

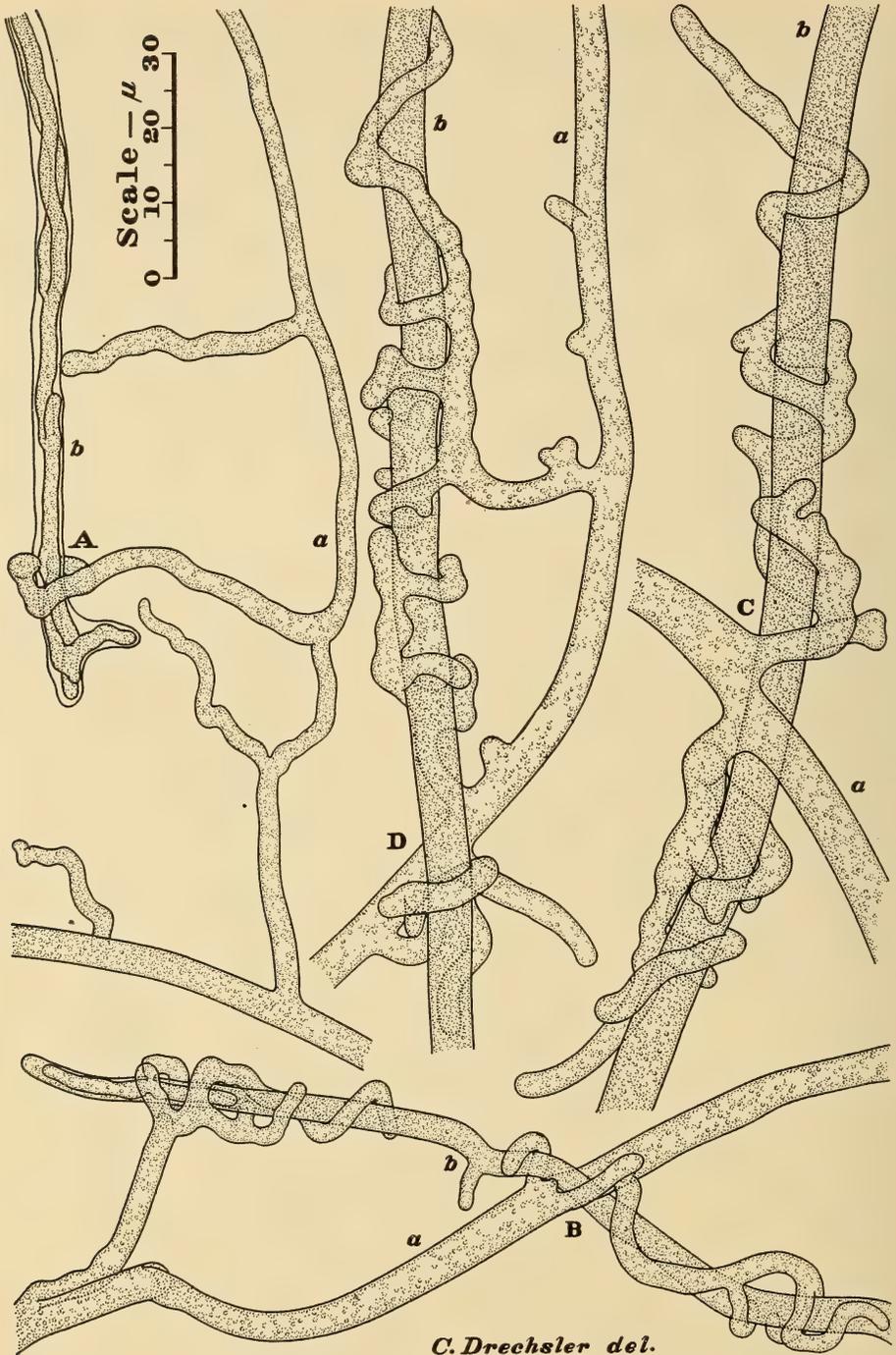


Fig. 3.—Harmful relationships between various oomycetes; all parts drawn to a uniform magnification with the aid of a camera lucida;  $\times 1000$ . A, *Pythium complens*, a, attacking and invading *Pythium oligandrum*, b. B, *Plectospora myriandra*, a, attacking *P. oligandrum*, b. C, Spinach strain of *Aphanomyces cladogamus*, a, attacking a filament, b, of *Pythium undulatum* sensu Dissmann. D, Pansy strain of *A. cladogamus*, a, attacking *Pythium dissotocum*, b.

When this saprolegniaceous parasite encounters *Pythium debaryanum* or *P. mamillatum* in dual culture, it abruptly halts the advance of the alien mycelium and causes protoplasmic degeneration in terminal portions of alien hyphae along the zone of encounter; the injury evidently coming about, for the most part, from mere proximity, since often no special involvement of alien hyphae can be detected. Growing in opposition to *P. myriotylum* Drechsl., which frequently is responsible for field decay of watermelon fruits in Florida, *A. cochlioides* has sometimes been observed extending rangy hyphae to wind loosely about alien filaments here and there, and occasionally has, in addition, been seen putting forth short branches to promote protoplasmic degeneration in these filaments, or even to invade them internally on a small scale.

From their pathogenic behavior under experimental conditions there is reason to believe that both *Aphanomyces cochlioides* and *A. cladogamus* operate mainly as direct parasites on the phanerogamic plants in which they occur habitually. The direct parasitism of *Pythium periplocum* and *P. acanthicum* in causing blossom-end rot of watermelon (*Citrullus vulgaris* Schrad.) fruits could not readily be questioned even if experimental evidence of their infective capabilities were lacking, for when occurring in specimens of this rot the two echinulate species are usually unaccompanied by other likely agents of decay. In the ecological assemblage of oomycetes here under consideration, a capacity for bringing about disease in higher plants can manifestly coexist with a capacity for attacking and injuring other members of the assemblage. However, as the several saprolegniaceous fungi hitherto found attacking higher plants all have smooth oogonia, it appears probable that the spiny *A. exoparasiticus*, described by Couch (5) as being parasitic on various phycomyces, may not be pathogenic to any species of phanerogams.

The parasitic and antagonistic relationships between oomycetes associated with root rot come into strongest expression where both of the fungi concerned are in a

high state of vegetative vigor. In dual cultures that have been started by planting the two species some distance apart hyphal envelopment and hyphal degeneration, if present, is always most pronounced in the narrow zone where the growing mycelia encounter each other, that is, in the zone where, without exception, young vigorous hyphae of the aggressor come upon equally young hyphae of the opposing form. Dual cultures incubated at a temperature of 28°C., which is fairly close to the optimum temperature for mycelial growth in many species of *Pythium*, usually show more extensive hyphal envelopment than similar cultures incubated at 18°C. Hyphal envelopment is usually more abundant when rather soft maize meal agar, containing 15 grams of agar-agar to the liter, is employed than when the medium used contains 25 grams of agar-agar to the liter. As *Pythium oligandrum*, *P. acanthicum*, and *P. periplocum* initiate and conclude sexual reproduction earlier than most congeneric forms, and as they usually exhaust their mycelia almost completely in producing sexual apparatus, areas in dual cultures first occupied by these species may later be invaded by other species of *Pythium* without much hindrance except, perhaps, from accumulated staling products.

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## ZOOLOGY.—A redescription of *Typhlonema salomonis* Kreis (*Nematoda*).<sup>1</sup>

JOHN T. LUCKER, Bureau of Animal Industry.

Male and female specimens of a nematode from the digestive tract of skinks of the genus *Mabuya*, collected in 1939 in Belgian Congo by Arthur Loveridge, of the Museum of Comparative Zoology, Harvard University, are believed by the writer to represent *Typhlonema salomonis* Kreis, 1938. This genotype was based on female characters, and partly because of this the systematic position of the genus *Typhlonema* has been regarded as uncertain.

The available specimens are not from the type host or locality of Kreis's species. The writer's identification of them, therefore, is based entirely on morphological grounds. It should be emphasized, however, that there are certain discrepancies between the morphology of the females, as determined by the writer, and the characteristics ascribed to *T. salomonis* by Kreis.<sup>2</sup> The African specimens have an anus, weakly developed, but distinct, equal lips and the typical ascaridoid complement of cephalic papillae. In view of well-established facts concerning the structure of ascaridin nematodes generally, it seems very likely, however, that a reexamination of Kreis's specimens, if undertaken, will show that they

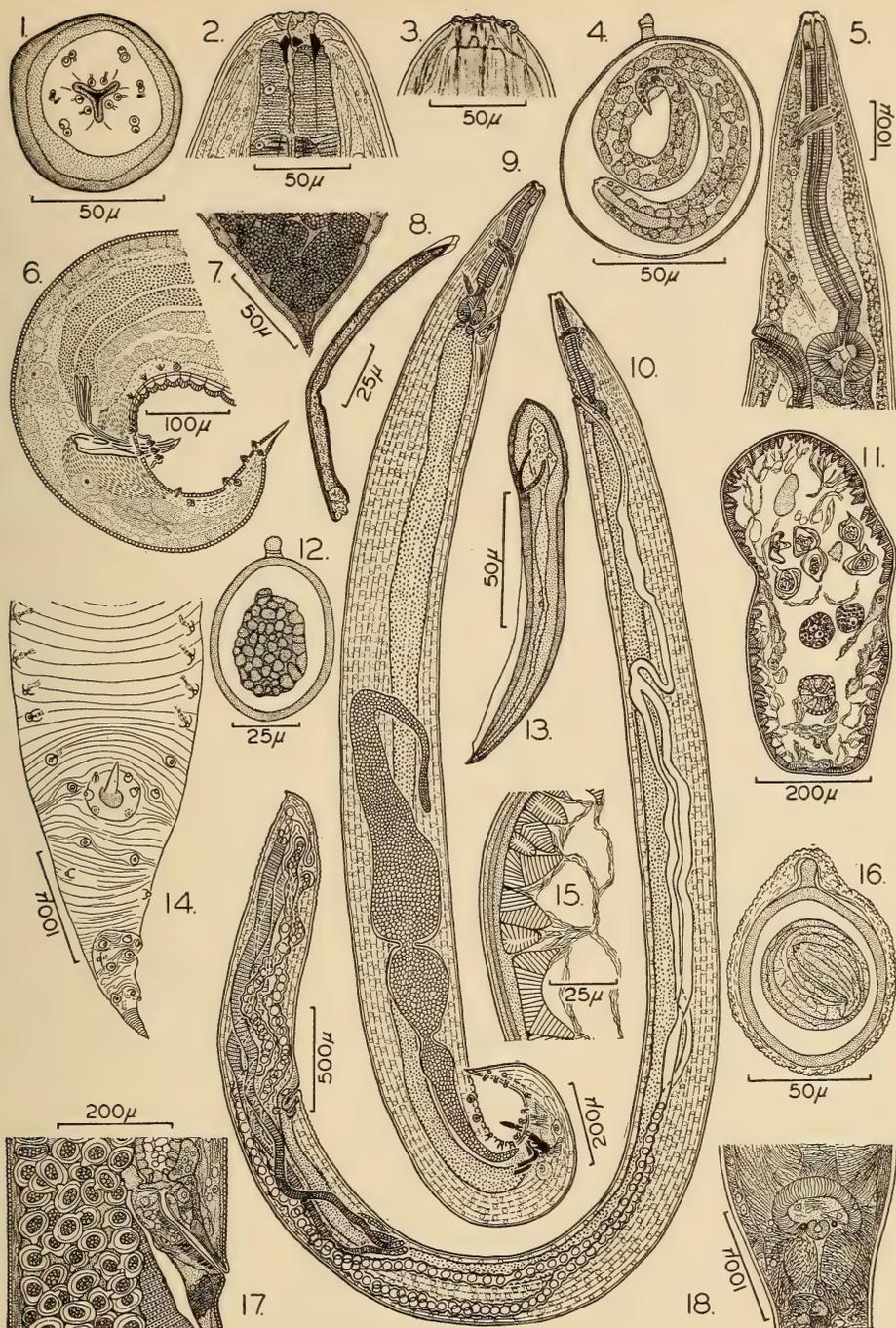
also have an anus and the usual number, as well as a normal distribution, of cephalic papillae. Hence, because the available females agree with Kreis's description in the important points of vulva position and structure of eggs, both of which are unusual, as well as in many other details, the writer has no hesitancy in regarding them as belonging to the genus *Typhlonema*. Also, there appears to be no acceptable evidence and little chance that the specimens from *Mabuya* differ specifically from Kreis's specimens from *Gecko*. Therefore, there is here presented, as a recharacterization of *T. salomonis*, the following description of the female and male specimens from Africa in an effort to delineate more satisfactorily the characteristics and affinities of *Typhlonema*.

### *Typhlonema salomonis* Kreis, 1938

*Description*.—Lips flat, weakly developed; each probably corresponding to apical portion only of typical ascaridoid lip. Cephalic papillae of internal circle very prominent; amphids and the four double papillae of external circle well developed; ventrolaterals present, but small and rather weakly developed (Figs. 1, 3). Oral opening roughly triangular; stoma small, apparently consisting of sclerotized protorhabdions partly surrounded by esophageal tissue (Fig. 2). Esophagus with short, histologically differentiated vestibule (Figs. 2, 5); corpus

<sup>1</sup> Received September 29, 1942.

<sup>2</sup> KREIS, HANS A., *Beiträge zur Kenntnis parasitischer Nematoden. VIII. Neue parasitische Nematoden aus dem Naturhistorischen Museum Basel*. Zentrabl. Bakteriol., 1 Abt. Orig., **142** (5-6): 329-352. 1938.



Figs. 1-18.—*Typhlonema salomonis*: 1, Head (female), *en face* aspect. 2, Anterior extremity (female), optical section through protorhabdions and vestibule, slightly oblique dorsal aspect. 3, Cephalic region (female), showing papillae of dorsal lip, superficial dorsal aspect. 4, Egg from anterior portion of uterus, embryonated but lacking protein coat, optical section. 5, Female, esophageal region, lateral aspect. 6, Male, caudal region, lateral aspect. 7, Female, tip of tail, lateral aspect. 8, Spicule (left), lateral aspect. 9, Male, lateral aspect. 10, Female, lateral aspect. 11, Cross section (female) slightly anterior to anus, showing musculature. 12, Egg from posterior portion of uterus, in cleavage stage, optical section. 13, Gubernaculum, lateral aspect. 14, Male, caudal region, ventral aspect. 15, Portion of cross section (female), showing muscle cells. 16, Egg from ovijector, embryonated and with fully developed protein coat, optical section. 17, Female, anal region, lateral aspect. 18, Male, optical section through cloacal region, showing appearance of muscles slightly beneath ventral surface.

highly muscular, proportionately long, slender, of almost uniform diameter except for slight swelling in postcorporeal region; isthmus short, but definite, of lesser diameter than postcorpus; bulb ovoid, well developed, containing well developed valvular apparatus (Fig. 5). Deirids apparently absent. Excretory pore at level between bulb and postcorpus of esophagus; terminal excretory duct moderately long (Fig. 5). Lateral alae, narrow, distally bifid, extending from near cephalic region to near cloacal region in male; absent in female. Musculature, polymyarian-platymyarian in anterior part of body and polymyarian-coelomyarian in midbody (Figs. 11, 15). Body laterally compressed in some fixed specimens (Fig. 11), except in esophageal region, but nearly cylindrical in others.

*Female*.—Maximum length in available specimens about 16.85 mm; length in young, but gravid specimens ranging down to about 8.5 mm. Body of more or less uniform diameter except for gradual tapering in anterior one-tenth to cephalic extremity (diameter about 40–50 $\mu$ ) and sudden tapering posteriorly to tip of tail. Maximum dorsoventral width about 0.59 mm in large specimens and about 0.30 mm in smallest specimens. Anus (Figs. 10, 17) unusually far removed from posterior extremity. Tail long, equivalent to about one-sixth to one-fifth of body length; diameter throughout most of its length almost as great as that of midbody; tapering in its extreme posterior portion only and terminating in a small acutely pointed process (Figs. 7, 10). Vulva prominent, located alongside bulb, isthmus, or postcorpus of esophagus, behind excretory pore (Figs. 5, 10). Reproductive system opisthodelphic; in young specimens the moderately long vagina passes posteriorly from the vulva to a long ovijector which unites with two slender parallel uteri which extend posteriorly into the tail region, sometimes nearly to posterior tip of body where they unite with oviducts; oviducts reflexed anteriorly and somewhat coiled, leading to ovaries which pass anteriorly and parallel to region just anterior to anus where their tips are reflexed posteriorly (Fig. 10). In fully grown specimens the uteri are somewhat distended and coiled, particularly in caudal region, sometimes entwined about intestine and sometimes also coiled anteriorly and extending almost to

region of esophageal bulb so fundamental plan of reproductive system is obscured. Ovoviviparous; uterine eggs of eccentric oval to spherical shape, provided with monopolar knob, and of roseate hue, the coloration apparently localized in perivitellus space. Eggs in posterior portions of uteri in various cleavage stages, of variable size, tending to be distorted by pressure, with moderately thick, dense shell provided with monopolar thumb-like projection (Fig. 12); in middle portions of uteri some eggs embryonated, frequently with shell thinner than in less developed or mature eggs and also tending to be larger than these eggs (Fig. 4); in anterior portions of uteri, in oviduct and vagina, the eggs are larvated, almost spherical and are provided with well-developed rugose, mammillated protein coat anchored in part to true shell by monopolar thumblike process of latter and forming around this process a bluntly rounded knob (Fig. 16), the true shell being thicker than in uncoated embryonated eggs, apparently as result of compression. Fully developed eggs are about 60 $\mu$  to 87 $\mu$  long, including the monopolar knob, and about 50 $\mu$  to 60 $\mu$  wide.

*Male*.—Much shorter and comparatively more robust than female; about 3.1 mm long by about 0.24 mm in maximum dorsoventral width; esophagus about 0.37 mm long. Reproductive system simple (Fig. 9); testis reflexed near middle of body. Tail subulate, terminating in an extremely minute spike, curved sharply ventrad and anteriorly in available fixed specimens; about 0.22 to 0.24 mm long. Cuticle in region just anterior to cloaca thrown up into prominent transverse folds not appearing to be homologous with mamelons and not bearing plectanes, appearing to be provided with close-set longitudinal intrastrial ridges. Preanal sucker absent, but circumcloacal elevation present (Figs. 6, 9, 14); arrangement of musculature in pericloacal region as shown in figure 18; caudal alae absent. Caudal papillae consisting of 16 pairs, including 5 preanal sublateral pairs and 11 pairs distributed as follows: 4 subventral pairs in the circumcloacal or adanal position, 3 of them on the circumcloacal elevation and 1 lateral to it; 7 definitely postanal pairs, 4 of them subventral (first, third, fifth and seventh pairs from the caudal tip) and 3 sublateral (second, fourth and sixth pairs

from caudal tip; Fig. 6). The posteriormost pair on the circumcloacal elevation is weakly developed (Fig. 14). Five pairs of the postanals are grouped near the caudal tip; the two sub-lateral pairs in this group are smaller than the three subventral pairs (Fig. 14). Gubernaculum cuneiform, very prominent, robust, strongly sclerotized, alate, about 0.143 mm long; provided with a proximal pair of triangular latero-ventrally directed wings; distal tip usually protruding from cloacal opening and rather sharply pointed (Figs. 6, 9, 13, 14). Spicules two, elongate, very slender, about 0.130 mm long, lightly sclerotized, slightly expanded proximally, with bluntly pointed alate hyaline distal tip (Figs. 6, 8, 9).

*Hosts.*—*Gecko vittatus* Hoult. (type host); *Mabuya striata* (Peters); *Mabuya megalura* (Peters).

*Location.*—Stomach and intestine.

*Distribution.*—Makira, Solomon Islands; Molinga River, Idjwi Islands, Belgian Congo.

*Specimens.*—U.S.N.M. Helm. Coll. nos. 40695; 40698; 45308. (Specimens also in Museum of Comparative Zoology, Harvard Univ.)

*Remarks:* Kreis<sup>2</sup> placed *Typhlonema* in the Oxyuroidea and in the subfamily Oxyurinae. Walton,<sup>3</sup> in a key to some oxyuroid genera from reptiles, tentatively included the genus under the Oxyuridae, remarking on the difficulty of placing it systematically and stating that it shows affinities to both Atractidae and Oxyuridae. On the basis of the foregoing description, it is the writer's opinion that *Typhlonema* belongs in the Ascaridoidea, as conceived by Chitwood and Chitwood,<sup>4</sup> and in the family Cosmocercidae. Although the musculature in *Typhlonema* is polymyarian, whereas the family Cosmocercidae is characterized by authors as meromyarian, in other respects the genus appears to be far more closely related to certain cosmocercid genera than to any belonging in the four other ascaridoid families recognized by the Chitwoods.

<sup>3</sup> WALTON, A. C. *Some oxyurids from a Galapagos turtle.* Proc. Helm. Soc. Washington 9(1): 1-17. 1942.

<sup>4</sup> CHITWOOD, B. G., and CHITWOOD, M. B., *An introduction to nematology*, sect. 1, pt. 1, 53 pp. 1937.

## PROCEEDINGS OF THE ACADEMY

### 378TH MEETING OF THE BOARD OF MANAGERS

The 378th meeting of the Board of Managers was held in the library of the Cosmos Club on November 16, 1942. President CURTIS called the meeting to order at 8:01 P.M., with 17 persons present, as follows: H. L. CURTIS, F. D. ROSSINI, R. J. SEEGER, J. E. GRAF, F. H. H. ROBERTS, Jr., F. G. BRICKWEDDE, F. C. KRACEK, W. G. BROMBACHER, F. M. SETZLER, H. L. HALLER, A. WETMORE, F. B. SILSBEE, E. W. PRICE, L. W. PARR, H. G. DORSEY, and, by invitation, G. A. COOPER and A. SEIDELL.

The minutes of the 377th meeting were read and approved.

President CURTIS announced the appointment of F. B. SILSBEE (chairman), J. E. GRAF, and C. L. GARNER to constitute a special committee to consider recommendations for increasing the income of the Academy.

For the committee to consider ways and means of decreasing the expenses of the Academy, Chairman BRICKWEDDE presented a complete and detailed report embodying a number of recommendations. In acting upon this report, the Board authorized the appointment of a special committee to consider a

change in the number of issues of the JOURNAL from 12 monthly to 6 bimonthly issues a year without decreasing the total number of pages or the amount of material published each year, and also to consider a change in the kind of printing of the JOURNAL from the present typeset printing to a photographic offset process. Suggestions regarding certain other possible economies were referred to the 1943 Executive Committee.

For the committee to consider recommendations for increasing the income of the Academy, Chairman SILSBEE presented a complete and detailed report. As a result of the suggestions made, the Board authorized the appointment of a committee to contact the U. S. Office of Coordinator of Inter-American Affairs with regard to the purchase by them of subscriptions to the Academy's JOURNAL for transmission to the more important libraries in South America.

The Secretary reported the deaths of two members.

Senior Editor SEEGER reported that the December number of the JOURNAL might need to be sharply curtailed to insure keeping within the 1942 allotment. The Board authorized the Editors to expend, if necessary, up to \$65

beyond their 1942 allotment to prevent curtailing the December number of the JOURNAL unduly. The extra allotment thus provided is the amount of estimated balances unexpended from other items in the 1942 budget of the Academy.

The changes in the Standing Rules of the Board, proposed at its previous meeting, were approved, as follows:

(1) Under the present Rule 3, delete the present version and substitute the following: "There shall be four standing committees, as follows: Executive Committee, Committee on Meetings, Committee on Membership, and Committee on Monographs. Two members of the Board shall be appointed to serve on the Executive Committee. The Committee on Membership shall include at least three persons reappointed from the preceding year. All appointments shall be for one year unless otherwise specified, and shall be made by the President, who shall announce them at the first meeting of the Board following the annual meeting."

(2) Under the present Rule 8, delete the second sentence.

(3) Between the present Rules 6 and 7, insert the following new Rule: "Associate Editors of the JOURNAL shall be appointed by the President for a term of three years."

The Board instructed the Custodian and Subscription Manager of Publications, W. W. DIEHL, to provide the Board with information on the list of free subscriptions to the JOURNAL and on the number and distribution of Government subscriptions.

The meeting adjourned at 10:38 p.m.

#### 314TH MEETING OF THE ACADEMY

The 314th meeting of the Academy was held jointly with the Philosophical Society of Washington in the Assembly Hall of the Cosmos Club at 8:15 p.m. on November 19, 1942, with President CURTIS presiding. W. G. BROMBACHER introduced the speaker.

DEANE B. JUDD, physicist in the section on photometry and colorimetry at the National Bureau of Standards, delivered an address on *Color blindness and its relation to the detection of camouflage*. Dr. JUDD indicated the requirements for camouflaging ground positions correctly, showed which of these requirements can be met in a practical way, and described under what conditions color-blind observers can spot certain camouflaged positions.

There were about 135 persons present.

FREDERICK D. ROSSINI, *Secretary*.

## Obituary

ALFRED N. FINN, chief of the glass section, National Bureau of Standards, died on September 21, 1942, at Lincoln, Nebr. He had been in ill health for the past year and had retired from active work.

Mr. Finn was born in Denver, Colo., in 1882. He received his A.B. degree in 1906 and his M.A. in 1909 from the University of Denver. After several years as an instructor at the University of Denver he was appointed in 1911 as an assistant chemist at the National Bureau of Standards. His work dealt with cements, paints and oils, boiler waters and boiler compounds, protective coatings for metals, and corrosion of ferrous and nonferrous alloys. In 1919 he accepted a position as chief chemist

and metallurgist for the Hydraulic Steel Co., Cleveland, Ohio, but later returned to the Bureau as chief of the glass section.

Mr. Finn was an authority on glass technology and had charge of the Bureau's production of optical glass. He also directed the making of a glass disk 70 inches in diameter and 11 inches thick for use as a reflector in an astronomical telescope now in use at the Ohio Wesleyan University. He had been a member of the following organizations: Washington Academy of Sciences, American Chemical Society, American Ceramic Society, American Society for Testing Materials, Optical Society of America, and American Institute of Chemists.

P. H. BATES.



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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 monthly, on the fifteenth of each month. Volumes correspond to calendar years.

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# JOURNAL

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No. 2

ORNITHOLOGY.—*Two new birds from Morelos, Mexico.*<sup>1</sup> PIERCE BRODKORB, University of Michigan Museum of Zoology. (Communicated by HERBERT FRIEDMANN.)

While studying the Mexican birds belonging to the United States National Museum and to the Fish and Wildlife Service, United States Department of the Interior, I discovered two previously unrecognized subspecies from Morelos and neighboring states. For permission to describe these forms I am under obligation to Dr. John W. Aldrich, biologist of the Fish and Wildlife Service. This study was aided by a grant from the Faculty Research Fund by the Horace H. Rackham School of Graduate Studies in the University of Michigan.

***Chamaethlypis poliocephala pontilis*,**  
n. subsp.

*Type*.—U.S.N.M. 186396; adult male; Puente de Ixtla, Morelos; June 8, 1903; E. W. Nelson and E. A. Goldman, original no. 10144.

*Characters*.—Agrees in color with *Chamaethlypis poliocephala poliocephala* (Baird), from Sinaloa to Nayarit, but wing and tail longer.

Agrees with *C. poliocephala ralphi* (Ridgway), from Texas, in having whitish eyelids and pale posterior underparts (i.e., lower breast and belly mixed with pale yellow, white, and buffy; flanks pale buffy brown), but throat and upper breast deeper yellow; back more olive, less grayish; wing and tail longer.

Differs from *C. poliocephala palpebralis* Ridgway, from Caribbean Mexico, in having whitish (instead of yellowish) eyelids; paler coloration throughout; and larger size.

*Chamaethlypis poliocephala caninucha* (Ridgway) and *C. poliocephala icterotis* (Ridgway), both from Central America, have black eyelids and are smaller and much more brightly colored.

<sup>1</sup> Received October 29, 1942.

*Measurements*.—Four males: wing, 61.5–63 (62.3); tail, 66–68.5 (67.3). Three females: wing 55.5–58.5 (57.0); tail, 59.5–61.5 (60.3).

In *poliocephala* the wing measures 57–58.5 in the male (♀ 52); tail, 60.5–62 (♀ 57.5). In *ralphi* the wing is 57.5–60 (♀ 52.5–55); tail, 57.5–65 (♀ 56.5–58.5). In *palpebralis* the wing is 54.5–60 (♀ 53–57); tail, 56.5–65 (♀ 55.5–62).

*Range*.—Pacific watershed of central Mexico, in states of Morelos and Michoacán.

*Material examined*.—Morelos (Puente de Ixtla, 1; Yautepec, 1); Michoacán (Queréndaro, 1; Zamora, 1; Los Reyes, 2). Also adequate series of the described forms, including the types of *poliocephala*, *ralphi*, *palpebralis*, *caninucha*, and *icterotis*.

***Sicalis luteola mexicana*,** n. subsp.

*Type*.—U.S.N.M. 186386; adult male; Puente de Ixtla, Morelos; June 8, 1903; E. W. Nelson and E. A. Goldman, original no. 10149.

*Characters*.—Differs from *Sicalis luteola chrysops* Selater, of the Caribbean slope of Mexico, in larger size; paler, more golden yellow (less greenish yellow) crown, rump, and underparts; dark streaks of crown narrower and not extending forward beyond eye.

*Measurements*.—Eleven males: wing, 68–72.5 (70.0); tail, 43–49 (45.8). Two females: wing, 66–70 (68.0); tail, 43.5–46 (44.8).

In *chrysops* 13 males measure as follows: wing, 63–67 (65.8); tail, 41–44.5 (43.7). Three females: wing, 60–65 (62.0); tail, 41–43.5 (42.0).

*Remarks*.—The type of *chrysops*, for which the locality is given simply as "Mexico merid.," was received from the dealer Parzudaki. The figure of the type (Ibis, 1872: pl. 2, fig. 1) clearly indicates a dark bird. The measurements of the type published by Selater (Proc. Zool. Soc. London, 1861: 376) and by Sharpe

(Cat. Birds Brit. Mus. 12: 384. 1888) are not identical, yet both sets of measurements show that the type was a small individual. I therefore restrict the type locality of *chrysops* to Orizaba, Veracruz, where the small, dark subspecies currently passing under the name is known to occur, and which town was a likely place of origin for a collection in 1861.

This species of finch was heretofore unknown in literature from the Pacific side of Mexico.

*Range*.—Pacific watershed of central Mexico, in states of Morelos and Puebla.

*Material examined*.—*S. l. mexicana*: Morelos (Puente de Ixtla, 12); Puebla (Atlixco, 2). *S. l. chrysops*: Veracruz (Orizaba, 1); Chiapas (Palenque, 15).

ENTOMOLOGY.—*New genera and species of Neotropical bark beetles (Coleoptera: Scolytidae).*<sup>1</sup> M. W. BLACKMAN, Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

Described here are two new genera of Neotropical bark beetles, belonging to the subfamily Ipinae, tribe Pityophthorini, one of them containing two and the other three previously undescribed species. One of the genera is based upon material in the United States National Museum and recognized as new for a number of years, while the other is from material only recently received from Panama.

#### *Gnatholeptus*, n. gen.

Very similar to *Pityophthorus* Eichhoff in habitus and in many structural details. Body subcylindrical, weakly to moderately shining; frons flattened, finely, closely punctured with fine hairs in the female; eye large, emarginate, facets coarse; antenna similar to that of *Pityophthorus*, with club distinctly longer than 5-segmented funicle, ovate, with first two sutures strongly but incompletely septate; mandible long, slender, curved, extending well in front of rest of mouthparts, biting surface gougelike, comprising one-fourth or less of inner margin; pronotum margined at base, with anterior area concentrically asperate, summit rather low, with weak transverse impression; elytral declivity sloping, weakly to moderately sulcate at each side, third interspace with or without granules, vestiture moderate.

Genotype: *Gnatholeptus mandibularis*, n. sp.

This genus, although superficially similar to *Pityophthorus* and, indeed, much like certain of the species groups of that genus in many details such as antennal structure, can immediately be separated by the extraordinary development of the mandibles. In all known spe-

cies of *Pityophthorus*, as well as in most of the Scolytidae, the mandibles are short and stout, with the biting or chewing surface comprising nearly all the inner margin. In *Gnatholeptus*, however, the mandibles are long, curved, and comparatively slender. As their bases are widely separated and as only the distal fourth to sixth meet to form the biting surface, they form a sort of arch through which the ventral mouthparts may be seen.

It would be interesting to know the feeding habits and mode of life of *Gnatholeptus* to see what advantage is gained by such unusual mandibles. All the specimens of this genus, however, were taken at light, and nothing is known of their food or habits.

#### *Gnatholeptus mandibularis*, n. sp.

*Female*.—Light reddish brown; 1.77 mm long, 3.10 times as long as wide.

Frons convex above, finely, sparsely punctured, shining, flattened between eyes below, feebly concave in median area, finely, densely punctured, with a dense brush of fine, yellow, plushlike pubescence of moderate length. Eye rather large, half divided by a deep, V-shaped emargination, facets rather coarse. Antenna similar to that of *Pityophthorus*, with club 1.44 times as long as 5-segmented funicle, 1.30 times as long as wide, widest through third segment; sutures arcuate, the first two strongly but incompletely septate. Mandible long, slender, with biting surface confined to only the distal fourth of the inner margin.

Pronotum 1.18 times as long as wide, widest on posterior half; posterior border margined, feebly arcuate, posterior angles scarcely rounded; sides straight and subparallel on posterior half, broadly rounded in front, anterior

<sup>1</sup> Received September 10, 1942.

margin with numerous low, very wide serrations; summit near middle, not high; anterior area with very broad, low asperities in nearly regular concentric rows; posterior area feebly, broadly impressed behind summit, finely, rather shallowly punctured, with interstices feebly shining, distinctly reticulate; median line narrow, weakly elevated, impunctate; vestiture of fine hairs on anterior area, disk subglabrous.

Elytra equal to pronotum in width and 1.64 times as long, 1.94 times as long as wide; sides nearly straight and subparallel on anterior three-fourths, rather broadly rounded at posterior angles, with extreme apex subacuminate owing to elevation of sutures; surface moderately shining; punctures moderately large, deep, in slightly irregular, rather crowded stria rows, only the first impressed; interspaces narrow, rugulose, nearly impunctate except at base and near declivity; disk and sides nearly glabrous. Declivity sloping, bisulcate; suture elevated throughout, more strongly at apex, with fine semierect hairs; first and second striae and intervening second interspace forming rather narrow, moderately deep sulcus, punctures much smaller than on disk, third interspace elevated, forming summit of lateral callosity, with a row of three small, rather pointed tubercles; interspaces finely punctured and with fine erect hairs.

Male unknown.

*Type locality*.—Barro Colorado Island, Panama.

*Host*.—Unknown.

*Type material*.—Holotype and 13 paratypes, U.S.N.M. no. 56418.

The type series was collected at light, June 20, 1941, by James Zetek.

#### *Gnatholeptus panamensis*, n. sp.

Rather light reddish brown (somewhat immature); 1.56 mm long, nearly exactly 3.0 times as long as wide; similar to *mandibularis*, n. sp., but with mandibles longer and each bearing a tuft of hairs, and elytral declivity without granules in third interspace.

Head retracted, concealing frons; epistomal margin in its median sixth extended to form a projection nearly three times as long as its basal width. Eye coarsely faceted, large, nearly half divided by a V-shaped emargination. Antenna similar in general to that of *mandibularis*.

Mandible even longer and more slender than in *mandibularis*, its shaft in middle third bearing a tuft of very fine, stiff, yellow hairs, arising from its dorsal surface and extending distad; biting surface confined to distal sixth of its inner margin.

Pronotum 1.19 times as long as wide, widest near base; posterior border margined, feebly arcuate, posterior angles scarcely rounded; sides very feebly arcuate, broadly rounded in front, anterior margin with many very low, broad serrations (more numerous and less developed than in *mandibularis*); anterior area with concentric rows of very low, broad asperities, fused to form nearly entirely regular, concentric ridges; summit rather low, at middle; posterior area feebly, transversely impressed behind summit; surface feebly shining, faintly reticulate; punctures fine, shallow; median line narrow, scarcely elevated, impunctate; disk subglabrous, anterior area with fine, short hairs.

Elytra equal to pronotum in width and 1.65 times as long, 1.91 times as long as wide; sides subparallel on anterior two-thirds, narrowly rounded, not acuminate behind; surface rather weakly shining; punctures deep, moderate in size, in nearly entirely regular rows, only the first impressed; interspaces moderate, slightly wider than in *mandibularis*, finely rugulose, nearly impunctate on central disk, with a few very fine, short hairs. Declivity more sloping than in *mandibularis*; suture rather wide, about equally elevated throughout, with a few fine, erect hairs; first stria strongly impressed, punctures obsolete; second stria not impressed, the narrow sulcus formed largely by impression of first stria; third interspace without granules and not so strongly elevated as in *mandibularis*; interspaces with a few fine punctures bearing fine, semierect hairs.

The form described is believed to be a female. The other sex is unknown.

*Type locality*.—Barro Colorado Island, Panama.

*Host*.—Unknown.

*Type material*.—Holotype, U.S.N.M. no. 56419. The holotype was taken at light, June, 1941, by James Zetek.

#### *Tachyderes*, n. gen.

Body cylindrical with surface more or less shining; frons convex above, transversely im-

pressed between eyes; antenna with 5-segmented funicle, club notably longer, oval, compressed, with three arcuate sutures indicated by setal rows, none of them septate; eye of moderate size, inner line emarginate, facets fine to coarse; pronotum little if any longer than wide, margined at base and on sides behind, anterior area strongly, rather sparsely asperate, summit moderately elevated above the shining, finely punctured posterior area; elytra finely punctate-striate, subglabrous on disk; declivity arched, very feebly or not at all sulcate, vestiture scanty to abundant.

Genotype: *Tachyderes floridensis*, n. sp.

***Tachyderes floridensis*, n. sp.**

*Female*.—Light reddish brown; 2.06–2.43 mm long, holotype 2.30 mm long, 2.60 times as long as wide.

Frons very wide between eyes; convex above, weakly concave between eyes; surface shining, finely granulate, with one or several large granules or small tubercles above concavity; hairs fine, rather short, inconspicuous except in profile. Eye moderately large, short oval, about one-third divided by a wide emargination; facets coarse. Antenna with club flattened, ovate, 1.29 times as long as wide, notably longer than funicle, with three subparallel, arcuate sutures indicated by setal rows, none of them septate.

Pronotum 1.11 times as wide as long, widest near base, posterior border indistinctly margined, nearly straight, posterior angles not rounded; sides feebly arcuate on posterior third, semicircularly rounded in front, without anterior lateral constriction; anterior margin with eight strong, coarse serrations, longer than wide (occasionally only seven are present); summit central in position and moderately high; anterior area steeply arched, with slightly irregular, concentric rows of coarse, moderately sparse, wide asperities; posterior area shining, broadly transversely impressed, with shallow, fine, indistinct punctures; median line impunctate, not elevated; vestiture fairly conspicuous on anterior area, very inconspicuous on disk.

Elytra equal to pronotum in width and 1.89 times as long, 1.71 times as long as wide; sides subparallel on anterior two-thirds, narrowly rounded behind; surface light reddish brown,

moderately shining, reticulate; punctures moderately small, shallow, close, in nearly regular stria rows, the first rather weakly impressed; interspaces nearly impunctate on disk and sides, with very few, fine, short hairs. Declivity sloping, suture weakly elevated; first stria distinctly impressed, with punctures obsolescent; second stria slightly impressed, with intervening second interspace forming a very shallow, narrow sulcus; interspaces with a few very fine, shallow punctures, bearing moderately short, erect, spatulate bristles.

*Male*.—Much smaller, 1.51 mm long, 2.30 times as long as wide; frons convex above, transversely impressed below, more finely sculptured than in female; pronotum with marginal serrations reduced or partly obsolete; elytra with dorsal contour arcuate from base to apex, sculpture weak.

*Type locality*.—Paradise Key, Fla.

*Additional localities*.—Haiti, Virgin Islands, Mexico, Texas.

*Host*.—*Rhacoma crossopetalum* L.

*Additional host*.—*Hevea brasiliensis* Muell.

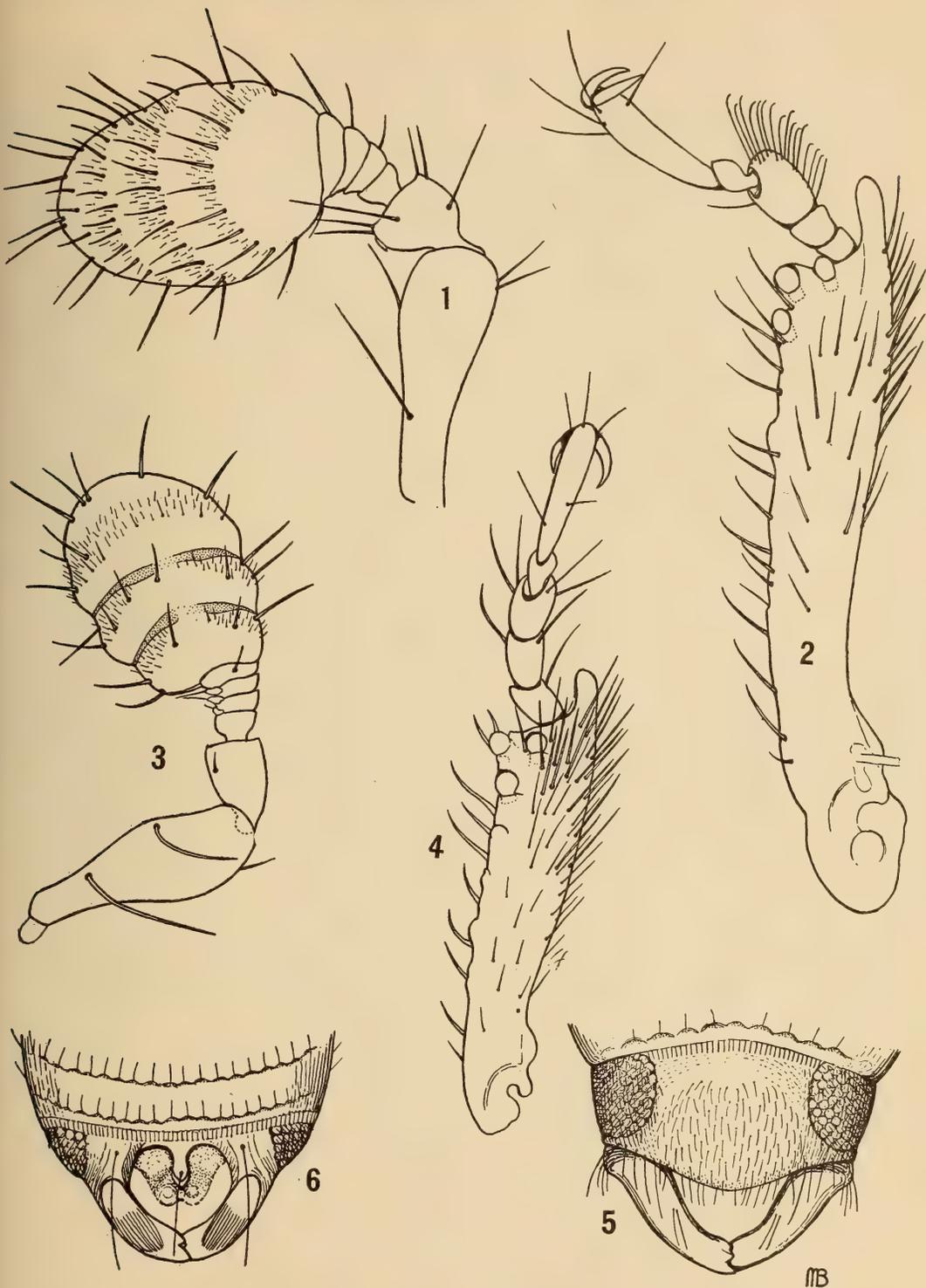
*Type material*.—Holotype, allotype, and 60 paratypes, U.S.N.M. no. 56415.

The holotype and 2 paratypes were taken March 9, 1919, on Paradise Key, Fla., by H. S. Barber; the allotype and 45 paratypes were reared from *Rhacoma crossopetalum*, Big Pine Key, Fla., by Barber and Schwarz; 1 paratype each from Biscayne and Key West, Fla., were collected by Hubbard and Schwarz; 1 paratype, Royal Palm, Fla., March 21, 1929, by W. S. Blatchley; 5 paratypes taken by W. H. Jenkins from *Hevea brasiliensis* at Bayeux, Haiti; 5 paratypes from Tampico, Mexico, by E. A. Schwarz; 1 paratype taken by Jones and Pratt at Brownsville, Tex., March 20, 1908; 1 paratype, St. Croix, Virgin Islands, H. A. Beatty, collector.

***Tachyderes parvus*, n. sp.**

*Female*.—Reddish brown; 1.71 mm long, 2.61 times as long as wide; considerably smaller than *floridensis* and darker in color.

Frons very wide between eyes, feebly shining, convex above, somewhat flattened between eyes, strongly granulate-punctate, with granules coarser above and at sides, and nearly lacking below in median line, hairs sparse, fine, short and inconspicuous. Eye smaller than in



Figs. 1-6.—1, Antenna of female of *Tachyderes floridensis*, n. sp.; 2, fore tibia of *T. floridensis*, female; 3, antenna of *Gnatholeptus mandibularis*, n. sp.; 4, fore tibia of *G. mandibularis*; 5, frontal view of *G. mandibularis*; 6, frontal view of *G. panamensis*, n. sp. The drawings were made by Mrs. Mary F. Benson under the author's supervision.

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*floridensis* and facets much finer, nearly one-third divided by a rather wide emargination. Antenna similar to that of other species, club with sutures not so strongly arcuate, none of them septate.

Pronotum almost exactly as wide as long, widest near base, posterior outline nearly straight, weakly margined, posterior angles scarcely rounded; sides nearly straight and subparallel on posterior half, moderately rounded in front, with anterior margin bearing nine moderately large serrations (smaller than in *floridensis*); summit very slightly behind middle, moderately high; anterior area with irregularly concentric rows of asperities, higher and sharper and more numerous than in *floridensis*; posterior area feebly shining, moderately, transversely impressed, with small, moderately shallow punctures; median line impunctate; vestiture scanty.

Elytra slightly wider than pronotum, and 1.69 times as long, 1.65 times as long as wide; sides subparallel on anterior three-fifths, then gradually narrowed, rather narrowly rounded behind; surface dark reddish brown, moderately shining, finely reticulate; punctures moderately fine, moderately shallow, in nearly regular strial rows, only the first row faintly impressed; interspaces nearly impunctate on disk and sides, with a few minute hairs. Declivity moderately sloping, first and second striae slightly impressed, the punctures obsolescent; interspaces with a few rather short hairs, not thickened as in *floridensis*.

Male unknown.

*Type locality*.—Cayamas, Cuba.

*Host*.—Unknown.

*Type material*.—Holotype, U.S.N.M. no. 56416, collected by E. A. Schwarz.

#### ***Tachyderes harringtoni*, n. sp.**

*Female*.—Reddish brown; 1.38 mm long, 2.55 times as long as wide; smaller than either *parvus* or *floridensis*.

Frons strongly convex, granulate, subopaque above, impressed in median area below, shining, finely punctured, with fine, inconspicuous hairs. Eye moderately small, facets rather fine, less than a third divided by a wide emargination. Antenna similar to that of *floridensis* but with sutures of club more weakly arcuate.

Pronotum nearly as wide as long, widest near base, posterior outline nearly straight, finely but distinctly margined, posterior angles scarcely rounded; sides feebly arcuate, nearly semicircularly rounded in front, with anterior margin bearing moderate-sized serrations; summit moderate, slightly behind middle; anterior area with rather sparse, broad, rather low asperities, irregularly, subconcentrically arranged; posterior area feebly shining, broadly, shallowly, transversely impressed, with small, rather indistinct punctures, the interstices finely reticulate; median line impunctate, not elevated; vestiture moderate on anterior area, scanty and inconspicuous on posterior area.

Elytra equal in width to pronotum and 1.70 times as long, 1.68 times as long as wide; sides subparallel on anterior two-thirds, moderately rounded behind; surface reddish brown, subopaque to feebly shining, finely reticulate; punctures of moderate size, rather shallow, in nearly regular strial rows, only the first stria feebly impressed on disk; interspaces finely rugulose, with a few fine, shallow punctures, and with a very few fine, short hairs. Declivity of the usual type for the genus, with first stria impressed, the punctures obsolete on first, reduced on other striae; interspaces with short, erect, cinereous, spatulate hairs more numerous than on other species of the genus.

Male unknown.

*Type locality*.—Yaguacua, Bolivia.

*Host*.—Unknown.

*Type material*.—Holotype and five paratypes, U.S.N.M. no. 56417, collected by G. L. Harrington in March, 1924.

ENTOMOLOGY.—*New species of syrphid flies in the National Museum.*<sup>1</sup> FRANK M. HULL, University of Mississippi (Communicated by ALAN STONE.)

This paper concludes a study of miscellaneous syrphid flies in the United States National Museum that was begun several years ago. Earlier reports upon this material have appeared in this JOURNAL. I wish to thank C. T. Greene and Dr. E. A. Chapin for many helpful courtesies and facilities in the study of these flies. The types are in the National Museum; paratypes where available are in the author's collection.

*Mesogramma guttifera*, n. sp.

Distinct in the pairs of oval spots upon the abdomen; the pattern suggests certain species of *Xanthandrus*.

*Female*.—Length 7 mm. *Head*: Vertex shining black; front for a trifle more than the median third shining blue-black, the sides bright yellow; frontal pile white, vertical pile black. Face and all but the posterior portion of cheeks pale yellow, white pilose, the former very short in profile; a very low tubercle lies at the point of greatest forward production. Antennae light brown, the third joint dark but reddish below at base. *Thorax*: Humeri, the lateral margins throughout, a complete marginal border upon the shining, brownish-black scutellum, the posterior half of the mesopleura and upper half of the sternopleura, all light yellow. Disk of mesonotum dull black with a broad, median vitta, which in some lights is light gray, in others bright steel-blue. There are on each side of this vitta three additional vittae, the middle one of which is much wider, suturally divided, and all three of which are margined at least narrowly with dark blue-black color. *Abdomen* narrowly oval, shining blackish marked with pairs of translucent, oval, yellow or light brown spots. First segment light yellow, black on posterior half. Second segment with a pair of oval yellowish spots, transverse, lying in the middle of each half of the segment, but broadly confluent with each other medially. Third segment, in the middle of each half, with a large subquadrate, but almost trapezoidal, slightly diagonal spot, the two well separated. Fourth segment with similar spots of almost the same

size, their corners barely more rounded. Fifth segment with similar but smaller and much more rounded oval spots. *Legs* yellow; the hind femora with a wide, subapical black annulus, their tibiae dark brown at base and apex, narrowly yellow in the middle, their tarsi blackish; other tarsi brownish. *Wings* hyaline; stigma dark brown.

Holotype, female (U.S.N.M. no. 56421), Guatemala City, IV, 10 (J. M. Aldrich).

*Baccha amabilis*, n. sp.

Somewhat similar to *flavipennis* Wiedemann, with narrower abdomen and fewer linear vittae.

*Male*.—Length 7 mm. *Head*: Vertex shining black. The front on upper third is opaque black viewed vertically, and at the eye margin at each lower angle of this triangle there is a small, punctate, white, hemispherical pubescent spot. The very swollen front is shining brown below, yellowish above the antennae. Face tuberculate, metallic black, with another white pubescent spot on each side at the upper eye margin. Antennae small, light brown, the third joint orange below; second joint nearly as long as third. *Thorax* very dark brown, with a pair of linear, widely separated, very obscure, gray or blue-black vittae; medially there is a pair of close, still more faint, brown-black vittae. Scutellum light brown, translucent, its pile and that of mesonotum erect, black, its basal fringe of five or six hairs pale. *Abdomen* moderately slender, parallel-sided from beyond the second segment, that segment constricted a little upon the basal half; color of abdomen light orange-brown, with darker vittae. Third to fifth segments with a pair of very narrowly separated (confluent upon the fifth segment) and narrow, medial vittae; these segments, on each side, with a pair of narrow, lateral vittae, each pair of which is confluent upon its posterior half, and whose outer section comprises the lateral margin itself. Second segment light brown with a small, rounded, yellowish, diffuse spot near the middle upon each side. Abdominal pile black, fairly long and abundant on the sides of the first segment. *Legs*: All the femora light yellow, except a wide subapical annulus upon the hinder pair; remainder of

<sup>1</sup> Received August 10, 1942.

first two pairs yellowish except the tarsi; their tarsi and remainder of hind legs blackish brown; all pile blackish; middle femora with a long fringe on the posterior surface. *Wings* light gray, very gradually becoming smoky brown on the basal third.

Holotype, male (U.S.N.M. no. 56422), Iquitos, Peru, March–April, 1931 (R. C. Shannon).

***Baccha nepenthe*, n. sp.**

Related distantly to *conopida* Phillipi. This species is characterized by the very slender, light colored, basal petiole of the abdomen, the broadly expanded black terminal part, and the slight dip in the third vein.

*Male*.—Length 10 mm. *Head*: Front, face and cheeks, and antennae reddish brown, the third antennal joint somewhat darker above. *Thorax*: Mesothorax black except upon the pleura, humeri, wide lateral margins, scutellum and an extensive area in front of the scutellum, all of which are reddish brown. Pile everywhere extremely short, thick, and pale. There is a median gray-pollinose vitta; also there is a transverse vitta, similar though fainter on each side on the anterior margin of the suture. *Abdomen* very spatulate, the second segment long and cylindrical and together with the narrow lateral corners of the first segment and the greatly compressed base of the third segment light orange-brown. Remainder of the expanded, flattened abdomen black and black pilose. *Legs* light reddish brown. *Wings*: Anterior margin brownish to the end of the stigmal cell, this cell a little darker and the brown color expanded centrally. Third longitudinal vein slightly curved near the middle, the subapical cross vein very sigmoid.

Holotype, male (U.S.N.M. no. 56423), Bonita, Fla., 5-20-1932 (A. R. Taylor). Ex *Dactylopius tomentosus*. Also one male and one female paratype in U.S.N.M. One paratype in author's collection.

***Baccha nymphaea*, n. sp.**

Related to *carlota* Curran; distinguished by the bicolored nonfasciate abdomen; lateral mesonotal margins continuously yellow almost to scutellum.

*Female*.—Length 11 mm. *Head*: Vertex and an annular ring before the antennae black.

Front, face, and cheeks yellow, the first tending to brown. Antennae elongate, the first two joints yellowish brown, the third joint black, narrowly reddish below, the arista light brown. *Thorax*: Mesonotum light ochraceous-brown with four black vittae, the medial pair chiefly confluent along their medial margins and diverging posteriorly and evanescent some distance from the scutellum. Between the black vittae there is golden pubescence. Scutellum and all of pleura subtranslucent pale yellow. *Abdomen* subtranslucent yellow to a little before the middle of the third segment and throughout most of the sides of the third segment. Remainder of abdomen brownish black with black pile. *Legs* yellow, the bases of the tibiae whitish yellow, the hind tarsi more brownish above. Pile yellow except upon the hind trochanters and medial surface of their coxae. *Wings* with the stigmal cell and both sides of the third longitudinal vein to a point about the middle of the stigmal cell light brown. Third longitudinal vein rather arcuate, the subapical cross vein sigmoid.

Holotype, male (U.S.N.M. no. 56424), Campinas, São Paulo, Brazil (H. F. G. Sauer). One paratype, same data, in author's collection.

***Baccha eruptova*, n. sp.**

Related to *peruwiana* Shannon but differing in the abdominal proportions and pattern.

*Female*.—Length 15 mm (abdomen 10 mm); wing 10.5 mm. *Head*: Vertex shining black with a bluish tinge. Upper half of the front, except narrowly along the sides, opaque black, lower half strongly shining blue-black; narrow sides of front for two-thirds of its height, linearly white pubescent and this pubescence discontinuous with that on the sides of the face. Frontal and upper facial pile black. Face tuberculate, metallic black, the sides yellowish and white pubescent; cheeks black. Antennae black, of normal shape, the inner end of second joint a little produced. *Thorax* brown-black, obscurely shining, with a pair of slender, widely separated, very obscure, dark brown pollinose vittae. Scutellum dark brown, shining, its pile and that of mesonotum black and short; its fringe in part black, rather long, of thirty or more bristles. Squamae and fringe dark brown. *Abdomen* elongate, the second and sixth segments of about equal length, the former as wide apically

as the latter at base; third to fifth segments of slightly decreasing length, the third four-fifths as long as second, and about twice as wide at its apex as at the narrowest width of the second segment; last segment cylindrical at base and strongly compressed laterally at apex. Color of abdomen shining blackish to dark mahogany, the basal corners of the second and third segments light mahogany, and on the second this color extends two-thirds of the length of the segment along its sides. There is a narrow-pronged, opaque triangle (black in oblique view) in the middle of the second segment, and a wider shorter one upon the third segment. Abdominal pile black, abundant and rather long on the sides of the first segment. *Legs* dark brown, the hinder pair black as far as the middle of the basitarsal joint, yellowish white and similarly pilose upon the terminal portion; elsewhere the legs are black pilose. *Wings* brown on the basal two-fifths as far as anterior cross vein.

Holotype, female (U.S.N.M. no. 56425), Iquitos, Peru, March-April 1931 (R. C. Shannon).

***Volucella brunnigaster*, n. sp.**

Somewhat similar in general appearance to *mellea* Jaen., but distinguished by the scutellar depression and numerous other differences.

*Male*.—Length 12 mm. *Head*: Front, face, and cheeks reddish orange-brown, rather deep, the low tubercle with long black pile. The sides of the face with reddish-golden pubescence, a few similar hairs and a few long hairs above. Antennae orange-brown, the third joint twice as long as basal width, the arista with 15 dorsal rays. *Thorax* shining black with a golden cast, the sides dark brown, the bristles black, the pile thick, short, yellowish, among which are numerous very long and slender black hairs; no prescutellar bristles. Scutellum brown with rugose transverse depression and six pairs of black marginal bristles. Scutellar pile, except in the corners, black. *Abdomen* translucent, orange-brown, with some black upon the first two segments. The first segment, except the sides, and a medial, narrow and posteriorly attenuated vitta on the second segment black. Pile of abdomen widely black upon the posterior half of the third and fourth segments and narrowly toward the sides on the posterior margin of the second segment, otherwise golden.

*Legs* black. The apices of the femora, the wide base of all the tibiae, and their apices narrowly reddish brown. Tarsi brown, becoming blackish upon their distal joints. *Wings*: Veins margined with brown, the central cross veins a little darker and an obscure spot at the end of the subcosta. Marginal cell very widely opened.

Holotype, male (U.S.N.M. no. 51351), Meta District, Colombia, B. Guevara collector, 1932. One paratype, same data, in author's collection.

***Volucella viridigaster*, n. sp.**

Related to *verdigaster*, n. sp., but with less extensive vittae and fascia upon the abdomen and the wing veins not conspicuously margined.

*Male*.—Length 11 mm. *Head*: Front, face, and cheeks pale whitish yellow. There is a pale, diffuse, brownish vitta separating face and cheeks and one down the middle of the deep-conical face. The low tubercle is densely short black pilose, the front longer black pilose, the sides of the face white pilose and pubescent. Antennae orange, the third joint two and one-half times as long as the basal width. *Thorax*: Mesonotum black, the sides light brownish yellow, the bristles black, the scutellum sub-translucent brownish yellow with five pairs of black bristles, a shallow preapical depression and black pile. Pile of thorax chiefly black with considerable whitish pile anteriorly. There are no prescutellar bristles. Squamae light yellow with brown fringe. *Abdomen* pale green translucent: the middle of the first segment, a narrow medial expanding vitta on the second segment black and confluent with a linear, black posterior border; the black border evanescent laterally; a similar evanescent black border on the third segment. Pile of abdomen black, short, dense, and appressed except over the basal portion of each segment. *Legs* black, the apices of the femora, the bases of the tibiae and the basal tarsal joints dark brown. *Wings* pale brown, cross veins clouded, the marginal cell widely opened.

Holotype, male (U.S.N.M. no. 51350), Ecuador, F. Campos R. A paratype, same data, in author's collection.

***Volucella verdigaster*, n. sp.**

Related to *inconsistens* Curran, but with wide black median vittae on the abdomen as well as fasciae.

*Male*.—Length 12 mm. *Head*: Middle of front black, the sides of front and face pale yellow. The cheeks and broad middle of the face black. Face deep conical, the pile thick over the tubercle and chiefly black with some shorter pile mixed with longer black hair on the sides. Antennae dark brown, the third joint twice as long as basal width, the arista with 27 dorsal rays. *Thorax*: Mesonotum black with a bluish and violaceous tinge, the humeri, a presutural and prenotopleural, besides a pair of prescutellar spots and a pair of elongate spots almost adjacent to the postcalli, all light yellow. Thoracic bristles and pile black except for some short white pile upon the yellow spots and in the midline anteriorly. No prescutellar bristles. Scutellum dark brown with transverse rugose depressions and five pairs of long black bristles. *Abdomen* black with large, subrectangular, apple-green translucent spots in the lateral corners of the second segment, and more irregular spots in the lateral corners of the third and fourth which extend posteriorly to cover the entire lateral margin. Pile very dense, rather long, nearly erect, and black except upon the pale areas, where it is whitish. *Legs* black and black pilose. *Wings* hyaline, strongly clouded with brown along all of the cross veins and the distal portions of the second, third and fourth longitudinal veins; marginal cell widely opened.

Holotype, male (U.S.N.M. no. 51354), and one paratype, Bogotá, Colombia, B. Guevara collector, in U. S. National Museum; one paratype, same data, in author's collection.

#### *Volucella flavogaster*, n. sp.

This species suggests *zonaria* Linnaeus, of Europe. It is characterized by the linear black fascia of the abdomen and other markings.

*Male*.—Length 14 mm. *Head*: Entire face except for a pale, diffuse vitta separating face and cheeks bright yellow, golden pilose. The eyes of the male instead of being holoptic are merely approximated. Antennae orange, the third joint short, one and one-half times as long as basal width, the dorsal margin concave. The long arista has 26 dorsal rays. Ocellar pile orange. *Thorax*: Mesonotum orange-brown with a sublateral black vitta broken at the suture, and on the posterior area of the dorsum a pair of submedial anterolaterally attenuated

blackish spots. There are 9 or 10 prominent, black, prescutellar bristles, and all the lateral bristles are black. Scutellum orange-brown, swollen, with four pairs of black bristles. Squamae and fringe yellow. *Abdomen* orange-yellow marked with black as follows: Whole of the first segment, a basal fascia on the second expanded in the middle into a vitta that connects with a very narrow line at posterior margin; laterally this posterior marginal line is confluent with a transverse, narrow fascia occupying the lateral fourth of the segment just beyond the middle. Third segment with a narrow, basally attenuated, medial black vitta, a still narrower, posterior, black marginal marking, which is confined to the margin and not connected with the narrower transverse fascia. Fourth segment similar except that the marking along posterior margin is absent and the transverse fascia now occupies the middle of the long convex segment. *Legs* light yellow, the femora somewhat more brownish, their pile blackish on the lateral surfaces; elsewhere the pile is golden. *Wings* strongly tinged with yellow, the posterior margin pale brown, the marginal cell closed and stalked, it and the cell behind it light brown.

Holotype, female (U.S.N.M. no. 51356), Chinkiang, China, May 1923. A paratype, same data, in author's collection; also two paratypes from Nanking, China, one in the Vienna Museum, one in author's collection.

This is a very pretty species, and I have not been able to identify it with any Asiatic species known to me.

#### *Gryptomyza globigaster*, n. sp.

This species suggests *flavorhyncha* Hull in the pattern of its abdomen; the fasciae are not medially expanded, however, and the face is short.

*Female*.—Length 6 mm. *Head*: Front, face, and cheeks pale yellow, marked with black; a narrow medial black stripe on the front and brownish down the middle of the face, darker between face and cheeks. Four or five blackish hairs on the tubercle and a few shorter ones below. Antennae elongate, orange, the third joint grayish above and three and one-half times as long as wide. The arista is nonplumose. *Thorax*: Mesonotum broadly black, the humeri, propleura, most of the mesopleura pos-

teriorly, the wide lateral margins of the mesonotum and the area before the scutellum, all pale yellow. Scutellum dark brown, blackish over the broad central concavity. Thoracic and scutellar bristles black, the short pile yellow. *Abdomen* oval-globose, subtranslucent, orange-brown marked with black as follows: a black fascia lying on the posterior portion of the second segment attenuated medially and medially indented behind and withdrawn from the margin; this fascia is continuous with an abruptly diagonal and slender, sublateral black vitta on each side of the third segment, which extends to the posterior corner and leaves the anterior corner pale. The posterior portion of the third segment is marked with a similar diverging black fascia, which, however, is broadly interrupted medially but also attenuated; laterally it connects narrowly with a wider and similar sublateral vitta. Fourth segment with a long, median vitta and a pair of sublateral, shorter, more posterior black vittae; these black vittae are wide and anteriorly rounded and none of them reaches the basal margin. *Legs* pale yellow, the apical fourth of the hind femora and all of hind tibiae black and chiefly black pilose, elsewhere the pile is pale. *Wings* hyaline with a pair of pale, slightly oblique, brownish fasciae beginning at the ends of the first and second longitudinal veins. The first of these bands reaches the base of the lower cross vein, the second reaches and follows the subapical cross vein. There is a small brown spot at the end of the subcostal vein.

Holotype, female (U.S.N.M. no. 52904), and 2 paratype females in U. S. National Museum, Island of Biliran, Philippines, C. F. Baker, collector. Paratype, same data, in author's collection.

#### *Brachypalpus trilineata*, n. sp.

Differing from any described species in the narrow, pale fascia of the abdomen.

*Female*—Length 14 mm. *Head*: Front and

vertex shining black, the sides of the former narrowly yellow pubescent, all pile except a few black hairs at ocelli and above the antennae, yellowish. The prominent face is bare, dull and very dark mahogany, the cheeks shining black. Face with a very large, low, long tubercle, and a quite wide, thickly golden pubescent stripe reaching from eye to epistoma and continued broadly up the sides of the face to unite below the antennae. Antennae short, black, the third joint almost circular in outline. *Thorax* rather light brownish pollinose with rather obscure, broad vittae. Pleura thickly covered with ochre-colored pollen. The abundant pile of pleura and mesonotum is ochraceous, except for a few long, erect, black hairs on the posterior third of the mesonotum. Scutellum shining black, long, yellow-pilose, with a copious ventral fringe. *Abdomen* very broad and flat, with nearly parallel sides, a little wider in the middle of the abdomen. Abdomen dully shining black, marked with yellow to brown fascia. First segment light brownish basally. Second segment with a transverse, yellow-brown, basomedially indented, parallel-sided fascia near the middle running almost to the lateral margin. Third and fourth segments each with a subbasal, narrower, parallel-sided, light-yellow and yellow-pollinose fascia reaching the lateral margin; the fascia upon the fourth segment is slightly arcuate, especially toward the sides. Abdominal pile rather short, appressed and black except upon the first segment and the sides of the base of the second segment. *Legs*: Femora black; all the tibiae and tarsi except their distal joints, light orange. *Wings* light brown, the stigmal cell no darker, the stigmal cross vein heavy. The small cross vein is located four-fifths of the length of the discal cell from its base.

Holotype, female (U.S.N.M. no. 56426), Tjibodas, Mount Gede, Java, 4.09, Bryant and Palmer, collectors.

ZOOLOGY.—North American monogenetic trematodes: VI. The family *Diclidophoridae* (*Diclidophoroidea*).<sup>1</sup> EMMETT W. PRICE, Bureau of Animal Industry.

As in previous sections of the series, this paper deals with flatworms that live as external parasites on cold-blooded vertebrates. The members of the family *Diclidophoridae* are for the most part parasites of marine fishes, living on the gills and occasionally in the mouth. The organization and purpose of this paper are the same as for previous installments (Price, 1937, 1938, 1939a, 1939b, 1942).

DICLIDOPHOROIDEA Price, 1936

*Diagnosis*.—Anterior haptor in form of two lateral, oval or circular suckers opening into the oral cavity. Posterior haptor variable in shape and position, usually at the posterior end of body, sometimes ventral or lateral, usually provided with two rows of suckers or clamplike adhesive organs having a complicated, heavily cuticularized, riblike, supporting structure; posterior tip of haptor often terminating in a tonguelike structure or "languette" frequently armed with one to three pairs of hooks. Digestive system consisting of a prepharynx serving as an oral cavity, a bulbous pharynx, a short esophagus, and an intestine consisting, except in *Diplozoon*, of two principal branches provided with numerous median and lateral diverticula. Eyes absent. Male and female genital apertures usually opening to exterior through a common pore situated ventrally. Cirrus armed or unarmed. Testes usually numerous, postovarial, occasionally preovarial. Ovary elongate, folded. Vaginae present or absent, usually opening dorsally. Parasites of fishes, or of crustaceans parasitic on fishes.

*Type family*.—*Diclidophoridae* Fuhrmann, 1928.

KEY TO FAMILIES OF DICLIDOPHOROIDEA<sup>2</sup>

- 1. Framework of haptoral suckers consisting of 8 principal pieces (Fig. 1, A).....  
.....DICLIDOPHORIDAE Fuhrmann

<sup>1</sup> Received September 7, 1942.

<sup>2</sup> No entirely satisfactory key can at present be formulated to distinguish the families of *Diclidophoroidea*. The principal group characters are in

- Framework of haptoral suckers consisting of fewer than 8 principal pieces. ....2
- 2. Framework of haptoral suckers consisting of 3 pieces (Fig. 1, F)...HEXOSTOMATIDAE Price  
Framework of haptoral suckers consisting of more than 3 pieces. ....3
- 3. Haptoral suckers relatively strongly muscular (Fig. 1, B); vagina double (absent in *Octomacrum*), openings lateral.....  
.....DISCOCOTYLIDAE Price  
Haptoral suckers relatively weakly muscular; vagina when present, usually single and opening dorsally.....4
- 4. Haptoral suckers usually numerous, framework as shown in Fig. 1, C.....  
.....MICROCOTYLIDAE Taschenberg  
Haptoral suckers variable in number, framework not as above.....5
- 5. Haptoral suckers usually numerous, framework as in Fig. 1, D...GASTROCOTYLIDAE, n. f.  
Haptoral suckers few in number, framework as in Fig. 1, E.....MAZOCRAEIDAE Price  
Family *Diclidophoridae* Fuhrmann, 1928

*Synonym*.—*Choricotyliidae* Rees and Llewellyn, 1941.

*Diagnosis*.—Haptor terminal, usually bearing four pairs of cuplike adhesive structures having a complicated, heavily cuticularized framework of the general type as shown in Fig. 1, A. Cirrus usually armed with a circle of curved hooks, which are crescentic in cross section.<sup>3</sup> Seminal receptacle usually, if not always, present. Vaginae usually absent.

*Type genus*.—*Diclidophora* Diesing, 1850.

KEY TO SUBFAMILIES OF DICLIDOPHORIDAE

- Haptoral sucker clamplike or pincerlike.....  
.....DICLIDOPHORINAE Cerfontaine
- Haptoral suckers cuplike.....  
.....CYCLOCOTYLINAE, n. subf.

Subfamily *Diclidophorinae* Cerfontaine, 1895

*Diagnosis*.—Haptor with four pairs of pedunculated clamplike suckers of the type shown in Fig. 1, A. Cirrus armed. Vaginae absent.

*Type genus*.—*Diclidophora* Diesing, 1850.

the number and shape of the pieces composing the framework of the haptoral suckers; so far no descriptive terms have been proposed for these structures that will impart a sufficiently clear picture of their appearance.

<sup>3</sup> The hooks of the genital coronet are crescentic in cross section and this frequently gives them the appearance of being "double pointed."

KEY TO GENERA OF DICLIDOPHORINAE

1. Haptor distinctly set off from body proper . . . . . *Diclidophoroides*, n. gen.  
Haptor not distinctly set off from body proper . . . . . 2
2. Testes postovarial . . . . . *Octodactylus* Dalyell  
Testes preovarial and postovarial . . . . .  
. . . . . *Diclidophora* Diesing

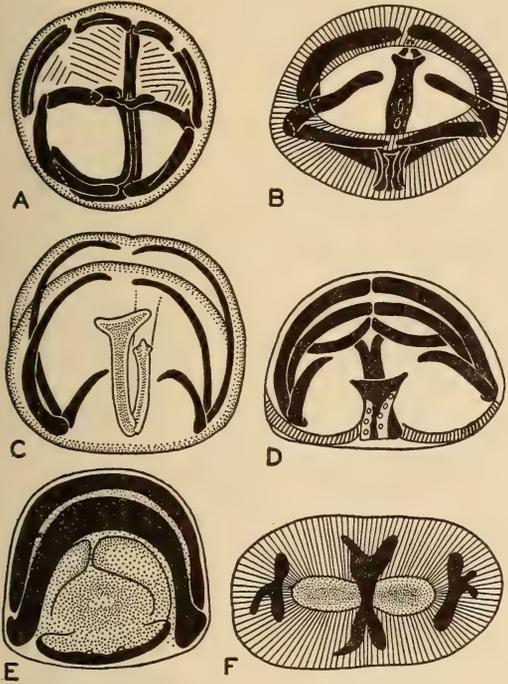


Fig. 1.—Types of haptor suckers in the superfamily Diclidophoroidea: A, Diclidophoridae; B, Discocotylidae; C, Microcotylidae; D, Gastrocotylidae; E, Mazocraeidae; F, Hexostomatidae.

Genus *Diclidophora* Diesing, 1850

*Synonyms*.—*Dactycotyle* Beneden and Hesse, 1863; *Dactylocotyle* Marschall, 1873.

*Diagnosis*.—Haptor not set off from body proper, bearing four pairs of pedunculated, clamplike suckers. Testes numerous, preovarial and postovarial. Eggs with polar prolongations.

*Type species*.—*Diclidophora longicollis* Diesing, 1850 [= *D. merlangi* (Kuhn, in Nordmann, 1832)].

The genus *Diclidophora* was proposed by Diesing (1850) for two species, *D. longicollis* Diesing and *D. palmata* (F. S. Leuckart), the former being *Octostoma merlangi* Kuhn (in Nordmann, 1832) renamed. Both of these species were regarded by Cerfontaine (1895) as

congeneric with *Dactycotyle pollachii* Beneden and Hesse, 1863, the type (subsequent designation by Stiles and Hassall, 1908) of *Dactycotyle* Beneden and Hesse, 1863 (= *Dactylocotyle* Marschall, 1873). Of the two species originally included in the genus *Diclidophora*, *D. palmata* (F. S. Leuckart) is apparently identical with *Octodactylus inhaerens* Dalyell (1853). Since the original species of *Diclidophora*, as well as several species subsequently added to the genus, are clearly divided into two groups on the basis of testicular distribution, it appears desirable to recognize both *Diclidophora* Diesing and *Octodactylus* Dalyell as valid genera. *Diclidophora merlangi* (Kuhn) of MacCallum, 1917, having characters of the subfamily but not being congeneric with either *Diclidophora* or *Octodactylus*, is placed in the new genus *Diclidophoroides*.

The species comprising the genus *Diclidophora* (*s. str.*)<sup>4</sup> are *D. merlangi* (Kuhn, in Nordmann, 1832),<sup>5</sup> from *Gadus merlangus* in Europe; *D. denticulata* (Olsson, 1876), n. comb., from *Pollachius virens*; *D. luscae* (Beneden and Hesse, 1863), n. comb., from *Morrhua lusca*; and *D. pollachii* (Beneden and Hesse, 1863), n. comb., from *Pollachius pollachius*.

<sup>4</sup> *Dactylocotyle minor* Ishii (1936) renamed *D. thunni* Ishii, in Ishii and Sawada (1938), does not belong to the genus *Dactylocotyle* (= *Diclidophora*) but is a species of *Mazocraea*.

<sup>5</sup> Dollfus (1922) has raised the question as to the authorship of the name *merlangi*, which was credited to Kuhn by Nordmann (1832), and prefers to regard Nordmann as the author since the name credited to Kuhn was only a manuscript name. In spite of the fact that the name "*Octostoma merlangi* Kuhn" is a manuscript or label name, which probably accompanied specimens that were sent by Kuhn to Rudolphi and later studied by Nordmann, the following are reasons for recognizing Kuhn as the author: Nordmann placed the name "*Octostoma merlangi* Kuhn" as a synonym of "*Octobothrium(?) merlangi*" (= *Diclidophora merlangi*), thereby crediting Kuhn with the name of the species. Opinion 4 of the International Rules of Zoological Nomenclature states that "Manuscript names acquire standing in nomenclature when printed in accordance with the provisions of Art. 25, and the question as to their validity is not influenced by the fact whether such names are accepted or rejected by the author responsible for their publication." The name in question was used for the species now known as *Diclidophora merlangi* and the conditions under which it was used conform to those stipulated under Art. 25; therefore, there seems to be no question as to the validity of the name, and the authorship of the species should, accordingly, be credited to Kuhn, in Nordmann, 1832.

*Diclidophora denticulata* (Olsson, 1876),  
n. comb.  
Figs. 2-3

*Synonyms*.—*Octobothrium denticulatum* Olsson, 1876; *Dactylocotyle denticulatum* (Olsson, 1876) Cerfontaine, 1895; *D. carbonarii* Cerfontaine, 1895.

*Description*.—Body 7 mm long by 1.6 mm wide at level of ovary, tapering gradually anteriorly. Anterior haptors in form of a pair of suckers, each about  $170\mu$  in diameter, opening into oral cavity. Posterior haptor more or less rectangular, about 2.1 mm long, not set off from body proper, bearing four pairs of pedunculated clamplike suckers; no terminal hooks. Suckers about equal in size,  $680\mu$  wide, supported by complicated cuticular structure (Fig. 3); wall of suckers muscular; outer anterior quadrant of suckers armed with 30 to 40 lancetlike spines. Oral aperture subterminal; pharynx oval,  $187\mu$  long by  $153\mu$  wide; remainder of digestive tract not observable in available material. Male genital aperture median, about  $595\mu$  from anterior end of body; cirrus about  $95\mu$  in diameter, armed with 13 inwardly curved hooks. Testes numerous, small, extending from about one-third of total body length from anterior end to about level of anterior end of haptor. Ovary N-shaped, median, about  $400\mu$  in front of anterior limit of haptor. Vitelline follicles abundant, extending from level of female genital pore to posterior end of haptor. Seminal receptacle and vitelline reservoir preovarial. Genito-intestinal canal not observed. Uterus long and slender, in median field. Female genital aperture median, about  $190\mu$  posterior to male genital aperture. No fully formed eggs present in available specimen.

*Host*.—*Pollachius virens* (Linnaeus).

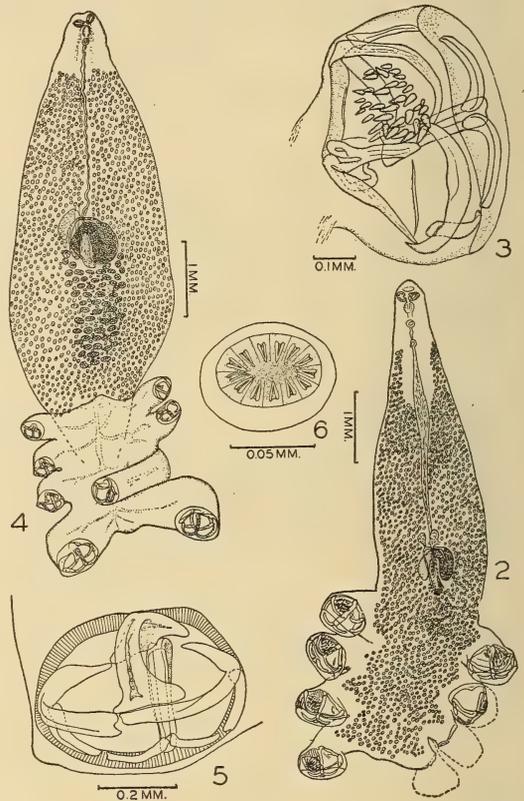
*Location*.—Gills.

*Distribution*.—United States (Woods Hole, Mass.) and Canada (St. Mary Bay, Nova Scotia).

*Specimen*.—U.S.N.M. Helm. Coll. no. 6508.

This species was originally described by Olsson (1876) from specimens collected from *Gadus virens* (= *Pollachius virens*) from the Skaggerak, and, later, Cerfontaine (1895) gave a detailed description of the parasite. In North America there appear to be three records of its occurrence: Linton (1900) reported the finding of one specimen by Prof. H. M. Kelly at

Woods Hole, Mass., and Stafford (1904) and Cooper (1915) reported this species from Canada. The specimen reported by Linton is the one on which the above description is based. This specimen, a toto mount, was in fair condition despite the fact that two of the clamplike suckers of the haptor had been torn off. *D. denticulata* is readily distinguishable from the other members of the genus by the presence of spines on the haptoral suckers.



Figs. 2-3.—*Diclidophora denticulata*: 2, Complete worm, ventral view; 3, clamplike haptoral sucker. Figs. 4-6.—*Diclidophoroides maccallumi*: 4, Complete worm, ventral view; 5, clamplike haptoral sucker; 6, cirrus.

Genus *Octodactylus* Dalyell, 1853

*Synonym*.—*Pterocotyle* Beneden and Hesse, 1863.

*Diagnosis*.—Haptor not distinctly set off from body proper. Testes confined to post-ovarial portion of body. Eggs usually without polar prolongations.

*Type species*.—*Octodactylus inhaerens* Dalyell, 1853 [= *O. palmata* (F. S. Leuckart, 1830), n. comb.].

This genus contains *Octodactylus palmata* (F. S. Leuckart, 1830)<sup>6</sup> (syns. *O. inhaerens* Dalyell, 1853; *Octobothrium digitatum* Rathke, 1843; *Dactylocotyle molvae* Cerfontaine, 1895), from *Molva molva*; *O. minus* (Olsson, 1876), n. comb., from *Gadus poutasson*; and *O. morrhuae* (Beneden and Hesse, 1863),<sup>7</sup> n. comb., from *Gadus morrhua*. As none of these species occurs on North American hosts, the genus will not be considered further.

#### Diclidophoroides, n. gen.

*Diagnosis*.—Haptor distinctly set off from body proper. Testes postovarial. Otherwise similar to *Octodactylus*.

*Type species*.—*Diclidophoroides maccallumi*, n. sp.

In addition to the type species, it is possible that *Dactylocotyle phycidis* Parona and Perugia, 1889, from *Phycis blennoides* in Europe may belong here. The description of *D. phycidis*, however, is too inadequate for definite generic allocation. *Heterobothrium ecuadori* Meserve (1938) from *Cheilichthys annulatus* and *H. galapagensis* Meserve (1938) from *Paranthias furcifer*, both from the Galapagos Islands, are tentatively included in *Diclidophoroides*, the new combinations being *D. ecuadori* (Meserve) and *D. galapagensis* (Meserve), respectively. The pincerlike or clamplike nature of the haptor suckers definitely eliminates these two species from the genus *Heterobothrium*. Only the type specimens of Meserve's species were available for examination, but these show the haptors to be fairly well set off from the body proper, although not so distinctly so as in *D. maccallumi*; the haptor suckers are subsessile and equal in size.

#### *Diclidophoroides maccallumi*, n. sp.

Figs. 4-6

*Synonyms*.—*Diclidophora merlangi* MacCallum, 1917; *Dactylocotyle minor* (Olsson, 1876) of Manter, 1926; *D. phycidis* Parona and Pe-

<sup>6</sup> MacCallum (1917) reported finding on the gills of *Lota maculosa* "a rather delapidated specimen of what seems to answer to the description of *D. palmata*." This specimen has been examined and found not to be a trematode, consequently the report of this species from North America is erroneous.

<sup>7</sup> The form reported by Scott (1901) from *Gadus callarius* (= *G. morrhua*) under the name of *Pterocotyle morrhuae* is probably not this species.

*rugia*, 1889, of Stafford, 1904; *Choricotyle merlangi* (MacCallum, 1917) Llewellyn, 1941.

*Description*.—Body elliptical, 4.2 to 6.9 mm long by 1.5 to 2.1 mm wide. Anterior haptor in form of a pair of suckers, each 76 to 115 $\mu$  wide, opening into oral cavity. Posterior haptor somewhat rectangular, 1.8 mm long by 2.3 mm wide in largest specimen, distinctly set off from body proper, bearing four pairs of pedunculated clamplike suckers, peduncles and suckers of different sizes, first pair smallest and posterior pair largest, with complicated cuticular supporting structure (Fig. 5); smallest suckers 170 to 255 $\mu$  wide, largest 425 to 510 $\mu$  wide. Posterior tip of haptor armed with 2 pairs of minute hooks. Oral aperture subterminal; pharynx oval, 157 to 170 $\mu$  long by 70 to 114 $\mu$  wide; remainder of digestive tract not traceable except in haptor, here branches observed to enter peduncles of suckers. Genital aperture median, 247 to 340 $\mu$  from anterior end of body. Cirrus muscular, 38 to 95 $\mu$  in diameter, armed with a circle of 13 to 16 inwardly curved hooks. Testes relatively numerous, small, in median field posterior to ovary; a few testes sometimes lateral to ovary. Ovary elongate, N-shaped, median, equatorial. Vitelline follicles abundant, extending from a short distance back of genital aperture to posterior end of body proper. Seminal receptacle anterior to, and to right of, ovary; vagina and genito-intestinal canal not observed. Uterus slender, in median field. No eggs present in available specimens (eggs non-filamented, according to Manter, 1926).

*Host*.—*Urophycis chuss* (Walbaum).

*Location*.—Gills.

*Distribution*.—United States (Woods Hole, Mass., and Mount Desert Island, Maine) and Canada.

*Specimens*.—U.S.N.M. Helm. Coll. nos. 35106 (type and paratypes), 35585, and 35586.

*Diclidophoroides maccallumi* appears to be the same species as that described by Manter (1926) as *Dactylocotyle minor* (Olsson) from *Urophycis chuss*, and as that reported by Stafford (1904) under the name *D. phycidis* Parona and Perugia from the same host in Canada. That *Diclidophoroides maccallumi* is distinct from the form described by Olsson (1868) as *Octobothrium palmatum* Leuck. f. *minor* seems clear, since the haptor in Olsson's form shows the pedunculated suckers to be

equal in size and not unequal as is the case in the specimens described by Manter, or in the specimens collected by MacCallum.

MacCallum thought that this species might be identical with *Dactylocotyle merlangi* (Kuhn), but Dollfus (1922) has pointed out that the two species are not identical and that the name *merlangi* MacCallum should be retained for the species described by MacCallum (1917), since *merlangi* (Kuhn, of authors) belongs in the genus *Dactylocotyle* (= *Diclidophora*). Unfortunately Dollfus's proposal, which is concurred in by Llewellyn (1941), is untenable, as *merlangi* (Kuhn) was placed in the genus *Diclidophora* by Krøyer (1838-40, p. 606) and also by MacCallum (1917); consequently *Diclidophora merlangi* MacCallum is a homonym and must be renamed.

**Diclidophora** spp.

Linton (1905) reported *Dactylocotyle* sp. from the gills of *Brevoortia tyrannus* and *Diclidophora* sp. from the gills of *Orthopristis chrysopterus*. The first of these forms was illustrated but not described and the second was described briefly as follows: "This specimen is very fragile, the posterior finger-like processes appearing to be somewhat macerated. Dimensions, in millimeters; length 1.68, length exclusive of posterior sucker 1.28; diameter at anterior end 0.08; maximum diameter of body 0.52, of sucker region 0.96; diameter of one of the 8 small suckers 0.13."

The illustration of the form from *Brevoortia tyrannus* indicates that it is probably a new species and may not belong to the genus *Diclidophora*, but the details were not clearly brought out and as no description was given, it seems inadvisable to name it. The description of the form from *Orthopristis chrysopterus* is too inadequate to warrant further consideration.

**Cyclocotylinae**, n. subf.

*Synonym*.—*Diclidophorinae* Cerfontaine, 1895 in part.

*Diagnosis*.—Haptor with four pairs of sessile, subsessile, or pedunculated cuplike suckers, each provided with a heavily cuticularized framework of the type shown in Fig. 1,A. Cirrus armed (except in *Cyclocotyloides*) with hooks as in *Diclidophorinae*. Vaginae usually absent.

*Type genus*.—*Cyclocotyla* Otto, 1823.

KEY TO GENERA OF CYCLOCOTYLINAE

1. Cirrus hooks absent . . . . . *Cyclocotyloides*, n. gen.  
Cirrus hooks present . . . . . 2
2. Vaginae present . . . . . *Diclidophoropsis* Gallien  
Vaginae absent . . . . . 3
3. Framework of anterior pair of haptoral suckers orientated inversely as compared with those of posterior 3 pairs . . . . .  
 . . . . . *Heterobothrium* Cerfontaine  
Framework of all 4 pairs of haptoral suckers occupying same relative orientation . . . . . 4
4. Testes both pre- and postovarial . . . . .  
 . . . . . *Cyclobothrium* Cerfontaine  
Testes entirely postovarial . . . . . 5
5. Posterior pair of suckers sessile and widely removed from anterior 3 pairs of pedunculated suckers . . . . . *Pedocotyle* MacCallum  
Posterior pair of suckers either subsessile or pedunculated and not separated from other pairs . . . . . 6
6. Vitellaria extending into haptor . . . . .  
 . . . . . *Cyclocotyla* Otto  
Vitellaria not extending into haptor . . . . .  
 . . . . . *Neoheterobothrium*, n. gen.

**Genus Cyclocotyla** Otto, 1823

*Synonyms*.—*Octostoma* Otto, 1823, not Kuhn, 1829; *Cyclostoma* Otto, 1823, not Lamarck, 1799; *Cyclobothrium* Cerfontaine, 1895, in part; *Choricotyle* Beneden and Hesse, 1863; *Diclidophora* Diesing, of Goto, 1894, in part; *Mesocotyle* Parona and Perugia, 1889.

*Diagnosis*.—Haptor distinctly set off from body proper; suckers either subsessile or pedunculated, more or less equally spaced. Genital atrium non-muscular; cirrus armed; testes postovarial. Vaginae absent; vitellaria extending into haptor.

*Type species*.—*Cyclocotyla bellones* Otto, 1823.

This genus was proposed by Otto (1823) for a parasite collected from the "Rucken-Haut eines Hornhechts" at Naples. The description of the species is limited to external characters, but the figure shows it to be closely related to, and possibly the same as, *Cyclobothrium charcoti*, which was described by Dollfus (1922a; 1922b) from a crustacean parasitic on the skin and in the mouth of *Trachurus trachurus* and *Box boops*. A comparison of the essential characters of these forms with those of the type and other species at present included in the genus *Choricotyle* Beneden and Hesse (1863) shows them to be sufficiently similar as to be regarded as congeneric.

As present constituted the genus *Cyclocotyla* contains the following species: *Cyclocotyla belones* Otto, 1823, from "Hornhecht," *C. charcoti* (Dollfus, 1922), n. comb., from *Cymothoa* (*Meinertia*) *oestroïdes* parasitic on *Trachurus trachurus* and *Box boops*; *C. chrysophryi* (Beneden and Hesse, 1863), n. comb., from *Chrysophrys aurata* and *Pagellus centrodontus*; *C. caulolatlili* (Meserve, 1938), n. comb., from *Caulolatlilus princeps*; *C. elongata* (Goto, 1894), n. comb., from *Pagrus tumifrons*; *C. labracis* (Cerfontaine, 1895), n. comb., from *Labrax lupus*; *C. neomaenis* (MacCallum, 1917), n. comb., from *Lutianus analis*; *C. pagelli* (Gallien, 1937), n. comb., from *Pagellus centrodontus*; *C. prionoti* (MacCallum, 1917), n. comb., from *Merulinus carolinus*; *C. smarisi* (Ijima, in Goto, 1894),<sup>8</sup> n. comb., from *Smaris vulgaris* (on caudal segment of a *Cymothoa*); *C. squillarum* (Parona and Perugia, 1889), n. comb., from *Bopyrus squillarum*; and *C. taschenbergii* (Parona and Perugia, 1889), n. comb., from *Sargus rondeletii*. Of these, only *C. neomaenis* and *C. prionoti* are known to occur on North American hosts.

***Cyclocotyla neomaenis*** (MacCallum, 1917),  
n. comb.  
Figs. 7-9

*Synonyms*.—*Diclidophora neomaenis* MacCallum, 1917; *Choricotyle neomaenis* (MacCallum, 1917) Llewellyn, 1941.

*Description*.—Body fusiform, 9 mm long, including haptor, by 1.1 mm wide. Anterior haptor in form of a pair of suckers, each 80 $\mu$  in diameter, opening into oral cavity. Posterior haptor 2.5 mm long, distinctly set off from body proper by an isthmuslike constriction, bearing four pairs of pedunculated clamplike suckers. Suckers of anterior three pairs about equal in size, 460 $\mu$  wide, and those of posterior pair much smaller, 320 $\mu$  wide; suckers of general type of other representatives of genus, but with heavy corrugations of surface of inner wall of outer quadrants, and with fleshy linguiform pad in depth of sucker cavity; cuticular supporting structure somewhat more complicated than that of other species (Fig. 8); no hooks observed between posterior pair of peduncles. Oral aperture subterminal; pharynx oval, 80 $\mu$

<sup>8</sup> The question of authorship of this species in this case parallels that of *Diclidophora merlangi*.

long by 64 $\mu$  wide; remainder of digestive tract not observable. Excretory apertures laterodorsal, slightly anterior to level of genital aperture; remainder of excretory system not observable. Genital aperture median, about 696 $\mu$  from anterior end of body. Cirrus 88 $\mu$  in diameter, armed with 12 inwardly projecting hooks. Testes relatively few, in median field posterior to ovary. Ovary preequatorial: oötype pre-ovarian, massive, surrounded by numerous unicellular glands. Vitelline follicles numerous, occupying almost entire body width from level of genital aperture to posterior end of body proper, extending into haptor. Vagina and genitointestinal canal not observed. No eggs present.

*Host*.—*Lutianus analis* (Cuvier and Valenciennes).

*Location*.—Gills.

*Distribution*.—United States (Key West, Fla.).

*Specimen*.—U.S.N.M. Helm. Coll. no. 35587 (type).

This species was described from a single specimen collected by the late Dr. G. A. MacCallum at the New York Aquarium, from a muttonfish obtained from Key West, Fla. The species differs from all others of the genus in the peculiar structure of the haptoral suckers.

***Cyclocotyla prionoti*** (MacCallum, 1917),  
n. comb.  
Fig. 10

*Synonyms*.—*Diclidophora prionoti* MacCallum, 1917; *Choricotyle prionoti* (MacCallum, 1917) Llewellyn, 1941.

*Description*.—Body elongate, 3 to 3.7 mm long by 540 to 640 $\mu$  wide, anterior end with constriction between tip of body and genital aperture. Anterior haptor in form of a pair of suckers, about 88 $\mu$  in diameter, opening into oral cavity. Posterior haptor palmate, about 640 to 720 $\mu$  long, with four pairs of pedunculated suckers about 240 $\mu$  in diameter; peduncles of suckers relatively long and thick. Oral aperture subterminal; pharynx piriform, about 160 $\mu$  long by 88 $\mu$  wide; remainder of digestive system not ascertainable in available specimens. Genital aperture median, about 400 $\mu$  from anterior end of body. Cirrus 40 to 48 $\mu$  in diameter, armed with 10 inwardly curved hooks. Testes 21 to 32 in number, relatively

large, median, postovarial. Ovary tubular, folded, median, about one-third of body length from anterior end. Vitelline follicles relatively large, extending from slightly anterior to genital aperture to posterior end of haptor. Seminal receptacle oval, relatively large, posterior to ovary and to right of median line. Genitointestinal canal and vagina not observed. Oötype postovarial, surrounded by prominent mass of unicellular glands. No eggs in available specimens.

*Host*.—*Merulinus carolinus* (Linnaeus).

*Location*.—Gills.

*Distribution*.—United States (Woods Hole, Mass.).

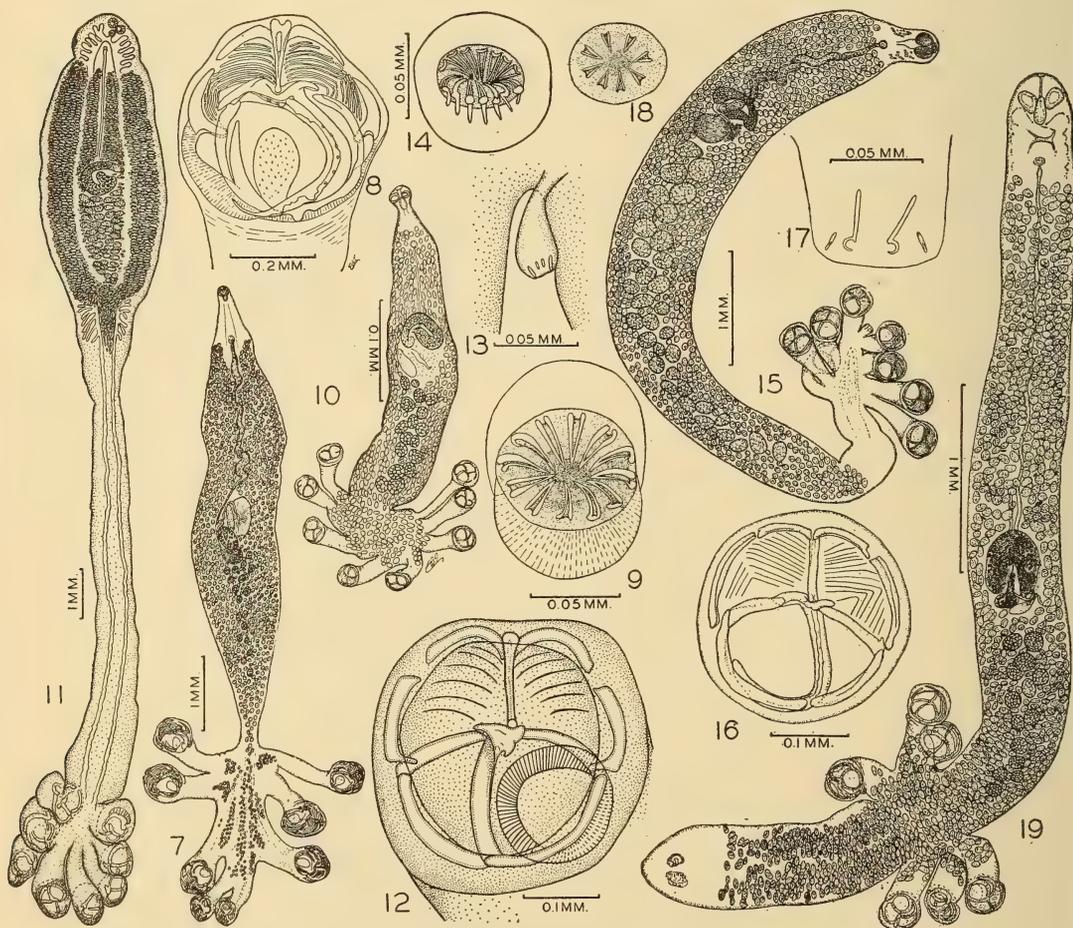
*Specimens*.—U.S.N.M. Helm. Coll. nos. 35589 (cotypes), 35590, and 35591.

This species is closely related to *Cyclocotyla chrysophryi* (Beneden and Hesse); it differs from that species, in so far as one can determine from the original description, in the number of genital hooks (8 in *C. chrysophryi* and 10 in *C. prionoti*). MacCallum (1917) stated that the number of genital hooks was 13, but this is an error.

Genus **Cyclobothrium** Cerfontaine, 1895

*Synonym*.—*Diclidophora* Diesing, of Goto, 1894, in part.

*Diagnosis*.—Haptor indistinctly set off from body proper; suckers sessile. Genital atrium nonmuscular; cirrus armed. Testes numerous, preovarial and postovarial. Vaginae absent.



Figs. 7-9.—*Cyclocotyla neomaenis*: 7, Complete worm, ventral view; 8, haptoral sucker; 9, cirrus. Fig. 10.—*Cyclocotyla prionoti*, complete worm, ventral view. Figs. 11-14.—*Neoheterobothrium affine*: 11, Complete worm, dorsal view; 12, haptoral sucker; 13, haptoral languette; 14, cirrus. Figs. 15-18.—*Neoheterobothrium cynoscioni*: 15, Complete worm, ventral view; 16, haptoral sucker; 17, haptoral languette; 18, cirrus. Fig. 19.—*Pedocotyle morone*, complete worm, dorsal view.

*Type species.*—*Cyclobothrium sessilis* (Goto, 1894) Cerfontaine, 1895.

This genus comprises *Cyclobothrium iniistii* Yamaguti (1937), from *Iniistius dea*; *C. semicossyphi* Yamaguti (1938), from *Semicossyphus reticulatus*; and *C. sessilis* (Goto, 1894), from *Choerops japonicus* and *Semicossyphus reticulatus*; all three species are from Japanese hosts.

Genus **Heterobothrium** Cerfontaine, 1895

*Synonym.*—*Diclidophora* Diesing, of Goto, 1894, in part.

*Diagnosis.*—Haptor separated from body proper by a long slender isthmus; suckers sessile, framework of anterior pair orientated inversely with respect to that of posterior three pairs. Genital atrium nonmuscular, cirrus armed; testes postovarial. Vaginae absent; vitellaria not extending into haptor.

*Type species.*—*Heterobothrium tetrodonis* (Goto, 1894) Cerfontaine, 1895.

The type and only species of this genus was obtained from the gills of *Tetrodon* sp. in Japan; it is not known to occur on North American hosts.

**Neoheterobothrium**, n. gen.

*Diagnosis.*—Haptor separated from body proper by a long slender isthmus; suckers pedunculated, with framework of all pairs orientated in same manner. Other characters as in *Heterobothrium*.

*Type species.*—*Neoheterobothrium affine* (Linton, 1898), n. comb.

The species referable to this genus are *Neoheterobothrium affine* (Linton, 1898) from *Paralichthys dentatus* and *N. cynoscioni* (MacCallum, 1917), n. comb., from *Cynoscion regalis*, both from North America; and possibly *Octobothrium leptogaster* (F. S. Leuckart, 1830) (= *N. leptogaster* (F. S. Leuckart, 1830), n. comb.) from *Chimaera monstrosa* in Europe.

**Neoheterobothrium affine** (Linton, 1898),  
n. comb.

Figs. 11–14

*Synonyms.*—*Octoplectanum affine* Linton, 1898; *Diclidophora affinis* (Linton, 1898) Linton, 1901; *Choricotyle affine* (Linton, 1898) Llewellyn, 1941.

*Description.*—Body elongate, 11 to 20 mm long by 2 to 3 mm wide, divided into three parts, namely, body proper, isthmus and hap-

tor. Anterior haptor consisting of a pair of suckers 120 to 170 $\mu$  in diameter, opening into oral cavity. Posterior haptor 2 to 3 mm. in diameter, consisting of 8 digitate appendages bearing suckers 425 to 510 $\mu$  in diameter supported by a heavily cuticularized framework as shown in Fig. 12. Between peduncles of posterior pair of suckers is a small projection or "languette," about 50 $\mu$  long by 25 $\mu$  wide, apparently bearing two pairs of hooks (hooks missing but insertions clearly visible). Oral aperture subterminal; pharynx piriform, 170 to 180 $\mu$  long by 110 to 170 $\mu$  wide; intestinal branches with prominent lateral diverticula as far back as isthmus, then without diverticula, extending into haptor. Genital aperture median, about 510 to 680 $\mu$  from anterior end of body; cirrus armed with a circle of incurved hooks, 12 to 16 in number, each about 20 $\mu$  long. Testes numerous, number not ascertainable, postovarial, in median field. Ovary folded, median, approximately in equatorial region of preisthmian portion of body. Vitelline follicles extending from a short distance posterior to level of genital aperture to distal part of preisthmian portion of body. Seminal receptacle and genitointestinal canal not observed. Egg about 150 $\mu$  long by 57 $\mu$  wide, with prolongation at each pole.

*Host.*—*Paralichthys dentatus* (Linnaeus) and *P. lethostigmus* Jordan and Gilbert.

*Location.*—Mouth.

*Distribution.*—United States (Woods Hole, Mass., and Grand Island Region, La.).

*Specimens.*—U.S.N.M. Helm. Coll. nos. 4876 (type), 4875, and 8156.

The redescription of this species as given here is based on toto mounts of the type and other specimens described from Woods Hole, Mass., by Linton (1898; 1901; 1940). The preparations were not very good and some details could not be made out. Melugin (1940) has reported this species from Louisiana.

*Neoheterobothrium affine* resembles *Octobothrium leptogaster* (F. S. Leuckart) [= *Neoheterobothrium leptogaster* (F. S. Leuckart)] as described by Olsson (1876) and by Parona and Perugia (1892) in possessing a long, slender isthmus between body proper and haptor. The two species are also similar in that both possess a hook-bearing lobe or "languette" between the peduncles of the posterior pair of haptoral

suckers (see Ruszkowski, 1934, for description of the hooks of *O. leptogaster*). The presence of a "languette" in these species may not be of especial significance, however, as many of the members of the family Diclidophoridae possess this structure. In spite of obvious similarities there is little likelihood of the two species being identical because of their host affinities, there being an extraordinary host specificity among the Monogenea.

***Neoheterobothrium cynoscioni***

(MacCallum, 1917), n. comb.

Figs. 15-18

*Synonyms*.—*Diclidophora cynoscioni* MacCallum, 1917; *Choricotyle cynoscioni* (MacCallum, 1917) Llewellyn, 1941.

*Description*.—Body elongate, 7 to 10 mm long by 400 to 616 $\mu$  wide, attenuated posteriorly. Anterior haptor in form of a pair of suckers 120 $\mu$  in diameter opening into oral cavity. Posterior haptor somewhat palmate, about 640 $\mu$  long, with four pairs of pedunculated suckers, and with small, flaplike lobe bearing two pairs of hooks between peduncles of last pair of suckers; suckers about 288 $\mu$  in diameter, with heavily cuticularized framework as shown in Fig. 16; posterior lobe 120 $\mu$  long by 72 $\mu$  wide, outer hooks 12 $\mu$  long and inner hooks 28 to 30 $\mu$  long. Oral aperture subterminal; pharynx piriform, 120 $\mu$  long by 80 $\mu$  wide; esophagus and intestinal branches not traceable in available specimens. Genital aperture median, about 430 to 460 $\mu$  from anterior end of body. Cirrus 48 to 50 $\mu$  in diameter, armed with eight hooks. Testes 28 to 30 in number, relatively large, occupying median field posterior to ovary. Ovary tubular, folded, median, about one-third of body length from anterior end. Vitelline follicles extending from level of genital aperture to about midway between level of last testis and anterior margin of haptor. Seminal receptacle oval, relatively voluminous, posterior to ovary and slightly to right of median line. Genitointestinal canal and vagina not observable. No eggs present.

*Host*.—*Cynoscion regalis* (Bloch and Schneider).

*Location*.—Gills.

*Distribution*.—United States (Woods Hole, Mass.).

*Specimens*.—U.S.N.M. Helm. Coll. nos. 35592 (type) and 35593.

The type specimen of this species is greatly elongated and somewhat mutilated; it was collected by the late Dr. G. A. MacCallum August 26, 1914. Three additional specimens are available, collected by MacCallum July 2, 1924; these are in much better condition than the type, and the greater part of the above description is based upon these specimens. In the type specimen the small lobe or "languette" at the posterior end of the haptor was folded over one of the peduncles and was not observed by MacCallum.

***Cyclocotyloides*, n. gen.**

*Diagnosis*.—Haptoral suckers pedunculated. Genital atrium strongly muscular; cirrus unarmed; otherwise similar to *Cyclocotyloides*.

*Type species*.—*Cyclocotyloides pinguis* (Linton, 1940), n. comb.

Only one species, the type, is referable to this genus. *C. pinguis* was described by Linton (1940) as *Diclidophora pinguis* and was based on specimens from the mouth of *Albatrossia pectoralis*. The specimens available to the writer were fragmentary and nothing can be added to the original description. The absence of clamp-like haptoral suckers excludes this species from the genus *Diclidophora* and the presence of a muscular genital atrium and the absence of an armed cirrus exclude it from other genera of the Cyclocotylineae.

**Genus *Diclidophoropsis* Gallien, 1937**

*Diagnosis*.—Haptoral suckers pedunculated. Genital atrium nonmuscular; cirrus armed; testes postovarial. Vaginae present; vitellaria extending into haptor.

*Type species*.—*Diclidophoropsis tissieri* Gallien, 1937.

The type and only species was described by Gallien (1937) from specimens collected on *Macrurus laevis* in the Atlantic Ocean south of Ireland.

**Genus *Pedocotyle* MacCallum, 1913**

*Synonym*.—*Podocotyle* MacCallum, 1913, not Dujardin, 1845.

*Diagnosis*.—Haptor linguiform, not distinct from body proper, bearing three pairs of pedunculated suckers at anterior end of haptor and one pair of smaller sessile suckers near posterior end. Testes postovarial. Vitellaria extending into haptor.

*Type species.*—*Pedocotyle morone* MacCallum, 1913.

***Pedocotyle morone* MacCallum, 1913**

Fig. 19

*Synonym.*—*Podocotyle morone* MacCallum, 1913.

*Description.*—Body slender, 5.9 mm long by 500 $\mu$  wide, apparently flat and ribbonlike, sides parallel. Anterior haptor in form of two suckers, 115 $\mu$  in diameter, opening into mouth cavity. Posterior haptor linguiform, not distinguishable from body proper, with 3 pairs of pedunculated suckers at its anterior end and one pair of smaller sessile suckers near posterior end. Anterior pedunculated suckers 228 $\mu$  in diameter, with heavily cuticularized supporting structure similar to that in *Neoheterobothrium cynoscioni* (see Fig. 16); peduncles about 228 $\mu$  long by 180 $\mu$  in diameter; suckers of posterior pair about 76 $\mu$  in diameter, apparently of the same structure as those of anterior pairs (crushed in type specimen). Mouth terminal; pharynx piriform, 150 $\mu$  long by 83 $\mu$  wide; esophagus and intestine not discernible in available specimen. Genital aperture median, about 375 $\mu$  from anterior end of body. Cirrus muscular, 57 $\mu$  in diameter, armed with 10 inwardly curved hooks. Testes 14 in number, about 115 $\mu$  in diameter, in median field between ovary and anterior end of haptor. Ovary tubular, folded, median. Vitelline follicles occupying greater part of body from level of genital aperture to near posterior end of haptor. Seminal receptacle small, posterior to ovary and to right of median line. Genitointestinal canal and vagina not observed. Oötype prominent, surrounded by numerous unicellular glands. No eggs in available specimen.

*Host.*—*Morone americana* (Gmelin).

*Location.*—Gills.

*Distribution.*—United States (New York).

*Specimen.*—U.S.N.M. Helm. Coll. no. 35594 (type).

This species, based on a single specimen and originally described by MacCallum (1913a; 1913b), is peculiar in the arrangement of the suckers of the posterior haptor; because of its unique appearance, further comment as to its differentiation from related forms is unnecessary.

DICLIDOPHORIDAE OF UNCERTAIN POSITION

Genus ***Platycotyle*** Beneden and Hesse, 1863

*Diagnosis.*—Haptor rectangular, bearing four widely separated pedunculated suckers; terminal hooks absent.

*Type species.*—*Platycotyle gurnardi* Beneden and Hesse, 1863.

The type and only species of the genus is known only from the very inadequate description given by Beneden and Hesse (1863); this worm was collected from the gills of *Trigla gurnardus* in Europe.

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ZOOLOGY.—*Notes on Mexican urocoptid mollusks.*<sup>1</sup> PAUL BARTSCH, U. S. National Museum.

The preparation of a monograph on the Cuban land mollusks of the family Urocoptidae by Dr. Carlos de la Torre and myself has made it necessary to subject the entire family to a critical overhauling. This has brought to light considerable misunderstanding on the part of the older authors,

due largely to the fact that at the time when they were working little was known of the anatomy and structure of the columella, the lamellation of the interior shell, and even less of the circumscribed ecologic conditions under which these animals exist. Today some of the deficiencies have been met, more or less, and the mass of material available for study furnishes a clearer viewpoint, and the results of the revisional work show a

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consistent zoogeographic pattern. For the new species here described I am indebted largely to the energetic efforts of Miss Marie E. Bourgeois.

Genus **Bostrichocentrum** Strebel

*Bostrichocentrum* Strebel, Beitr. Kentn. Fauna Mexico, pt. 4: 80. 1880.

Type: *Bostrichocentrum tryoni* Pfeiffer.

This group appears confined to central Mexico. The known species are listed with their type localities:

*tamaulipense* Bartsch: Camargo, Tamaulipas  
*hidalgoensis* Bartsch: Bonanza, Zimapan, Hidalgo

*veracruziana* Dall: Misantla, Veracruz

*veracruzicolum*, n. sp.: Veracruz

*ronzoni*, n. sp.: Pajaro Verde, Puebla

*pilsbryi* Dall: City of Puebla, Puebla

*tryoni* Pfeiffer: Matamoros de Izucar, Puebla

*eurybia* Bartsch: Near Rio Balsas, Guerrero

*galathea* Bartsch: Near Rio Balsas, Guerrero

*goldmani* Bartsch: Tamazulapan, Oaxaca

*gealei* H. Adams: Putla, Oaxaca

*B. hogeana* von Martens, Maltrata, Veracruz, is doubtfully referred here.

**Bostrichocentrum veracruzicolum**, n. sp.

Fig. 4

Shell cylindroconic, flesh colored with the nucleus and the early postnuclear whorls pale horn colored. The nucleus consists of 2.7 turns, which are well rounded, microscopically granulose, and form an obtuse apex. The five postnuclear whorls following increase regularly in size, after which the shell becomes cylindric. They are marked by retractively curved axial riblets, which gradually become less strongly developed and on the cylindric portion are merely indicated as incremental lines. The postnuclear whorls on the conic portion are well rounded, while the later turns are almost flattened. The suture is well constricted. The last whorl is short, narrowly umbilicate, with well-rounded base crossed by axial riblets, which are irregular in their development, size, and spacing. The last whorl is usually solute, though at times adnate to the parietal wall. The solute portion rarely extends over one-tenth of a turn. The aperture is very broadly pear shaped, the narrow portion being at the posterior angle. The peristome is moderately expanded and reflected. The columella is hollow and bears a strong fold a little posterior to the basal wall on

the penultimate whorl, which fades out on the turn preceding it.

The type, U.S.N.M. 536877, was received from Miss Bourgeois, who states that it was collected in the neighborhood of Orizaba or Cordoba, or a little farther south, in the state of Veracruz. It has 12.8 whorls and measures: height, 12 mm; diameter, 2.9 mm. U.S.N.M. 536878 contains two topotypes, and another topotype is in the collection of Miss Bourgeois.

In type of sculpture this species resembles *B. pilsbryi* but is easily differentiated by its much smaller size and less elongate form.

**Bostrichocentrum ronzoni**, n. sp.

Fig. 3

Shell small, pupiform, white, with the nuclear whorls horn colored. The nuclear turns and the first four postnuclear whorls increase regularly in size to form a conic apex. The rest of the shell is cylindric, the last whorl being slightly contracted. The nucleus consists of 2 turns, which are strongly rounded and minutely granulose. The postnuclear whorls are marked by numerous closely spaced, well-developed, axial riblets, which are separated by intercostal spaces that vary from mere impressed lines to equal the width of the ribs. Beginning with the middle of the cylindric portion, the axial ribs become stronger and more distantly spaced, reaching their greatest width on the last turn. All the postnuclear whorls are well rounded. Suture well impressed. Periphery of the last whorl well rounded. Base short, well rounded, narrowly openly umbilicated, and marked by the continuation of the axial ribs. Aperture subovate; peristome slightly expanded and reflected, usually adnate on the parietal wall to the preceding turn though at times slightly solute. The columella is hollow and bears a fold a little above the basal wall which is very strong in the penultimate whorl and extends feebly throughout the rest of the spire. The columella shows retractively curved incremental lines.

The type, U.S.N.M. 536874, was received from Miss Bourgeois and was collected by Dr. M. del Campo at Pajaro Verde, Puebla. It has 12.2 whorls and measures: height, 10.1 mm; diameter, 3.9 mm. U.S.N.M. 536875 contains two topotypes and an additional topotype is in Miss Bourgeois's collection. U.S.N.M. 536876 contains five additional specimens, which are

said to have come from either Cordoba or Orizaba, the exact locality being not definitely known. An additional specimen from this lot also is in Miss Bourgeois's collection.

This species in sculpture resembles *B. tryoni* but can readily be distinguished by its much smaller size. It has much finer sculpture than *B. eurybia* and stronger sculpture than *B. galathea*.

#### Genus *Haplocion* Pilsbry

*Haplocion* Pilsbry, Man. Conch. 15: 89. 1902.

Type: *Holospira pasonis* Dall.

The known species, with their type localities, are:

- bryantwalkeri* Pilsbry: Rio Conchos near Rio Grande, Chihuahua  
*semisculpta* Stearns: San Carlos Cañon, Chihuahua  
*townsendi* Bartsch: Cerro Chilicote, Chihuahua  
*coahuilensis* Binney: Cienega Grande, Coahuila  
*minima* von Martens: Hermosillo, Sonora  
*remondi* Gabb: Valle de Sahuaripa, Sonora  
*guaymasensis*, n. sp.: Guaymas, Sonora  
*percostata* Pilsbry: Sonora  
*mazatlanica*, n. sp.: Mazatlan, Sinaloa  
*matthewsoni* Bartsch: D. F. Mexico,  
*mariae* Bartsch: Ixtapan de la Sal, Mexico.  
*campoi*, n. sp.: Las Grutas, Guerrero  
*bartschi* Pilsbry & Cockerell: Balsas, Guerrero  
*fusca* von Martens: Omilteme, Guerrero  
*pasonis* Dall: El Paso, Texas  
*mesolia* Pilsbry: Sanderson, Texas  
*tantalus* Bartsch: Arizona or New Mexico

#### *Haplocion guaymasensis*, n. sp.

Fig. 1

Shell elongate-pupiform, flesh colored. The nucleus consists of 2.5 well-rounded, microscopically granulate turns. These, combined with the first four postnuclear whorls, form a conic apex. The remaining turns are cylindrical. The postnuclear whorls are well rounded and crossed by decidedly retractorily slanting axial ribs, which are separated by spaces double the width of the ribs or even wider. Suture strongly constricted. The last two turns are inflated and strongly rounded. Base short, strongly rounded, openly umbilicated and marked by the weak continuation of the axial ribs. The last whorl is solute for about one-tenth of a turn. Aperture subcircular; peristome broadly expanded and reflected. The columella is rather broad and hollow and smooth.

The type, U.S.N.M. 536883, was collected by Miss M. E. Bourgeois near the beach at

Guaymas, Sonora. It has 13 whorls and measures: height, 12 mm; diameter, 4 mm. U.S.N.M. 522967 contains two topotypes.

This species resembles most nearly *Haplocion mazatlanica* but differs in being stouter and in having the whorls much less rounded and the axial ribs more distantly spaced.

#### *Haplocion mazatlanica*, n. sp.

Fig. 6

Shell small, cyliandroconic, pale horn colored. The nucleus consists of 2.5 well-rounded granulate turns. The postnuclear whorls are decidedly inflated, strongly rounded, and marked by somewhat sinuous, retractorily curved axial ribs, which are almost as wide as the spaces that separate them. Suture very strongly constricted. The last whorl is short. Base short, strongly rounded, narrowly openly umbilicated, and marked by the continuation of the axial ribs. Aperture subcircular; peristome broadly expanded, widest on the inner lip and parietal wall. Columella moderately stout, hollow with a slight twist in the later whorls.

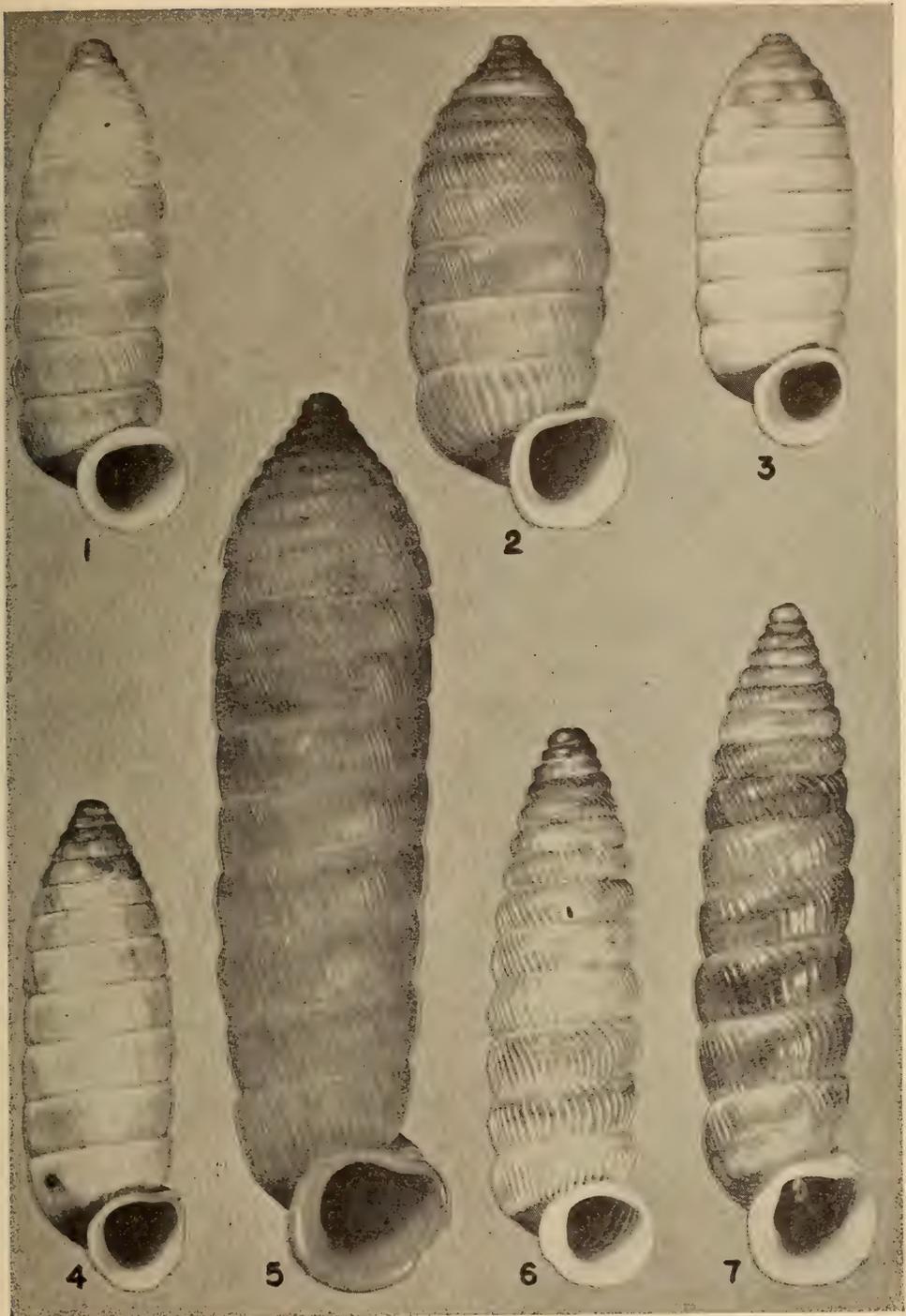
The type, U.S.N.M. 536884, was collected by C. R. Orcutt at Mazatlan. It has 14 whorls and measures: height, 13.5 mm; diameter, 4.1 mm. U.S.N.M. 381625 contains four topotypes.

This species resembles most nearly *Haplocion guaymasensis* but differs from it in being slenderer and having the whorls much more inflated and the axial ribs more closely spaced.

#### *Haplocion campoi*, n. sp.

Fig. 7

Shell cyliandroconic, pale horn colored with the interior of the aperture pale brown. The nucleus consists of 2.5 well-rounded whorls, of which the last half of the first is wider than the rest of the turns. They are minutely granulate. Beginning with the sixth postnuclear whorl the shell assumes a cylindrical form. All the whorls are almost flattened, well rounded, and marked by retractorily curved, well-rounded, strongly developed axial ribs, which are about as wide as the spaces that separate them on the early turns, but a little less wide on the later whorls. Suture strongly constricted. The last whorl is somewhat attenuated and rather long. The base is short and rimate at the umbilicus and crossed by the continuation of the axial ribs. The last whorl is solute for about one-eighth of a turn. Aperture subequal; peristome moder-



Figs. 1-7.—New species of Mexican urocoptid mollusks: 1, *Haplocion guaymasensis*; 2, *Coelostemma presidioensis*; 3, *Bostrichocentrum ronzonei*; 4, *Bostrichocentrum veracruzicum*; 5, *Coelostemma antricola*; 6, *Haplocion mazatlanica*; 7, *Haplocion campoi*.  
 (All figures  $\times 6$ )

ately expanded and reflected. Columella slender and almost solid in the later whorls, but more hollow in the earlier turns, almost straight.

The type, U.S.N.M. 536880, has 15 whorls and measures: height, 17 mm; diameter, 4.6 mm. It was collected by Dr. Martin del Campo at Las Grutas, Cacahuamilpa, Guerrero. U.S.N.M. 536881 contains nine topotypes. U.S.N.M. 536882 contains four additional topotypes collected by Miss M. E. Bourgeois.

This species in the inflation of the whorls resembles *Haplocion mariae* Bartsch but differs from it in being much larger and in having the ribs more closely spaced.

#### Genus *Coelostemma* Dall

*Coelostemma* Dall, *Nautilus* 9: 50. 1895.

Type: *Holospira elizabethae* Pilsbry.

Following are the known species, with their type localities:

- dalli* Pilsbry: Sierra Guadalupe, Coahuila  
*strebliana* Pilsbry: Sierra Guadalupe, Coahuila  
*lichenophora* Dall: Encarnacion, Hidalgo  
*bourgeoisiana* Bartsch: Ixtapan de la Sal, Mexico  
*antricola*, n. sp.: Las Grutas, Guerrero  
*igualaensis* Bartsch: Iguala, Guerrero  
*balsasensis* Bartsch: Rio Balsas, Guerrero  
*adria* Bartsch: Rio Balsas, Guerrero  
*adana* Bartsch: Rio Balsas, Guerrero  
*elizabethae* Pilsbry: Amula, Guerrero  
*herrerae* Bartsch: Silacayoapan, Oaxaca  
*presidioensis*, n. sp.: Presidio, Veraacruz

The following species whose columellar structure is unknown are doubtfully placed here:

- cretacea* Pfeiffer: Mexico, without specific locality  
*microstoma* Pfeiffer: Mexico, without specific locality  
*imbricata* von Martens: Mexico, without specific locality  
*teres* Menke: Puebla  
*teres* var.  $\beta$  Crosse & Fischer: Puebla

#### *Coelostemma antricola*, n. sp.

Fig. 5

Shell elongate-cylindroconic, with the nucleus and the early post-nuclear whorls horn colored, the rest flesh colored. The nucleus consists of 2.5 well-rounded, minutely granulose whorls. The succeeding seven turns increase rapidly in size to form a conic apex. The rest of the shell is cylindrical, but the whorls become slightly contracted from the broadest expansion at the junction of the cylindrical portion and the

conic part anteriorly. The conic part and the last whorl are marked by strong, rather distantly spaced axial ribs. Here these are only about half as wide as the spaces that separate them and they develop slight nodules at the slightly overhanging portion of the turns at the suture. On the cylindrical portion the axial ribs become much finer and more closely spaced. Suture moderately strongly constricted. The last whorl is somewhat prolonged, slightly angulated at the periphery. Base short, slightly rounded, rimate at the umbilicus, and marked by the continuation of the axial ribs. The last whorl is solute for about one-fifth of a turn. Aperture subtriangular; peristome moderately expanded and reflected. The columella is very broad, widest in the later part of the conical portion of the shell, hollow, and marked by slender, retractively curved, axial riblets.

The type, U.S.N.M. 536885, was collected at the base of a limestone boulder in a ravine near Las Grutas, Cacahuamilpa, Guerrero. It has 18.3 whorls and measures: height, 21.1 mm; diameter, 5.6 mm. A topotype is in Miss Bourgeois's collection.

This species recalls *Coelostemma bourgeoisiana* but is much larger and much more cylindrical.

#### *Coelostemma presidioensis*, n. sp.

Fig. 2

Shell small, pupoid, pale horn colored, the later whorls flesh colored, which is also the color of the interior of the aperture. The nucleus consists of 2 well-rounded, microscopically granulose whorls. The nucleus, plus the succeeding five turns, complete the conic spire, the remaining turns being more or less cylindrical, contracting slightly toward the base. All the whorls are moderately well rounded. On the conic portion they are covered by rather strong, distantly spaced ribs, which are only about one-half to one-third as wide as the spaces that separate them. On the central part of the cylindrical portion the ribs become much finer and more closely spaced. On the penultimate whorl they are almost obsolete, while on the last whorl they are again very strong and very distantly spaced, the intercostal spaces being at least four times the width of the ribs. Suture very strongly constricted. Base very short, narrowly umbilicated, and marked by the strong continuation of the ribs which extend over the umbilicus. Aperture subtriangular;

peristome moderately expanded, reflected, and thickened. The columella is stout, almost one-fourth the width of the interior of the whorls, and crossed by slender, slightly retractively curved axial ribs.

The type, U.S.N.M. 536886, was collected by Miss M. E. Bourgeois at Presidio, Veracruz. It

has 13 whorls and measures: height, 12 mm; diameter, 5 mm.

The small form and pupoid shape will differentiate this from all other species except possibly *Coelostemma imbricata* von Martens, in which the middle whorls are not cylindrical.

ICHTHYOLOGY.—*Two marine fishes new to the fauna of Alaska, with notes on another species.*<sup>1</sup> LEONARD P. SCHULTZ, U. S. National Museum.

Recently in identifying a collection of fishes taken in Alaskan waters by Dr. Waldo L. Schmitt, two of the species proved to be new to the known fauna of Alaska and of North America. Additional information is given on another species.

*Sebastodes polyspinis* Taranetz and Moiseev  
Fig. 1

*Sebastodes polyspinis* Taranetz and Moiseev, in Taranetz, Vestnik dv. Eiliala Akad. Nauk SSSR no. 1-3: 69. 1933; Taranetz, Bull. Pacific Sci. Inst. Fish. Oceanog., 2: 94. 1937.

The discovery of six specimens of *Sebastodes* in Schmitt's collection with XIV dorsal spines all belonging to the same species was a surprise, because among the hundreds of specimens of this group examined from the American side of the North Pacific, all have had XIII dorsal spines. From time to time species of *Sebastodes* have been reported from the Asiatic side of the North Pacific Ocean with XIV spines, but these specimens are thought to be the first recorded from Alaska. My studies indicate that the Alaskan specimens belong to the species *Sebastodes polyspinis*. Although there are some minor differences, such as in color, it is thought best not to describe them as a new form without first making direct comparisons with the types of *S. polyspinis*, which is not now possible because of the war.

The following key was prepared from the available specimens and literature, and by means of it one should be able to identify the North Pacific species of *Sebastodes* with XIV

dorsal spines that have a flattish to convex interorbital space.

1a. Tubes in the lateral line 44 or fewer.

2a. Lateral line tubes 35; vertical scale rows from upper edge of gill opening to base of caudal fin about 65; scales above lateral line at base of first soft ray of dorsal 6 and below lateral line at origin of anal 16; mandible scaly; pectoral rays 16, lower 8 unbranched and swollen; anal rays III, 8; dorsal XIV, 13; interorbital a little convex; nasal and preocular spines present; parietal, postocular, and nuchal with weak spine; color reddish, marked with about 5 indefinite dark saddles along the back; peritoneum black; mouth cavity and gill cavities dusky; Japan... *Sebastodes owstoni* Jordan and Thompson<sup>2</sup>

2b. Tubes in lateral line 40; mandible probably naked; pectoral rays 17; anal III, 10; dorsal XIV, 15; interorbital space flat; nasal and parietal spines strong; preocular, supraocular and postocular very weak; tympanic, coronal and nuchal absent; color red, no spots. Southeast coast of Siberia... *Sebastodes pavlenkoi* Wales<sup>3</sup>

1b. Tubes in lateral line 45 or more.

3a. Tubes in lateral line about 63; vertical rows of scales above lateral line about 115; scales above lateral line 11 or 12 and 17 below; pectoral rays 19, 9 lower ones unbranched; anal III, 7; dorsal XIV, 13; gill rakers 12+27; mandible scaly; interorbital convex; nasal spine small but sharp; other cranial spines absent; peritoneum black; color brownish, top of head and upper sides clouded with dusky; lateral line run-

<sup>2</sup> *Sebastodes owstoni* Jordan and Thompson, Mem. Carnegie Mus. 6 (4): 270, pl. 31, fig. 3. 1914; Jordan and Hubbs, Mem. Carnegie Mus. 10(2): 260, 1925; SCHMIDT, P. J., Trans. Pacific Committee Acad. Sci. USSR 2: 94. 1931.

<sup>3</sup> *Sebastodes ruber* Pavlenko, Fishes Peter the Great Bay, Trd. Obsc. Test. Kanzani, p. 42. 1910 (name preoccupied); *Sebastodes pavlenkoi* Wales, Copeia, No. 1, p. 10. 1930 (new name).

<sup>1</sup> Published by permission of Secretary of the Smithsonian Institution. Received September 5, 1942.

ning in a conspicuous light streak; upper part of opercles with a black spot. Japan . . . *Sebastes itinus* Jordan and Starks<sup>4</sup>

3b. Tubes in lateral line 45 to 50; vertical scale rows 85 to 100; gill rakers on first gill arch 10 to 12+26 or 27; peritoneum black; interorbital convex; nasal spines small but sharp; other cranial spines absent.

4a. Mandible naked; vertical scale rows about 100 (these data based on a specimen, U.S.N.M. no. 102454, from Okhotsk Sea); pectoral rays 19, lower 10 or 11 unbranched; anal rays III, 8; dorsal rays XIV, 17; gill rakers about 10+26; black streak along maxillary; one below eye, then a white streak, then a broad blotch behind eye; two blotches on opercle; an indistinct blotch or bar below spiny dorsal and another below soft dorsal. Asiatic side Bering Sea . . . *Sebastes glaucus* (Hilgendorf)<sup>5</sup>

4b. Mandible scaly; vertical rows 88 to 91; pectoral rays 18, lower 8 or 9 unbranched; anal rays III, 7 or 8; dorsal XIV, 14 or 15; lips of lower jaw dusky; a blackish streak along lower part of maxillary; another oblique black streak from under eye across preopercle, a pale one above and behind eye dusky; opercle with 2 dusky blotches; upper median fins dusky; body above more or less coarsely reticulated or marbled with dusky; mouth and gill cavities with traces of dusky shades here and there; base of pectoral with dusky area; trace of a wide pale band along upper sides and another along lower sides, both probably reddish in life. Bering Sea; Shumagin and Aleutian Islands . . . *Sebastes polyspinis* Taranetz and Moiseev

Since the publication by Taranetz (1933: 69-70) is mostly in Russian, I give below a

<sup>4</sup> *Sebastes itinus* Jordan and Starks, Proc. U. S. Nat. Mus. 27: 99, fig. 1, 1904. Fig. 1 has but XIII dorsal spines, but Dr. G. S. Myers informs me that the type has XIV dorsal spines, and there are 63 lateral-line tubes instead of 54 as published.

<sup>5</sup> *Sebastes glaucus* Hilgendorf, S. B. Ges. Naturf. Freunde, p. 170. 1880. Although I have not been able to locate the specimen from Bering Island reported upon as *S. glaucus* (by Jordan and Gilbert, Rept. U. S. Fur Seal Comm., pt. 3: 447. 1898; Jordan and Evermann, U. S. Nat. Mus. Bull. 47, pt. 2: 1777, 1898; and Jordan and Starks, Proc. U. S. Nat. Mus. 27: 97. 1904), it probably is not this species but *Sebastes polyspinis* Taranetz and Moiseev.

translation (made for me) of the description of *S. polyspinis*:

"Description of our specimens: D XIV (XIII), 13-15; A III, 7-8; gill rakers on the outside surface of first arch 9-12+23-26; P 18 (4 fish); tubes in lateral line 48-50 (57?); 28 vertebrae (4 fish) with urostyle.

"The body is covered with ctenoid scales; accessory scales are missing; the head, except the gill membranes, is covered with very small scales; the smallest are situated on the upper and lower jaws on the brachioistegal rays, and on the front of the head; ridges on the head are not developed except the parietals; on the operculum there are 2 sharp spines: on the preoperculum there are blunt spines, two or three of them are split at the ends; nasal spines hidden in the skin: base of skull curved; parietals not connected; interorbital space is convex; lower jaw protrudes forward and has a strong knob on the symphysis.

"The next to the last dorsal spine extends half way out along the last; the second anal spine is shorter and thicker than the third one.

"Color in formalin: Sides of body are dark without spots; the dorsal part is darker; the ventral side pale; the edges of the first dorsal black; peritoneum black; other fish vary from pale to brown with black spots.

"D. XIV, 13; A III, 8; P. 18; gill rakers 12+26; lateral line tubes 48-50. The length of the head is 107 mm. The length of the body 360 (?); without caudal 305; diameter of eye 21.0; diameter of orbit 25.5; interorbital space 23.1; upper jaw 47.2; lower jaw 59.0; height of the head 88.3; length of the longest gill raker 14.7; maximum height of the body 110.5; minimum 25.9; length of pectoral (from the upper edge of the base to the end of longest ray when the fin is folded against the body) 80.7; base of pectoral 29.0; length of pelvic 62.2; length of base of pelvic 35.9; length of base of first dorsal 111.5; second dorsal 59.7; length of base of anal 42.9; height of longest dorsal spine (fifth) 33.4; height of 13th spine 16.1; of 14th 24.8; length of second anal spine 29.6; length of third anal spine 29.8

"From other species *S. pavlenkoi* Wales (= *S. ruber* Pavlenko) differs by the number of pores in lateral line, by the absence of spines on the upper part of the head, and in other details. No other type of *Sebastes* has 14 dorsal

spines except *S. glaucus* to which ours is not related. Our fish differs from *S. jordani*, *S. goodei*, *S. paucispinis* by the presence of 14 spines in the first dorsal and in the number of pores in the lateral line.

"A fish referred to by P. J. Schmidt as *S. ciliatus* (*S. taczanowskii* according to Soldatov and Lindberg, p. 156, not *S. ciliatus* Tilesius) appears to be the same, but because of slight variations in formulae we can not affirm it conclusively as P. J. Schmidt does not check on it further.

"Distribution: from about Pribilof Islands to east coast of Kamchatka."

The data presented in Tables 1 and 2 form the basis for the identification of the Alaskan specimens as *S. polyspinis*, which were collected as follows:

U.S.N.M. no. 119375. Alaska: 22 miles ENE. Castle Rock, off Big Koniuji Island (Shumagin Islands), trawl, 95-120 fathoms, October 2, 1940, 1 specimen, 208 mm.

U.S.N.M. no. 119379. Alaska: Pavlof Bay, trawl, 10-30 fathoms, September 25, 1940, 1 specimen, 117 mm.

U.S.N.M. no. 19376. Alaska: King Cove, trawl, 15-22 fathoms, October 16, 1940, 2 specimens, 189 and 144 mm.

U.S.N.M. no. 119378. Alaska: Castle Bay, trawl, 45-60 fathoms, October 29, 1940, 1 specimen, 153 mm.

U.S.N.M. no. 119377. Alaska: Olga Bay, trawl, 38-95 fathoms, November 4, 1940, 1 specimen, 145 mm.

TABLE 1.—COUNTS AND MEASUREMENTS OF SEBASTODES POLYSPINIS TARANETZ AND MOISEEV. (All measurements expressed in hundredths of the standard length.)

Characters	Types from Bering Sea	Alaskan Specimens	
Dorsal spines . . . . .	XIV	XIV	XIV
Dorsal soft rays . . . . .	13-15	14	15
Anal rays . . . . .	III, 7-8	III, 7	III, 8
Gill rakers first arch . . . . .	9 to 12 + 23 to 26	12+27	11+26
Pectoral rays . . . . .	18	18-18	18
Unbranched lower pectoral rays . . . . .	—	9-9	8
Tubes lateral line . . . . .	48-50	50	48
Vertical scale rows . . . . .	—	91	85
Scales above lateral line . . . . .	—	11	10
Scales below lateral line . . . . .	—	17	16
Standard length in millimeters . . . . .	305	208	117
Diameter of orbit . . . . .	8.38	9.62	9.4
Interorbital space . . . . .	7.01	7.69	7.7
Length of maxillaries of upper jaw . . . . .	15.4	15.4	15.6
Length of lower jaw . . . . .	19.4	17.8	17.5
Longest gill raker . . . . .	4.82	5.05	5.12
Depth (greatest) . . . . .	36.2	32.7	34.7
Least depth caudal peduncle . . . . .	8.46	9.13	9.4
Length of pectoral fin . . . . .	26.4	27.2	28.6
Length of pelvic fin . . . . .	20.4	20.9	20.1
Length of base first dorsal . . . . .	36.7	37.5	37.6
Length of base second dorsal . . . . .	19.6	20.7	22.6
Length of base of anal . . . . .	14.2	15.8	15.4
Length of longest dorsal spine (5th) . . . . .	10.9	12.5	12.8
Length of thirteenth dorsal spine . . . . .	5.28	7.21	8.53
Length of fourteenth dorsal spine . . . . .	8.16	10.1	12.8
Length of second anal spine . . . . .	9.68	11.1	12.8
Length of third anal spine . . . . .	9.78	11.5	14.1
Length of head . . . . .	—	33.2	34.2
Preorbital width . . . . .	—	1.68	1.88
Length of caudal peduncle . . . . .	—	20.9	23.1
Postorbital length of head . . . . .	—	15.6	16.2

TABLE 2.—COUNTS RECORDED FOR CERTAIN SPECIES OF SEBASTODES WITH XIV DORSAL SPINES

Species	Fin rays													Lower unbranched pectoral rays			
	Soft dorsal					Soft anal				Pectoral				8	9	10	11
	13	14	15	16	17	7	8	9	10	16	17	18	19				
<i>polyspinis</i> . . . . .	1	5	1	—	—	3	4	—	—	—	—	7	—	1	6	—	—
<i>glaucus</i> . . . . .	—	—	—	—	1	—	1	—	—	—	—	—	2	—	—	1	1
<i>itinis</i> . . . . .	1	—	—	—	—	1	—	—	—	—	—	—	1	—	1	—	—
<i>owstoni</i> . . . . .	1	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—
<i>pavlenkoi</i> . . . . .	—	—	1	—	—	—	—	—	1	—	1	—	—	—	—	—	—

Species	Number of gill rakers on first gill arch																	
	Above angle			Below angle		Total gill rakers				Pore in lateral line								
	10	11	12	26	27	36	37	38	39	35-37	38-40	41-43	44-47	48-50	51-53	54-57	58-60	61-63
<i>polyspinis</i> . . . . .	3	2	2	5	2	2	3	1	1	—	—	—	4	3	—	—	—	—
<i>glaucus</i> . . . . .	1	—	—	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—
<i>itinis</i> . . . . .	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>owstoni</i> . . . . .	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
<i>pavlenkoi</i> . . . . .	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—

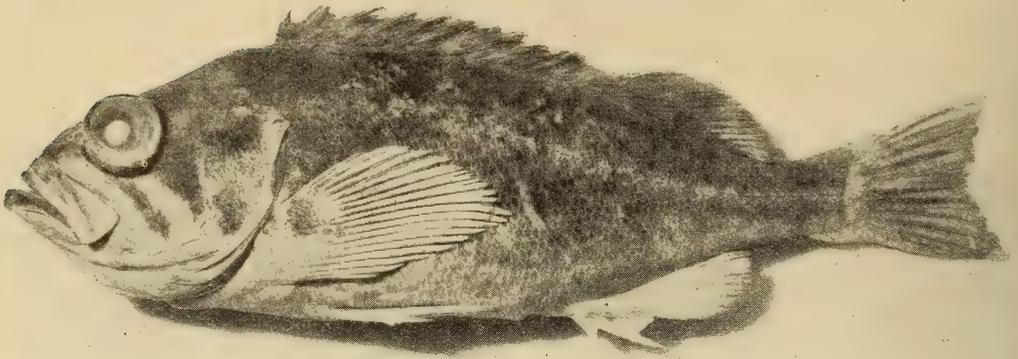


Fig. 1.—*Sebastodes polyspinis* Taranetz and Moiseev. Photograph of an Alaskan specimen.

**Eurymen gyrinus** Gilbert and Burke

*Eurymen gyrinus* Gilbert and Burke, Bull. U. S. Bur. Fish. 30: 64. 1912 (type, U.S.N.M. no. 74377, from Avatcha Bay, east coast Kamchatka); Schmidt, P. J., Compt. Rend. (Doklady) Acad. Sci. URSS 15(5): 279–280. 1937 (see this paper for synonyms and literature).

Since the two specimens reported here are probably the first published record of the occurrence of this species on the American side of the North Pacific Ocean, I record in Table 3 data from them.

U.S.N.M. no. 119387, taken in Canoe Bay, Alaska, September 19–21, 1940, in a gill net at 30–40 fathoms by Dr. W. L. Schmitt.

**Triglops metopias** Gilbert and Burke

*Triglops metopias* Gilbert and Burke, Bull. U. S. Bur. Fish. 30: 50, fig. 8. 1912; Soldatov and Lindberg, Bull. Pacific Sci. Fish. Inst. 5: 195. 1930; Taranetz, Bull. Pacific Sci. Inst. Fish. Oceanogr. 11: 109, 110. 1937; Andriashev, Explor. Mers URSS, Instit. Hydrolog. Leningrad, fasc. 25: 303, 1937.

Because this species is rare and seldom reported, it was thought best to give here a brief description.

U.S.N.M. no. 119438, one specimen taken in Canoe Bay, Alaska, November 4, 1940, by Dr. W. L. Schmitt.

The following measurements in millimeters were made on a specimen from Canoe Bay, Alaska, collected by Dr. W. L. Schmitt, November 4, 1940: Standard length 107; head

TABLE 3.—COUNTS AND MEASUREMENTS ON TWO SPECIMENS OF EURYMEN GYRINUS. (Measurements expressed in hundredths of the standard length.)

Character	Specimen	
	1	2
Standard length.....	131	140
Head length.....	42.0	45.4
Fleshy interorbital.....	9.93	11.1
Diameter of eye.....	7.64	7.15
Length of snout.....	9.55	11.1
Postorbital length of head.....	24.4	26.8
Length of upper jaw.....	19.8	20.7
Greatest depth.....	29.8	32.1
Least depth.....	6.64	7.15
Length of caudal peduncle.....	8.24	9.86
Longest ray pectoral.....	26.0	26.1
Longest ray caudal.....	23.7	22.8
Length base dorsal.....	60.0	57.5
Length base anal.....	29.6	33.5
Dorsal rays.....	31	30
Anal.....	16	16
Pectoral.....	24	24
Gill rakers first arch.....	0+8	0+9

32.5; snout 11.1; eye 9.1; interorbital space 3.0 postorbital length of head 12.5; greatest depth of body 15.2; least depth of caudal peduncle 3.8; length of caudal peduncle 15.5; maxillaries (tip of snout to rear of maxillary) 15.0; length of longest (sixth) dorsal spine 12.2; longest soft dorsal ray 12.8; longest anal ray 11.0; longest caudal fin ray 18.5; shortest (middle) caudal fin ray 12.8; longest pectoral fin ray 26.2; longest pelvic ray 15.2; length of base of soft dorsal 44.5; length of base of anal fin 43.5; snout to origin of first dorsal 29.7.

The following counts were made: Dorsal X, 26; anal 24; pectoral 20; plates in lateral line 51; gill rakers 0+7.

## PROCEEDINGS OF THE ACADEMY

379TH MEETING OF THE BOARD  
OF MANAGERS

The 379th meeting of the Board of Managers was held in the library of the Cosmos Club on December 14, 1942. President CURTIS called the meeting to order at 8:07 P.M., with 19 persons present, as follows: H. L. CURTIS, F. D. ROSSINI, N. R. SMITH, W. W. DIEHL, J. E. GRAF, F. H. H. ROBERTS, JR., F. G. BRICKWEDDE, H. B. COLLINS, JR., F. C. KRACEK, F. M. SETZLER, J. B. REESIDE, JR., J. E. McMURTREY, JR., W. A. DAYTON, W. RAMBERG, E. W. PRICE, L. W. PARR, C. L. GARNER, and by invitation G. A. COOPER and A. SEIDELL.

The minutes of the 378th meeting were read and approved.

President CURTIS announced that R. J. SEGER (chairman), F. G. BRICKWEDDE, R. W. BROWN, G. A. COOPER, and F. D. ROSSINI would compose the Committee to make recommendations concerning the printing and publishing of the JOURNAL, and that ALEXANDER WETMORE would compose the Committee to investigate the purchase by the U. S. Office of Coordinator of Inter-American Affairs of copies of the JOURNAL for distribution to libraries in South America.

In accordance with the action of the Board at its previous meeting, the Executive Committee studied the matter of recommending to future Boards the use of accumulated surplus, if necessary, to avoid curtailing the JOURNAL. At a meeting held just preceding the meeting of the Board, the Executive Committee, with H. L. CURTIS, J. E. GRAF, L. W. PARR, and F. D. ROSSINI in attendance, prepared the following statement: "The surplus in the treasury of the Academy has been accumulated to further the work and usefulness of the Academy. The Academy should build up this surplus to insure the future usefulness of the Academy. Withdrawals from the surplus should not be made unless absolutely required to continue its service to science. On this basis, modest withdrawals from surplus might be made to continue the JOURNAL and to maintain the normal high standards of the meetings of the Academy. However, such withdrawals should be made only after all reasonable steps have been taken to increase the income and reduce the expenses of the Academy." The Board voted to place this statement in the record.

The Committee to make recommendations concerning the printing and publishing of the JOURNAL presented a report carrying the following recommendations: (a) That the Board of Editors be given the power to publish a minimum of 6 bimonthly issues a year for the duration of the war whenever it decides, with

the approval of the Executive Committee, that the objectives of the JOURNAL will be best met by such a change; (b) that the Board of Editors be instructed to study the various offset processes that could be used for printing the JOURNAL, with a view to their consideration by the Board of Managers after the war. The Board approved both recommendations as submitted by the Committee.

The Committee to investigate the purchase by Office of the Coordinator of Inter-American Affairs of subscriptions to the JOURNAL for distribution to libraries in South America presented a report advising the Board that the Office of the Coordinator of Inter-American Affairs would be receptive to a letter from the Academy informing them of the cost of subscriptions to the JOURNAL and of the present distribution of subscriptions in Latin America. The Board instructed the Custodian and Subscription Manager of Publications to send this information.

The Secretary reported two deaths and one resignation.

The Treasurer presented a report showing that to date the income of the Academy was actually \$200.52 higher for 1942 than the amount of income for this year estimated in January, 1942.

The Custodian and Subscription Manager of Publications reported the number of free subscriptions to the JOURNAL and the number of Government bureaus that subscribe to the JOURNAL.

The meeting adjourned at 9:39 P.M.

## 315TH MEETING OF THE ACADEMY

The 315th meeting of the Academy was held jointly with the Anthropological Society of Washington in the Assembly Hall of the Cosmos Club at 8:15 P.M. on December 17, 1942, with President CURTIS presiding. JULIAN H. STEWARD, Vice-President of the Anthropological Society, introduced the speaker.

MATTHEW W. STIRLING, Chief of the Bureau of American Ethnology of the Smithsonian Institution, delivered an address entitled *Anthropological explorations in Netherlands New Guinea*. Mr. Stirling described how an expedition of 700 men, sponsored jointly by the Netherlands Government and the Smithsonian Institution and operating under his direction, entered New Guinea from the north by the Mamberamo River and reached the Snow Mountains, where an interesting negrito population living in a stone-age culture was discovered and studied. The lecture was illustrated with moving pictures. About 175 persons were in attendance.

FREDERICK D. ROSSINI, *Secretary*.

## Obituary

IN THE sudden death of HENRY CORBIN FULLER on August 26, 1942, at New Haven, Conn., the Academy has lost an active member, the vice-president of its Biological Section, and his associates have lost a valued friend. He was born on November 13, 1879, at Worcester, Mass., where he also secured his basic chemical education at the Worcester Polytechnic Institute. After graduation in 1901 he was engaged by commercial houses in analyzing drugs and chemicals used in the production of medicines. Later he entered as a chemist the U. S. Department of Agriculture under Dr. Harvey W. Wiley, whom he referred to as his mentor, working on problems incident to the Food and Drug Act of 1906. Collaborating with Dr. Wiley in his work for *Good Housekeeping*, Fuller did much of the analytical work on the articles discussed in "1001 tests" published in 1914. During the period covered by the World War, Fuller was in the Institute of Industrial Research of Washington, at the same time supervising drug propagation on a commercial scale and managing a drug farm in Virginia, growing digitalis and other important medical plants—1914–19. Although active officially, he found time to publish three books of note: *Medical preparation*, 132 pages, 1912; *The chemistry and analysis of drugs and medicine*, 1,072 pages, 1920; *The story of drugs*, a popular exposition of their origin, preparation, and commercial importance, 358 pages, 1922. He published also a number of shorter papers on current chemical subjects. He was secretary of the Scientific Section of American Pharmaceutical Association, 1917–18. He spent some time in Europe during 1922 and 1924 on problems concerning the wine industry of Italy and France.

One of Fuller's avocations, in which he used great care and discrimination, was the bringing together a wonderful collection of stamps, containing 27,000 different forms, which is more than one-quarter of all the world's issue. The United States part is noted for its rare stamps and for the completeness of its series.

Ornithology also was a pet avocation, and he never lost an opportunity to observe birds in their native haunts. Birds are so closely as-

sociated in their habitat with varied and diverse forms of other life that he who follows them soon learns that Nature has in store other treasures for those interested, and that the Great Outdoors is a real paradise for those who delve. This was as Fuller thought. On an occasion, in order to broaden his view of the wilder country and its animal and plant life, he made a trip through the West to the Pacific States and British Columbia with friends who were familiar with the whole region. Every time he saw a bird or mammal new to him in life, he was thrilled by the experience.

As a well-known chemist and nature lover with his easy and cordial manner of approach, Fuller had a wide and varied acquaintance, especially among kindred spirits whose problems were similar to his. He was a good court witness, defending his case with clearly stated facts, and with a facile tongue effective in either thrust or parry. He was much interested in the activities of a debating club that he entertained at his home, and he took special delight in the wide variety of subjects that come up from time to time and the expertness with which they were handled by real authorities.

Fuller was a man of good breeding, with a fine sense of honor, strict regard for his obligations, and consideration for the rights and feelings of others; hence a gentleman, whom we shall sorely miss. He had such perfect understanding with his children that this close communion with their father always will be among their most cherished memories.

He was an associate member of the American Ornithologists' Union, member of the Washington Biologists' Field Club (president), Biological Society of Washington (president), Baird Ornithologists Club, Washington Academy of Sciences, Cosmos Club, American Chemical Society, American Pharmaceutical Association, Society of Chemical Industry, London, and Fellow of the American Institute of Chemists.

He is survived by his widow; a son, Henry Shepard Fuller, M.D.; and two daughters, Mrs. Thomas Watson and Miss Josepha Fuller.

A. K. FISHER.



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No. 3



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OF THE

# WASHINGTON ACADEMY OF SCIENCES

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# JOURNAL

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## WASHINGTON ACADEMY OF SCIENCES

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BOTANY.—*The travels of Thomas Coulter, 1824–1827.*<sup>1</sup> ROGERS McVAUGH,  
Bureau of Plant Industry. (Communicated by B. Y. MORRISON.)

Dr. Thomas Coulter, an Irish botanist<sup>2</sup> who lived and traveled in Mexico from 1825 until about 1834, made large collections of herbarium specimens and less extensive collections of living plants, especially of cacti. The most detailed published account of Coulter's life and work in Mexico is that by Coville (1895). The Mexican collections comprised more than 50,000 specimens, according to the brief biographical sketch of Coulter published the year after his death (Romney Robinson, 1844). The herbarium specimens were distributed, after Coulter's death, from Trinity College in Dublin; before distribution they were assigned numbers according to their supposed systematic position, the numbers probably totaling about 1,700. Some of the replicate sets were distributed to American herbaria, the most nearly complete ones now being found at the Gray Herbarium and in the Torrey Herbarium at the New York Botanical Garden. All the Coulter specimens in American herbaria, however, seem to lack data relative to the time and place of collection, having been distributed under the numbers assigned at Dublin but without any other notations. The "first set" of the collection, according to Coville, went to the herbarium at Kew, and many of the specimens were cited, with collection number and locality, by Hemsley in the botany of the *Biologia Centrali-Americana* (1879–1888). As pointed out by Coville, little has been published concerning the details of Coulter's travels in Mexico, and the specimens cited by Hemsley have remained the chief source of information on this score. The present paper contains an account of

the botanist's itinerary from the time of his departure from London, in September, 1824, until October, 1827. This account has been drawn up from Coulter's own notebook, lent by his nephew, Joseph A. Coulter, to Dr. F. V. Coville, and now on deposit in the files of the Division of Plant Exploration and Introduction, Bureau of Plant Industry.

Most of the notes taken by Thomas Coulter in Mexico are those relative to his observations while traveling; he carried a compass, sextant, barometer, thermometer, and two chronometers and recorded all the details of his instrumental data and his calculations thereon. Although evidently much interested in the plants and animals he saw, he did not write of any collections he may have made but confined himself to brief notes upon the places he visited and occasional comments upon his experiences. His entries were made at irregular intervals except when he traveled, when he seems to have been careful to record the movements of each succeeding day. He was employed by the Real del Monte Mining Co., and his travels took him to the several areas in which they had interests. Landing at Veracruz on January 28, 1825, he went as rapidly as possible to Real del Monte. After some months spent there (except for two trips to Mexico City) he traveled up the old highway to Zacatecas, where he stayed more than a year, making in the meantime one trip to the mines at Bolaños, Jalisco. Leaving Zacatecas in January, 1827, Coulter made his way to the mining district at Zimapán, Hidalgo, where he made his headquarters at least until October of that year. He seems to have made few collections while traveling, if one may judge by the numbers

<sup>1</sup> Received November 21, 1942.

<sup>2</sup> Born 1793, died 1843.

of specimens cited by Hemsley; approximately 300 numbers are cited from Zimapan, nearly 150 from Real del Monte, and nearly 50 from Zacatecas, but no more than 15 in all from along the routes connecting these places. This may have been due in part to the exigencies of travel by mule, as noted by Ward (1828, p. 316): "In Mexico, you never stop upon the road to bait, but perform the whole distance, whatever it may be, without a halt. It is better for the horses and mules, as they have a longer time together for rest and food, which, in so hot a climate, they do not enjoy without water, and this cannot be given them, in any quantity, until the day's work is done."

The first entry in Coulter's notebook is dated, at London, August 18, 1824, and is followed in the next few weeks by several having to do with the regulation of the chronometers. On September 21 Coulter boarded his ship, the *Thalia*, and on the next day she sailed from Gravesend. She reached Funchal, Madeira, on October 13 or 14 and left again on November 5. Antigua was sighted on November 29, and on December 8 the ship came to anchor off Port Maria, Jamaica. Coulter found it impossible to take his baggage overland to Kingston, so obtained passage in a small boat and reached Kingston on the 14th.

At Kingston, through a gentleman whom he had known previously in Ireland, Coulter secured permission to continue his trip on the British ship *Primrose*, which carried the mails to Veracruz, and left Jamaica on January 6, 1825. On January 27 the ship came to anchor just south of Veracruz, and the next day Coulter passed the customs and received his passport at Mocambo. His experiences for the next few days may be told in his own words:

Friday Feby. 4th. 1825 I have not got mules before today. Set out at four oclock. As far as Xalapa, which we reach on the 8th (five days) the road lies thro' the *tierras calientes*—& as the country is rather flat, with a good deal of wood, we see but little of it—We rest a day (9th) at Xalapa—I make the acquaintance [of] the Count de Sache (is it so he spells it) who is travelling here to collect—& go out a shooting with his aide [whom Coulter calls Ferd. Deppe de Berlin].

Feby. 10th Proceed. from Xalapa the road ascends rapidly, but is good. The scenery exceed-

ingly alpine but this ceases in one day. We sleep at La Joia—& may now consider ourselves on the tableland. [La Joia, 6 or 7 miles northwest of Jalapa, appears on Humboldt's (1812) map as "La Hoya"; Ward (1828, p. 196) uses the latter spelling; a nearby mountain appears as "La Jolla" on Ward's maps.]

Feby. 11th At La Cruz Blanca we quit the great road to Mexico & take to the Steppe, passing at first thro' a fine forest of pines & sleep at Sierite Leonce [spelling?].

On the 12th the party passed Santa Gertrudis, on the 13th Virreyes, on the 14th "St. Miguel Franco," and on the 16th Santa Buenaventura. The route for these five days was at first southwest, then northwest, approximately along the course now followed by the Ferrocarril Interoceánico. Humboldt shows the route between Jalapa and Franco, which is apparently the "St. Miguel Franco" of Coulter; La Cruz Blanca, or Cruz Blanca, is about 10 miles northeast of the modern Perote, Veracruz; Sierite Leonce is apparently near the Cerro de León, about 6 miles southwest of Perote. Near this point, or about 6-7 miles southwest of Perote, Coulter's road forked; Santa Gertrudis lay on the more northern road, about 2 miles from the fork. Beyond Virreyes, in the state of Puebla, the road turned again to the northwest; Franco is in eastern Tlaxcala and Santa Buenaventura is in the northwestern part of the same state. Coulter continues:

17th Pass Apan [i.e. Apam, Hidalgo] & stop at an Hacienda—good horses here but dear—(Talahiote) [i.e. Tlalayote, Hidalgo]. We have now been seven days on the steppe with hills on each side of us—& might still continue on it to Tulancingo—but take a shorter road to Real del Monte.

18th After a league of plains we take to the mountains—& reach a considerable pueblo on the borders of a pretty large plain. 19th reach Guajolote, on the companys possessions. Sunday, Feby. 20th, 1825. Real del Monte.

On leaving Apam, Coulter seems to have doubled back to the east to reach Tlalayote, then turned to the northwest before reaching Tulancingo. Guajolote is 8 or 10 miles east of Pachuca, Hidalgo.

Real del Monte (often appearing on modern maps as Mineral del Monte) was an ancient mining center, the site of some of the workings of the Real del Monte Mining

Co., with whom Coulter had a 3-year contract as medical attendant. At the mine he made his headquarters for some months. The entries in his diary were made here at various times from February 20 until April 16. On this latter date he left for Mexico City, sleeping at San Mateo and reaching the capital on the 17th. He stayed in Mexico at least until the 27th, but on the 29th he was back in Real del Monte, where he stayed until June 15. From June 17 to June 28 he was in Mexico again, and from June 30 until October 31 the entries indicate that he was at Real del Monte more or less continuously.

On October 31, 1825, Coulter began what was to be a three weeks' trip to Zacatecas. His daily entries during this trip give his movements in the minutest detail; he attempted to fix his position at intervals each day by means of compass bearings on prominent points, by the courses of streams, by barometric readings, and by the estimated distances traveled. The route led westward from Pachuca to Tetepango and Tula, Hidalgo, and thence along the old highway from Mexico to Zacatecas. The details are well shown on Humboldt's maps (1812); the part of the road between Tula and Silao is described by Ward (1828, p. 411 *et seq.*). The itinerary of Coulter's trip, as taken from the entries in his diary, is as follows:

## 1825

- Oct. 31. Real del Monte to Pachuca, Hidalgo.  
 Nov. 1. Pachuca to Tetepango, Hidalgo.  
 2. Tetepango, via the pueblo of San Pedro and via Tula, to San Antonio, Hidalgo.  
 3. Remained at San Antonio.  
 4. San Antonio to Arroyo Sarco [i.e., Zarco], México.  
 5. Arroyo Sarco to San Juan del Río, Querétaro.  
 6. San Juan del Río to the city of Querétaro.  
 7. Remained at Querétaro.  
 8. Querétaro to Celaya, Guanajuato.  
 9. Celaya to Salamanca, Guanajuato.  
 10. Salamanca to Hacienda de Burras [i.e., Burras], Guanajuato, via Santa Rosa and Jarapitio.  
 11. Hacienda de Burras to the city of Guanajuato, via Marfil. During the day Coulter spent some time at the Valenciana mine, northeast of the city.  
 12. Guanajuato to Silao, Guanajuato.

- Nov. 13. Silao to León, Guanajuato.  
 14. León to Lagos, Jalisco [sometimes called Lagos de Moreno].  
 15. Lagos to Mesón de Sauces, "a wretched place." This hostelry, which appeared on some contemporary maps of Mexico simply as "Inn," was known to Humboldt as "Venta de los Sauces," and stood at the point where the road turned from its northwesterly course from Lagos to run almost due north to Aguascalientes.  
 16. Mesón de Sauces to Aguascalientes.  
 17. Aguascalientes to the hot springs and return.  
 18. Aguascalientes to Rincón de Romos, Aguascalientes.  
 19. Visited a long-abandoned tin mine, 1 league west of Rincón; left Rincón after noon; at 4:15 was a league north of La Punta, and at 5:20 stopped at an unnamed hamlet [apparently near the northern boundary of the state of Aguascalientes].  
 20. Continued to Soquité [i.e., probably Zóquite, a few miles southeast of the city of Zacatecas].  
 21. Zóquite to Veta Grande, Zacatecas.  
 22. Veta Grande to Zacatecas.  
 23. Zacatecas to Veta Grande.

The mines at Veta Grande, north of the city of Zacatecas, were taken over by the Bolaños Mining Co. in 1825, according to Ward (1828). Coulter made his headquarters at Veta Grande for more than a year and for most of that time was in partial or complete charge of actual mining operations (Romney Robinson, 1844; Ward, 1828, p. 628-629); his connection with the Bolaños Co. is not clear, although its director, a Captain Vetch, was also the director of the Real del Monte Co. (Ward, 1828).

From the time of his arrival until December 12, 1825, Coulter seems to have remained at Veta Grande. From Friday to Sunday, December 2 to 4, he reported a cold snap, with the minimum temperatures ranging between 16° and 20° F. On December 8 he says: "The Maguays have suffered but very little by the hard frost of Friday to Sunday last—Those only that were about flowering seem a little nipped. They however do not thrive well here—are scarcely cultivated." Temperatures at Veta Grande for December 2, 3, 4, 6, and 12, 1825, were later reported by Coulter in his *Notes on Upper California* (1835).

On the 12th Coulter began a hurried journey to Bolaños, Jalisco, to attend a Mr. Martin who was ill of a fever. Leaving at 7:30 P.M., he reached Xeres [i.e., Jerez, now Ciudad García, about 25 miles west-southwest of Zacatecas] at 4 the following morning—with the temperature at 12° F.—and continued to Santa María, which he reached the same night. Starting early the morning of the 14th, he reached Bolaños at night. He stayed at Bolaños until Christmas night; of his start on the return journey he says: "That I might not travel on a Sunday I spend the evening at a ball in the priest's & at midnight start on my return to Zacatecas." On December 28 he proceeded from Tlaltenango, Zacatecas, to Colotlán, Jalisco; on the 29th he went from Colotlán to Villa Nueva, Zacatecas, and on the 30th he reached the city of Zacatecas.

After his return from Bolaños Coulter seems to have spent most of the year 1826 at Zacatecas (more accurately, at Veta

Grande, where he lived), but the entries in his notebook are few. (The entries are dated January 12, February 23 and 24, April 9 and 16, May 14, June 11.) Ward (1828, p. 619) records a visit to Zacatecas, December 21 to 26, 1826, and comments upon the hospitality shown him by Coulter at this time.

The entries in the notebook are nearly complete for the first months of the year 1827. Coulter left Zacatecas on Monday, January 15, enroute for the mines at Zimapán, Hidalgo. His way is easily followed, but many of the ranches and haciendas at which he stopped are not to be found on modern maps. His direction of travel was generally southeast:

1827

Jan. 15. Started for Saucedá and reached El Refugio, Zacatecas; his day's journey was some 20 miles, made in 5½ hours.

16. Reached Buenavista in about 6 hours.

17. Reached Ciénaga Grande in 8 hours.

18. Reached Letras in 7½ hours.

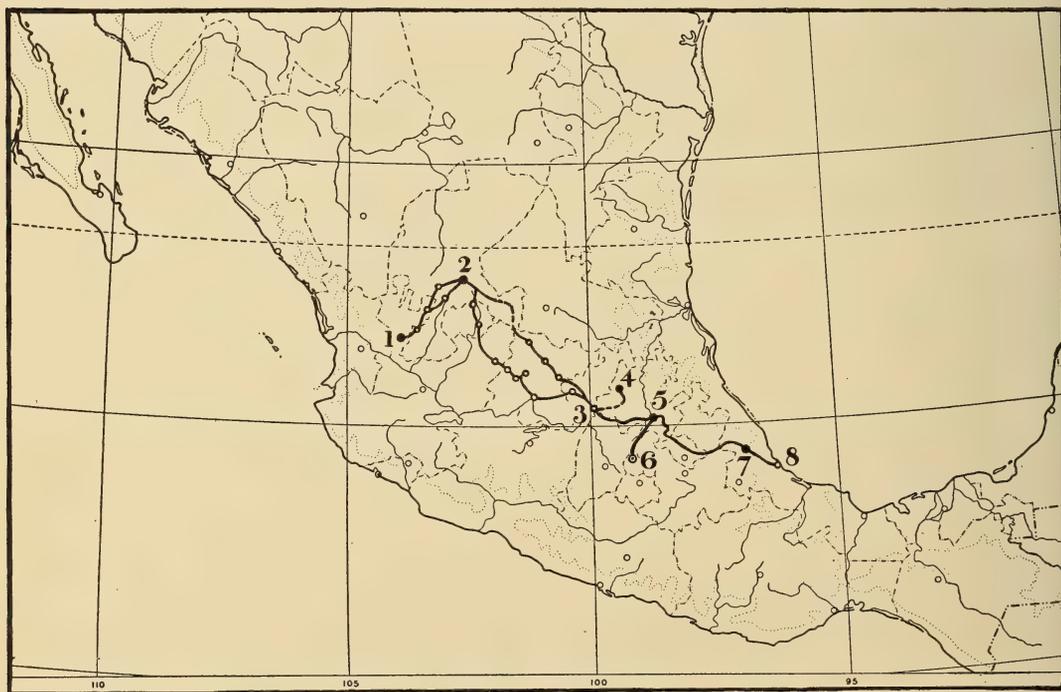


Fig. 1.—The routes followed by Coulter in Mexico, 1825–1827. The circles along the routes indicate the principal places, and solid dots indicate localities at which Coulter is known to have collected plants. Broken lines indicate uncertainty as to the exact route followed. The numbered localities are as follows: 1, Bolaños, Jalisco; 2, Zacatecas, Zacatecas; 3, San Juan del Río, Querétaro; 4, Zimapán, Hidalgo; 5, Real del Monte, Hidalgo; 6, México, D.F.; 7, Jalapa, Veracruz; 8, Veracruz, Veracruz.

Jan. 19. Reached Ojuelos in 6 hours. This appears to be the Ojuelos in the north-eastern corner of the state of Jalisco, but Coulter's route there from Zacatecas is not entirely clear. A manuscript map in the British Museum (B.M. additional ms. 17659A, "Mapa del Reyno de Nueva Galicia Año de 1812," photostat copy in the Library of Congress) shows Letras (a Rancharía) about 5 miles northwest of Ojuelos, and Ciénega Grande (an Hacienda) about 20 miles west of Ojuelos. On the same map appear two haciendas called Buenavista; one is about 5 miles northeast of Letras, and the second a few miles north of Saucedá.

20. Reached a rancho near "Sta. Iphegenia" in 8 hours.
21. Reached San Felipe, Guanajuato, in 4 hours.
22. Remained at San Felipe.
23. Reached La Quemada, Guanajuato, in  $4\frac{1}{2}$  hours. From San Felipe to San Miguel he was apparently following the regular route from San Luis Potosí to Mexico City.
24. Stopped to shoot, apparently in the vicinity of La Quemada.
25. Reached Dolores [i.e., Dolores Hidalgo], Guanajuato.
26. Dolores to San Miguel el Grande [i.e., San Miguel of modern maps], Guanajuato, passing Atotonilco about noon.
27. San Miguel to Rancho de los Ricos, in  $4\frac{1}{2}$  hours. "Rancho de los Ricos" is apparently the place appearing on some maps as Ricos, near the eastern boundary of Guanajuato, about 15 miles south of east of San Miguel.
28. Passed through Chichimequillas, Querétaro (about 10 miles northeast of the city of Querétaro) and reached Hacienda de Mascala [i.e., probably Amascala, Querétaro, about 5 miles southeast of the city].
29. Reached San Juan del Río, Querétaro.
30. Remained at San Juan del Río.
31. Reached Huichapa [i.e., Huichapán], Hidalgo, in 9 hours. At San Juan del Río he left the road to Mexico and turned eastward.

Feb. 1. Huichapán to La Bahía in 7 hours.

2. La Bahía to Zimapán, Hidalgo. The route followed is not entirely clear, as La Bahía seems not to appear on modern maps of Hidalgo. Coulter left La Bahía at 7 A.M., reached the edge of the barranca of the Río Tula at 9:45, crossed the river by the bridge

about noon, and reached Zimapán at 6 P.M. His note says that he passed "by left (S) of San Juanico," so it is probable that he crossed the river either at Izmiquilpán or at Tula, the latter being the site of one of the few bridges over the Río Tula. If he then followed a course more or less parallel to the river, he must have passed to the south and west ("left") of San Juanico.

The notebook contains entries dated at Zimapán, February 4, 5, 11, and 24, and one final entry dated October 11, 1827. In Coulter's *Notes on Upper California* he reports observations made at Zimapán between April 8 and 15; this presumably refers to the year 1827 or to a later year, for at the same time in 1825 he was in Real del Monte, and in 1826 at Veta Grande.

The date of Coulter's departure from Zimapán is unknown, but it may have been at the expiration of his 3-year contract, either late in 1827 or early in 1828. In the early part of the latter year he sent to A. P. DeCandolle a shipment of living cacti, which the latter reported upon at a meeting on July 22, 1828. Forty-seven species were described as new, so that at least a short time must have elapsed between their arrival in Europe and their presentation by DeCandolle (DeCandolle, 1828). Allowing time for their passage across the Atlantic by sailing vessel, we may fix the time of their dispatch from Veracruz at about the first of May, or perhaps earlier. One may suppose that the shipment had been gathered by Coulter during the closing months of his stay at Zimapán and sent abroad upon the completion of his work there.

Almost nothing is known of Coulter's life and activities between the time of his departure from Zimapán and that of his arrival in California, late in November, 1831. He is known to have been in Sonora, in the vicinity of Hermosillo, in December, 1829 (Coville, 1895), and from the specimens cited by Hemsley it seems that he made at least one trip from San Blas, the seaport of Tepic, Nayarit, along the old highway through Tepic to Guadalajara; specimens labeled "San Blas to Tepic" or "San Blas to Guadalajara" are occasionally cited. He is also known to have collected at Guaymas,

Sonora, and at Mazatlán, Sinaloa, and may well have spent much of the period from 1827 to 1832 in mining centers in the western states of Mexico. If one may judge by the specimens cited by Hemsley, Coulter collected very few plants in western Mexico. From Zimapán, as pointed out above, approximately 300 species are listed in the *Biologia Centrali-Americana*; from Real del Monte almost 150 species are noted, and from Zacatecas about 50. From all western Mexico together, however, scarcely 75 specimens are cited, and more than half of these are from "Sonora Alta," which may refer to the region about Guaymas or to the region about Yuma visited by Coulter in 1832.

BOTANY.—*Four new species of Acanthaceae from Guatemala.*<sup>1</sup> E. C. LEONARD, U. S. National Museum. (Communicated by WILLIAM R. MAXON.)

Recent studies of the Acanthaceae of Guatemala, especially of material collected by Julian A. Steyermark on the 1939-40 expedition of the Field Museum of Natural History to that country, have resulted in the recognition of four new species described herewith.

*Dyschoriste skutchii* Leonard, sp. nov.

Herba, caulibus puberulis; lamina foliorum ovalis vel suborbicularis, apice obtusa vel rotundata basi angustata, parce hispidula; petioli tenues; inflorescentia subcapitata, terminalis, bracteis oblanceolatis; calyx glaber vel parce hirsutus, segmentis subovatis; corolla lilacina, minute pubescens; ovarium glabrum.

Stems usually numerous, prostrate, erect or ascending from a short woody base, puberulous, the hairs retrorsely curved, white, the roots thick-fibrous; leaf blades oval to suborbicular, up to 18 mm long and 14 mm wide, obtuse or rounded, cuneate at base, bright green, darker above, sparingly hispidulous (the larger hairs confined to costa and veins), sometimes ciliate toward base, the costa and veins (usually 4) prominent; petioles slender, up to 3 mm long, more or less puberulous, sometimes ciliate; flowers crowded in heads at the tips of the

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branches; bracts oblanceolate, somewhat smaller than the leaves but resembling them in most respects; calyx up to 13 mm long, the tube 3 mm long, glabrous or sparingly hirsute, the segments subulate, hirsute, the hairs white, spreading, up to 0.75 mm long, but gradually shorter and very minute toward the bristle-like tips of the lobes; corolla lavender, minutely and inconspicuously pubescent, about 13 mm long, the narrow portion of the tube about 5 mm long and 1.5 mm in diameter at base, narrowed to 1 mm just above base, thence gradually expanded to 4 or 5 mm at throat, the limb about 8 mm broad, the lobes rounded; stamens 3 and 4 mm long, the anthers ovate, the minute white mucronate tips of their basal lobes slightly divergent; ovary glabrous; mature capsules not seen.

Type in the U. S. National Herbarium, no. 1586098, collected on an open hillside near Tecpam, Department of Chimaltenango, Guatemala, altitude 2,100 meters, July 22, 1933, by A. F. Skutch (no. 474). *Lehmann* 1524 from Huehuetenango, Guatemala, altitude 1,500 meters, and *Steyermark* 33063, collected on dry slopes of pine woods just southwest of Minas de Croma, Department of Jalapa, Guatemala, are also this species.

*Dyschoriste skutchii* is related to *D. capitata* (Oerst.) Kuntze but is amply distinct in its oval or suborbicular leaves and in its puberu-

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received December 15, 1942.

lous stems. In *D. capitata* the leaves are obovate and the stems pubescent, with longer and more spreading hairs. The latter species seems to be limited to southern Mexico.

***Dicliptera vulcanica* Leonard, sp. nov.**

Frutex, caulibus parce pilosis; lamina foliorum ovata, breve-acuminata, basi obtusa vel acuta, in petiolum decurrens, parce hirsuta; petioli tenues, pilosi; cymae pedunculatae; bracteae floriferae herbaceae, pilosae, puberulae, bractea posterior linearis, anterior oblanceolata; bracteae laterales angusto-lanceolatae vel subulatae, chartaceae, puberulae; calycis segmenta lanceolato-subulata, papilloso-puberula et pilosa; corolla subrufa, pubescens, labio superiore leviter emarginato, minute apiculato, inferiore oblongo, trilobo, lobis parvis, rotundatis; capsulae parvulae; semina plana, orbiculata, fulva, minute verrucosa.

Shrub up to 2 meters tall; stems sparingly pilose, the hairs white, spreading or retrorsely curved, up to 1 mm long, more or less arranged in 2 lines, or the lower portions of the stems glabrous; leaf blades ovate, up to 10 cm long and 5 cm wide, short-acuminate (the tip blunt), acute or obtuse at base and decurrent on the petiole, thin, drying dark green, sparingly hirsute, the hairs spreading, 0.5 to 1 mm long, confined chiefly to costa and veins (6 or 7 pairs); petioles slender, up to 2.5 cm long, pilose; flowers borne in axillary peduncled cymes (3 flowers in each cluster), the peduncles up to 6 cm long, sparingly pilose, usually branched at tip, each bearing 3 to 5 stalked flower-clusters; bracts subtending the secondary peduncles subulate, up to 5 mm long, pilose, the pair of outer floral bracts herbaceous, both pilose and puberulous (at least some of the hairs glandular), the posterior one linear, about 10 mm long and 1.5 mm wide, acute, the anterior one oblanceolate, 13 mm long and 3.5 mm wide, acute, the interior floral bracts narrowly lanceolate or subulate, up to 8 mm long and 1 mm wide, chartaceous, puberulous, the hairs papilliform; calyx 7 to 8 mm long, the tube subglabrous, the segments about 6 mm long, lance-subulate, 1 mm wide at base, thence gradually narrowed to a slender tip, the pubescence a mixture of minute papilliform hairs and longer pointed ones; corolla 33 mm long, dull reddish, finely pubescent, the tube about 13 mm long, the lower portion about 3 mm

broad for 8 mm of its length, thence gradually and somewhat obliquely enlarged to 6 mm at throat, the posterior lip oval, about 6 mm wide, rounded, shallowly emarginate and minutely apiculate, the anterior lip oblong, about 5 mm wide, the 3 lobes rounded, about 1 mm long and wide or slightly wider, the middle one ciliate; capsule 12 mm long, 5 mm broad, puberulous; seeds flattened, orbicular, 3 mm in diameter, brown, minutely verrucose, or smooth with age.

Type in the herbarium of the Field Museum of Natural History, no. 1045321, collected at base of barranca along stream between Tajumulco and Loma Buena Vista, on the north-western slope of Volcán Tajumulco, Guatemala, altitude 2,300 to 2,800 meters, February 28, 1940, by Julian A. Steyermark (no. 36861); isotype in U. S. National Herbarium, no. 1820956.

This well-marked species is characterized by the thin hirsute leaf blades, the peduncled cymes, and the peculiar minute papilliform hairs of the calyx and bracts.

***Odontonema steyermarkii* Leonard, sp. nov.**

Frutex glaber; lamina foliorum ovata vel oblonga, acuminata, basi angustata, in petiolum decurrens; panicula parce ramosa; bracteae subulatae, ciliolatae; pedicelli tenues; calycis segmenta subulata, parce puberula; corollae tubus pallide ochraceus, lobis lilacinis, ovalibus, rotundatis; ovarium glabrum.

Glabrous shrub up to 2 meters high; leaf blades ovate to oblong, up to 18 cm long and 8 cm wide, acuminate (the tip blunt), narrowed or rounded at base and decurrent on the petiole, the costa and veins prominent; petioles up to 3 cm long; inflorescence a sparingly branched panicle, the flowers borne in umbels of usually 3 to 6 flowers each, the lowermost of these peduncled (5 mm long, successively shorter toward tip), the uppermost sessile; bracts subtending the peduncles subulate, 1.5 mm wide at base, gradually narrowed to a slender tip, ciliate, those subtending the umbels similar but slightly smaller; pedicels slender, up to 6 mm long; calyx 3.5 mm long, the segments subulate, about 3 mm long and 0.5 mm wide at base, sparingly puberulous toward tip; corolla up to 24 mm long, 2 mm in diameter at base, narrowed about 5 mm above base to 1 mm,

thence enlarged to about 4 mm at throat, the tube pale buff, the lobes lilac, oval, 5 mm long and 2.5 mm wide, rounded at tip; ovary glabrous; fruit not seen.

Type in the Herbarium of the Field Museum of Natural History, no. 1046653, collected along road between Finca Pirineos and Calahuaché, Department of Quezaltenango, Guatemala, altitude 1,200 to 1,300 meters, January 27, 1940, by Julian A. Steyermark (no. 35020); isotype in the U. S. National Herbarium, no. 1820953.

This species may be recognized by its narrow, sparingly branched panicles of flowers, which are said by the collector to be pale buff and lilac.

***Odontonema galbanum* Leonard, sp. nov.**

Frutex, caulibus glabris vel parce et minute pubescentibus; lamina foliorum oblonga, longe acuminata, basi angustata, plus minusve falcata; panicula angusta, terminalis; bracteae subulatae, glabrae; calyx glaber, segmentis subulatis; corolla glabra, galbana, labio superiore bilobo, lobis parvis, rotundatis, ciliolatis, inferiore trilobo, lobis ovalibus, parce ciliolatis; ovarium glabrum.

Shrub up to 2 meters high; stems glabrous or sparingly and minutely appressed-pubescent;

leaf blades oblong, up to 36 cm long and 5.5 cm wide, long-acuminate (the tip often curved), gradually narrowed at base, rather thin, veiny, the costa and lateral veins (usually 10 to 12 pairs) fairly prominent; inflorescence a narrow terminal panicle 20 cm long, the flowers borne in small sessile or subsessile umbels, the pedicels up to 5 mm long, these and the rachis glabrous; bracts of the rachis subulate, 3 mm long and 1 mm wide at base or less, keeled, glabrous, those subtending the pedicels similar but smaller; calyx glabrous, 2.5 to 3 mm long, the segments subulate; corolla glabrous, greenish yellow, up to 27 mm long, 2 mm in diameter at base, narrowed to 1.5 mm just above base, the throat 3 mm in diameter, the lips 5 mm long, the upper lip 2-lobed, the lobes 1.5 mm long, rounded, ciliolate, the lower lip of 3 oval lobes 3 mm wide, rounded, sparingly ciliolate at tip; ovary glabrous; fruit not seen.

Type in the U. S. National Herbarium, no. 1790033, collected in moist forest near Baranca Hondo, above Lake Lajas, Department of Escuintla, Guatemala, altitude about 1,200 meters, January 31, 1939, by Paul C. Standley (no. 63875). *Standley* 65014, collected at essentially the same locality, is also of this species.

*Odontonema galbanum* is easy to recognize by its slender glabrous panicle of greenish-yellow flowers.

ENTOMOLOGY.—*Some undescribed species of flies of the genus Baccha* (Syrphidae).<sup>1</sup> F. M. HULL, University of Mississippi. (Communicated by ALAN STONE.)

This paper presents descriptions of several species of *Baccha*. These flies were found among material lent for study by Dr. C. L. Fluke, whom I wish to thank for his kind assistance in my study of the genus. The types are in Dr. Fluke's collection. Paratypes where available are in the author's collection.

***Baccha boadicea*, n. sp.**

Related to *gracilis* Williston. Distinguished by the small spot in the center of the wing and by the larger size.

*Male*.—Length 9.5 mm. Head: face and front shining black, both yellowish-white pubescent along the sides, the former bluish centrally and

with yellow pile; the face in profile without tubercle and barely concave beneath the antennae. The pile of the front is dark brown centrally. The antennae are orange, widely black above on the third joint. The vertex is shining black with black pile in front, yellow behind. Thorax: mesonotum shining black, nonvittate, short golden pilose, the humeri brown, the pleura brownish black with yellow pile and pollen, the scutellum shining black with creased rim, short yellow pile and fringe. Squamae pale. Abdomen: elongate, slender, dark brown, the first joint almost black, the third laterally yellow on the base on each side, the yellow extending about two-fifths the length of the segment. Fourth segment obscurely but narrowly yellow basally, its basal pile yellow,

<sup>1</sup> Received November 4, 1942.

its apical pile black. Legs: yellow on the first two pairs, their femora brownish on the basal half or more, their pile yellow. Hind femora and their tibiae, except the narrow bases, brown and black, respectively, their tarsi pale yellow. Wing: pale brown with microscopic slender alula; stigmal cell dark, and a small spot above the small cross vein brown.

Holotype, male. Pinas, Ecuador, 1,506 meters, July 14, 1941, D. B. Laddey. (Fluke collection.)

***Baccha vespuccia*, n. sp.**

Near *papilio* Hull. The abdominal fascia and vittae are differently shaped. Abdomen widest at end of fourth segment.

*Male*.—Length 8–10 mm. Head: face and front brownish yellow, a shining blackish half circle over the antennae and a black spot on lunula. Antennae orange, the third joint blackish above. Thorax: mesonotum metallic brownish or aeneous-black, with a pair of rather close brown vittae. The humeri, the lateral margins, the post calli and the scutellum are light yellowish brown, the latter with a few black hairs and no fringe. Mesopleurae and pteropleurae orange; pleura posteriorly blackish. Abdomen: spatulate, the apex barely wider than the base, sepia brown, the narrow sides of the first segment yellowish; the second segment is one and a half times as long as wide with, on each side, a diagonal, yellowish fascia meeting in the midline. Third segment with a similar fascia, divided medially and medially expanded, their posterior margins indented. Fourth segment with, on each side, an inverted Y-shaped figure. Fifth with submedial, yellowish vittae and short sublateral vittae narrowly connected basally with the medial ones. Legs: brownish yellow, the hind femora and tibiae dark brown. Wings: entirely dark brown; alulae quite narrow.

*Female*.—Front with continuous medial vittae; mesonotum with four violet stripes.

Holotype male, allotype female, and one male paratype, Nova Teutonia, Brazil; Fritz Plauermann. (Fluke collection.)

***Baccha aurora*, n. sp.**

Slender, without alulae. Mesonotum dark brown and yellow laterally, with two gray pollinose vittae. Related to *argentina* Curran.

*Female*.—Length 10 mm. Head: face and front pale yellow, the latter with a linear brown stripe on the upper part and a tiny black dot on lunula. Pile short, sparse, and black. Vertex black with gray pollen. Antennae yellow, the third joint missing. Thorax: mesonotum brassy black, with a pair of widely separated, steel-blue vittae with gray pollen that reach to the scutellum, and a similar median one on the posterior half. Lateral margins, humeri, scutellum, and all of pleura except a posterior black stripe, pale yellow. Scutellum with a few black hairs and three or four black, central fringe hairs. Abdomen: rather slender, the first segment brown, the anterior corners pale yellow with about 10 black setaceous hairs and a few long pale ones. Second segment with the base light brown and a pair of lateral, subquadrate, brownish-yellow spots just past the middle which are narrowly separated above; the remainder of this segment is blackish. Third segment with an obscure, basal, lateral vittate spot. Fourth segment with a large lateral vitta extending from the base to the posterior two-thirds, its posteromedial margin rounded. Fifth segment shining black. Legs: yellow, the hind femora and tibiae pale brown with subapical brown annulus and the tibiae with the middle paler. Hind basitarsi brownish yellow, the remaining joints dark brown. Wing: hyaline; stigmal cell very dark; no alula.

Holotype: female. Villa Rica, Paraguay, August 1939, F. Schade. (Fluke collection.)

***Baccha niobe*, n. sp.**

Related to *placiva* Williston. The pile on the sides of the first segment is long. Wing apex with a spot.

*Male*.—Length 9 mm. Head: face and front yellow, with a black dot on lunula. Antennae orange; arista dark brown. The pile of the front is black. Vertex black, rather shining. Thorax: mesonotum cinnamon-brown with a violaceous stripe adjacent to the wide yellow margins. Pleura yellow with a golden reflection. Scutellum brownish orange with a few slender brown hairs and no fringe. Abdomen: elongate, slender, the second and third segments cylindrical. First segment orange and brown, the second orange-brown basally, black on the posterior half, shining apically, in the middle with a pair of oblique, leaflike spots that are

narrowly separated above; these spots are margined on all sides by opaque black, the opaque black forming a triangle behind. Third segment similar, the oblique spots and the median black extend narrowly to the base. Fourth segment with small black triangles in the anterior corners and a large, orange spot basally on each side, its medial margins parallel, its posterior margins oblique and serving to extend the spots apically to the lateral margins. Last segment violaceous-black. Legs: yellow, the hind femora brown at base and with a wide, brown preapical band, their tibiae broadly brown through the middle. Wing: light brown, diffusely blackish at the tip, the alula quite narrow but equally developed throughout.

Holotype: male. Palmar, Manabi, Ecuador, 200 meters, April 10, 1941, D. B. Laddey; a paratype male with same data. (Fluke collection.)

***Baccha danaida*, n. sp.**

Related to *sepia* Hull. The first abdominal segment is yellow on the sides, the third segment has a pair of triangles. The cheeks and pleura are wholly dark brown.

*Male*.—Length 11 mm. Head: face and cheeks yellow; the tubercle and a stripe above are brown; the front is widely black above but yellow on the sides. It is black pilose. Antennae orange-brown, the arista darker. Thorax: mesonotum brassy brown with a pair of wide, prominent, reddish-brown vittae; the lateral margins are yellowish brown. The pleurae are metallic, dark brown, blackish behind, yellowish on mesopleurae and upper sternopleurae. Scutellum light yellowish brown with sparse dark hair and no fringe. Abdomen: spatulate, wide basally, sepia brown, the sides of the first segment yellow with long black hairs, the second has a slender, diagonal, laterally expanded pair of fascia; the third as a pair of central, narrowly separated, triangular spots. The fourth segment has a pair of comma-shaped spots, and fifth a pair of basal, obscure vittae, laterally extended. Legs: first pair brownish yellow; middle femora light brown,

their tibiae and tarsi yellowish; hind femora dark brown, their tibiae black, their basitarsi brown basally, its apex and all the remaining segments yellow. Wing: wholly dark brown, stigma narrow.

Holotype: male. Nova Teutonia, Brazil; Fritz Plaumann. (Fluke collection.)

***Baccha saffrona*, n. sp.**

Abdomen with oblique, triangular vittae, wing light brown, alula rudimentary. Related to *scintillans* Hull.

*Male*.—Length 9 mm. Head: face and front yellow, a black dot on the lunula; antennae orange-brown with blackish arista. Frontal pile long and black. Thorax: mesonotum light reddish brown, the sides yellowish brown. Vittae if present obscured; scutellum yellowish or reddish brown, the whole pleura yellow-brown. Abdomen: slender, subcylindrical, reddish brown on the first segment and base of second, the latter with a pair of oblique, leaflike orange spots near the middle, not meeting above and margined with opaque black. Third segment with similar, longer, more triangular spots, which reach the base of the segment. Base of segment otherwise blackish, blue-green in the lateral corners. Fourth segment with a similar wider spot more widely extended on the base of the segment, the corners and posterior margin of this segment and the whole of the fifth segment, except for a pair of small basal spots, peacock-blue. Legs: deep yellow, the hind femora quite brown at base and subapically, yellow in the middle, their tarsi dark brown except at base and extreme apex, their tarsi deep yellow. Wing: wholly light brown, the stigmal cell darker; the alula quite narrow.

*Female*.—Similar to the male, spots absent on fifth segment, the blue areas more violet and the apex of the wings with an ill-defined smoky spot, the whole wing pale. This may belong to a different species.

Holotype: male. Palmar, Manabi, Ecuador, April 7, 1941, D. B. Laddey. Allotype, female; two paratypes, males, two females, all same data. (Fluke collection.)

ZOOLOGY.—A new trichostrongylid nematode from the stomachs of American squirrels.<sup>1</sup> JOHN T. LUCKER, Bureau of Animal Industry.

The worms described in this paper were collected by L. Wayne Wilson from two squirrels (*Sciurus*) taken near Moorefield, Hardy County, W. Va., in November, 1941. Examination of the specimens revealed that they were trichostrongyloid nematodes, but it was immediately apparent that the males were very unusual, since certain of the bursal rays were observed to be chitinized.<sup>2</sup>

So far as the writer has been able to ascertain, the only trichostrongyloid nematode in which the occurrence of chitinized bursal rays has been reported is *Böhmiella perichitinea* Gebauer, 1932. Travassos,<sup>3</sup> in his extensive monograph on the Trichostrongylidae, agreed with Gebauer,<sup>4</sup> that, except in this genotype, chitinized bursal rays are unknown among the Strongyloidea.

The specimens collected by Mr. Wilson are here described as representing a new species, closely related to *B. perichitinea*, and for it the name *B. wilsoni* is proposed. While not admissible as evidence of zoological relationship, it is nevertheless of interest that both *B. perichitinea* and *B. wilsoni* are stomach worms of rodents. The known rodent hosts of the respective worms are not, however, closely allied species. *B. perichitinea* was found in a nutria or coypú, *Myocastor coypus*, in Germany. Whether it was introduced into Europe with the coypú, which is indigenous to South America, or normally occurs in European rodents is a question that as yet can not be answered, because there appears to be no subsequent report of its occurrence.

Although previously unrecognized, *B. wilsoni* evidently has existed in squirrels in

the southeastern United States for many years, since 4 females, undoubtedly the same as *B. wilsoni*, were found by the writer among specimens (U.S.N.M. Helm. Coll. no. 2934) collected by Dr. Albert Hassall from *Sciurus carolinensis* in 1897.

#### *Böhmiella wilsoni*, n. sp.

(Figs. 1-17)

*Description*.—Head small; diameter ( $40\mu$  to  $50\mu$ ) approximately the same as that of the adjacent cervical region. Lips absent; oral opening roughly circular; circumoral membrane present (Fig. 4). Amphidial pores and tips of ventrolateral papillae reaching cuticular surface adjacent to outer margin of circumoral membrane. Submedian papillae four in number, single, externally directed, their tips slightly protruding within depressions located slightly posterior to level of circumoral membrane. In *en face* view, semicircular strands of fibrillike nature may be seen extending outwardly from beneath margin of circumoral membrane to base of each submedian papilla; these strands apparently represent complete union and fusion of terminal branches of submedian papillary nerves. Margin of mouth opening apparently bearing superficially a row of extremely minute denticlelike structures which are interpreted as representing a weakly developed corona radiata (Fig. 4). Oral cavity very shallow, saucer-shaped; lining nonsclerotized. Esophagus communicating with buccal cavity by minute triangular opening and with a minute denticle, formed by lining of dorsal sector, protruding through opening into mouth cavity (Fig. 6). Esophagus swollen at anterior extremity; swollen portion histologically differentiated somewhat from tissue of remainder and partially surrounds mouth cavity (Figs. 3, 6). Cuticular covering of dorsal esophageal sector just posterior to minute terminal denticle forming a comparatively large, more or less transversely directed onchium with lumen and orifice at tip, presumably representing opening of dorsal esophageal gland, since a fine duct connecting with the lumen passes posteriorly into the tissue of the dorsal sector; tip of onchium not reaching floor of

<sup>1</sup> Received September 7, 1942.

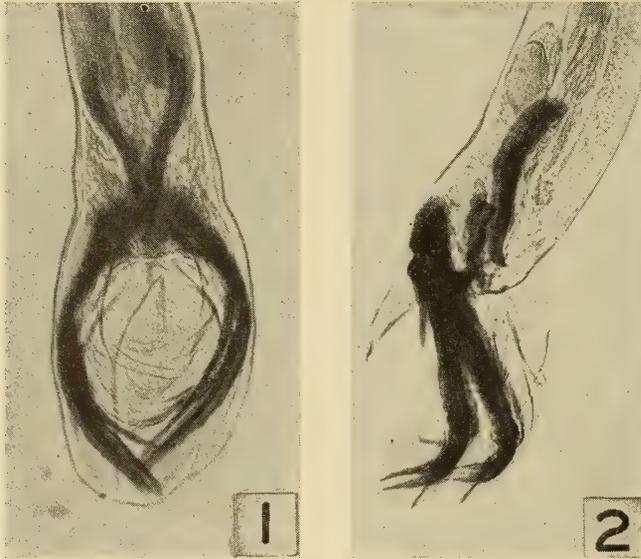
<sup>2</sup> In this paper derivatives of the noun chitin are used not in the chemical sense but as convenient descriptive terms to indicate the presence in the specified locations of a dense, brownish substance, probably similar to that composing the spicules of trichostrongylins and identical with it in appearance.

<sup>3</sup> TRAVASSOS, LAURO. *Revisão da família Trichostrongylidae* Leiper, 1912. Mongr. Inst. Oswaldo Cruz no. 1, 512 pp., 295 pls. 1937.

<sup>4</sup> GEBAUER, OTTO. *Böhmiella perichitinea* n. sp. ein neuer Trichostrongylide (Nematodes) des Nutria. Zeitschr. für Parasitenk. 4(4): 730-736, illus. 1932.

buccal cavity (Figs. 5, 6). Cuticular covering of each subventral sector of esophagus at level near base of onchium forming two minute, denticlelike, transversely directed eruptions; also forming rounded hyaline expansions at anterior extremity (Fig. 3). Cervical papillae, large, located slightly posterior to level of nerve ring; excretory pore between level of nerve ring and cervical papillae (Fig. 7). Lateral alae absent; cuticle of mid-body provided with about 50 longitudinal ridges.

deeper than that between the latter and left lateral lobe (Fig. 10). Ventral rays with common origin; directed posterolaterally for about two-thirds their length, curving anteriorly to bursal margin in their distal one-third, separated and somewhat divergent, but with their tips rather close together (Fig. 14). Ventroventrals smallest rays of lateral lobes, appearing as branches of lateroventrals, the latter having greater flexure than the ventroventrals and being the most robust of the bursal rays

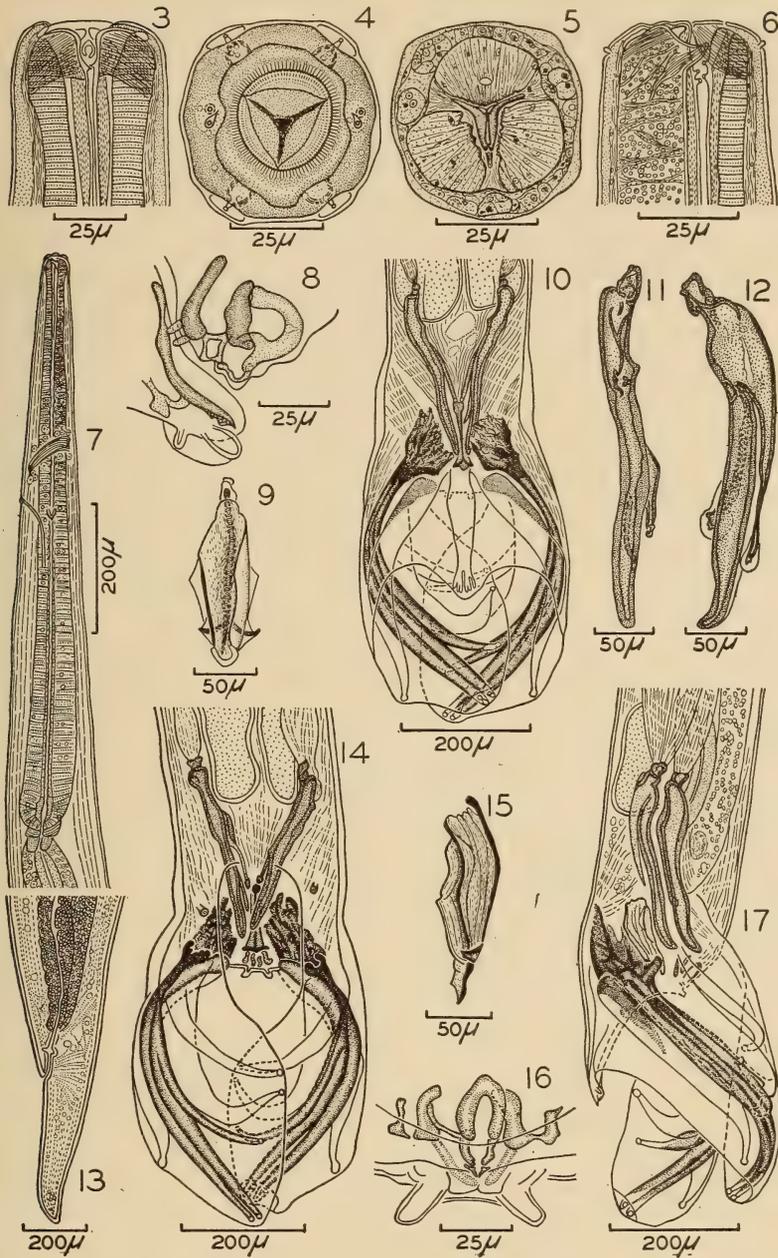


Figs. 1-2.—*Bohmiella wilsoni*, n. sp., caudal region of male: 1, Ventral aspect; 2, lateral aspect. (Photomicrographs; magnification approx.  $\times 80$ .)

*Male*.—In 3 available specimens 17.1 to 20.3 mm long by 0.21 to 0.24 mm wide just in front of bursa; esophagus, 0.84 to 0.94 mm long; distance from nerve ring and cervical papillae to anterior extremity, 0.32 to 0.35 and 0.43 to 0.45 mm, respectively; length of spicules, 0.300 to 0.321 mm; axial length of gubernaculum, 0.121 to 0.135 mm, length measured along curvature, 0.140 to 0.153 mm.

Prebursal papillae well developed (Fig. 14). Lateral bursal lobes roughly triangular with mediolateral and posterolateral rays supporting apex, originating near median ventral line of body surface a considerable distance anterior to genital cone, and with fine veinlike markings. Cleft between right lateral lobe and comparatively small dorsal lobe only slightly

(Figs. 10, 14). Laterals with common origin, comparatively slender, directed posterolaterally, except that externolaterals, which are parallel and contiguous to mediolaterals through most of their length, curve anteriorly away from the latter in distal one-third, so that their tips—which do not quite reach bursal margin—are considerably anterior to tips of mediolaterals (Figs. 10, 14, 17). Mediolaterals and posterolaterals equal, parallel, and contiguous, longer than externolaterals and other rays; tips close together, reaching bursal margin. Externodorsals more robust than laterals, but less robust than lateroventrals, apparently originating high up on stem of dorsal, parallel and contiguous to posterolaterals for most of length, but curving anterodorsally away from



Figs. 3-17.—*Böhmiella wilsoni*, n. sp.: 3, Anterior end (female), ventral aspect, optical section through dorsal onchium and two subventral esophageal teeth; 4, head (female), en face aspect; 5, optical cross section through esophagus in region of dorsal onchium, aspect in en face mount of head; 6, anterior end (female), lateral aspect, optical section through dorsal onchium and two pairs of subventral esophageal teeth; 7, esophageal region (male), lateral aspect; 8, telomon, lateral aspect; 9, gubernaculum, lateroventral aspect; 10, caudal region of male, dorsal aspect (chitinization represented by stippling); 11, right spicule, ventral aspect; 12, left spicule, ventro-lateral aspect; 13, caudal region of female, lateral aspect; 14, caudal region of male, ventral aspect (chitinization represented by stippling); 15, gubernaculum, lateral aspect; 16, telomon, ventral aspect; 17, caudal region of male, lateral aspect (chitinization represented by stippling, to simplify the figure only part of the left lateral lobe of the bursa is shown).

them distally so their tips, which reach the bursal margin, are considerably removed from the tips of the posterolaterals; length about same as externolaterals (Fig. 14). Dorsal ray much shorter than other rays, not asymmetrically located, straight; stem wide, bifurcate in distal one-fourth, each branch typically tridigitate but one may be bidigitate; ventral surface of stem without accessory branch (Fig. 10). Lateral rays with dense brownish chitinization at base and less dense chitinization extending nearly to tips, particularly along margins (Figs. 1, 2, 10, 14, 17). Externodorsal rays usually chitinized at base only (Fig. 10). In lateral view (Figs. 2, 17) chitinized tissues seen to extend internally and anteriorly from bases of these rays towards gubernaculum and anteriorly for a short distance along dorsal body wall, probably representing for most part modification of muscular tissues; in ventral view (Figs. 1, 14) these chitinized extensions appearing as a sort of median transverse bridge in region of spicule tips and gubernaculum. Genital cone with two submedian, thumblike, posteriorly directed processes. Spicules complex, brownish, consisting of complicated proximal knob and alate shaft and terminating distally in three processes, the longest representing a continuation of main shaft (Figs. 11, 12); proximal ends located laterally near body wall and in frontal plane; main shafts extending slightly dorsad and mediad in proximal two-fifths of length and rather sharply ventrad and mediad in distal three-fifths so tips reach median line in cloacal region (Figs. 1, 2, 10, 14). Shorter of two subsidiary distal prongs of each spicule originating from mediodorsal surface of main shaft, paralleling it and terminating in rather blunt, but digitate, medioventrally directed tip; remaining subsidiary prong originating from laterodorsal surface of main shaft, paralleling other prongs in most of length, usually curving dorsally away from them to rather sharp but digitate tip (Figs. 11, 12). Gubernaculum brownish, more or less boat-shaped, with very strongly chitinized dorsal keel ending proximally in knob and branching near distal tip to form pair of lateral crura (Fig. 9) reenforcing small dorso-lateral triangular alate projections, which merge with main lateroventrally directed wings (Fig. 15). In cloacal region light brownish chitinized structures, representing the telemon,

present; telemon grossly appearing in lateral view to be organized into three main sections, one lying along the posteroventral body wall, one along the lateroventral wall of the cloaca, and the remaining one along the laterodorsal wall of the cloaca (Figs. 2, 17), but consisting of a considerable number of more or less distinct, yet interrelated and apparently interconnected elements (Figs. 8, 16).

*Female*.—In 6 specimens 37.7 to 43.3 mm long by 0.40 to 0.58 mm wide at vulva; esophagus, 1.00 to 1.29 mm long; tail, 0.41 to 0.56 mm long; distance from vulva to posterior extremity 8.2 to 9.6 mm (ratio to body length, 1:4.1 to 1:4.7); eggs 88 to 105 $\mu$  by 50 to 62 $\mu$ . Tail digitiform, bent slightly dorsad at tip, without terminal spike or other cuticular or hypodermal modification (Fig. 13).

*Hosts*.—*Sciurus carolinensis leucotis*; *S. carolinensis*; *S. niger niger*.

*Location*.—Stomach.

*Locality*.—Moorefield, Hardy County, W. Va.; Virginia; Newton, Ga.

*Specimens*.—U.S.N.M. Helm. Coll. no. 36814 (holotype, male); no. 36853 (allotype); no. 36854 (paratypes, 1 male and several females); no. 45329 (removed from lot no. 2934); no. 42772.

*Remarks*.—The striking and readily observed character of ray chitinization is obviously one of great practical value in identification. The systematic importance, however, that should be attached to it is a question concerning which a consensus is not likely to be reached until specimens with chitinized rays have been more widely discovered and studied. Travassos<sup>5</sup> included *Böhmiella* in the Trichostrongylinae provisionally only and believed that further study of the bursa of the genotype might justify placing the genus in a separate major group. The writer does not regard ray chitinization as a fundamental morphological modification and believes that, by itself, the character should be assigned no more than specific value. It seems probable that this was Gebauer's<sup>6</sup> opinion also, since he did not propose *Böhmiella* simply because of the occurrence of this phenomenon. It is in a combination of characters that *B. perichitinea* appears to differ from other trichostrongylins sufficiently to warrant considering it a representative of a distinct genus.

<sup>5</sup> *Op. cit.*

<sup>6</sup> *Op. cit.*

The specimens here described are in many of their general features similar to *B. perichitinea* and are, therefore, regarded as representatives of the same genus. They differ in many respects, however, from the genotype as described by Gebauer and, therefore, are regarded as representing a new species.

It is conceded that certain of the described differences between *B. wilsoni* and *B. perichitinea* are of possible generic value. Notable among them are discrepancies in the number of cephalic papillae and in the nature of the buccal cavity and of the anterior end of the esophagus, and, corollary to the last, in the derivation, position, and orientation of the dorsal onchium and the denticles associated with it; also in this category are the presence in *B. wilsoni* of a circumoral elevation and a rudimentary leaf crown. However, the writer suspects that reexamination of the type specimens of *B. perichitinea* may reveal a closer similarity and relationship to *B. wilsoni* in these respects than now is evident.

In addition to the differences thus far alluded to, *B. wilsoni* is distinguished from *B. perichitinea* by presence of prebursal papillae and a telemon, absence of cervical alae, less marked inequality in the depth of the clefts between the dorsal and lateral lobes of the bursa, lack of dextral curvature and an accessory ventral rodlike process in the dorsal ray, longer spicules of different shape and orientation, larger gubernaculum, larger females with more anteriorly situated vulva, greater number of longitudinal cuticular ridges, shorter dorsal onchium, mediolateral and posterior-lateral rays longer than externolaterals, and lateroventral rays thicker than externodorsals. There also appear to be differences in the extent of the internal chitinized processes in the caudal region, notably, the absence in *B. wilsoni* of a narrow process extending between the spicules and the anterior extremity of the dorsal process, as well as absence of the pair of broom-shaped lateral processes, figured for *B. perichitinea*.

ZOOLOGY.—*Observations on the route of migration of the common liver fluke, Fasciola hepatica, in the definitive host.*<sup>1</sup> WENDELL H. KRULL and R. SCOTT JACKSON, U. S. Bureau of Animal Industry.

The essentials of the life history of the common liver fluke, *Fasciola hepatica*, have been known since 1882, when Thomas and Leuckart, independently, showed that the snail *Lymnaea truncatula* served as an intermediate host of this important parasite. In spite of these and subsequent investigations there still remain details concerning the development of the fluke in the intermediate and definitive hosts that have not been fully worked out. Important among these is the route of migration to the liver of the young fluke after its excystment in the digestive tract of the definitive host.

Three possible routes of migration have been postulated, namely, (1) direct migration from the intestine to the bile ducts through the hepatic duct; (2) passive transportation by the portal circulation after penetration of the intestinal mucosa, the young fluke gaining access to the bile ducts by perforation; and (3) penetration of the

intestine, active migration in the peritoneal cavity, perforation of the liver capsule, and migration through the liver parenchyma to the bile ducts. The first of these possible routes is the one most generally accepted, although it is the only one entirely unsupported by experimental evidence. On the other hand, Bugge (1935) concluded, on the basis of his examination of numerous infected calves, that the young flukes reached the liver via the portal system. Sinitsin (1914) demonstrated young flukes in the washings from the abdominal cavity of rabbits to which encysted cercariae had been administered and concluded that the flukes must reach the liver through active penetration of the liver capsule; this observation was supported by Shirai (1927). Sinitsin's theory was further supported by Shaw (1932), who injected larval flukes directly into the peritoneal cavities of rabbits, guinea pigs, and lambs and observed that the young flukes penetrated the hepatic

<sup>1</sup> Received November 2, 1942.

capsule; juvenile flukes were later recovered from the liver. While the observations of these investigators demonstrated the ability of the excysted metacercariae to gain access to the liver by penetration of the liver capsule, it was not shown that this route is the normal one or that the young flukes on reaching the liver could gain access to the bile ducts and become mature. Since the flukes are sometimes found in such abnormal locations as the lungs and elsewhere, and may even be acquired prenatally, it would seem reasonable to conclude that migration to the liver via the peritoneal cavity was not the usual one. In order to secure additional information on the course of migration of *F. hepatica* in the definitive host, a number of experiments involving the transfer of larval flukes from one definitive host to another were carried out; the results of these experiments are presented in this paper.

#### MATERIALS AND METHODS

The larval flukes used in the transfer experiments described herein were obtained by administering to white mice and guinea pigs (first definitive hosts) cysts of *F. hepatica* obtained from laboratory infected snails. After a number of days had elapsed, the definitive hosts were killed, the young flukes recovered either from the peritoneal cavity or the liver tissue, and transferred in saline by means of a pipette directly into the peritoneal cavities of guinea pigs, rabbits and sheep (second definitive hosts). Guinea pigs were found to be unsatisfactory for this purpose, as the flukes failed to reach maturity in them. In making the transfers, a surgical incision was made in the test animal in the region of the flank, in the case of abdominal transfers, and between the ribs, in the thoracic transfers, the operative openings being closed by sutures. The operations were carried out either under local or general anesthesia.

#### EXPERIMENTAL DATA

##### 1. *Direct transfer of immature flukes to abdominal cavity of rabbits and sheep*

Larval flukes were transferred directly to the abdominal cavities of 20 rabbits and 3 sheep, and the results of these experiments

are given in Table 1. The data presented in this table show that young flukes obtained from one definitive host will, when transferred to a second definitive host, reach the liver and become mature in the bile ducts. These data also indicate that the average time for the flukes to reach fertile maturity in rabbits is somewhat less than in sheep, the range being 62 to 99 (average 71) days in rabbits and 79 to 101 (average 86) days in sheep (includes period in first definitive host). Since only three sheep were involved in these experiments it is possible that had a larger number of animals been used the average time required for the flukes to mature might have been slightly less.

The importance of a sufficient flow of bile for the fluke in the bile duct is shown by the data for rabbit 1. These flukes although 88 days old when recovered were still immature, being only 9 and 12 mm long, respectively, when relaxed. They had lodged in the minor, peripheral bile ducts of the lobes of the liver, whereas the flukes which make a normal growth are usually found in the largest ducts.

Usually conspicuous points of entrance of juvenile flukes are discernible on the liver surface. The lesions persist for weeks, and the ability to repair such damage seems to vary considerably with different species. Healing is more rapid and complete in guinea pigs than in sheep and rabbits.

In order to ascertain whether the transfer of immature flukes from one host animal to another affected the rate of maturity, encysted metacercariae were administered *per os* to three rabbits and one sheep. The first rabbit received 11 cysts; eggs appeared in the feces 66 days later and 1 fluke was recovered at necropsy. The second rabbit received 17 cysts; eggs appeared in the feces in 69 days, and six flukes were recovered at necropsy. The third rabbit received 40 cysts; eggs appeared in the feces in 81 days, and six flukes were recovered at necropsy. The sheep (no. 12039) received 130 cysts; eggs appeared in the feces in 75 days, and 21 mature flukes were recovered from the bile ducts when the animal was necropsied 30 days later.

The results of these experiments parallel

those obtained by direct transfer of the immature flukes and show that the time required for reaching maturity is not materially affected by the manipulations necessary during the transfers.

2. *Direct transfer of immature flukes to the pleural cavity of rabbits*

Since the liver fluke has been reported on a number of occasions from abnormal locations, even under circumstances indicating prenatal infection,<sup>2</sup> the prevailing opinion is that in order for the flukes to reach unusual locations they must be transported by the circulation. In order to secure information on this point, limited experiments were conducted as follows:

Four 30-day-old larval flukes obtained from the liver of a mouse were transferred

<sup>2</sup> One case of liver fluke infection was observed in the vicinity of Logan, Utah, in a 6-weeks-old calf; the flukes were all mature.

to the thoracic cavity of a fully grown rabbit. This animal was examined two months later and the thoracic organs appeared normal; examination of the liver, however, revealed a single specimen of *F. hepatica*, 20 mm long by 7 mm wide, in one of the bile ducts. In a second rabbit, about one-fourth grown, two 22-day-old flukes were transferred to the thoracic cavity; this animal was examined a month later and a single fluke 25 mm long by 6.5 mm wide that had just reached maturity was recovered from the liver. A typical entrance point was observed in the liver capsule indicating that the fluke had reached the liver by migration.

A third rabbit, almost fully grown, received by direct transfer into the thoracic cavity four 30-day-old flukes. A week later this animal developed paralysis of the hind quarters and died a week after the symptoms appeared. On examination one lung was found to be hemorrhagic, a portion of

TABLE 1.—RESULTS OF INFECTIONS OF *FASCIOLA HEPATICA* IN RABBITS AND SHEEP PRODUCED BY THE DIRECT TRANSFER OF IMMATURE FLUKES TO THE ABDOMINAL CAVITY

Animal designation	Source of flukes	Length of flukes	Age of flukes at time of transfer	Flukes transferred	Appearance of eggs in feces <sup>5</sup>	Age of flukes at time of oviproduction <sup>6</sup>	Days in final host—rabbit or sheep	Flukes recovered
		<i>Mm</i>	<i>Days</i>	<i>Number</i>	<i>Days</i>	<i>Days</i>	<i>Days</i>	<i>Number</i>
Rabbit 1	Mouse	—	7	2	0	—	81	2 <sup>1</sup>
Rabbit 2	do	—	8	3	66	74	76	1
Rabbit 3	Mice	1.0-1.5	8	2	66	74	73	2
Rabbit 4	Mouse	1.0-1.5	9	2	61	70	66	1
Rabbit 5	do	3.0±	16	3	52	68	55	3
Rabbit 6	do	3.0±	16	11	50	66	63	11
Rabbit 7	do	—	16	5	54	70	66	4
Rabbit 8	do	—	9	2	0	—	78	0
Rabbit 9	Mice	2.0-4.0	20	8	45	65	58	8
Rabbit 10	Mouse	1.0-1.5	8	6	0	—	35	6 <sup>1</sup>
Rabbit 11	do	6.5-8.0	28	3	34	62	36	2
Rabbit 12	do	6.5-8.0	28	3	44	72	62	2
Rabbit 13	do	6.5-8.0	28	1	44	72	64	1
Rabbit 14	do	6.5-8.0	28	3	34	62	62	1
Rabbit 15	do	6.5-8.0	27	4	—	—	15	3 <sup>1</sup>
Rabbit 16	do	6.5-8.0	30	4	46	76	88	3
Rabbit 17	Mice	—	30	4	—	—	19	2 <sup>1</sup>
Rabbit 18	Guinea pig	8.0	29	1	—	—	77	0
Rabbit 19	do	6.0	31	2	—	—	99	2
Rabbit 20	do	6.0	31	3	68	99	68	2
Sheep 12023	Mice	less than 1.0	5	15	74	79	697	— <sup>2</sup>
Sheep 12083	do	1.0-2.0	11	41	90	101	100	10 <sup>3</sup>
Sheep 12026	do	2.0-4.0	20	48 <sup>4</sup>	59	79	77	17

<sup>1</sup> Immature.

<sup>2</sup> Animal not destroyed, fluke eggs still numerous.

<sup>3</sup> Some flukes immature.

<sup>4</sup> Transfer made through cannula; some young flukes may have been lost.

<sup>5</sup> Days in rabbit or sheep.

<sup>6</sup> Total days in mouse or guinea pig and rabbit or sheep.

the pericardium was thickened and congested, and the thymus was hemorrhagic with adhesions between it and the thoracic wall. No flukes were recovered directly from the organs, but one specimen that showed considerable growth was recovered from the water in which the thoracic organs were manipulated. It is assumed that the paralysis occurring in this case was the result of the fluke infection as no cases of this sort have occurred during several years in the rabbit colony from which this animal was obtained.

In the fourth experiment three 27-day-old flukes were transferred to the thoracic cavity of a mature rabbit. This animal died 22 days after the transfer. On necropsy the parietal pleura in the region of the operative opening was roughened, and there were small hemorrhages in the intercostal muscles. Flecks and strands of fine connective tissue were present on the surface of the lung and areas of scar tissue were observed in the lung tissue which were probably the result of injuries caused by the migrating flukes. The pleural sac was ruptured medially posterior and dorsal to the heart and a portion of the lung had passed through this opening and had become strangulated. The strangulated portion of the lung was consolidated and was showing evidence of necrosis; adhesions and connective tissue deposits were present in this region. No flukes were recovered from this animal.

#### SUMMARY AND CONCLUSIONS

These experimental data show that, if juvenile flukes reach the peritoneal cavity of rabbits and sheep, they migrate to the liver, penetrate the capsule and parenchyma, enter the bile ducts, and mature.

Furthermore, it is shown that entrance through the bile duct is precluded as necessary in the infection of rabbits and sheep; however, it is not eliminated as a possible infection route. In view of the experiments recorded in this paper, particularly those concerning the transfer of flukes to the thoracic cavity, and because of the large size of some of the flukes transferred, the circulatory system as a transfer route also is precluded as being necessary; however, a source of blood seems to be essential for survival; the juvenile flukes are able to secure blood because of their ability to penetrate tissues. Since 78 percent (56 flukes) of the 72 juvenile flukes used in the transfer experiments with rabbits were recovered in necropsies, there is reason to believe that infection via the peritoneal cavity is the principal, if not the sole route, of infection. The limited experiments involving the transfer of juvenile flukes to the thoracic cavity indicate that obscure symptoms of disease, or death, may be traced to liver flukes, even though the flukes themselves may not always be recoverable.

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ZOOLOGY.—*Pycnogonida of the Bartlett collections.*<sup>1</sup> JOEL W. HEDGEPEETH.  
(Communicated by WALDO L. SCHMITT.)

Most of the pycnogonids collected by Capt. Robert A. Bartlett in Greenland and Arctic America up to the year 1935 were sent to Dr. Louis Giltay, formerly of the Royal Museum of Natural History, Brussels, Belgium, who prepared a short manuscript on them. Unfortunately Dr. Giltay died before the manuscript was ready for the printer.<sup>2</sup> At the request of Dr. Waldo L. Schmitt, I have prepared this paper on the pycnogonids taken by Captain Bartlett in the Arctic and have included the identifications made by Dr. Giltay, which are designated by an asterisk.

Although the collections made by Captain Bartlett from the coasts of Greenland add no new species to the known fauna of that region, those from Fox Basin represent a hitherto unreported region for these animals. The specimens from Fox Basin comprise the most extensive collection of pycnogonids from the American Arctic that has yet been made. Heretofore, our knowledge of this fauna has been supplied principally by Cole's list (1921) of three species from Dolphin and Union Strait, a single record of *Nymphon serratum* from James Bay (Giltay, 1942), and the earlier records by Rodger (1893) from the coast of Labrador.

Of the 14 species represented in the Bartlett collections 9 are from Fox Basin. These are all well-known Arctic species whose previously established distribution is summarized in Stephensen's (1933) excellent paper on Greenland pycnogonids. American Arctic pycnogonids are still poorly represented in our collections, however, and it is certain that future collecting will add many species to our lists.

I have not seen the material identified by Dr. Giltay. As his manuscript consisted only of identifications, I am responsible for the synonymies, remarks, and arrangements of this paper. All the specimens, ex-

cept where otherwise noted, were procured by Captain Bartlett on personally sponsored expeditions. The localities from which pycnogonids were secured are listed in geographic sequence from north to south, beginning with Fox Basin (Fig. 1.) The collections, with the exception of two lots taken by the Hudson Bay Fisheries Expedition of 1930 on a steam trawler, the *S. S. Loubyrne*, are in the United States National Museum.

Family NYMPHONIDAE Wilson, 1878

Genus *Boreonymphon* G. O. Sars, 1891

*Boreonymphon robustum* (Bell)

*Boreonymphon robustum* Stephensen, 1933, pp. 4-5, fig. 1 (map); p. 38, fig. 11.

*Localities.*—Walrus grounds, Murchison Sound, NW. Greenland, app. 77°45'N., station 124, Aug. 7, 1938, 1 large ♀, encrusted with sponges, hydroids, and foraminifers.

King Francis Josef Fjord, NE. Greenland, No. 6A, Aug. 4, 1936, 1 specimen.

*Distribution.*—A widely distributed Arctic species, perhaps circumpolar but not yet known from between latitudes 120° W. and 160° E. It is often taken in considerable numbers. Stephensen (p. 38) suggests that this species may live on *Umbellula encrinus* and other corals.

Genus *Nymphon* J. C. Fabricius, 1794

*Nymphon hirtipes* Bell

*Nymphon hirtipes* Wilson, 1878, pp. 22-23, pl. 5, figs. 2-3; pl. 6, fig. 2a-k.

*Nymphon hirtum* Wilson, 1880, pp. 495-497, pl. 7, figs. 38-41.

*Chaetonymphon hirtipes* Sars, 1891, pp. 103-107, pl. 11, fig. 2a-k.

*Chaetonymphon hirtipes* Cole, 1921, p. 4.

*Chaetonymphon hirtipes* Stephensen, 1933, pp. 8-9, figs. 2, 10 (maps).

*Localities.*—\*Entrance to Fury and Hecla Straits, Sept. 3, 1933, 30 fathoms, 3 specimens (Norcross-Bartlett Expedition).

\*East end of Cobourg Island, Baffin Bay, 75° 40' N., 78° 50' W., station 7, Aug. 3, 1935, 140-210 fathoms, bottom sample, gravel, 39 specimens (incl. ovig. ♂♂).

<sup>1</sup> Received December 28, 1942.

<sup>2</sup> Dr. Louis Giltay died on July 25, 1937. A biographical notice with bibliography was published by V. van Straelen in Bull. Mus. Roy. Hist. Nat. Belgique 14 (23). (1938).

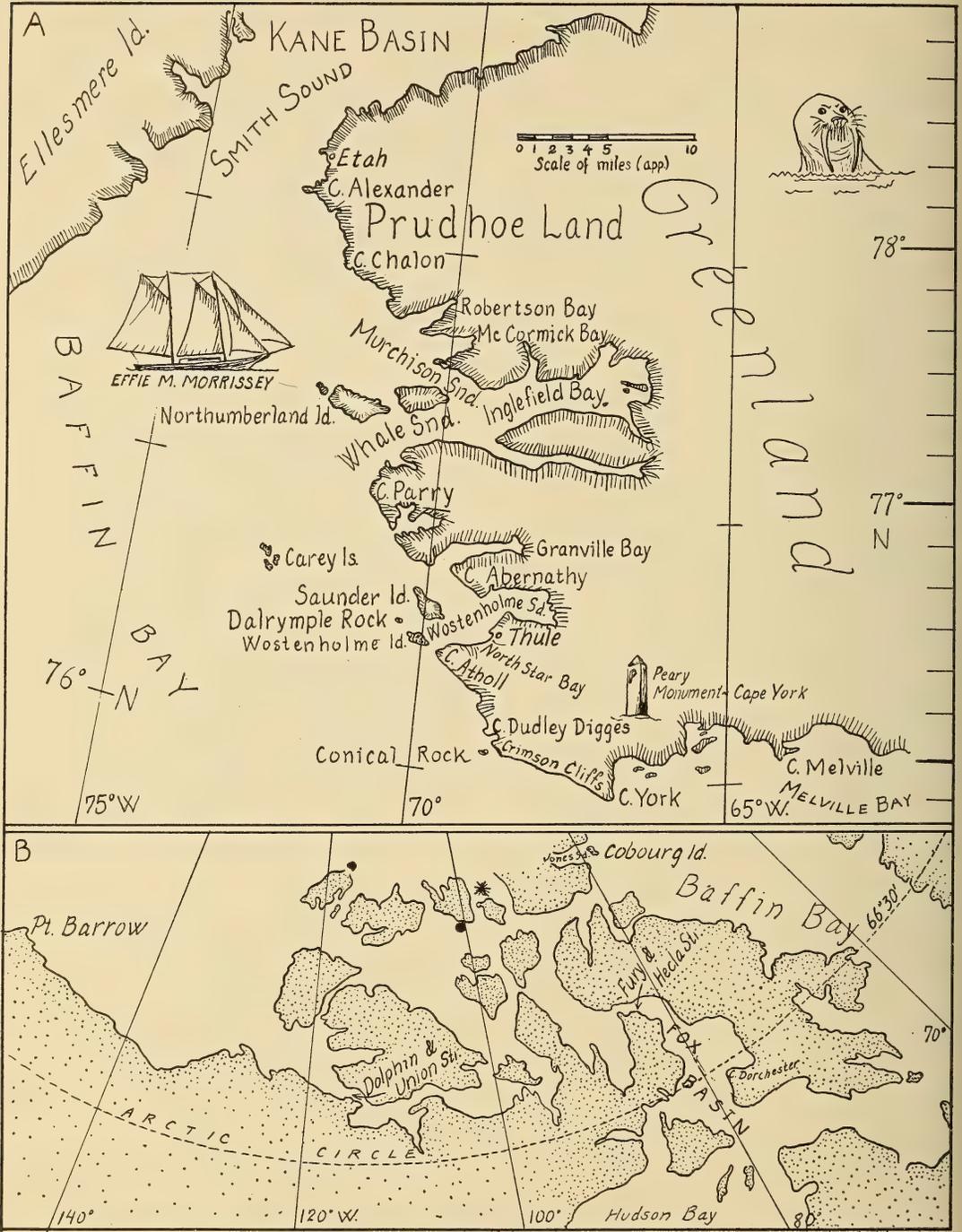


Fig. 1.—A, Detail of NW. Greenland, showing localities represented in the Bartlett collections; B, The American Arctic (only those localities from which pycnogonids have been collected are indicated). \*Type locality of *Boreonymphon robustum* (approximate; probably also of *Nymphon hirtipes*). ●Type locality of *Colossendeis proboscidea* (approximate).

\*Thule, North Star Bay, NW. Greenland, 76° 32' N., 68° 45' W., Aug. 27, 1932, 12 fathoms, 1 specimen (Peary Memorial Expedition).

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45' N., station 124, Aug. 7, 1938, otter trawl, 5 specimens.

Murchison Sound, NW. Greenland, app. 77° 43' N., station 134, Aug. 7, 1938, otter trawl, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 38' N., station 146, Aug. 8, 1938, otter trawl, 5 specimens.

Along west side of Wolstenholme Island, station 43, July 23, 1940, 12 fathoms, 1 specimen.

Between north shore of Parker Snow Bay and Conical Rock, NW. Greenland, station 25, July 22, 1940, 25-45 fathoms, +7 specimens.

Off Conical Rock, NW. Greenland, 76° 3' N., 67° 30' W., station 76, July 29, 1938, dredged, 1 ♀.

One mile northwest of Conical Rock, NW. Greenland, station 37, July 22, 1940, 25-60 fathoms, 7 specimens.

\*Angmagsalik, SE. Greenland, Aug. 30, 1930, dredge, 1 specimen.

Off SE. Greenland, 61° N., 62° 30' W., station 166, Aug. 24, 1939, otter trawl, mud and pebbles, 5 specimens.

Prince Christian Sound, SE. Greenland, 61° 10' N., station 175, Aug. 25, 1939, 80-90 fathoms, otter trawl, 2 specimens.

Off Cape Farewell, S. Greenland, station 207, Aug. 25, 1939, 40-100 fathoms, otter trawl, 1 specimen.

\*NE. Greenland, 74° 21' N., 16° 30' W., July 29, 1931, 120 fathoms, 1 specimen (Norcross-Bartlett Expedition).

\*NE. Greenland, 74° 04' N., 17° 58' W., July 30, 1931, 120 fathoms, 4 specimens (Norcross-Bartlett Expedition).

*Distribution.*—An Arctic and boreal-Arctic species, widely distributed in the northern Atlantic and from Kara Sea to NW. Greenland in the Arctic. Cole's record from Dolphin and Union Strait is the westernmost record. It is known also from eastern United States, Halifax to Massachusetts Bay (Wilson). Apparently it is not circumpolar. Other hitherto unpublished records are Baldwin-Ziegler Polar Expedition; June, 1901, Aberdare Channel, east of Alger Island, Franz Josef Land, 7 specimens; and station 19, S. S. *Loubyrne*, Hudson Bay

Fisheries Expedition, 61° 11' N., 90° W., August 15, 1930, 75 fathoms, mud and stones, 1 specimen.

#### *Nymphon brevitarse* Krøyer

*Nymphon brevitarse* Stephensen, 1933, pp. 10-11.

*Localities.*—\*SE. corner of Fox Basin, 66° 46' N., 79° 15' W., Aug. 13, 1927, 34-37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

South shore of Southampton Island, Hudson Bay, 63° 10' N., 85° 25' W., station 3, Aug. 3, 1933, from floating seaweed, 1 specimen (Norcross-Bartlett Expedition).

Between Cape Alexander and Cape Chalon, NW. Greenland, station 29, Aug. 2, 1937, 25-40 fathoms, rocky bottom, 3 specimens.

Walrus grounds, Murchison Sound, NW. Greenland, 77° 45' N., station 127, Aug. 7, 1938, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 38' N., station 146, Aug. 8, 1938, 1 specimen.

*Distribution.*—An Arctic species, from Spitsbergen to NW. Greenland and Fox Basin. From shallow water, not more than 50 fathoms. Rodger (1893) reports the species from the Straits of Belle Isle. One specimen was collected by the Baldwin-Ziegler Expedition in Aberdare Channel, Franz Josef Land.

#### *Nymphon grossipes* (O. Fabricius?) Krøyer

*Nymphon grossipes* Stephensen, 1933, pp. 11-12.

*Localities.*—\*Fox Basin, 66° 30' N., 80° W., Aug. 10, 1927, 14 specimens (Putnam Baffin Land Expedition).

Fox Basin, 66° 30' N., 80° W., Aug. 10, 1927, 4 specimens. Identified by Giltay as *N. mixtum*, a synonym of *N. grossipes*. (Putnam Baffin Land Expedition.)

Southeast corner of Fox Basin, 66° 46' N., 79° 15' W., Aug. 13, 1927, 34-37 fathoms, dredge, 1 specimen. Identified by Giltay as *N. mixtum*. (Putnam Baffin Land Expedition.)

\*Southeast corner of Fox Basin, 66° 46' N., 79° 15' W., Aug. 13, 1927, 37 fathoms, dredge, 15 specimens (incl. ovig. ♂♂) (Putnam Baffin Land Expedition).

\*Center of Fox Basin, Aug. 24-25, 1927, 25 fathoms, 10 specimens (Putnam Baffin Land Expedition).

\*Fox Basin, Aug. 26, 1927, 25–31 fathoms, 1 specimen (Putnam Baffin Land Expedition).

East end of Cobourg Island, Baffin Bay, 75° 40' N., 78° 40' W., Aug. 3, 1935, 140–210 fathoms, gravel, 1 specimen. Identified by Giltay as *N. mixtum*.

\*South end of Cobourg Island, Baffin Bay, 75° 40' N., 78° 58' W., Aug. 4, 1935, 48–80 fathoms, rocky, 1 specimen.

\*South end of Cobourg Island, Baffin Bay, 75° 40' N., 78° 59' W., Aug. 4, 1935, 68–120 fathoms, rocky, 1 specimen.

Between Cape Alexander and Cape Chalon, NW. Greenland, station 27, Aug. 2, 1937, 25–40 fathoms, rocky, 3 specimens.

\*Walrus feeding grounds, 5 miles north of Cape Chalon, Prudhoe Land, NW. Greenland, July 27, 1932, 1 specimen.

Murchison Sound, NW. Greenland, app. 77° 45' N., station 126, Aug. 7, 1938, otter trawl, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 38' N., station 146, Aug. 8, 1938, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45' N., station 124, Aug. 7, 1938, otter trawl, 3 specimens.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45' N., station 127, Aug. 7, 1938, otter trawl, 1 specimen.

Northumberland Island, NW. Greenland, station 49, Aug. 7, 1937, dredge, 1 specimen.

\*Northumberland Island, NW. Greenland, Aug. 1926, 1 specimen.

Off Dalrymple Rock, Wostenholme Sound, July 22, 1926, 2 specimens (1 ovig. ♂).

Off northwest shore of Wostenholme Island, NW. Greenland, station 57, July 23, 1940, 13–25 fathoms, 1 specimen.

Off Wostenholme Island, NW. Greenland, station 44, July 23, 1940, 13–17 fathoms, 1 specimen.

Off Wostenholme Island, NW. Greenland, station 46, July 23, 1940, 13–17 fathoms, 1 specimen.

One mile northwest of Conical Rock, NW. Greenland, station 38, July 23, 1940, 25–60 fathoms, dredge, 1 specimen.

Kerkoliak, Salve Island, Melville Bay, NW. Greenland, Aug. 28, 1932, dredge, 1 specimen. Identified by Giltay as *N. mixtum*.

Off Cape Farewell, S. Greenland, station 207,

Aug. 25, 1939, 40–100 fathoms, otter trawl, 2 specimens.

Off Cape Farewell, S. Greenland, station 196, Aug. 25, 1939, 60–70 fathoms, 1 specimen.

Off Cape Farewell, S. Greenland, station 218, Aug. 25, 1939, 60–70 fathoms, 3 specimens.

\*Clavering Fjord, NE. Greenland, Aug. 2, 1930, 1 specimen.

*Nymphon mixtum* Krøyer and *N. glaciale* Sars can not be separated from *N. grossipes*, as Stephensen (p. 12) has shown, and I concur with his synonymy.

*Distribution*.—A widely distributed and very variable species, found on the North American coast as far south as Long Island Sound on the east and Puget Sound on the west. It is circumpolar, Arctic, and boreal-Arctic; littoral to +500 fathoms.

#### ***Nymphon longitarse* Krøyer**

*Nymphon longitarse* Norman, 1908, pp. 212–213.

*Nymphon longitarse* Cole, 1921, p. 4.

*Nymphon longitarse* Stephensen, 1933, pp. 13–14, fig. 3 (map).

*Nymphon longitarse* Losina-Losinsky, 1933, pp. 67–68.

*Nymphon longitarsi* Hilton, 1942a, pp. 3–4.

*Locality*.—Frobisher Bay, Baffin Land, about 60 fathoms, 1 specimen.

*Distribution*.—A boreal-Arctic species, widely distributed from the coasts of Norway and Britain in Europe to Cape Cod on the American coast (rarely south to about lat. 40° N., but not to Cape Hatteras as suggested by Norman in his distribution table, p. 199). It is also circumpolar, having been recorded from Point Barrow (Cole) and from eastern Siberian waters (Losina-Losinsky). Hilton lists its from Kodiak and "Alaskan waters." It is a littoral to sublittoral species.

#### ***Nymphon sluiteri* Hoek**

*Nymphon sluiteri* Cole, 1921, pp. 3–4.

*Nymphon sluiteri* Stephensen, 1933, p. 14, fig. 4 (map).

*Localities*.—\*East end of Cobourg Island, Baffin Bay, 75° 40' N., 78° 55' W., Aug. 3, 1935, 150–280 fathoms, muddy, 1 specimen.

Between Cape Alexander and Cape Chalon, NW. Greenland, station 29, Aug. 2, 1937, 25–40 fathoms, rocky, 1 specimen (juv.).

*Distribution*.—A circumpolar Arctic species, found in shallow water in the high Arctic and in deeper water in the southern part of its range (Faroës and Jan Mayen). Several specimens were collected by the Baldwin-Ziegler Polar Expedition in Aberdare Channel, Franz Josef Land, June, 1901.

*Nymphon sluiteri* has also been collected in the Gulf of St. Lawrence, where two specimens were dredged by Dr. Georges Préfontaine at Trois Pistoles, Quebec, in 200 meters, July, 1932 (U.S.N.M. 66540). This appears to be the southernmost record for this species. It does not appear to reach New England waters as do other Arctic species like *Nymphon hirtipes* and *Pseudopallene circularis*. Possibly its occurrence in the Gulf of St. Lawrence is rare or sporadic.

### *Nymphon elegans* Hansen

*Nymphon elegans* Stephensen, 1933, p. 17.

*Localities*.—Fox Basin, 45 miles east of Cape Dorchester, Aug. 8, 1927, 1 specimen (Putnam Baffin Land Expedition).

\*Southeast corner Fox Basin, 66° 45' N., 79° 15' W., Aug. 13, 1927, 34–37 fathoms, dredge, 5 specimens (Putnam Baffin Land Expedition).

\*Center of Fox Basin, Aug. 24–25, 1927, 25 fathoms, 3 specimens (Putnam Baffin Land Expedition).

\*Fox Basin, Aug. 26, 1927, 25–31 fathoms, dredge, 2 specimens (Putnam Baffin Land Expedition).

\*Fox Basin, 66° 30' N., 80° W., Aug. 10, 1927, 6 specimens (Putnam Baffin Land Expedition).

\*Fox Basin, 66° 43' N., 80° 07' W., Aug. 1927, dredge, 2 specimens (Putnam Baffin Land Expedition).

\*East end of Cobourg Island, Baffin Bay, 75° 40' N., 78° 40' W., Aug. 3, 1935, 140–210 fathoms, gravel, 10 specimens.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45' N., station 124, Aug. 7, 1938, otter trawl, 1 specimen.

*Distribution*.—An Arctic species, from the Kara Sea to W. Greenland, and Fox Basin. Usually taken in somewhat deeper water, i.e., about 100–300 fathoms.

### *Nymphon serratum* G. O. Sars

*Nymphon serratum* Stephensen, 1933, pp. 18–19.

*Nymphon serratum* Giltay, 1942, p. 459.

*Localities*.—\*Southeast corner Fox Basin, 66° 46' N., 79° 15' W., Aug. 13, 1927, 34–37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

Between Cape Alexander and Cape Chalon, NW. Greenland, station 29, Aug. 2, 1937, 25–40 fathoms, rocky, 1 specimen.

Walrus grounds, Murchison Sound, app. 77° 45' N., station 124, Aug. 7, 1938, otter trawl, 1 specimen.

Whale Sound, NW. Greenland, Jar H, July 28, 1937, rocky bottom, 1 specimen.

One mile northwest of Conical Rock, station 37, July 22, 1940, 25–60 fathoms, 1 specimen.

West Greenland, 70° 20' N., 56° W., June 12, 1884, Ensign C. S. McLain, U.S.N., coll., 1 specimen.

*Distribution*.—An Arctic, sublittoral species from Kara Sea to W. Greenland and Hudson Bay (Giltay). Another specimen from Hudson Bay was taken by the S.S. *Loubyrne* (Hudson Bay Fisheries Expedition), station 31, Aug. 22, 1930, 41 fathoms, gravel. It is occasionally taken in the Atlantic just south of Wyville-Thomson Ridge (Stephensen).

### *Nymphon megalops* G. O. Sars Fig. 2

*Nymphon megalops* Stephensen, 1933, p. 19.

*Localities*.—\*Fox Basin, 66° 43' N., 80° 07' W., Aug., 1927, dredge, 2 specimens. Identified by Giltay as *N. sarsi*. (Putnam Baffin Land Expedition.)

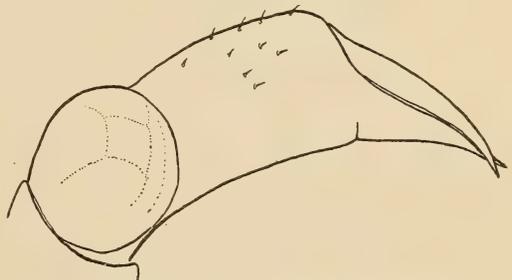


Fig. 2.—Right chela (reversed) of *Nymphon megalops*, showing rounded outgrowth.

Between Cape Alexander and Cape Chalon, NW. Greenland, Jar W, Aug. 2, 1937, 1 specimen.

Walrus feeding ground, Murchison Sound, NW. Greenland, app. 77° 42' N., station 135, Aug. 7, 1938, otter trawl, 2 specimens.

There seems to be no significant difference between this species and Meinert's (1899, pp.

48-49) *Nymphon sarsi*. The right chela of the specimen ( $\sigma$ ) from between Cape Alexander and Cape Chalon has a large rounded deformity (Fig. 2).

*Distribution*.—An Arctic species, from western Norway to Fox Basin; south to about  $61^{\circ} 30' N.$ , in the Faroe Channel. Usually from deep water.

Family PALLENIDAE Wilson, 1878

Genus *Pseudopallene* Wilson, 1878

For reasons to be discussed in detail in another paper, the use of *Phoxichilus* Latreille (hitherto used for *Endeis* Philippi by practically all authors) for *Pseudopallene* Wilson as recommended by Norman (1908, pp. 231-233) and Marcus (1940, p. 128) is rejected as an unnecessary confusion. It is much simpler to abandon *Phoxichilus* entirely.

*Pseudopallene spinipes* (O. Fabricius)

*Pseudopallene spinipes* Stephensen, 1933, p. 21.

*Localities*.—East end of Cobourg Island, Baffin Bay,  $75^{\circ} 40' N.$ ,  $78^{\circ} 40' W.$ , station 8b, Aug. 3, 1935, 140-200 fathoms, gravel, 1 specimen.

Off Cape Farewell, S. Greenland, station 197, Aug. 25, 1939, 60-70 fathoms, 1 specimen.

Off Cape Farewell, S. Greenland, station 208, Aug. 25, 1939, 60-70 fathoms, washed from seaweed, 1 specimen.

*Distribution*.—An Arctic species, from western Norway, Kara Sea, Franz Josef Land, and West Greenland; sublittoral.

*Pseudopallene circularis* (Goodsir)

*Pseudopallene circularis* Stephensen, 1933, pp. 20-21.

*Localities*.—Southern part of Fox Basin,  $66^{\circ} 30' N.$ ,  $80^{\circ} W.$ , Aug. 10, 1927, 2 specimens (Putnam Baffin Land Expedition).

Southern part of Fox Basin,  $66^{\circ} 43' N.$ ,  $80^{\circ} 07' W.$ , Aug. 12, 1927, 32-37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

\*Center of Fox Basin, Aug. 24-25, 1927, 25 fathoms, dredge, 3 specimens (Putnam Baffin Land Expedition).

\*Fox Basin, Aug. 25, 1927, 25-31 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

\*Southern part of Fox Basin,  $66^{\circ} 43' N.$ ,  $80^{\circ} 07' W.$ , Aug., 1927, dredge, 1 specimen (Putnam Baffin Land Expedition).

Walrus feeding grounds, Murchison Sound, NW. Greenland, app.  $77^{\circ} 42' N.$ , station 135, Aug. 7, 1938, otter trawl, 1 specimen.

Walrus feeding grounds, Murchison Sound, NW. Greenland, app.  $77^{\circ} 45' N.$ , station 127, Aug. 7, 1938, 1 specimen.

Just back of Cape Farewell, S. Greenland station 210, Aug. 25, 1939, 70 fathoms, 1 specimen.

*Distribution*.—A boreal-Arctic species, from Okhotsk Sea to West Greenland, south to the Firth of Forth and southern Norway on the coast of Europe and to Cape Cod in American waters; littoral to shallow water. It is much smaller in the southern parts of its range.

Family AMMOTHEIDAE Dohrn, 1881

Genus *Eurycyde* Schödte, 1857

*Eurycyde hispida* (Kröyer)

*Eurycyde hispida* Stephensen, 1933, p. 27.

*Localities*.—\*Southern part of Fox Basin,  $66^{\circ} 30' N.$ ,  $80^{\circ} W.$ , Aug. 10, 1927, 2 specimens (Putnam Baffin Land Expedition).

\*Southeast corner Fox Basin,  $66^{\circ} 46' N.$ ,  $79^{\circ} 15' W.$ , Aug. 12, 1927, 34-37 fathoms, 7 specimens (Putnam Baffin Land Expedition).

\*Center of Fox Basin, Aug. 24, 1927, 25 fathoms, 13 specimens (Putnam Baffin Land Expedition).

\*Fox Basin,  $67^{\circ} 45' N.$ ,  $79^{\circ} 09' W.$ , Aug. 24, 1927, 38 fathoms, 3 specimens (2 ovig.  $\sigma$   $\sigma$ ) (Putnam Baffin Land Expedition).

\*Fox Basin, Aug. 26, 1927, 25-31 fathoms, 2 specimens (Putnam Baffin Land Expedition).

\*Fox Basin,  $67^{\circ} 43' N.$ ,  $80^{\circ} 07' W.$ , Aug., 1927, dredge, 3 specimens (Putnam Baffin Land Expedition).

Walrus feeding grounds, Murchison Sound, NW. Greenland, app.  $77^{\circ} 42' N.$ , station 136, Aug. 7, 1938, 1 specimen.

*Distribution*.—An Arctic, littoral to sublittoral species, ranging from the Kara Sea to Baffin Land and Greenland (Stephensen) and as far south as Kristiansund on the Norwegian coast. It is unknown from Iceland.

Family COLOSSENDEIDAE Hoek, 1881

Genus *Colossendeis* Jarzynsky, 1870

*Colossendeis proboscidea* (Sabine)

*Colossendeis proboscidea* Stephensen, 1933, p. 28, fig. 6 (map).

*Locality*.—\*Southeast corner Fox Basin,  $66^{\circ}$

46' N., 79° 15' W., Aug. 13, 1927, 34–37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

*Distribution.*—Possibly a circumpolar Arctic Basin species, from shallow water to about 500 fathoms. Unknown outside of Arctic waters (Stephensen).

#### ZOOGEOGRAPHICAL REMARKS

The status of our present knowledge of the distribution of pycnogonids in the American Arctic is summarized in Table 1. There are undoubtedly many more species in this sector; Stephensen (1933, pp. 32–33) lists at least 30 species from the waters west of Greenland alone, and the 14 species in the table are but half that number. While this is a considerable addition to the 6 species mentioned by Cole (1921, p. 5) for the region, our records from the north of Canada are far from extensive, and the localities represented are remarkably few. It is worthy of note that the American Arctic is the type locality for two of the character species of the Arctic Basin, *Boreonymphon robustum* and *Colossendeis proboscidea* (Fig. 1, B).

In recent preliminary papers, Hilton (1942a, b) has listed some pycnogonids from the Bering Sea and Alaskan waters that may establish the circumpolar distribution of certain well-known Arctic species when more adequately identified. Although it is

impossible, from the preliminary diagnoses, to recognize or identify any of the species mentioned in these papers, the occurrence of *Nymphon gracile* Leach in Alaskan waters (Hilton, 1942a, p. 7) is doubtful. This might be *Nymphon brevitarse*; *N. gracile* (sometimes confused with *N. rubrum* Hodge or *N. brevirostre* Hodge, e.g., *Nymphon gracile* Sars, 1891, non Leach—see also Stephensen, 1935, pp. 9–10) is a European species, from Denmark to the Mediterranean. "*Nymphon gracillipes*" (*stromi*?) is also listed (*ibid.*, p. 4), from the Bering Sea at Albatross station 3540 (Aug. 9, 1893, 56° 34' 00" N., 167° 19' 00" W., 57 fathoms). Two new species of *Pseudopallene*, *P. setosa* and *P. spinosa*, are alluded to (Hilton, 1942b, p. 39), one or both of which might be the variable *Pseudopallene circularis*.

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TABLE 1.—DISTRIBUTION OF PYCNOGONIDS IN THE AMERICAN ARCTIC (EXCLUSIVE OF WEST GREENLAND)

Species	Labrador	Baffin Land (and Cobourg Island)	Hudson Bay	Fox Basin	Dolphin and Union Strait	Point Barrow	Other records <sup>1</sup>
<i>Boreonymphon robustum</i> .....		×					76°52' N., 97° W.
<i>Nymphon hirtipes</i> .....	×	×	×	×	×		
<i>brevitarse</i> .....	×	×	×	×			
<i>grossipes</i> .....	×	×		×		×	
<i>longitarse</i> .....		×			×	×	
<i>sluiteri</i> .....	×	×			×		
<i>elegans</i> .....	×	×		×			
<i>serratum</i> .....			×	×			
<i>megalops</i> .....				×			
<i>macronyx</i> .....		×					
<i>Pseudopallene spinipes</i> .....		×					
<i>circularis</i> .....	×	×		×			
<i>Eurycyde hispida</i> .....		×		×			
<i>Colossendeis proboscidea</i> .....				×			75° N., 100° W.

<sup>1</sup> Both of these records are type localities. *Nymphon hirtipes* probably has the same type locality as *Boreonymphon robustum*, but I have not had access to the original paper to verify this. Both species were described by T. Bell in *The Last of the Arctic voyages*, by Edward Belcher, vol. 2, pp. 400–411, 1855.

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ICHTHYOLOGY.—*Notes on the affinity, anatomy, and development of Elops saurus Linnaeus.*<sup>1</sup> SAMUEL F. HILDEBRAND, Fish and Wildlife Service.

C. Tate Regan in "A Revision of the Fishes of the Genus *Elops*" (Ann. Mag. Nat. Hist. (ser. 8) 3: 37-40. 1909), among other revisions, recognized the inhabitants of this genus on the Pacific coast of America as distinct from *E. saurus* of the Atlantic coast, with which they had been considered identical. He named the Pacific coast species *E. affinis*. In the same paper, Regan recognized the form with small scales (the one with large scales being *E. lacerta* Cuvier and Valenciennes) of the west coast of Africa as also distinct from *E. saurus*, giving it the name *E. senegalensis*. Recently I have studied many specimens of *E. saurus*, including growth series, ranging from leptocephali with virtually undeveloped fins, except for the forked caudal, to large adults. The specimens were collected in many localities on the Atlantic coast of America from Cape Cod to Recife, Brazil, and the West Indian Islands. I have had for comparison several leptocephali and a moderately large series of adults from several localities on the Pacific coast of America from Guaymas, Mexico, to Payta, Peru; also three adults from Elmina, Ashantee, Africa. The validity of the species mentioned, recognized as new by Regan, originally apparently described from few specimens, has been confirmed by this study.

*Elops affinis* seems to differ from *E. saurus* only in the greater number of gill rakers, wherein *E. senegalensis* agrees with *E. saurus*, as shown by Table 1. However,

<sup>1</sup> Received November 9, 1942.

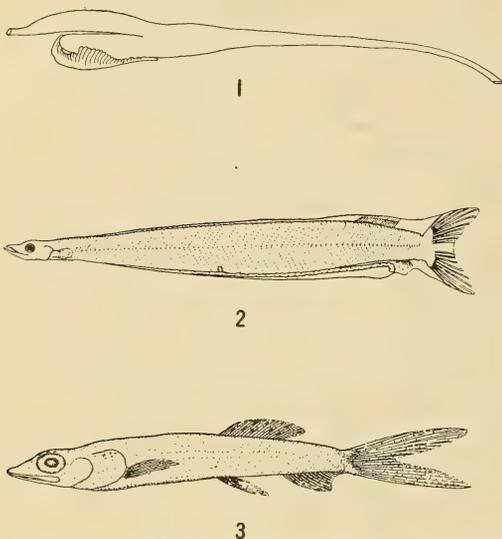
the scales in a lateral series are fewer in *E. senegalensis* than in *E. saurus*, as indicated in Table 2. *E. senegalensis* differs from *E. saurus* and *E. affinis* also in having fewer vertebrae. Ten specimens of *E. saurus* have, respectively, 73, 74, 75, 75, 75, 77, 78, 79, 80, and 80 vertebrae in the main axis. Nine leptocephali of the same species have, respectively, 77, 78, 78, 78, 79, 80, 82, 82, and 82 myomeres (enumerations somewhat uncertain because of indistinctness of myomeres posteriorly). The only adult *E. affinis* examined has 77 vertebrae, and six leptocephali have, respectively, 76, 77, 79, 80, and 81 myomeres. The single adult *E. senegalensis* examined has 67 vertebrae. These enumerations are in agreement with those given in Dr. Regan's revision.

So far as I know, the validity of *Elops affinis* has not been questioned. On the other hand, it was accepted by Meek and Hildebrand (Publ. Field Mus. Nat. Hist., zool. ser., 15 (1): 176. 1923), who compared specimens from the opposite coasts of Panama.

The situation with respect to *Elops senegalensis* is somewhat different, as it has been synonymized with *E. saurus*, at least, by Fowler (Bull. Amer. Mus. Nat. Hist. 70 (1): 155. 1936), though accepted by Boulenger (Cat. Fresh-water Fish. Africa 4: 152. 1916). Although only three specimens from Africa have been available to me for examination, it is evident from the many specimens from the Atlantic coast of America studied that the range in the number of scales in the lateral series in American speci-



many at hand are, respectively, 34, 35, and 37 mm long. Although these specimens have the forked caudal fin well developed, the other fins remain undifferentiated. These young larvae are also the most strongly compressed, that is, the thinnest and most unsubstantial ones in the collections studied. Two other larvae, although of about the same length, 34.5 and 36.5 mm long, are slightly more advanced, as a thickening within the finfolds indicates the development of the dorsal and anal fins (see Fig. 2).



Figs. 1-3.—*Elops saurus* Linnaeus: 1, Diagram of alimentary canal showing its forward-projecting blind sac with a "comb" of pyloric caeca; 2, leptocephalus, one of the earliest stages known, drawn from a specimen 35 mm long; 3, recently transformed "young adult," drawn from a specimen only 20 mm long. All drawings by Mrs. Alice C. Mullen.

The largest leptocephali seen are, respectively, 42, 42, and 44 mm long. These specimens may represent about the maximum length attained by the larvae. However, the development at any particular length is quite uneven, as already indicated, and more clearly shown subsequently. The development in these large larvae has progressed somewhat further than in those previously mentioned, as the rays in the dorsal and anal fins are somewhat differentiated, the pectoral fins appear as tufts of membrane and the development of pelvic fins is suggested by thickened places in the abdominal wall. A considerably older speci-

men, "reduced" in length to 27 mm, has the dorsal and anal fins sufficiently developed to permit the enumeration of the rays, and the pectorals show signs of rays, though the pelvics remain undifferentiated. While the body remains strongly compressed, it nevertheless has become more substantial. Other specimens of the same length are more retarded as the dorsal and anal rays are scarcely differentiated.

In all the leptocephalus stages known the head is strongly depressed, and the snout viewed either ventrally or dorsally, is rather sharply triangular. Pigmentation in preserved specimens consist of two series of dark spots running the full length of the abdomen, a row being situated on each side of the alimentary canal, which in this species, as in larval herring and other herring-like fishes studied, is loosely attached to the body.

The smallest young adult, that is, a specimen that has become rather robust, though still more strongly compressed than fully developed adults, with all the fins, except the pelvics, well developed, is only 16 mm long. This specimen represents the maximum shrinkage among the many young studied. The rather numerous young adults in the collections at hand show a wide range in development. For example, a specimen scarcely 20 mm long (see Fig. 3) is fully as well developed as others around 30 mm long. Then, there is a 30-mm specimen in the collection that has advanced fully as far in acquiring characters of the adult as others 35 to 40 mm long. A great difference in development of color also is evident. The 20-mm specimen, already mentioned, has some of the silvery color of the adult, with all the color markings of the leptocephalus missing, whereas some specimens around 30 mm long remain pale, and retain the two series of dark dots on the abdomen of the juveniles already described.

The small, exceptionally advanced specimens were all taken in brackish to nearly fresh water pools and ponds, near the sea, whereas the retarded specimens were taken at sea. The indication, then, is that the environment greatly affects development.

Even though development is not uniform,

it nevertheless may be stated that generally when the leptocephali have become reduced to a length of about 20 mm they are virtually young adults. At that stage the fins, exclusive of the pelvics, are well developed, considerable thickening of the body has taken place, the outline of the gular plate is visible under magnification, and usually general pigmentation is under way. Scales begin to appear at a length of about 50 mm and by that time the teeth in the jaws, which are in a single series in the leptocephali, definitely are in bands. Scalation and pigmentation are complete at a length of 60 to 65 mm, and the young then are very similar to full-grown adults.

The leptocephali of this species evidently do not grow so large as those of *Albula vulpes*, as the longest leptocephalus of *Elops saurus* in the collections studied is only 44 mm long, whereas the largest one of *A. vulpes* has a length of 70 mm, and many others of that species are only slightly shorter. Furthermore, the leptocephali of *A. vulpes* have a rather heavier body. The larvae of the two species are readily distinguishable by the shape of the head. In *E. saurus* the head is rather broad and strongly depressed, and the snout as seen from above or from below is rather sharply triangular. In *A. vulpes* the head is notably narrower, not especially depressed, and the snout is conical. The larvae may be distinguished, also, by the number of myomeres, as *E. saurus* has about 77 to 82, whereas *A. vulpes* has about 66 to 72. When the dorsal and anal fins become sufficiently developed to permit the enumeration of the rays, the species are readily separated by the number of rays, as *E. saurus* has 21 to 25 dorsal and 14 to 17 anal rays, whereas *A. vulpes* has 14 to 17 dorsal, and only 8 or 9 anal rays.

The young of *Tarpon atlanticus* remain largely unknown, only one specimen about 20 mm long (no longer extant) having been described (Hildebrand, Copeia, 1934, No. 1: 45). This specimen was in the transition stage. It was readily distinguishable from both *E. saurus* and *A. vulpes* by the fewer myomeres, of which only 52 were present, and by the short dorsal with 12 rays and the long anal with 20 rays.

The spawning season and the place where *Elops saurus* spawns remain unknown. However, ripe or nearly ripe fish have been found. One female with large roe was caught at Beaufort, N. C., on October 23, and 20 ripe or nearly ripe fish, consisting of 7 males and 13 females, were taken in February on the Canal Zone (Hildebrand, Zoologica 24: 25. 1939). These 20 fish were chosen at random from hundreds that became stranded when the Gatun Locks were dewatered in 1935. As every fish examined, selected from among the many present, contained gonads in an advanced state of development, it perhaps may be assumed that at least most of many hundreds present were gravid fish. It seems proper to conclude, therefore, that at least some spawning takes place during our winter months.

Leptocephali in the various stages of development, already described, were collected at Beaufort, North Carolina, during January, February, March, April, May, October, November, and December. Leptocephali were collected in Texas, mostly at Corpus Christi, in February, March, April, and November. Others were taken in the Florida Keys in November, and in Cuba during May. Young adults, in or just past the transition stage, were collected at Beaufort, N. C., in March, May, June, July, and August; in Aransas Pass, Tex., in June; and at Key West, Fla., in March and November. This wide spread of time over the year of the capture of the young, even in one locality, as at Beaufort, N. C., suggests either that spawning takes place during most of the year or that the development is unequal.

If the slow development of the leptocephali of the fresh-water eels may be used as a criterion, even the youngest leptocephali of *Elops saurus* described may be several months old. Also, if the life history is similar to that of the eels the youngest larvae of *Elops saurus* at hand may have been captured far from the place of their birth. It apparently may be stated with some degree of certainty that the early stages of the leptocephali do not occur in the shallower waters in the vicinity of Beaufort, N. C., where more or less advanced stages de-

scribed herein are moderately common. In that vicinity intensive collecting with several types of gear, was carried on during every month over a period of many years in the inshore waters and to a somewhat lesser extent offshore to a depth of about 12 fathoms. The suggestion that spawning probably takes place far offshore presents itself.

Although no gravid examples of *Albula vulpes* were seen, the leptocephali and young adults were taken somewhere along the At-

lantic and in the West Indies between Beaufort, N. C., and Panama, virtually throughout the year (collections for October and December only being missing). Many leptocephali and young adults of this species from the Pacific coast of Panama and a few from Colombia taken during February, March, and "autumn" also have been examined. Therefore, the remarks as to spawning made in the preceding pages probably apply equally as well to this species as to *Elops saurus*.

## PROCEEDINGS OF THE ACADEMY

### 380TH MEETING OF THE BOARD OF MANAGERS

The 380th meeting of the Board of Managers was held in the library of the Cosmos Club on January 11, 1943. President CURTIS called the meeting to order at 8:05 P.M., with 19 persons present, as follows: H. L. CURTIS, F. D. ROSSINI, H. S. RAPPLEYE, N. R. SMITH, R. J. SEEGER, J. E. GRAF, F. G. BRICKWEDDE, F. C. KRACEK, A. WETMORE, J. E. MCMURTREY, JR., W. A. DAYTON, W. RAMBERG, E. W. PRICE, L. W. PARR, C. L. GARNER, H. G. DORSEY, and by invitation G. A. COOPER, A. SEIDELL, and L. V. JUDSON.

The minutes of the 379th meeting were read and approved.

President CURTIS announced appointment of the following committee to obtain more subscriptions of the JOURNAL from Government bureaus: F. G. BRICKWEDDE (chairman), W. W. DIEHL, and F. H. H. ROBERTS, JR.

For the Committee on Membership, Chairman KRACEK presented nominations of 12 persons (11 resident and 1 nonresident).

The Committees on Awards for Scientific Achievement for 1942, ALEXANDER WETMORE, general chairman and chairman of the Committee for the Biological Sciences, H. N. EATON, chairman of the Committee for the Engineering Sciences, and L. V. JUDSON, chairman of the Committee for the Physical Sciences, presented the names of three candidates for the awards, which were approved by the Board for announcement at the annual meeting of the academy.

The Secretary reported three deaths, three resignations, and three retirements.

The Board authorized the President to appoint a Committee on the A.A.A.S. Research Grant for 1943, which will amount to \$150 for the Academy.

The meeting adjourned at 9:27 P.M.

FREDERICK D. ROSSINI, *Secretary*.

## Obituaries

The death on July 13, 1942, of HENRY GRANGER KNIGHT, chief of the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, marked the passing of one of the most notable and interesting figures among American agricultural chemists. His 16 years as director of three widely separated State experiment stations and his 15 years as chief of a Federal bureau gave him an administrative experience in agricultural chemistry that has few parallels in the history of American science.

Knight was born on July 21, 1878, at Bennington, Kans., on a prairie farm, from which his parents moved a few years later to Port Townsend on Puget Sound. He entered Wash-

ington State University at Seattle where he earned his way by various activities. After obtaining his A.B. degree at Washington in 1902, he spent one year as student and assistant in chemistry at Chicago University, and then returned to Washington as Assistant Professor of Chemistry.

In 1904 Knight accepted the double appointment of professor of chemistry and State chemist at the University of Wyoming, the duties of which he resigned in 1910 to accept the directorship of the Wyoming Agricultural Experiment Station. His administrative duties were further increased in 1911, when he was appointed dean of the Wyoming College of Agriculture. While at Wyoming Knight published

four bulletins on the chemical composition of Wyoming forage plants; he wrote bulletins also on the death camass and woody aster, plants poisonous to livestock. In 1916-17 he did postgraduate work at the University of Illinois for which he obtained his Ph.D. degree for a thesis on acidity and acidimetry of soils. In 1918 Knight resigned his position in Wyoming to accept the directorship of the Oklahoma Experiment Station and the deanship of its school of agriculture. Political disturbances caused him to resign this position in 1921. After a year's postgraduate study at Cornell University as honorary fellow, Knight accepted a call to the University of West Virginia as director of its experiment station and in 1926 as dean of its school of agriculture.

In 1927, when the U. S. Bureau of Soils and the Fixed Nitrogen Laboratory were merged with the research work of the Bureau of Chemistry, direction of the newly constituted Bureau of Chemistry and Soils was awarded to Dr. Knight, who had the courage to accept what lack of homogeneity had caused others to decline. Although he strove valiantly toward welding a discordant collection of activities into a unified bureau, the task was an impossible one, the result being transfer of the soils, fertilizer, and insecticides work to other bureaus. These losses, although discouraging, were more than counterbalanced by Knight's acquiring direction of four new regional research laboratories. It was while giving his last depleted resources of mind and body to organizing these laboratories for the needs of war that Henry G. Knight paid the inevitable price.

Dr. Knight preferred to be recognized more as an organizer and administrator of research than as an actual contributor to science. His extensive experience as a director of State experiment stations helped greatly toward establishing more cordial relations between these institutions and the Federal Department of Agriculture. The extent of his influence within the Department of Agriculture is indicated by his membership in 12 intradepartmental committees. From 1930 to 1942 he served as chairman of the Editorial Committee for the *Journal of Agricultural Research*. He was president of the American Institute of Chemists in 1933-35, and in May 1941 received from Vice-President Wallace the Institute's gold medal

for outstanding accomplishments in agricultural chemistry. Temperamentally he was a man of jovial disposition who will long be held in affectionate remembrance by a host of friends.

C. A. BROWNE.

THOMAS LEONARD WALKER, who died on August 6, 1942, was born near Brampton, Ontario, on December 30, 1867, of English parentage. His father, William Walker, was a native of Whitby, England, while his mother, Hannah Sanderson Walker, came from Scarborough, England. He attended schools in both Brampton and Orangeville, Ontario, and then entered Queen's University, Kingston, from which he received the silver medal in chemistry and the degree of master of arts in 1890, and at a later period the Gowan Prize in botany.

For a short time after his graduation from Queen's University he was employed as chemist at the Murray Mine, and for two years was laboratory demonstrator in the Faculty of Mines, Queen's University. He was awarded one of the first 1851 Exhibition Scholarships and continued his studies under Prof. F. Zirkel in the University of Leipzig, where, in 1896, he was awarded the degree doctor of philosophy. At a later time he also continued his studies in crystallography in the University of Heidelberg with Prof. Victor Goldschmidt.

In 1897 Dr. Walker was appointed assistant superintendent of the Geological Survey of India. While in India he made a scientific expedition across the high passes of the Himalayas into Tibet, making incidentally a collection of Himalayan mosses, many of which were new to science.

In 1901 he returned to Canada to become professor of mineralogy and petrography in the University of Toronto, a position that he held until his retirement in 1937. In 1913 the Royal Ontario Museum of Mineralogy, Toronto, appointed him its first director. Through the years Dr. Walker worked indefatigably for the Museum. By collecting, judicious purchase, and exchange he built up a Museum of Mineralogy that ranks among the best seven in the world.

Dr. Walker was one of the founders and the first vice-president of the Mineralogical Society of America, in 1920, and president in 1922. He was a fellow of the Geological Society of

America (1903) and vice-president (1922 and 1931). He was made an honorary member of the Mineralogical Society of Great Britain and Ireland in 1937 after being an ordinary member since 1913. He was a fellow of the Royal Society of Canada (1919) and president of Section IV (Geological Sciences) 1927-28; a fellow of the Geological Society of London; fellow of the Royal Geological Society of Cornwall; member of the Canadian Institute of Mining and Metallurgy; and a member of this Society. For many years he was a member of the committee on the measurement of geologic time in the National Research Council (United States).

He was an indefatigable worker and accomplished much that was worth while. His thesis for the doctorate started an intensive study of the conditions governing the deposition of the nickel-copper ores of the Sudbury basin. His reports on the tungsten and molybdenum ores of Canada called attention to materials that have become of great importance. He was one of the pioneers in the use of the 2-circle goniometer on this continent and wrote his Crystallography to make this method more readily available in the English language.

The mineral temiskamite, almost simultaneously described under the name maucherite, which was described by him, was the cause of much dispute as to its true composition. The latest examination by means of X-rays agrees within reasonable limits with the composition as given by Walker, although the name maucherite is preserved as having priority in publication. Other minerals that were described by him are spencerite, chapmanite, schoepite, enelectrite, and, in collaboration with the writer, ellsworthite.

In view of the limited facilities for publishing in English articles dealing with mineralogy and petrography Dr. Walker started the series of "Contributions to Canadian Mineralogy from the Department of Mineralogy and Petrography in the University of Toronto" in 1921. This publication has appeared annually since that time, except for the year 1936, when he was stricken with his fatal illness. It was then deferred until the next year when a double number was issued.

Special recognition was given to the accomplishments of Dr. Walker in 1938 when the University of Toronto granted him the degree doctor of science (*honoris causa*), and in 1941 the Royal Society of Canada conferred him further honor by the bestowal of the Flavelle Medal for his important contributions to mineralogical science.

He traveled widely and was a member of nearly every International Geological Congress during his academic career, and on each occasion he brought home material to enrich the collections of the University and of the Royal Ontario Museum of Mineralogy.

Dr. Walker will be remembered because of the men he trained. He will also be long remembered as the builder of a great mineral museum. To these great objectives he devoted his life, and his accomplishments were of no mean order.

In 1906 Dr. Walker married Mary Augusta Woods, daughter of the late Sir James Woods, of Toronto. He is survived by his wife and also by two sons, James Woods Walker and William P. Walker, and one daughter, Euphemia B. Walker.

A. L. PARSONS.



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OF THE

# WASHINGTON ACADEMY OF SCIENCES

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# JOURNAL

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TOXICOLOGY.—*Toxicity of some dinitrophenols to the American dog tick, Dermacentor variabilis (Say).*<sup>1</sup> OSCAR E. TAUBER, ANNE HÄGER TAUBER,<sup>2</sup> CHARLES R. JOYCE,<sup>2</sup> and WILLIS N. BRUCE. (Communicated by CARL J. DRAKE.)

Pastac (11) indicates, without reference or date, that the first notice of the value of a nitro dye as an insecticide came through the observation that clothes moths did not molest wool dyed with martius yellow (dinitronaphthol). In the past 30 years a considerable number of laboratory and field tests with many dinitrophenols have been conducted on a number of different insects (3, 7, 8, 8a, 9, 9a, 10, 11, 12, 13, 14, 15). Some of these same dinitro compounds have been recommended as weedkillers, fungicides, etc. (2, 6, 11, 17). No records of the effects of any dinitrophenols on ticks have been found.

Ticks are particularly concerned in the transmission of relapsing fever and typhus-like diseases. Recently (1942) Anigstein and Bader (1) reported evidence suggesting *Amblyomma americanum* as an additional carrier of Rocky Mountain spotted fever. At this writing, when military training and actual warfare bring many thousands of men into possible contact with various potentially dangerous Ixodidae, any suggestions that may contribute to methods for extermination of ticks should prove timely.

Ticks are very tenacious of life. Past at-

tempts at control and eradication have involved such laborious procedures as mechanical removal by handpicking or entanglement in sheep wool; dipping domestic animals; cutting or burning tick infested brush; or by trapping, poisoning, or shooting of hosts other than man and domestic animals. Since these hosts sometimes also include such active forms as bats and birds, the last three of the enumerated methods of eradication are hardly possible or efficient. Also, elimination of rodents or other wild hosts over a large area is likely to upset some biologic balance and initiate new problems of another nature.

The experiments to be described were begun as preliminary ground-work for contemplated field trials to kill ticks in selected areas by dusting vegetation in which they are concentrated. Such dustings might reach the ticks directly as they rested on the vegetation or crawled on the ground. It might reach them when their wild hosts, such as mammals and ground-feeding birds, moved through the dusted herbage and brushed and shook the toxic material on themselves and their parasites. So far as we can determine, this proposed approach is a new attack on the tick problem.

Should this dusting of vegetation prove of value in killing ticks, such a technique might be useful in reducing populations of mosquitoes, chiggers, certain flies, and other forms that rest on herbage, or wait for victims while hanging on grass, shrubs, or other plants. The method might conceivably be the answer to ridding jungle trails of blood-sucking land leeches, which are a real

<sup>1</sup> Received February 10, 1943. Journal Paper No. J-1091 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 372.

<sup>2</sup> Funds for employment provided by Iowa State Department of Health of Des Moines, Iowa, and Industrial Science Research Institute of Iowa State College. The authors are indebted to Dr. Carl F. Jordan, director of the Division of Preventable Diseases, Department of Health, State of Iowa; and Drs. C. J. Drake and C. H. Richardson, of Iowa State College, for suggestions and criticisms.

menace to travelers and soldiers in Indo-China, Malaya, and other areas of that region where rainfall is especially abundant. "Blanket" dusting of refuse piles and dumps may also serve to bring the toxic dusts to fleas and lice carried by rats.

With these and other ideas of control in mind, preliminary tests on fleas and other pests have been inaugurated to ascertain killing doses before field work is begun. These latter results will be published in subsequent papers.

#### CHEMICALS

Whenever possible, toxic compounds were obtained as pure chemicals and diluted as desired in the laboratory. To insure thorough dispersal, weighed ingredients were first mixed by spatula on a glass plate, then shaken in a large jar, and last placed on a home-made "roller-ball-mill" by which a cylinder, containing the mixture and pebbles or glass marbles, was rolled over and over for several hours (see Fig. 1). Among the more promising toxic materials were dinitro-ortho-cresol (DN-o-C), supplied by Standard Agricultural Chemicals, Inc.; dinitro-ortho-cyclohexyl-phenol from Dow Chemical Co.; and ammonium-dinitro-ortho-cresylate and guanidine dinitro-ortho-cresylate from American Cyanamid & Chemical Corporation. Diluents included 320 mesh sulphur from Stauffer Chemical Co.; "Pyrophyllite" from E. I. du Pont de Nemours & Co.; and "Pyrite" from Dow. Other compounds, such as sodium arsenite, were pure chemicals available from laboratory stock.

The outstanding toxicity of 3,5-dinitro-ortho-cresol, as demonstrated by Decker and Drake (3), when compared with 24 other dinitro compounds, was the incentive for using the DN-o-C as the main toxic agent when these investigations were begun. Preliminary tests with other compounds were inserted in the program as the chemicals became available from the manufacturers.

There is some disagreement regarding the correct naming of the dinitro-ortho-cresol. Insect toxicologists generally refer to it as the 3,5-compound, but Filbert (5), of du Pont de Nemours & Co., states that 4,6-

dinitro-o-cresol is the correct numbering as approved both by Chemical Abstracts and Beilstein.

#### EXPERIMENTAL ANIMALS

*Dermacentor variabilis* (Say) is a widely distributed American dog tick. It is implicated in transmission and dispersal of Rocky Mountain spotted fever. The number of infested specimens usually runs from 1 in 200 to 1 in 600 (16). In certain areas of Iowa it has sometimes been numerous enough (4) to be a potentially dangerous carrier of spotted fever to human beings.

Adult specimens of *D. variabilis* were collected by hand from dogs, or by "flagging" in those localities of Iowa where ticks of this species were known to be numerous. Ticks thus obtained were kept over moist sand in cotton-stoppered vials. These collections included ticks of all ages within their adult life span. Also, individuals ranged through all stages of nutrition, including full engorgement, interrupted feeding, and starvation. In some cases the period of starvation may have been for more than a year. In addition, the collections sometimes included spent females, or gravid females that began to oviposit while under observation as control or experimental subjects. In short, these adult ticks were of wild stock and possessed both the good and bad characteristics of an heterogeneous population.

Larval ticks were hatched from eggs deposited in the laboratory by females taken in the field. Larvae of a known age were thus available for tests. Other larvae were allowed to feed on white-footed mice, *Peromyscus leucopus noveboracensis* (Fischer), and, after transformation to nymphs, established a source of nymphs of known age.

Egg masses were collected in the laboratory, and tests were made of some of the dinitrophenols as tick ovicides.

#### METHODS

Not the least of the problems this investigation involved was that of devising some technique of bringing the ticks and the compounds together in a simple procedure that could be easily and reasonably duplicated. After various trials, the following set-up

and technique were employed for adult ticks: A circular opening, 6 inches in diameter, was cut in a piece of cardboard resting on a sheet of paper toweling. A 2-inch disk of cardboard was placed in the center of the 6-inch opening. Over the opening was placed a dusting tower consisting of a tall bell jar with an opening near the bottom, through which a dusting nozzle could be inserted (see Fig. 1). Known weights of dust were pumped into the tower while the nozzle was shifted about, inside the apparatus, to insure as even a distribution of dust as possible. After the dust settled, the tower was lifted away, and the entire cardboard pattern was removed. A 2-inch circular band of dust was thus formed on the toweling. Ticks to be tested were placed in the central dust-free area, and then recaptured outside the dust ring after voluntarily walking across it to the outer dust-free area.

With nymphal ticks, the band of dust was reduced to 1 inch by merely using a 4-inch disk to make the inner dust-free surface. Younger larval ticks were so small and "bogged down" so easily in the dust ring that a further modification was necessary. For all larvae, therefore, the following uniform procedure was used. A small nontoxic dust ring of pyrophyllite was first set up. The test larvae were set free inside this ring. The dust tower was then set in place and the dust blown in. When the tower was removed the dusted larvae were picked up and then confined to vials.

Adult ticks and larger nymphs were easily handled with tweezers. Larval ticks were moved about on the pointed tip of a moistened brush.

After treatment, adult and nymphal ticks were confined separately in small vials and examined at regular, convenient intervals. Death of the specimen was recorded when no movement whatsoever was elicited even in the close approach to warmth from a light bulb. Larval ticks were usually kept in groups of 5 or 10 individuals to the vial.

All untreated controls were kept in the same type of container and under the same conditions as the treated ticks.

Actual determinations of the weight of dust distributed in the ring under the dust tower gave a quantity equivalent to about

65 to 75 pounds an acre for the adult and nymph treatments. For larvae, the quantity was about 20 to 25 pounds an acre.

#### RESULTS AND DISCUSSION

All results presented throughout this paper represent data collected under controlled laboratory conditions. Under no circumstances are they to be construed as results to be expected with field trials. It was the intention to carry on field opera-



Fig. 1.—In the background is the tall bell jar used as a dusting tower. A charge of dust is suspended in its interior. In the foreground is the mixing-mill used to roll the dust mixtures.

tions during 1942, but by the time these preliminary laboratory tests were completed, the season suitable for outdoor tests was too far advanced. Since these present results may be of value to other workers who could make field runs before we can in the summer of 1943, our data are presented now. In any event, field trials will be conducted in Iowa in 1943 if the necessary equipment and labor can be assembled.

Although test specimens were often kept under observation for a week or more, and controls were checked for several weeks at least, only the 24- and 48-hour mortality percentages are presented here. From the standpoint of toxicological interest, the 24- and 48-hour results are probably of most significance. Beyond 48 hours other factors than the exposure to the test dust are likely to come into play. Also, if a tick is a vector of a disease, the faster it is eliminated the better, if no other complications are involved.

### Adult Dog Ticks

One of the first facts that became clearly evident in the results was the difference in resistance to DN-o-C between unfed and engorged adult ticks. This characteristic is demonstrated in the sample of data presented in Table 1.

TABLE 1.—MORTALITY OF UNFED AND ENGORGED ADULT DOG TICKS (*Dermacentor variabilis*) AFTER CONTACT WITH DINITRO-O-CRESOL DILUTED WITH PYROPHYLLITE

Nutritional state	DN-o-C	Number tested	Dead at 24 hours	Dead at 48 hours
	<i>Percent</i>		<i>Percent</i> <sup>1</sup>	<i>Percent</i> <sup>1</sup>
Unfed.....	2	20	35	35
Unfed.....	4	20	40	45
Unfed.....	8	50	64	68
Unfed.....	12	50	72	88
Engorged....	8	50	36	36
Engorged....	12	50	45	45

<sup>1</sup> Throughout this entire paper, percent of mortality is expressed in the nearest whole number.

Additional evidence that the nutritional state of these ticks is an important consideration was demonstrated in the summary of mortality of specimens of this species kept as controls under laboratory conditions. This summary is given in Table 2.

TABLE 2.—MORTALITY OF ADULT CONTROL SPECIMENS OF *Dermacentor variabilis*

Nutritional state	Number observed	Dead at 24 hours	Dead at 48 hours
		<i>Percent</i>	<i>Percent</i>
Unfed.....	180	11	17
Engorged.....	65	3	4

The high mortality of the unfed individuals is rather striking, and no explanation can be offered. Unfavorable humidity is probably a factor under laboratory conditions, even though some efforts were made to keep the test ticks from dehydration. So little is known regarding certain limiting ecological factors in the tick's life history that some of our colony-maintenance procedures were probably faulty. Under the pressure of present conditions, however, it was decided not to take time to explore these rearing problems, but to proceed to the more important toxicological aspects.

In regard to the high mortality, difference in the nutritional conditions is naturally the

first suggested clue, but more complicated relationships may be involved. No attempt was made to check the life span of individuals under field conditions, but there is no reason to assume that such a high mortality among adults is a natural one. When one considers, also, that most unfed ticks were collected by the "flagging" method, which entails only slight chances of injury, while the engorged specimens were often dislodged with considerable difficulty from the skin of their hosts, the difference in mortality of the two types is even less easily explained. Nevertheless, in spite of the high death rate of unfed controls, the data of Table 1 show a good gradient of effect through the use of increased strengths of the dinitro-ortho-cresol.

Just what parts body surface and body volume, considered separately or together, might have in effecting the difference in mortality of unfed and engorged ticks is also unknown. Engorged ticks generally picked up considerably more of the chemical while walking through the band of dust. However, this factor of actual greater contact by swollen engorged ticks apparently was not sufficient to counteract the relatively larger amount of dust which the unfed ticks acquired. The ratio of body surface to body volume would, of course, be higher in the unfed ticks. The smaller, unengorged specimens could thus acquire a higher internal concentration of the absorbed poison, even though the actual contact was less.

TABLE 3.—MORTALITY OF UNFED AND ENGORGED ADULT DOG TICKS AFTER CONTACT WITH SULPHUR-DILUTED DINITRO-ORTHO-CRESOL

Nutritional state	DN-o-C	Number tested	Dead at 24 hours	Dead at 48 hours
	<i>Percent</i>		<i>Percent</i>	<i>Percent</i>
Unfed.....	4	100	57	65
Unfed.....	8	50	73	77
Unfed.....	12	50	60	68
Unfed.....	20	135	91	94
Unfed.....	25	110	87	98
Engorged....	4	25	16	28
Engorged....	8	50	42	60
Engorged....	12	25	47	80
Engorged....	25	70	51	96

When ordinary 320-mesh dusting sulphur was substituted for pyrophyllite as a diluent for the dinitro-ortho-cresol, a rather well-

marked general trend of increased toxicity was often noted, especially in the lower concentrations of DN-o-C. These data are given in Table 3 (compare with Table 1).

Tests with 100 per cent, 320-mesh sulphur in the 2-inch circular band of dust served to emphasize again the difference in susceptibility of unfed and engorged ticks. This information is found in Table 4.

TABLE 4.—TOXICITY OF 100 PERCENT SULPHUR (320 MESH) TO THE ADULT DOG TICK

Nutritional state	Number tested	Dead at 24 hours	Dead at 48 hours
Unfed.....	120	Percent 19	Percent 27
Engorged.....	25	3	3

Weather conditions at, and transportation difficulties to, the usual sites of collections sometimes made it impossible to obtain, at the right time, as large samples as were desired for tests. With larger numbers of individuals, the discrepancy in the 8 per cent and 12 per cent trials with unfed specimens of Table 3 might be eliminated. The small sample and the heterogeneous character of the field-collected ticks may also account for the lower mortality among the few engorged ticks tested with 100 per cent sulphur than among the larger sample of control ticks in Table 2. Comparison of per cent mortalities in Tables 1 and 3 shows, however, that the use of sulphur as a diluent is a valuable procedure, especially with unfed ticks. Similar trials with 100 per cent pyrophyllite showed no mortality percentage above that found for the controls.

No attempt was made to set up experiments to test for synergistic action in the sulphur and dinitro-ortho-cresol mixtures. Such tests are planned when next season's ticks become available.

Just before the 1942 tests had to be terminated because of increased seasonal difficulties in obtaining ticks, several other compounds were received from manufacturers, and preliminary tests were run with the few ticks then available. One of these chemicals, the ammonium dinitro-ortho-cresylate, has shown excellent promise with certain insects (8a) and other near relatives of ticks. Results from these compounds are in

Table 5. Also included in this table are data from the use of sodium arsenite at 4 per cent and 100 per cent levels. These arsenite tests were included merely as reference and comparison points with a more familiar toxic dusting compound.

TABLE 5.—PRELIMINARY RESULTS WITH MISCELLANEOUS COMPOUNDS USED AS DUSTS ON UNFED ADULT DOG TICKS

Compound	Per cent	Diluent	Number tested	Dead at 24 hours	Dead at 48 hours
NaAs <sub>2</sub> O <sub>3</sub> ...	4	Pyrophyllite	25	Percent 8	Percent 20
NaAs <sub>2</sub> O <sub>3</sub> ...	100	—	25	64	92
Guanidine dinitro-ortho-cresylate.	12	Sulphur	30	0	23
Ammonium dinitro-ortho-cresylate.	12	Sulphur	30	87	94

Tables 1, 3, and 5 offer the opportunity to compare the toxicity of several of the compounds tested on unfed dog ticks. At the 12 per cent level, the ammonium dinitro-ortho-cresylate seems the most toxic of the tested materials. At the 4 per cent levels, the sodium arsenite has about half the mortality per cent of dinitro-ortho-cresol; and, when the latter was combined with sulphur, a 25 per cent concentration had approximately the same toxicity for unfed specimens as 100 per cent sodium arsenite. Guanidine dinitro-ortho-cresylate was the least toxic of the chemicals tried on adult dog ticks.

TABLE 6.—MORTALITY OF NYMPHAL DOG TICKS AFTER CONTACT WITH VARIOUS DN-COMPOUNDS DILUTED WITH SULPHUR

Age	Compound	Per cent	Number tested	Dead at 24 hours	Dead at 48 hours
5 days...	DN-o-C	8	30	Percent 50	Percent 57
5 days...	DN-o-C	12	35	63	66
5 days...	DN-o-C	16	50	74	96
2 weeks..	DN-o-C	8	50	62	72
2 weeks..	DN-o-C	12	50	96	98
2 weeks..	DN-o-C	16	30	100	—
3 weeks..	DN-o-C	8	30	97	97
3 weeks..	DN-o-C	12	75	98	98
3 weeks..	DN-o-C	16	50	100	—
3 weeks..	Guanidine-DN-o-cresylate. ....	12	30	33	60
3 weeks..	Ammonium-DN-o-cresylate	12	80	100 (in 3½ hrs.)	—

*Nymphal Dog Ticks*

As stated previously, some larval ticks were allowed to feed in the laboratory on caged wild white-footed mice, and then used after transformation to the nymphal stage. All the data secured from tests on nymphs are set up in Table 6.

Several series of untreated, control nymphs were set up at the same time. Their data appear in Table 7.

TABLE 7.—MORTALITY OF UNTREATED NYMPHAL DOG TICKS

Age	Number observed	Dead at	Dead at
		24 hours	48 hours
		Percent	Percent
5 days . . . . .	30	0	0
2 weeks . . . . .	50	4	22
3 weeks . . . . .	30	13	28

One of the first facts apparent from Tables 6 and 7 is the decreased vigor of the nymphs as they become older. This point is demonstrated not only in the increased mortality of the controls, but also in the greater susceptibility to treatment with poisons. Table 6 also shows a regular progressive build-up in toxicity as the percentage of dinitro-o-cresol is increased. All nymphs were laboratory reared and were thus a stock of more nearly homogeneous

test animals whose history was better known than that of the field-collected adults. Consequently, discrepancies in resultant data are not so likely to occur because of differences in age, nutrition, and other factors.

In addition, Table 6 makes it clear that of the two tested cresylates the guanidine compound is decidedly inferior to the ammonium dinitro-o-cresylate, and the latter is superior to the dinitro-o-cresol. While the 12 per cent dinitro-o-cresol attained 98 per cent mortality in 48 hours, the 12 per cent ammonium dinitro-o-cresylate brought about 100 per cent mortality in only three and a half hours.

*Larval Dog Ticks*

A large supply of larval ticks made it possible to make runs through a longer series of concentrations at various ages of the test species. Trials were run at the following ages: 5 days, 2 weeks, 3 weeks, and 4 weeks. The first three ages were tested only with dinitro-o-cresol diluted with pyrophyllite. The 4-weeks larvae were tested after it was found that sulphur made a better diluent than pyrophyllite, and, unfortunately, it was not then possible to repeat the previous tests on younger larvae, using sulphur. Also, when the 4-weeks larvae were available, certain other chemicals were received and these were also tried. And, again, to our regret, it was not possible, last season, to use these latter compounds on other stages of ticks. Their data, however, are included as a matter of record of preliminary trials. Results on larval ticks will be found in the next two tables; a dash (—) in the body of the tables indicates that no check count for mortality was made at that particular time interval.

Contrary to the situation in nymphs, which seem to be less hardy with increasing age, Tables 8 and 9 show that larval ticks become more resistant as they get older. For example, at the 2 per cent level of dinitro-o-cresol the youngest larvae (5 days old) were all dead within 20 minutes; the 2-weeks specimens were all dead at 24 hours; and the three-weeks larvae had a mortality of 77 per cent at 48 hours. At 4 weeks of age, resistance increased to the point where 8 per

TABLE 8.—MORTALITY OF 5-DAYS, 2-WEEKS AND 3-WEEKS OLD LARVAL DOG TICKS AFTER DUSTING WITH DINITRO-ORTHO-CRESOL DILUTED WITH PYROPHYLLITE

Age	Concentration of DN-o-C	Number tested	Dead at						
			1 hour	3 hours	6 hours	18 hours	24 hours	48 hours	
			Percent	Percent	Percent	Percent	Percent	Percent	
5 days . . . . .	0.063	30	33	87	100				
5 days . . . . .	0.125	30	37	100					
5 days . . . . .	0.25	30	100						
5 days . . . . .	0.5	30	100 <sup>1</sup>						
5 days . . . . .	1.0	30	100 <sup>1</sup>						
5 days . . . . .	2.0	30	100 <sup>2</sup>						
2 weeks . . . . .	0.063	30	—	—	—	0	0		
2 weeks . . . . .	0.125	30	—	7	—	23	33		
2 weeks . . . . .	0.25	30	—	33	—	67	80		
2 weeks . . . . .	0.5	30	—	40	—	72	88		
2 weeks . . . . .	1.0	30	—	63	70	80	90		
2 weeks . . . . .	2.0	30	76	—	93	—	100		
3 weeks . . . . .	0.5	30	—	13	33	37	37		
3 weeks . . . . .	1.0	30	47	—	67	70	73		
3 weeks . . . . .	2.0	30	57	—	70	73	77		
3 weeks . . . . .	4.0	30	100						

<sup>1</sup> In 55 minutes.  
<sup>2</sup> In 20 minutes.

TABLE 9.—MORTALITY OF 4-WEEKS OLD LARVAL DOG TICKS AFTER DUSTING WITH VARIOUS COMPOUNDS

Compound	Concentration	Diluent	Number tested	Dead at					
				1 hour	3 hours	6 hours	12 hours	24 hours	48 hours
				Percent	Percent	Percent	Percent	Percent	Percent
DN-o-cresol . . . . .	4	Sulphur	30	3	—	6	30	50	63
DN-o-cresol . . . . .	8	Sulphur	30	10	67	90	—	100	
DN-o-cresol . . . . .	12	Sulphur	30	13	97	100 <sup>1</sup>			
DN-o-cresol . . . . .	8	Pyrophyllite	30	80	100 <sup>2</sup>				
DN-o-cresol . . . . .	12	Pyrophyllite	30	97	100 <sup>3</sup>				
DN-o-2nd butylphenol . . . . .	8	Pyrophyllite	30	97	100 <sup>4</sup>				
DN-o-cyclo-hexylphenol . . . . .	8	Pyrophyllite	30	67	80	100 <sup>5</sup>			
Dicyclohexyl-amine salt of DN-o-cyclo-hexylphenol	20	Pyrophyllite	30	3	20	—	57	100	
Dinitroso-resorcinol . . . . .	100	—	30	3	6	—	100		
Tetrachlorophenol . . . . .	100	—	30	33	100				
Pentachlorophenol . . . . .	100	—	30	0	77	—	100		
Hexachlorophenol . . . . .	100	—	30	6	57	—	100		
Sodium arsenite . . . . .	4	Pyrophyllite	30	—	10	—	17	17	27
Sodium arsenite . . . . .	100	—	30	73	87	100			

<sup>1</sup> In 5½ hours.<sup>2</sup> In 2½ hours.<sup>3</sup> In 1½ hours.<sup>4</sup> In 4½ hours.<sup>5</sup> In 8½ hours.

cent dinitro-o-cresol was necessary to give 100 per cent kill in 2½ hours; and with 12 per cent, 100 per cent mortality in 1½ hours.

Of the four other dinitrophenols listed in Table 9, two (the secondary butylphenol and the cyclo-hexylphenol) give promise of being as toxic as the dinitro-ortho-cresol, all tested at the 8 per cent level. The other two compounds (the amine salt and the resorcinol) were tested at much higher concentrations (20 per cent and 100 per cent, respectively) and showed no more toxicity for larval ticks than the 8 per cent DN-o-C.

All three of the -chlorophenols were tried without dilution, and, even at 100 per cent concentration, they were no more effective than DN-o-C in the range of 8 per cent and 12 per cent levels.

Two widely separated concentrations (4 per cent and 100 per cent) of sodium arsenite were tested on 4-weeks larvae, and just as in the case of unfed adult ticks (see Table 5), were considerably less effective than comparable percentages of dinitro-ortho-cresol.

The pronounced fragility of the young larval ticks is re-emphasized by the mortality data of controls, shown in Table 10. In this case, the high death rate of young larval ticks is probably a reflection of what occurs in nature also. When one compares

TABLE 10.—MORTALITY OF UNTREATED CONTROL LARVAL TICKS

Age	Number observed	Dead at	
		24 hours	48 hours
		Percent	Percent
5 days . . . . .	50	13	27
2 weeks . . . . .	50	0	0
3 weeks . . . . .	50	0	0
4 weeks . . . . .	50	0	0

the large number of eggs, which each female tick produces, with the smaller number of ticks which reach maturity, it is evident that there must be some phase of post-hatching development during which survival is difficult. Toxic dust treatments may be able to utilize the lethal possibilities of this critical period.

#### Dog Tick Eggs

Two experiments were set up to test DN-o-C as a tick ovicide.

In the first test 15 clumps of eggs were placed under a bell jar and dusted with 12 per cent DN-o-C at the rate of about 50 pounds/acre. There was no noticeable decrease in hatching, after the usual incubation period.

In the second test 10 clumps of eggs were dusted in the same manner but with 25 per cent DN-o-C. After a sufficient incubation

period elapsed, the clumps were examined. There was an obvious reduction in the number of eggs that hatched, in comparison with undusted control clumps kept under the same laboratory conditions. Eggs at the bottom of the dusted clumps, those eggs not directly in contact with the 25 per cent DN-o-C, were the only ones which produced young ticks. Those dusted eggs on top and at the sides evidently were killed.

If these two rough tests are of any significance, they indicate a considerable resistance to toxic substances by tick eggs. In both of the above tests the dusts remained in contact with the eggs throughout the entire incubation time. Dusts applied under field conditions would probably not remain so closely applied during approximately three weeks of weathering. Attempts at eradication or decrease of ticks by dusting the eggs would probably not be practicable. It appears that the egg stage is not the tick's most vulnerable period.

#### CONCLUSIONS

On the basis of laboratory tests alone, the following statements are presented.

1. Unfed and engorged adult specimens of the American dog tick, *Dermacentor variabilis*, possess a decided difference in susceptibility to contact with dinitro-ortho-cresol and other dinitrophenols. For example, 12 per cent DN-o-C, with pyrophyllite as a diluent, applied at the rate of 65 to 75 pounds to the acre, has a 48-hour mortality of 88 per cent with unfed adults; and 45 per cent with engorged adults.

2. The use of 320-mesh dusting sulphur as a diluent, in combination with DN-o-C, makes a more toxic mixture against ticks than that obtained with pyrophyllite as the diluent. With 8 per cent DN-o-C, at 48 hours, the per cent of mortality for unfed adults is 68 per cent with pyrophyllite; 77 per cent with sulphur. For engorged adults, with 8 per cent DN-o-C, the per cent dead is 36 with pyrophyllite and 60 with sulphur.

3. Sulphur alone has some toxicity for unfed adult dog ticks. Applied at the rate of 65 to 75 pounds an acre, 100 per cent sulphur killed 19 per cent unfed ticks in 24 hours. It had no effect on the particular

sample of 25 engorged specimens tested in the same manner.

4. Even in combination with sulphur, and at 65 to 75 pounds an acre, DN-o-C mixtures must contain at least 25 per cent of the DN compound to produce a kill over 95 per cent within 48 hours. The adult dog tick is tenacious of life.

5. Ammonium dinitro-o-cresylate gives promise of higher toxicity than DN-o-C. In preliminary tests, a 12 per cent concentration with sulphur is nearly equal in toxicity to 25 per cent DN-o-C when applied in identical dosages.

6. Undiluted sodium arsenite is slightly less toxic to unfed adult dog ticks than DN-o-C diluted at 25 per cent with sulphur, when applied in identical dosages, with identical technique.

7. Guanidine dinitro-ortho-cresylate does not show much promise as a tickicide.

8. Nymphal dog ticks decrease in vigor as they age during the nymphal stage. This is shown both by increased mortalities among untreated controls, and by greater susceptibility to dusting with DN compounds.

9. At 65 to 75 pounds an acre, a sulphur and DN-o-C mixture must contain at least 16 per cent of the cresol to kill more than 95 per cent of the younger (5 days old) nymphs within 48 hours. A 12 per cent DN-o-C will kill more than 95 per cent of 2 to 3 weeks old nymphs within 24 hours; 16 per cent kills 100 per cent in less than 24 hours.

10. With nymphal ticks ammonium DN-o-cresylate again shows superior toxicity; 12 per cent in sulphur kills 100 per cent of 3-weeks nymphs in 3½ hours.

11. Larval dog ticks become more hardy with age. For example, when treated with 2 per cent DN-o-C, 5 days old larvae were all dead in 20 minutes; the 2-weeks specimens were all dead at 24 hours; and 3-weeks larvae had a mortality of 77 per cent at 48 hours. At 4 weeks of age the DN-o-C concentration had to go to 8 per cent to kill 100 per cent in 24 hours.

12. When tested with 4-weeks old larval ticks, dinitro-o-secondary butylphenol and DN-o-cyclohexylphenol appear nearly as toxic as DN-o-C. The dicyclohexylamine

salt of DN-o-cyclohexylphenol is decidedly less toxic than DN-o-C.

13. Dinitrosoresorcinol, and the tetra-, penta-, and hexa-chlorophenols seem to have little value as tick larvicides.

14. Dog-tick eggs are quite resistant to poisoning by DN-o-C. When dusted with 12 per cent DN-o-C, no noticeable reduction in hatching occurred. Dusting with 25 per cent DN-o-C killed those eggs with which it came into direct contact, and on which it stayed during the entire incubation period.

15. With the above results in mind it seems an inevitable conclusion that field control of the American dog tick probably will be a difficult, but not impossible, problem if attacked with DN-o-C or  $\text{NH}_4$ -DN-o-cresylate. There seems to be no particularly vulnerable spot during its life history. It is most easily killed during early larval life, but that susceptibility does not help much, for practical purposes, since hatching occurs over a long period during warm weather. Only repeated dusting over several months could take advantage of this weakness.

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ENTOMOLOGY.—*Synoptic revision of the testaceipennis group of the beetle genus Phyllophaga.*<sup>1</sup> LAWRENCE W. SAYLOR.

The specific name *testaceipennis* (Blanchard) has long been applied to various species of *Phyllophaga* resembling the true *testaceipennis*, all moderate-sized, semipruinose species with a foveate fifth sternite and *Phytalus*-like cleft claws (which are minutely denticulate beneath) having been combined under this name. The present paper attempts to clarify the taxonomy of this complex. Drawings of the genitalia of the species involved are here presented for the first time.

Six names have been proposed for species known to me that belong in the group, and of these two are here considered as synonyms. Two species are described as new, so that the group, as treated in this paper, comprises six valid species. The following key is based on the male sex; as the females (all except that of *raydoma*, n. sp., are known) are difficult to separate, they will have to be determined primarily by association with the males.

1. First two segments of hind tarsus of nearly equal length; elytral hair dense and very obvious, though short, and of nearly uniform length; fifth sternite not foveate; prothorax entirely and evenly punctate, with short, erect, obvious hair of uniform length (Fig. 6a, g). Guatemala.....  
.....*pubicollis* (Blanchard)
- First segment of hind tarsus very noticeably shorter than the second; elytral hairs variable but elytra never densely covered with short hairs; fifth sternite distinctly foveate or at least noticeably impressed apically; prothorax variably punctate but unevenly so, and middisk often irregularly impunctate, the hairs of variable length or lacking..... 2
2. Fifth sternite densely punctate but distinctly not foveate apically, at most slightly transversely impressed; apex of fifth sternite straight and not at all emarginate..... 3
- Fifth sternite densely punctate and very noticeably foveate, midapex distinctly and usually broadly and arcuately emarginate... 4
3. Prothorax strongly shining, rufous, and glabrous or apparently so, the front angles sharp and subrectangular; antennal club slightly longer than funicle (Fig. 5a, b). British Honduras.....*bowditchi* Saylor

Prothorax subpruinose, rufocastaneous, and with short hairs and some longer hairs intermixed, front angles obtuse and not particularly noticeable; antennal club distinctly longer than funicle and subequal to entire stem (Fig. 1a, b). Guatemala.....

- .....*raydoma*, n. sp.
4. Prothorax with hairs minute and hardly noticeable, without longer hairs; color dorsally distinctly pruinose (Fig. 3a, b, f). Panama, Venezuela.....*odomi*, n. sp.
  - Prothorax always with noticeable hairs, these usually short, with intermixed longer hairs; color variable, either strongly shining or pruinose..... 5
  5. Color always very distinctly and very strongly shining, thorax deep rufous; elytra coarsely and rugosely punctate and without obvious striae (Fig. 4a). Costa Rica.....  
.....*sanjosicola* Saylor
  - Color highly variable but always evidently pruinose, thorax at most castaneorufous; elytra less rugosely punctured and usually with distinct striae (Fig. 2a-e). Mexico to Panama.....*testaceipennis* (Blanchard)

**Phyllophaga (*Phyllophaga*) *testaceipennis***  
(Blanchard)

Fig. 2, a-e

*Ancylonycha testaceipennis* Blanchard, Cat. Col. 1: 134. 1850.

*Lachnosterna testaceipennis* (Blanchard) Bates, Biol. Cent.-Amer. 2(2): 195. 1888.

*Male*: Form oblong-oval, wider behind. Color testaceous to rufotestaceous, varying to rufocastaneous or castaneopiceous, the thorax usually more rufous; above slightly to markedly pruinose, dorsal hair variable. Head with front convex, coarsely, rugosely and closely punctate with short erect hairs. Clypeus transverse, disk sparsely to moderately punctured, at times with smooth areas near the hardly impressed and faintly biarcuate suture; apex somewhat reflexed and hardly or not emarginate, the angles and sides not reflexed and the lateral angles so broadly rounded as to make the clypeal shape semiarculate. Antenna variable, 9- or 10-segmented, usually the latter; the club small and thick and usually a little longer than, or subequal to, the funicle. Thorax with sides straight before the submedian, obtuse lateral dilation, and faintly emarginate behind it, the angles distinct but very obtuse; disk smooth, the punctures irregularly placed and separated

<sup>1</sup> Received January 27, 1943.

by 1 to 3 times their diameters, sparser at center disk, which often possesses an irregular impunctate area; all punctures with short erect hairs and a moderate number of intermixed much longer hairs, the discal surface at least partly pruinose. Scutellum impunctate. Elytral punctures more regularly placed and separated by  $1\frac{1}{2}$  to 3 times their diameters, with short suberect hairs and some longer ones intercalated, especially near suture and base; striae variable, usually irregular but obvious, the sutural striae strong. Pygidium convex, polished or semipruinose, the surface frequently slightly wrinkled, and the punctures sparse and separated by two to four times their diameters, with short suberect hairs; apex well rounded and ciliate. Abdomen polished and subflattened at middle, and the sutures obliterated between sternites 2 to 5, the disk very sparsely, finely, and setigerously punctate, the hairs short and suberect; fifth sternite with a large median patch of about three dozen granules, the apical half of segment foveate and the center apex appearing widely and somewhat deeply emarginate; sixth sternite nearly as long as fifth, flattened, sparsely set with fine granules and long erect hairs, and the middle disk with a distinctly impressed longitudinal sulcus. Claws very short and rounded, appearing narrowly cleft very much as in *Phytalus*; the middle tooth as long as the apical but twice as wide through its middle part, its apex reflexed basally; basal dilation obtuse and the surface between it and basal tooth minutely denticulate. Segments 1-4 of anterior tarsus each with a small though distinct spine on the inner apical angle. Hind spurs free, spinose, the longest a little longer than first tarsal segment; first tarsal segment only three-fifths the length of the second.

*Female*: Similar to male except: Antennal club shorter than funicle; pygidium distinctly narrowed and pointed at center apex, and reflexed slightly into a sharp tumosity, the margin hardly thickened, but the surface below the "point" and on the underside of the pygidium very wide and smooth, the disk with very short erect hairs; fifth sternite plane, hardly different from the fourth; sixth sternite convex and irregularly punctate, the center discal area impunctate; claws slightly longer and very distinctly more widely cleft (see Fig. 2e). Length 13-16 mm.

Described from Mexico, this is an extremely common and widespread species, ranging from Mexico to Panama. Since the original description of half a dozen lines is so inadequate the species is here described in some detail. Most closely related to *sanjosicola* Saylor and *odomi* Saylor, this species is readily separated by the key characters and the form of the male genitalia.

**Phyllophaga (*Phyllophaga*) bowditchi**  
Saylor

Fig. 5, a-b

*Phyllophaga* (*Phyllophaga*) *bowditchi* Saylor,  
Proc. Biol. Soc. Washington 51: 189-190.  
1938.

This species is known to me only through the type series from "M-tee District of British Honduras, March." It most closely resembles *raydoma* Saylor of this species-complex, but the two species are noticeably different in all views of the male genitalia, as well as in the external characters noted in the key.

**Phyllophaga (*Phyllophaga*) raydoma**, n. sp.

Fig. 6, a, b

*Male*: Similar to *testaceipennis* (Blanchard) in most respects, differing only as follows: Antenna 10-segmented, the club long and subequal to the entire stem in length; scutellum very sparsely punctate; fifth abdominal sternite nearly flat, only faintly impressed apically and not at all foveate; first hind tarsal segment only one-half the length of the second; and the genitalia are different (see Fig. 1, a-c). Length 14 mm. Width 7.5 mm.

The unique male holotype in the Saylor collection is from "Alta Vera Paz, Guatemala." The species differs mainly from *testaceipennis* in characters of the antennal club, the fifth abdominal sternite, and the male genitalia.

**Phyllophaga (*Phyllophaga*) odomi**, n. sp.

Fig. 3, a, b, f

*Male*: Color rufotestaceous to rufocastaneous or rufopiceous, the thorax and head usually rufous or darker than the elytra; surface distinctly pruinose; dorsal surface variably hairy. Very similar in nearly all respects to *testaceipennis* except as follows: Clypeus at times more densely punctate and semitrapezoidal; thoracic hairs always *minute* and hardly or barely visible, *without* any longer intercalated hairs; elytral hairs also *minute*, with several short hairs

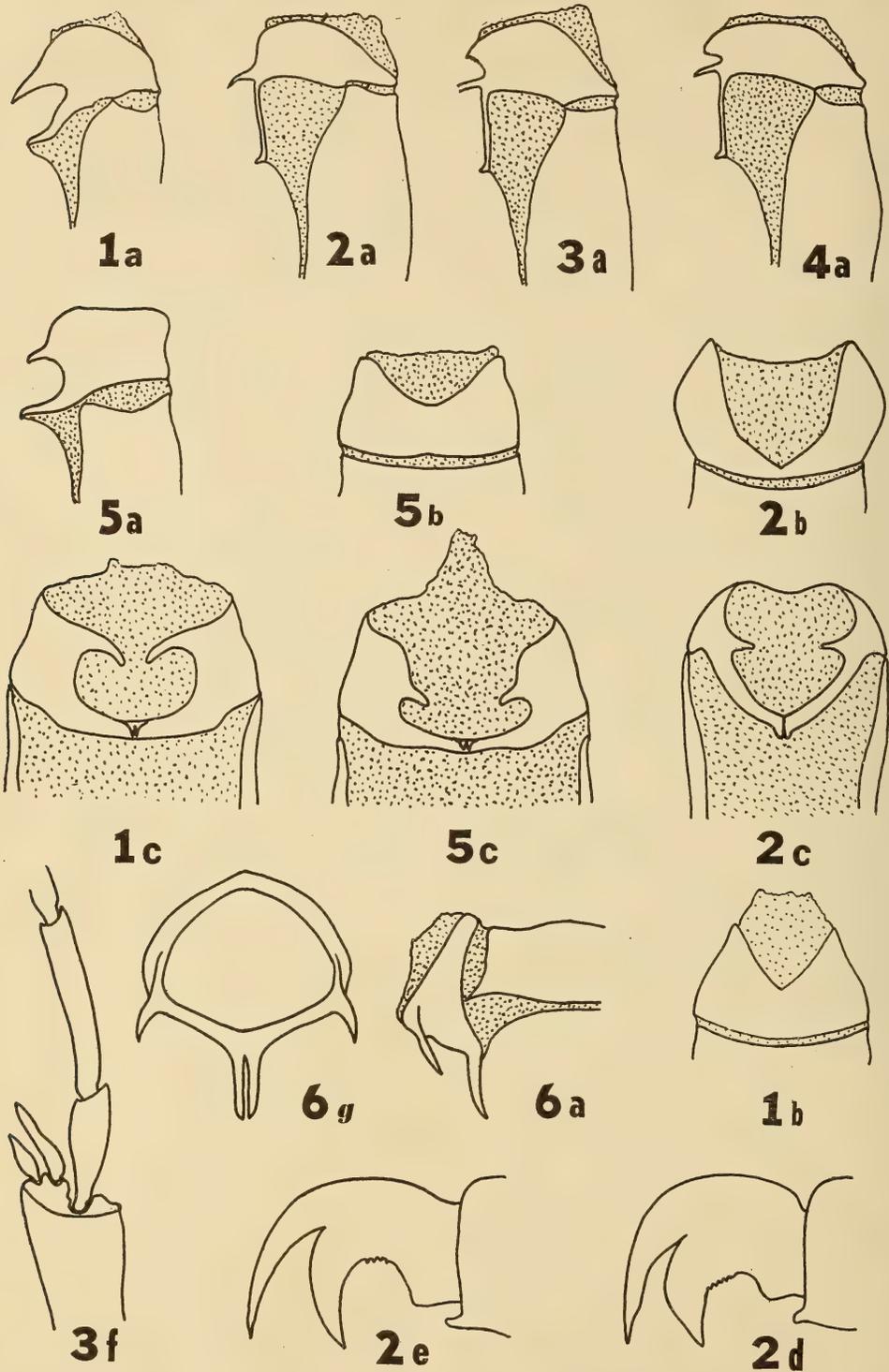


Fig. 1.—*Phyllophaga raydoma*, n. sp. Fig. 2.—*Phyllophaga testaceipennis* (Blanchard). Fig. 3.—*Phyllophaga odomi*, n. sp. Fig. 4.—*Phyllophaga sanjosi-ola* Saylor. Fig. 5.—*Phyllophaga bowditchi* Saylor. Fig. 6.—*Phyllophaga pubicollis* (Blanchard).  
 a, Lateral view of male genitalia; b, dorsal view of male genitalia; c, ventral view of male genitalia; d, front male claw; e, front female claw; f, ventral view of hind leg of male; g, en-face view of male genitalia.

adjoining the scutellum; genitalic form related to that of *testaceipennis*, but different, especially in lateral view (see Fig. 3, a).

*Female*: Similar to female of *testaceipennis* except that the thoracic hairs are all minute and hardly visible (in one female example of *odomi* about half a dozen long hairs are visible just before the midapex but the entire disk is minutely haired). Length 15–17 mm. Width 7–9 mm.

The male holotype is from "Madden Dam, Canal Zone, Panama, collected at light V-18-36 by M. M. Saylor"; the female allotype and several male and female paratypes are from "Los Canales, Kaiguata, Venezuela, VII-24-39, Vivas-Berthier Collector." An additional paratype is from "Caracas, Venezuela, D. F., VI-5-32." All are in the Saylor collection. I take pleasure in naming this handsome species for my close friend and collecting companion C. Ray Odom, of Virginia. *P. odomi* differs mainly from *testaceipennis* in the thoracic vestiture, larger size, and the slightly different male genitalia (which in lateral view appear to overhang slightly the upper tooth, but not so much as in *sanjosicola* Saylor).

**Phyllophaga (Phyllophaga) sanjosicola** Saylor  
Fig. 4, a

*Phyllophaga sanjosicola* Saylor, Rev. Ent. 5(4): 500. 1935.

*Phytalus valeriana* Saylor, Pomona Coll. Journ. Ent. Zool., Dec. 1934.

Known as yet only from the type series, all the specimens of which were collected "at light, San José, Costa Rica, May, 1,000–1,200 m." This series is divided between the Saylor collection and the Nevermann collection, which is now in the United States National Museum. The slightly larger size, distinctive shining, and more coarsely punctate surface will readily separate the species from *testaceipennis*, as will also the male genitalia (uppermost portion of *testaceipennis* genitalia in lateral view evenly rounded above the upper tooth, whereas in *sanjosicola* the uppermost portion very markedly overhanging the upper tooth).

**Phyllophaga (Phyllophaga) pubicollis**  
(Blanchard)

Fig. 6, a–g

*Phytalus pubicollis* Blanchard, Cat. Col. 1: 131. 1850.

*Phytalus (?) pubicollis* Blanchard, Bates, Biol. Cent.-Amer. 2(2): 126, 400. 1888.

*Lachnosterna heynei* Moser, Stett. Ent. Zeit., 1918: 164. (New synonymy.)

*Male*: Elongate, subparallel; color rufocastaneous and shining, the thorax and head shining rufous, above densely haired. Clypeus moderately long, the disk flat, sparsely and coarsely punctate, smooth near middle: apex subtruncate, unemarginate, and slightly reflexed, the angles very broadly rounded. Head with the front slightly convex, densely, coarsely and entirely punctate, with erect hairs of moderate length. Antenna 10-segmented, unicolorous castaneous, the club long and subequal to the entire stem. Thorax with the sides evenly arcuate and hardly dilated at middle, the margin entire and ciliate; angles very obtuse and not well marked; disk evenly and entirely punctured, the punctures separated by one and one-half to twice their diameters, with suberect short hairs, and many intermixed erect hairs of moderate length. Scutellum sparsely and setigerously punctured. Elytra punctate as thorax, with dense, short, semierect hairs and a few longer hairs near base; striae faintly indicated. Pygidium polished, convex, the disk coarsely and moderately densely punctate, with short suberect hairs and sparse, erect longer hairs, the apex subrounded, narrowed and slightly reflexed. Abdomen polished, faintly concave at middle, very sparsely and finely punctate and with short hairs (densely and more closely punctate at sides), and the sutures of sternites 2–5 effaced at middle; fifth sternite flattened, densely and coarsely punctate at middle, with a few small procumbent hairs; sixth nearly as long as preceding and transversely impressed, the disk finely and setigerously punctate and without any longitudinal sulcus, the hairs on disk long but nearly procumbent. Claws very short and cleft as in *testaceipennis* but the upper (i.e., closest to base) tooth  $2\frac{1}{2}$  times as wide at base as the apical tooth. Hind spurs free and very graceful; the first two hind tarsal segments subequal and the second only faintly the longest. Front tarsi slightly spinose on inner apical angles.

*Female*: Differs from male as follows: Antennal club subequal to funicle; pygidium small, plane, sparsely and not coarsely punctate, with short suberect hairs, the apex subrounded and narrowed and the apical fourth of disc some-

what smooth; abdomen semiconvex, the fifth sternites plane, and coarsely, densely punctate, the sixth convex and similarly punctate; claws distinctly more widely cleft; first segment of hind tarsus distinctly shorter than the second. Length 12.5 to 13 mm. Width 6-7 mm.

I have specimens from "Coban, Vera Paz, Guatemala, Conradt collector" (*Biologia material*), and also from "Alta Vera Paz, Guatemala." The species was very inadequately de-

scribed from Mexico by Blanchard, who placed it in *Phytalus* because of the cleft claws; however, the female claws are so widely cleft that the species cannot be included there. As indicated in the key the species is abundantly different from the others in the group but appears to belong with them in most general characters. Bates first placed the species in *Phytalus* and later removed it to *Lachnosterna* in the *Biologia Supplement*.

## PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

### THE ACADEMY

#### 45TH ANNUAL MEETING OF THE ACADEMY

The 45th annual meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on January 21, 1943. President CURTIS called the meeting to order at 8:15 P.M., with about 80 persons present. The minutes of the 44th annual meeting were approved as published on pages 85 to 91 of the JOURNAL of March 15, 1942. The reports of the several officers and of the Committees of Auditors and Tellers were read and accepted, as follows:

#### *Report of the Secretary*

During the past year, 23 new members (14 resident and 9 nonresident) were taken into the ACADEMY. Three of the new nonresident memberships were in the honorary class. The new members were distributed among the various sciences as follows: 3 each in bacteriology and physics, 2 each in astronomy, chemistry, and geology, and 1 each in agronomy, anthropology, archeology, biochemistry, botany, geochemistry, geography, hydraulics, physiology, plant pathology, and plant physiology.

Because of retirement from active practice of their profession, 10 members (7 resident and 3 nonresident) were placed on the retired list. Resignations were accepted from 11 members in good standing (9 resident and 2 nonresident).

The deaths of 17 members (8 resident and 9 nonresident) were reported, as follows:

- THOMAS HERBERT NORTON, White Plains, N. Y., December 2, 1941.  
 CLINTON HART MERRIAM, Berkeley, Calif., March 20, 1942.  
 WALTER FORD REYNOLDS, Baltimore, Md., May 1, 1942.  
 EDWARD CENTER GROESBECK, Washington, D. C., May 9, 1942.  
 SIR JOSEPH LARMOR, Cambridge, England, May 19, 1942.  
 MARCUS WARD LYON, JR., South Bend, Ind., May 19, 1942.  
 HENRY GRANGER KNIGHT, Washington, D. C., June 13, 1942.  
 ANDREW STEWART, Washington, D. C., June 28, 1942.

HARRY JOHN McNICHOLAS, Washington, D. C., July 23, 1942.

THOMAS LEONARD WALKER, Toronto, Canada, August 6, 1942.

HENRY CORBIN FULLER, Washington, D. C., August 26, 1942.

ALFRED NELSON FINN, Lincoln, Nebr., September 21, 1942.

WILLIAM EDWARD PARKER, Fort Lauderdale, Fla., September 30, 1942.

ROBERT WILCOX SAYLES, Chestnut Hill, Mass., October 23, 1942.

CHARLES SCHUCHERT, New Haven, Conn., November 20, 1942.

HERMAN STABLER, Washington, D. C., November 24, 1942.

JAMES EDMUND IVES, Washington, D. C., January 1, 1943.

On January 20, 1943, the status of the membership was as follows:

	Regular	Retired	Honorary	Patrons	Total
Resident	423	37	3	0	463
Nonresident	132	20	15	2	169
Total	555	57	18	2	632

The net changes in membership during the past year are as follows:

	Regular	Retired	Honorary	Patrons	Total
Resident	-10	4	0	0	-6
Nonresident	5	2	2	0	9
Total	-5	6	2	0	3

From February 6, 1942, to January 11, 1943, the Board of Managers held eight meetings, with an average attendance of 19 persons. Two special committees held over from 1941 completed their work. Of the 10 special committees appointed by the president during the past year, 8 have completed their work.

During the past year, the Academy held six meetings, beginning with the 310th and ending with the 315th as follows:

On February 19, 1942, jointly with the Anthropological Society of Washington, with an address entitled *The Aztecs of Mexico* by GEORGE C. VAILLANT, director of the Museum of the University of Pennsylvania.

On March 19, 1942, for the presentation of the Academy's Awards for Scientific Achievement for 1941 to G. ARTHUR COOPER, of the U. S. National Museum, in the biological sciences; to THEODORE R. GILLILAND, of the National Bureau of Standards, in the engineering sciences; and to STERLING B. HENDRICKS, of the U. S. Bureau of Plant Industry, in the physical sciences.

On April 16, 1942, jointly with the Philosophical Society of Washington, with an address entitled *Cosmic emotion*, by PAUL R. HEYL, chief of the Section on Sound at the National Bureau of Standards.

On October 15, 1942, jointly with the Washington Branch of the Society of American Bacteriologists, with an address entitled *Structural differentiation within the bacterial cell as shown by the electron microscope*, by STUART MUDD, professor of bacteriology in the School of Medicine at the University of Pennsylvania.

On November 19, 1942, jointly with the Philosophical Society of Washington, with an address entitled *Color blindness and its relation to the detection of camouflage*, by DEANE B. JUDD, physicist in the Section on Photometry and Colorimetry at the National Bureau of Standards.

On December 17, 1942, jointly with the Anthropological Society of Washington, with an address entitled *Anthropological explorations in Netherlands New Guinea*, by MATTHEW W. STIRLING, chief of the Bureau of American Ethnology, Smithsonian Institution.

Accounts of the first four of these meetings have already been published in the JOURNAL under the Proceedings of the Academy, and those of the last two will appear shortly. All the meetings were held in the Assembly Hall of the Cosmos Club.

Respectfully submitted by FREDERICK D. ROSSINI, *Secretary*.

*Report of the Treasurer*

CASH RECEIPTS AND DISBURSEMENTS

RECEIPTS:

From dues 1940.....	\$ 20.00
From dues 1941.....	100.00
From dues 1942.....	2,570.00
From dues 1943.....	65.00
From subscriptions 1941.....	47.20
From subscriptions 1942.....	479.70
From subscriptions 1943.....	330.00
From sales of JOURNAL.....	69.60
From sales of directory.....	6.85
From payments for reprints.....	488.15
From interest on deposits.....	.90
From interest on investments.....	982.06

Total receipts.....	\$5,159.46
Cash balance Jan. 1, 1942.....	4,802.97

To be accounted for..... \$9,962.43

DISBURSEMENTS:

For Secretary's Office.....	\$ 381.85
For Treasurer's Office.....	164.13
For JOURNAL printing 1941.....	242.75
For JOURNAL printing 1942.....	2,342.45
For JOURNAL reprints 1942.....	339.86
For JOURNAL illustrations 1941...	40.63
For JOURNAL illustrations 1942...	328.33
For JOURNAL Office 1941.....	20.74
For JOURNAL Office 1942.....	242.19
For Custodian & Subs. Mgr.....	15.37
For Meetings Committee.....	286.98
For directory.....	30.84
For refund on JOURNAL sales.....	5.40

Total disbursements..... \$4,441.52

Bank debit memos:

Subscriptions, 1942.....	13.95
Deposited in Savings Account....	.90

\$4,456.37

Cash balance Dec. 31, 1942..... 1,506.06

\$5,962.43

Invested in U. S. Series G Bonds.. 4,000.00

Total..... \$9,962.43

RECONCILIATION OF BANK BALANCE

Balance as per cash book 12-31-42...	\$1,506.06
Bank Balance American Sec. & Trust Co., per statement 12-31-42.....	1,558.06
Receipts not deposited.....	31.60
	<hr/>
	\$1,589.66

Checks outstanding, not cashed:

No. 170.....	\$21.50	
881.....	2.30	
882.....	25.00	
884.....	7.50	
885.....	4.80	
886.....	22.50	83.60

\$1,506.06

INVESTMENTS

409 Shares stock of Washington Sanitary Improvement Co., par value \$10 per share, cost.....		\$ 4,090.00
20 Shares stock Potomac Elec. Power Co., 6% Pref., cost.....		2,247.50
4 Certificates Corporate Stock of City of New York, 1 for \$500, 3 for \$100, cost.....		800.00
1 Bond of Chicago Railways Co., #1027; interest at 5%, due 1927, par value \$1,000 less \$250, cost.....		713.87
1 Real-estate note of T. Q. Donaldson (#6 of 12) dated June 26, 1937 (extended to 1943); interest 5%, cost.....		1,000.00
2 Real-estate notes of Yetta Korman et al., dated Oct. 5, 1938, for 3 years (#7 of 37 for \$500 and #8 of 37 for \$500), cost.....		1,000.00
2 Certificates (1 for \$4,000 and 1 for \$1,000) First Federal Savings & Loan Assn. Nos. 914 & 1063.....		5,000.00
2 Certificates (1 for \$4,500 and 1 for \$500) Northwestern Federal Savings and Loan Assn. Nos. 1380 and 1441.....		5,000.00
4 U. S. Government Series G Bonds at \$1,000 each, Nos. M332990G, M332991G, M332992G, M332993G.....		4,000.00
Deposited in Savings Account, American Sec. & Trust Co.....		46.65
		<hr/>
Cash Book balance Dec. 31, 1942.....		\$23,898.02
		1,506.06
		<hr/>
Total Assets.....		\$25,404.08
		<hr/>
Total Assets Dec. 31, 1942.....	\$25,404.08	
Total Assets Dec. 31, 1941.....	24,700.09	
	<hr/>	
Increase.....	\$	703.99

After payment of outstanding bills, the net increase in assets for 1942 will be about \$300.

ALLOTMENTS

	<i>Allotted</i>	<i>Expended</i>
Secretary's Office.....	450.00	381.85*
Treasurer's Office.....	200.00	164.13
JOURNAL.....	2800.00 + 593.08 = 3393.08	3010.64**
Meetings Committee.....	325.00	324.98†
Custodian & Subs. Mgr.....	75.00	27.37°
Membership Committee.....	10.00	—
Executive Committee.....	10.00	—
JOURNAL Clerical Asst.....	240.00	
JOURNAL Misc. Expense.....	60.00	
Addendum to Directory.....	60.00	
	} = 300.00	264.00°°
		30.84

\*Does not include unpaid bill of approximately \$10.00.

\*\*Does not include, Oct., Nov. or Dec. Reprints nor Nov. or Dec. Printing & Illustrations.

†Includes all charges for 1942, \$38.00 of which has been paid since Dec. 31, 1942.

°Includes all charges for 1942 \$12.00 of which has been paid since Dec. 31, 1942.

°°Includes all charges for 1942 \$21.91 of which has been paid since Dec. 31, 1942.

Respectfully submitted by HOWARD S. RAPPLEYE, *Treasurer*.

*Report of the Committee of Auditors*

The accounts of the Treasurer of the Washington Academy of Sciences for the year 1942 were examined by your committee on January 18, 1943. All receipts and imbursements included in his report were checked against all vouchers and balance sheets from the bank. Vouchers are properly approved and the report

is correct. Securities listed in the Treasurer's reports were inspected on January 18, 1943, and the statement of assets is correct. The orderly manner in which the records were kept is to be highly commended and made the committee task an easy one.

Respectfully submitted by JOHN W. ROBERTS (*Chairman*), EUGENE POSNJAK, and C. H. SWICK.

*Report of the Archivist*

During the past year little progress has been made in sorting the material turned over to the Archivist. A 5-foot steel safe, a 3-drawer steel file with lock, and a steel storage cabinet have been borrowed for storing the archives. The archivist was authorized to open a mysterious package that had remained sealed since the founding of the Academy. This package contained the original ballots for charter members and is open for inspection by any who are interested. A noteworthy archive, found by Dr. L. O. Howard when he moved his household effects to New York, was given to the Archives. This was a large book containing reproductions of the signatures and documents incident to the formation of the Royal Society of London. Any material of value to the Academy in its Archives will be greatly welcomed by the Archivist from the members of the Academy.

Respectfully submitted by NATHAN R. SMITH, *Archivist*.

*Report of the Board of Editors*

Volume 32 of the JOURNAL for the calendar year 1942 consisted of 12 issues of 376 pages distributed as follows:

<i>Classification</i>	<i>Number of Articles</i>	<i>Number of Pages</i>
Anthropology	2	18.3
Astronomy	1	28.0
Astrophysics	1	3.0
Bacteriology	1	4.0
Biophysics	2	10.1
Botany	13	66.5
Chemistry	5	21.2
Crystallography	1	11.0
Entomology	4	19.9
Ethnology	1	17.0
General Interest	2	14.9
Geodesy	1	5.3
Geology	1	2.3
Geophysics	1	15.0
Ichthyology	4	23.3
Index	1	4.0
Medical Entomology	1	3.0
Obituaries	7	5.0
Paleobotany	1	3.7
Paleontology	2	10.4
Proceedings—Academy		17.8
Proceedings—Anthrop.		.9
Proceedings—Chem.		2.1
Proceedings—Geol.		6.0
Proceedings—Phil.		7.3
Physics	2	20.4
Zoology	11	35.6
<b>Total</b>		<b>376.0</b>

These may be summarized as follows:

Biological Sciences	43	211.8	56.3%
Physical Sciences	12	106.2	28.2%
General Interest	2	14.9	4.0%
Proceedings; Obit.		39.1	10.4%
Index		4.0	1.1%

This volume included three presidential addresses; 58 line cuts, and 17 halftones. Of the 55 papers, 33 (60.0%) were contributed by members of the Academy. The previous volume contained 62 articles of which 36 (58.1%) were by Academy members.

Two facts worth noting in the above figures are:

A. Volume 32 is the smallest volume ever issued by the Academy since the initial volumes. The following comparative figures, reduced approximately to the equivalent number of pages in the new format, may be of interest:

Average number of pages for the period 1932-1941	442
Average number of pages for the period 1915, 1916, 1918, 1919	539
Number of pages for 1917	485

The Board of Editors believes that the trend of the last decade culminating in the 376 pages for 1942 is undesirable and that publication in the JOURNAL should be stimulated.

B. The JOURNAL undoubtedly fills a need for the biological sciences (taxonomic articles), whereas it is not sought for the publication of articles in the physical sciences. Perhaps this fact is the underlying reason why the JOURNAL has been for some time secretly in disrepute among many Academy members. The Board of Editors believes that members of the Academy should contribute more original articles of their own.

The primary reason for the small size of the volume just published was not lack of material, however; on December 15 there were on hand 59 pages in proof and approximately 15 pages in manuscript. Volume 32 was restricted in content in order that the budget allotment for the JOURNAL might not be exceeded. A financial statement follows together with some comparative figures:

	<i>Printing &amp; Mailing</i>	<i>Illustrations</i>	<i>Reprints</i>
Maximum 1930-1941	\$3410.78	\$500.70	\$618.44
Minimum 1930-1941	2564.59	227.70	398.17
Average 1930-1941	2826.16	344.78	517.07
1941	2650.17	294.46	602.70
1942	2523.47	330.67	*(386.29)

\* This amount includes only 10 months; bills for November and December reprints have not yet been received.

In 1942 authors, institutions, or societies paid the following amounts to cover the cost of excess illustrations, additional charges, and reprints (see the 1941 figures for comparison):

1941	168.85	90.18	344.55
1942	32.47	107.89	*(367.02)

The Editors' budget for 1942 was as follows (cf. 1941 figures for comparison):

	<i>Printing, Illustrations, Reprints, and Mailing</i>	<i>Clerical Assistance</i>	<i>Postage and Incidentals</i>
1941	\$3100.00	\$240.00	\$60.00
1942	2800.00	240.00	60.00

The amounts charged to the Editors' accounts were as follows:

1941.....	2941.08	240.00	28.93
1942.....	2735.05	240.00	25.80

The unexpended balances are:

1941.....	158.92	0.00	31.07
1942.....	64.95	0.00	34.20

In addition to the *cut* in the Editors' budget there was a 6 per cent *increase* in printing charges by the George Banta Publishing Co. This resulted in an increase in cost of \$58.06 for the last six months, or approximately \$87.08 for the year 1942 (the increase began with the April issue). The following steps were taken to meet these financial problems:

A. The format of the JOURNAL was changed from a single column in 1941 to a double column in 1942. This resulted in a saving of \$146.31 for the last six months, or approximately \$292.62 for the entire year 1942.

B. The author's share in the cost of reprints was increased with the January issue; the practice of giving an author 50 free reprints was discontinued with the March issue. It is estimated that a saving of \$187 was effected in this way.

C. Illustrations allowed an author were reduced from the equivalent of two pages of line-cut drawings to one page and a half with the May issue, and then further reduced to one page with the November issue. The full effect of the last reduction will not be felt until next year; that of the first reduction was estimated to be small.

D. Unusual costs of foreign, mathematical, and tabular materials, as well as alterations made in the proof by the author, were studied by the Editors. Whereas these may be small in comparison with the cost of illustrations individually, they may become excessive when totaled, as may be seen from the following charges to the Academy:

*Additional Typesetting*

<i>Charges</i>	1939	1940	1941	1942
Foreign material.....	\$68.82	\$68.70	\$75.19	\$114.56
Tables.....	24.55	77.95	96.75	109.34
Mathematical material	67.08	20.12	113.87	26.96
Other Type Charges..	67.05	76.92	61.61	83.21
Alterations.....	107.15	99.60	101.60	93.99

It is evident that an article without illustrations, but with sufficient typesetting changes, may cost the Academy more than one with illustrations, but with few typesetting changes. The Board of Editors has taken steps to limit the total additional charges to the Academy. Members of the Academy can assist in this economy by preparing their own manuscripts with greater care and by insisting upon the same carefulness in articles that they communicate.

The Board of Editors wishes to express its

appreciation of the excellent editorial assistance of Mr. PAUL H. OEHSE. His services have made possible a more uniform JOURNAL, as well as a more efficient editorial routine with resulting financial gain to the Academy. The Senior Editor is grateful for the willing cooperation of the other members of the Board of Editors and also of all the Associate Editors.

Respectfully submitted by G. ARTHUR COOPER, JASON R. SWALLEN, and RAYMOND J. SEEGER, *Senior Editor*.

*Report of the Custodian and Subscription Manager of Publications*

STOCKS OF PUBLICATIONS

The stocks of the Academy's publications have shown an increase during the year due to continued donations from various sources accompanied by a very small number of sales. As shown in the appended inventory there are 26 reserve sets (eight sets of vols. 1-30 of which one is incomplete, lacking but six numbers, seven sets of vols. 1-30 and 11 sets of vols. 16-30). Most of this reserve, together with the miscellaneous stocks including all of vols. 1-22, is stored in Washington, while the chief supplies of vols. 23-32 are stored with the printer at Menasha, Wis.

INVENTORY OF STOCKS OF PUBLICATIONS—  
DECEMBER 31, 1942

(Except where noted these are stored in Washington, D. C. in storage provided without cost by the Smithsonian Institution and by the U. S. Coast and Geodetic Survey)

Proceedings of the Washington Academy of Sciences:

Volumes 1-13 inclusive.....	50 Sets
Reserve sets of the Journal of the Washington Academy of Sciences:	
Bound volumes 1-29+vol. 30 unbound.....	1 Set
Unbound volumes 1-30 (complete).....	6 Sets*
Unbound volumes 1-30 (incomplete, lacking 6 nos).....	1 Set*
Unbound volumes 1-30.....	7 Sets*
Unbound volumes 16-30.....	11 Sets*

\* Some numbers at Menasha.

Nonreserve volumes of the Journal of the Washington Academy of Sciences (in Washington):

<i>Vol.</i>	<i>No. Vols.</i>	<i>Vol.</i>	<i>No. Vols.</i>
5.....	2	19.....	11
6.....	2	20.....	10
7.....	5	21.....	56
8.....	4	22.....	49
9.....	3	23.....	4
10.....	2	24.....	12
11.....	9	25.....	14
12.....	7	26.....	19
13.....	11	27.....	21
14.....	6	28.....	11
15.....	10	29.....	23
16.....	19	30.....	29
17.....	14	31.....	7
18.....	13		

Also miscellaneous collection of odd numbers of the Proceedings, the JOURNAL, the Directory (1897 to 1941 inclusive), and reprints of special articles.

SUBSCRIPTIONS

Owing to the international situation the subscriptions as well as sales of publications have been curtailed.

Nonmember subscriptions in United States	103
Nonmember subscribers in foreign countries	28
Nonmember subscribers (inactive) in enemy-controlled areas	31
Subscriptions Geological Society of Washington	13

EXPENDITURES

Because conditions have not warranted the expenditures anticipated the amount actually used has been but \$27.37 of the budget allowance, leaving an unexpended balance of \$47.63.

Respectfully submitted by WILLIAM W. DIEHL, *Custodian and Subscription Manager of Publications.*

*Report of the Committee of Tellers*

The Committee of Tellers met on January 16, 1943. A total of 230 ballot envelopes were delivered to the Committee by the Secretary. Of these, 1 bore no signature and 3 bore the signature of a member in arrears. In the remaining 226 envelopes there were found 206 ballots on the Amendments to the Constitution and 219 ballots for Officers and Managers of the Academy.

The count of the ballots on the Amendments showed the following results:

<i>Amendment No.</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
For amendment	193	198	202	200	205	205
Against amendment	11	6	2	3	0	0
Not voting	2	2	2	3	1	1

The count of the ballots on Officers of the Academy showed the following results:

	<i>For</i>	<i>Against</i>	<i>Not Voting</i>
For President, LELAND W. PARR	214	0	5
For Secretary, FERDINAND G. BRICKWEDDE	215	0	4
For Treasurer, HOWARD S. RAPPLEYE	213	0	6

Examination of the preferential ballot for Managers by the Hare system showed 1 unmarked ballot and 33 ballots that were invalid because marked with crosses from which no first choice could be determined, leaving 185 valid ballots. The Droop Quota was therefore  $(185 + 1) / (2 + 1) = 62$ . The count of the ballots showed the necessary quotas for FREDERICK D. ROSSINI and JOHN E. GRAF.

Respectfully submitted by WALTER RAMBERG, *Chairman*, LEWIS W. BUTZ, PAUL S. ROLLER.

*Election of Vice-Presidents*

For the respective affiliated societies, the Secretary presented the following nominations for Vice-Presidents of the Academy:

- Philosophical Society of Washington: RAYMOND J. SEEGER
- Anthropological Society of Washington: FRANK M. SETZLER
- Biological Society of Washington: HARRY B. HUMPHREY
- Chemical Society of Washington: HERBERT L. HALLER
- Entomological Society of Washington: AUSTIN H. CLARK
- National Geographic Society: ALEXANDER WETMORE
- Geological Society of Washington: CLARENCE S. ROSS
- Medical Society of the District of Columbia: FRED O. COE
- Columbia Historical Society: ALLEN C. CLARK
- Botanical Society of Washington: CHARLOTTE ELLIOTT
- Washington Section of the Society of American Foresters: WILLIAM A. DAYTON
- Washington Society of Engineers: FRANK B. SCHEETZ
- Washington Section of the American Institute of Electrical Engineers: FRANCIS B. SILSBEE
- Washington Section of the American Society of Mechanical Engineers: WALTER RAMBERG
- Helminthological Society of Washington: EMMETT W. PRICE
- Washington Branch of the Society of American Bacteriologists: RALPH P. TITSLER
- Washington Section of the Institute of Radio Engineers: HARRY DIAMOND
- Washington Section of the American Society of Civil Engineers: OWEN B. FRENCH

The Secretary was instructed to cast a unanimous ballot for these nominees.

*Awards for Scientific Achievement for 1942*

President CURTIS announced the recipients of the Academy's Awards for Scientific Achievement for 1942, as follows:

For the Biological Sciences, to—

ROBERT S. CAMPBELL, assistant chief of the Division of Range Research of the U. S. Forest Service, in recognition of his distinguished service in range research, particularly in the development of range utilization standards.

For the Engineering Sciences, to—

WALTER RAMBERG, senior physicist in the Section on Engineering Mechanics at the National Bureau of Standards, in recognition of his distinguished service in research on the static and dynamic strength of structural elements, particularly in relation to aircraft.

For the Physical Sciences, to—

MILTON HARRIS, director of research for the Textile Foundation and for the Textile Research Institute, both having laboratories at the National Bureau of Standards, in recognition of his distinguished service in conducting fundamental research on the composition and properties of textile fibers.

After a recess during which the 316th meeting of the Academy (see below) was held, President CURTIS appointed Past Presidents CHAMBLISS and CRITTENDEN to escort the new President, L. W. PARR, to the Chair. After a short address, President PARR adjourned the meeting.

#### 316TH MEETING OF THE ACADEMY

The 316th meeting of the Academy was held in the Assembly Hall of the Cosmos Club immediately following the 45th annual meeting of the Academy on January 21, 1943. President CURTIS called the meeting to order and explained the nature of the program arranged for this meeting. Reports on governmental publication of scientific research were presented by ATHERTON SEIDELL for the U. S. Public Health Service, by MELVIN C. MERRILL and RALPH SHAW for the U. S. Department of Agriculture, and KASSON S. GIBSON for the National Bureau of Standards. Censorship of scientific publications going abroad was described by EDWARD D. HILL, of the U. S. Board of Economic Warfare. Open discussion followed these reports, and ATHERTON SEIDELL presented the following statement for the consideration of the Academy:

"The Washington Academy of Sciences recommends that: Research papers originating in governmental laboratories and describing additions to scientific knowledge be published in Federal journals devoted to specific fields of scientific research and that these journals be issued at regular intervals and at subscription rates approximately sufficient to cover their cost. The present method according to which many individual agencies publish occasional bulletins or composite collections of papers in many fields of science is not in the opinion of the Academy the most effective method of distributing the information contained in the reports."

No action was taken on this recommendation.

FREDERICK D. ROSSINI, *Secretary*

#### CHEMICAL SOCIETY

##### 545TH MEETING

The 545th meeting was held jointly with the District of Columbia Section of the American Society of Civil Engineers in the main auditorium of the U. S. Chamber of Commerce on Tuesday, September 22, 1942, at 8:15 P.M. FRANK HOWARD, president of the Standard Oil

Development Co., spoke on *The manufacture and use of synthetic rubber*.

##### 546TH MEETING

The 546th meeting was held at the George Washington University on Thursday, October 8, 1942, at 8:15 P.M. At the conclusion of the general meeting, the following divisional meetings were held:

*Biochemistry*, M. X. SULLIVAN, *presiding*

*The inorganic constituents of bone*. S. B. HENDRICKS and W. L. HILL (Bureau of Plant Industry).

*The catalase activity of the tissues of tumor-bearing animals*. JESSE P. GREENSTEIN (National Cancer Institute).

*Heat-labile, avidin-uncombinable, species-specific vitamers of biotin*. DEAN BURK and R. J. WINZLER (National Cancer Institute).

*Canine cystinuria. Urinary excretion of cystine following the administration of homocystine, homocysteine, and some derivatives of cystine and cysteine*. W. C. HESS and M. X. SULLIVAN.

*Organic chemistry*, H. P. WARD, *presiding*

*The structure of diketene*. FRANCIS O. RICE (Catholic University of America).

*Optical rotation as a measure of aromatic substitution influences*. WARD PIGMAN (National Bureau of Standards).

*4-Methyl-d-mannose and some of its derivatives*. W. T. HASKINS, RAYMOND M. HANN and C. S. HUDSON (National Institute of Health).

*Physical chemistry*, B. D. VAN EVERA, *presiding*

*The polymorphism of phosphoric oxide*. W. L. HILL, G. T. FAUST, and S. B. HENDRICKS (Bureau of Plant Industry).

*The influence of molecular size on the properties of cellulose acetate*. MILTON HARRIS and ARNOLD SOOKNE (Textile Foundation).

*Measurement of moisture in gases by electrical conductance at different pressures*. E. R. WEAVER (National Bureau of Standards).

*Inorganic and analytical chemistry*, ROLLIN E. STEVENS, *presiding*

*The use of phosphate for the separation of cobalt from iron*. VICTOR NORTH and R. C. WELLS (Geological Survey).

*Radium content of certain ultrabasic rocks*. GORDON L. DAVIS (Geophysical Laboratory).

*Determination of active oxygen in the presence of lead and barium*. MICHAEL FLEISCHER (Geological Survey).

*Chemical and physical properties of leather*. PHILIP E. TOBIAS (National Bureau of Standards).

##### 547TH MEETING

The 547th meeting was held at the Cosmos Club on Thursday, November 12, 1942, at 8:15 P.M. MAX BERGMANN, of the Rockefeller Institute for Medical Research, spoke on *The speci-*

*fic action of proteolytic enzymes: Current problems and recent advances.*

548TH MEETING

The 548th meeting was held at the Cosmos Club on Thursday, December 10, 1942, at 8:15 P.M. GUSTAV EGLOFF, technical director of the Universal Oil Products Co., addressed the society on *Substitute fuels in a world at war.*

E. R. SMITH, *Secretary.*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting on January 19, 1943, elected the following officers: President, GEORGE S. DUNCAN; Vice President, REGINA FLANNERY; Secretary, WILLIAM N. FENTON; Treasurer, T. DALE STEWART; Members of the Board of Managers, W. H. GILBERT, H. W. KRIEGER, JULIAN H. STEWARD, J. E. WECKLER, W. R. WEDEL.

A report of the membership and activities of the Society since the last annual meeting follows: Life members, 2; active members, 41; associate members, 11; total, 54.

The members elected during the year were: Rev. GERALD DESMOND, Miss JENNY REITSMA, WILLIAM H. SPINKS, active members; Mrs. WILLIAM H. SPINKS, associate member.

Two active members, CARL W. BISHOP and JOHN G. CARTER were lost by death. The Society voted to record its deep sense of loss at the death of these members and to extend its sincere condolences to their relatives.

The Treasurer's report is as follows:

Funds invested in Perpetual Building Association (with interest to date).....	\$1,702.84
21 shares Washington Sanitary Improvement Co. (par value \$10 per share).....	210.00
2 shares Washington Sanitary Housing Co. (par value \$100 per share).....	200.00
U. S. Savings Bond, Series G.....	500.00
Cash in bank.....	263.66
	<hr/>
	\$2,876.50

Bills outstanding:

To American Anthropological Association.....	\$40.	40.00
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\$2,836.50

Total as of January 19, 1942.... 2,679.94

Increase..... \$ 156.56

Division of annual surplus

	<i>Previous</i>	<i>1943</i>	<i>Total</i>
Publication fund..	\$50.04	52.18	102.22
Speakers fund....	50.04	52.19	102.23
Investment fund..	50.05	52.19	102.24

The Society acted as host to the American Anthropological Association on the occasion of the annual business meeting of the latter on December 28, 1942, at the Cosmos Club.

It was voted that the Anthropological Society of Washington affiliate with the Inter-American Society of Anthropology and Geography.

Papers presented before the regular meetings of the Society were as follows:

January 20, 1942, 704th meeting, JOSEPH E. WECKLER, *Cundiyo, a Spanish village in New Mexico.*

February 19, 1942, 705th meeting, held jointly with the Washington Academy of Sciences, G. C. VAILLANT, *The Aztecs of Mexico.*

March 17, 1942, 706th meeting, ALFRED MÉTRAUX, *The Jesuits in South America.*

April 21, 1942, 707th meeting, address of retiring President, FRANK M. SETZLER, *Archaeological accomplishments during the past decade in the United States* (this JOURNAL, 32(9): 253-259. Sept. 1942).

October 20, 1942, 708th meeting, DOUGLAS L. OLIVER, *Ethnography on Bougainville, Solomon Islands.*

November 17, 1942, 709th meeting, FROELICH G. RAINEY, *Anthropology and the Alaska-Canada Highway.*

December 17, 1942, 710th meeting, held jointly with the Washington Academy of Sciences, MATTHEW W. STIRLING, *Anthropological explorations in Netherlands New Guinea.*

WILLIAM N. FENTON, *Secretary.*

## Obituaries

HERMAN STABLER'S untimely death in Washington on November 24, 1942, brought profound sorrow and a sense of irreparable loss to the Federal Service, the engineering profession, and his community. Of English descent and Quaker parentage, Herman Stabler was born on February 3, 1879, at Brighton, Montgomery County, Md. His early elementary education was followed by one year at Pacific College, Newburg, Oreg., and four years at Earlham College, Richmond, Ind., where he developed a bent for chemical and civil engineering and received the B.S. degree in 1899. After a year of special engineering study at Columbian (now George Washington) University, Washington, D. C., he served for the ensuing two years as instructor in mathematics and surveying at the National Correspondence Institute in that city.

In December 1903 Stabler entered the Federal service as a hydrographic aid in the Hydrographic (now Water Resources) Branch of the Geological Survey and until 1909 was engaged in studies of stream pollution, water quality, and effect of suspended matter on silting of streams in various parts of the country. While in the Reclamation Service in 1909-10 he completed a systematic study of the waters likely to be used on reclamation projects throughout the West to determine the influence of salinity on vegetable growth and the probable rate of silting in future reservoirs and canals. During these studies he devised a method of classifying waters for industrial purposes from analytical data expressed ionically, in parts per million, that is still widely used.

In 1911 Stabler became a member of the division of hydrographic classification in the newly created Land Classification Branch, thereafter succeeding N. C. Grover as chairman in June 1913, becoming assistant chief in 1920, and succeeding W. C. Mendenhall as branch chief in November 1922. In this period he became intimately acquainted with the natural resources of the West and the problems of their development through his direction of the extensive field and office investigations required to determine the power value and reservoir possibilities of streams in public-land States and the suitability of public lands for designation under the enlarged homestead acts of 1909 et seq., and the stock-raising homestead act of 1916.

He participated actively thereafter in the formulation of Federal policies affecting the use of public lands and the conservation of their natural resources, and assisted materially in organizing the work and procedure of the Federal Power Commission at its beginning in 1920.

On July 1, 1925, Stabler became chief of the Survey's Conservation Branch, created on that date to coordinate and carry on jointly the functions of land classification, theretofore discharged by the Land Classification Branch, and the work of supervising operations for mineral production from public and Indian lands pursuant to the Federal mineral-leasing laws, theretofore done by the Bureau of Mines. To this position, which he retained to the day of his death, he brought a broad perspective on western problems. He was responsible in no small part for legalizing the entry by Federal oil and gas lessees into agreements with each other or with others for the unit or cooperative development of oil and gas fields containing Government lands; for the replacement of the prospecting-permit system of disposing of Federal oil and gas lands with a straight leasing system; for requiring the measurement of oil from Federal and Indian lands on a 100-per cent basis less actual impurities instead of an arbitrary 96- or 97-per cent basis that assumed the difference to be impurities; for the assessment of compensatory royalty to offset drainage of oil or gas from Federal lands through wells on adjoining non-Federal lands; and for litigation, seeking to establish the right in the Secretary of the Interior to determine the value for royalty purposes of oil produced under Federal leases and disposed of at prices incompatible with its actual worth.

Indicative of his character and the variety of his interests was his confession a few months before his death that the most memorable and satisfying experiences of his life were his marriage, November 1, 1905, to Bertha R. Buhler, of Washington, D. C., who survives him; his participation in the topographic survey of Colorado River as a member of the Survey's Grand Canyon Expedition in 1923; his admission to the hole-in-one club at the Columbia Country Club, Chevy Chase, Md.; and his service as a director of the American Society of Civil Engineers from 1935 to 1937.—JOHN D. NORTHPROP

FRANK DAWSON ADAMS, a corresponding member of the ACADEMY, died on December 26, 1942, after a brief illness, at his home in Montreal, Canada.

Dr. Adams was born on September 17, 1859, in Montreal; he was graduated from McGill University with first rank honors in natural science in 1878, and, under the inspiration of Sir William Dawson, chose geology as his major subject. He continued his studies at Sheffield Scientific School, Yale University, at Heidelberg, Germany, where he obtained the Ph.D. degree "summa cum laude" in 1892, and at Zürich.

He joined the Geological Survey of Canada in 1880 and continued with that service until he was appointed lecturer in geology at McGill University in 1889. Four years later, upon the retirement of Sir William Dawson, Dr. Adams was appointed Logan professor of geology and head of the department. He became dean of the faculty of applied science in 1908, and later vice-principal of McGill University and dean of the faculty of graduate studies and research.

Contemporaneous with his academic work, Dr. Adams was very active in geological field-work and research, and approximately 90 papers were published in leading scientific journals in America and Britain as a result of his investigations. His experimental work on the flow of rocks was carried out over a period of years, and the results contributed largely to the clarification of geological thought on metamorphism in the earth's crust, the depth of the zone of flow, and on the study of ore deposits.

Dr. Adams was the recipient of many academic honors, among which were honorary degrees from Bishop's College, Tufts College, University of Toronto, Queen's University, McGill University, and Mount Allison University. A mere list of some of his distinctions marks the man as outstanding among his fellows: fellow of the Geological Society of America, 1888; fellow of the Geological Society of London, 1895; recipient of the Lyell medal of the latter Society, 1906; fellow of the Royal

Society of London, 1907; president of the Canadian Institute of Mining and Metallurgy, 1910-11; president, International Congress of Geologists, 1913; president, Geological Society of America, 1918; president, Royal Society of Canada, 1913; honorary member, Institution of Mining and Metallurgy; honorary member, American Institute of Mining and Metallurgical Engineers; honorary member, Engineering Institute of Canada; foreign associate, National Academy of Sciences, U.S.A.; corresponding member, New York Academy of Sciences; correspondent of the Academy of Sciences of Philadelphia; correspondent, Natural History Society of Ekaterinburg, Russia; member, American Philosophical Society; corresponding member, Geological Society of Stockholm; foreign honorary member, American Academy of Arts and Science; honorary member, Mineralogical Society of Russia; honorary member, Geological Society of Belgium; honorary member, Seismological Society of America; honorary member, Academia Asiatica, Teheran, Persia; foreign member, Swedish, and now Royal Swedish, Academy of Science.

Dr. Adams was a man of broad culture and wide travel. For some years after his retirement from active university work he traveled to libraries all over the world to accumulate the basic material for his important book *The birth and development of the geological sciences*, his last major contribution.

Interests as wide as his learning led him to take an active and leading part in the affairs of Rotary, the Boy Scouts, the Y.M.C.A., the Day Shelter for Unemployed Men, and other equally significant organizations. He was a devoted Anglican and was greatly interested in the welfare of the Church. A conclusion may be made in the words of Dean Dixon, who knew Dr. Adams intimately: "Few men have accomplished so much in a quiet unobtrusive way. The thing about his life that impresses me is the sense of completion which takes away the sting of death."

J. J. O'NEILL





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# 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 monthly, on the fifteenth of each month. Volumes correspond to calendar years.

*Manuscripts* may be sent to any member of the Board of Editors. It is urgently requested that contributors consult the latest numbers of the JOURNAL and conform their manuscripts to the usage found there as regards arrangement of title, subheads, synonymies, footnotes, tables, bibliography, legends for illustrations, and other matter. Manuscripts should be typewritten, double-spaced, on good paper. Footnotes should be numbered serially in pencil and submitted on a separate sheet. The editors do not assume responsibility for the ideas expressed by the author, nor can they undertake to correct other than obvious minor errors.

*Illustrations* in excess of the equivalent (in cost) of one full-page line drawing are to be paid for by the author.

*Proof.*—In order to facilitate prompt publication one proof will generally be sent to authors in or near Washington. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

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ASTROPHYSICS.—*The physical chemistry of a cooling planet.*<sup>1</sup> P. G. NUTTING.

A planet, starting as a mass of vapor torn from the sun and approaching the present condition of the earth, must pass through a number of well-marked epochs as its temperature falls. Its initial and final states may be studied, but intermediate conditions must be arrived at by deduction from the amounts of various elements present and their physical and chemical conditions at various temperatures. What would be the first crust to form, what was the composition and pressure of the atmosphere at a certain surface temperature, when did the ocean start, and how rapidly did it grow? The answers to these and similar important geologic questions may be obtained in approximate form from known data and principles, yet this field has aroused little interest. While the critical constants of a few elements and the dissociation constants of many minerals are still unknown, the lack of these introduces only minor uncertainties in the results.

The writer in 1926 presented a brief outline<sup>2</sup> of the epochs through which a cooling earth must have passed, omitting most of the physical relationships (assumed well known) used in arriving at the conclusions. Quotations from that paper by geologists indicate that the subject should be covered in far more detail. The objective is to reconstruct a history of the earth, not on a time scale but on a temperature scale, which is far more interesting and important to geologists.

Aside from temperature, the elements to be dealt with are those listed by F. W. Clarke in his *Data of geochemistry* as con-

stituting the 10-mile crust of the earth. Whether the bulk of the core consists chiefly of iron is of little consequence in the surface phenomena under discussion. Having a critical temperature probably above 4,500° K., iron would become a fluid sphere at an early stage. Iron alloys freely with but relatively few other metals (nickel, chromium, manganese . . .), and the nature of the residual vapors trapped in crustal rocks suggests the dominance of iron in any alloys that may constitute the earth's core. Clarke's tables show how eruptive rocks (95 percent) dominate the lithosphere, for the weighted average of all portions, including the oceans, the atmosphere, and all sedimentary rocks, differs very little from that of the eruptives; also that the hydrogen as water, the nitrogen of the air, and the carbon of living things, coal, and oil, so prominent in our lives, are almost negligible relative to other elements.

In Table 1 are given Clarke's weighted mean relative amounts of the various elements occurring in the earth's 10-mile crust, including the hydrosphere (oceans and lakes) and the atmosphere. To these have been added lists of the melting points, boiling points at present atmospheric pressure and critical temperatures, all on the absolute scale (273+° C.). The fourth column is obtained from the third by multiplying by 1.5 according to the Guldberg rule that the boiling point is always about two-thirds of the critical temperature on the absolute scale. It varies from 0.58 to 0.66 in known cases.

A temperature of 5,000° is reasonable for a planet just drawn from the sun by a passing star. At 5,000° there are, of course, *no compounds* present, and Table 1 shows that there can be *no liquids*, for all elements

<sup>1</sup> Received March 15, 1943.

<sup>2</sup> NUTTING, P. G., *Pressures in planetary atmospheres*. Journ. Washington Acad. Sci. 16: 254. 1926.

TABLE 1.—ELEMENTS OF THE EARTH'S CRUST

Element	Relative abundance	Melting point °K.	Boiling point °K.	Critical temperature °K.
Oxygen.....	46.20	54.8	90	155
Silicon.....	25.67	1680	2870	4300
Aluminum....	7.50	932	2070	3100
Iron.....	4.71	1708	3300	4900
Calcium.....	3.39	1080	1440	2160
Sodium.....	2.63	370.7	1153	1730
Potassium....	2.40	335.5	1033	1550
Magnesium....	1.93	924	1380	2070
Hydrogen....	0.87	14.0	20.4	32
Titanium.....	0.58	2070	3300	4900
Halogens.....	0.22	171 (Cl)	240	360
Phosphorus...	0.11	317	553	830
Manganese....	0.09	1530	2170	3250
Carbon.....	0.08	3800	4500	6700
S, Ba, Sr, N...	0.15	—	—	—
All others.....	0.47	—	—	—

except perhaps carbon are above their critical temperatures. Transmutations of elements, such as go on in the larger hotter stars, will have ceased except for the slow decay of a few scarce radioactive ones. Pressures near the center must have been near what they are now, about  $17 \times 10^5$  atmospheres or 12,500 tons per square inch.

At  $5,000^\circ$  such a mass of dense vapors would be subject to rapid cooling by radiation from its outer layers. Only a slight cooling would permit combinations of the elements (as oxides, carbides, etc.) with an evolution of heat amounting to a few hundreds of (kg) calories per gram. Such compounds would condense to liquids and fall back as rain to where the temperature was sufficient to vaporize and redissociate them, exciting visible *line spectra* of the elements. Thus such a mass of vapors would possess a bright *photosphere*. Chemical combination excites only band spectra and these chiefly in the infra-red. A mass of matter at  $5,000^\circ$  would in short be a violently agitated body of elementary vapors having a photosphere giving off bright-lined spectra of all elements but containing no liquids or chemical compounds except at extreme heights. The rapid transfer of heat by dissociation and combination farther out as well as by radiation and convection is being given attention by astrophysicists and is of primary importance.

At  $4,000^\circ$  conditions are vastly altered. Iron, titanium, and silicon are below their

critical temperatures and hence will largely condense to form a *liquid core*, a core containing minor amounts of tungsten, molybdenum, and other metals as alloys, and possibly a little of a few oxides and carbides in solution. There is little information on phase relations, critical temperatures, and dissociation constants at such temperatures. From the relatively low stability of iron oxides and carbides, liquid iron at  $4,000^\circ$  would be expected to float the stable carbides and oxides of other metals. In Table 2 are collected the available data on the higher melting compounds.

TABLE 2.—HIGHER MELTING COMPOUNDS

Compound	Melting temperature °C.	Boiling temperature °C.	Compound	Melting temperature °C.	Boiling temperature °C.
AlN.....	2,200	(Decomp.)	La <sub>2</sub> O <sub>3</sub> ...	2,000	4,200
MgAl <sub>2</sub> O <sub>4</sub> ..	2,135	—	MgO.....	2,800	—
Al <sub>2</sub> O <sub>3</sub> ....	2,050	2,250	MnO....	1,650	—
BaO.....	1,923	(2,000)	Mn <sub>2</sub> O <sub>4</sub> ..	1,705	—
BaSiO <sub>3</sub> ...	1,604	—	Mo.....	2,620	3,700
Be <sub>3</sub> N....	2,200	d 2,240	MoC <sub>2</sub> ....	—	4,500
BeO.....	2,570	3,900	SiC.....	2,700	—
Boron....	2,300	2,550	SiO <sub>2</sub> ....	1,700	d 2,200
B <sub>2</sub> C.....	2,350	3,500	ThO <sub>2</sub> ....	2,800	4,400
BN.....	2,730	(Subl.)	TiN.....	2,930	—
CdS.....	1,750	(Subl.)	W.....	3,370	4,727
CaC <sub>2</sub> ....	2,300	—	WC.....	2,777	(6,000)
CaO.....	2,572	2,850	UC <sub>2</sub> ....	2,260	4,100
CeO <sub>2</sub> ....	1,950	—	VrO <sub>2</sub> ....	2,830	3,900
Cr <sub>2</sub> C <sub>3</sub> ...	1,890	3,800	ZrO <sub>2</sub> ....	2,700	4,300
Fe <sub>2</sub> O <sub>3</sub> ...	1,565	—	ZrSiO <sub>4</sub> ..	2,550	—
Fe <sub>3</sub> C.....	1,875	—			

Pressures at  $4,000^\circ$ , due to the atmosphere above the liquid surface, can only be guessed without a much more complete knowledge of high-temperature compounds. That pressure was certainly more than the weight of the 10 mile crust (4,300 atmospheres or 32 tons/sq. inch) and probably less than ten times that. It was certainly well over all known critical pressures so that all elements having critical temperatures below  $4,000^\circ$  were either liquid or solid. Those having critical temperatures above  $4,000^\circ$  were vapors.

Of the few compounds probably stable (undissociated) at such temperatures and pressures, the carbides of boron, calcium, chromium, molybdenum, silicon, vanadium, and uranium and the oxides of beryllium,

calcium, magnesium, lanthanum, thorium, and zirconium seem the most likely. Other oxides and carbides than those would be too unstable to exist except as transients in the outer layers. There were certainly no nitrides or silicates of any kind. The spectrum of a planet at 4,000° would still consist chiefly of bright lines with some even reversed but all on a continuous background.

At 3,000–2,500°, while the core is still liquid iron and iron alloys, the *first solids* appear, probably as float on the liquid sphere. The list of stable oxides and carbides is the same as at 4,000°. However, some of these, such as WC and UC<sub>2</sub>, are heavier than iron and would sink in it, perhaps decomposing and losing their carbon to the iron. Of the compounds that are stable and solid at 2,500°, probably the more important are the oxides of beryllium, calcium, magnesium, and zirconium; silicon carbide (carborundum) and titanium nitride. The light carbides of boron and calcium freeze at about 2,300°, and should be abundant in liquid form at 2,500°. There is still no permanent silica or silicates as these decompose at about 2,200°. Aside from the appearance of the first stable solids the picture at 2,500° differs little from that at 4,000°.

Hydrogen and nitrogen require special consideration at this point. While according to Clarke (Table 1) hydrogen constitutes less than 1 percent of the 10-mile outer layer, it is sufficient to form all the oceans or enough to cover the entire earth to a depth of 2,600 meters or 1.6 miles. There was abundant oxygen to combine with the hydrogen; there is free oxygen today, in the air. Very little hydrogen could have been used up in hydrides for these are readily dissociated at high temperatures. Also very little nitrogen was used as nitrides for the same reason and much of it still remains free. Free carbon, however, is practically nonexistent. Clarke's data cover carbon chiefly as carbonates, hydrocarbons, and carbon dioxide, but not deeply buried carbides of which there may have been large quantities. At 2,500° there could have been no hydrocarbons or carbonates; the question is the probable division of carbon between the dioxide and the metal carbides,

particularly silicon carbide, which must have been abundant in vapor form since it sublimes far below its melting and dissociation temperatures.

Both water vapor and carbon dioxide are very stable at high temperatures as shown in Table 3 taken from Nernst's *Theoretical chemistry*, 5th English edition, p. 783; data of Bjerrum and others taken about 1912 by an ingenious and precise explosion method. Dissociations are given for six temperatures and three pressures for each gas, in percentages.

TABLE 3.—DISSOCIATION OF WATER AND CARBON DIOXIDE

°K.	Water vapor			Carbon dioxide		
	1 atm.	10 atm.	100 atm.	1 atm.	10 atm.	100 atm.
1,000..	2.58 ×10 <sup>-5</sup>	1.29 ×10 <sup>-5</sup>	0.556 ×10 <sup>-5</sup>	2.47 ×10 <sup>-5</sup>	1.14 ×10 <sup>-5</sup>	0.531 ×10 <sup>-5</sup>
1,500..	0.0202	0.00935	0.00433	0.0483	0.0224	0.0104
2,000..	0.582	0.270	0.125	2.05	0.960	0.445
2,500..	4.21	1.98	0.927	17.6	8.63	4.09
3,000..	14.4	7.04	3.33	54.8	32.2	16.9
3,500..	30.9	16.1	7.79	83.2	63.4	39.8

Log dissociation plotted against either 1/T or log pressure gives essentially a straight line. Dissociation is small except at the higher temperatures and decreases markedly at high pressures. In a contest between oxygen and silicon for the carbon it is difficult to say which would be favored but both compounds would be present.

With a surface temperature of 2,500° the earth's atmosphere at lower levels must have consisted mainly of heavy metallic vapors and the vapors of a few stable compounds of high density. These would condense at higher levels, rain down, and revaporize. Iron was probably metallic but may have been present as oxide. At intermediate and higher levels were large known quantities of water vapor (1.85 tons per square inch) mixed with large but uncertain amounts of carbon dioxide. The water would condense and rain downward much as it now does but in enormously greater volume and never reaching the surface. At the outer limits would be cool free gases.

The observed outer atmospheres of Jupiter and Saturn invite the question of what

happens when the proportion of hydrogen is large rather than small as on the earth. Abundant hydrogen, with plentiful nitrogen and but limited oxygen, would make possible the formation of much *ammonia* to form a cool, stable outer blanket, even with a core temperature of a thousand degrees.

At 1,500° to 1,200° the surface is vastly different from what it was at 2,500°. *Silica* and *silicates* have formed, some in solid others in fluid condition. All are fairly stable below 2,000°. They would cover the old core *miles deep* and suppress, chiefly as silicates, all but a few metallic vapors. At least the more volatile silicates would form the bulk of the lower atmosphere and would vaporize, rise, and reprecipitate in enormous storms. The lower layers of silicates would contain the less volatile metals, oxides, and silicates; the outer layers were probably the original igneous rock of the present lithosphere. There were still no *carbonates* and, of course, no hydrocarbons, and the water was still all in the outer atmosphere.

At 500° C. (a dull red heat) many carbonates and some hydrates, fluorides, sulphides, etc., are stable, but most of these probably formed at lower temperatures, long afterward. The oceans were still in the vapor state at high levels of the atmosphere. Most of the acid anhydrides would be stable and in the air. Surface showers would consist largely of fused and vaporized salts. They must have been huge and violent compared with any present-day storms but trivial in comparison with the snowstorms of silica in the range of temperatures from 1,800° to 2,500°. The range from 400° to 700° might be called the *chemical epoch*.

At the critical temperature of water 374° C., atmospheric pressure was about 252 atmospheres, considerably higher than the critical pressure of water, 217.8 atmospheres. Hence, condensation of a fraction (0.137) of the water vapor to liquid water occurred as soon as the temperature fell below 374° C., and 13.7 percent ( $= 1 - 217.8/252.3$ ) of the total water must have become liquid as cooling proceeded beyond that point. That fraction of the total water is sufficient to cover the entire earth to a depth of

$2,607 \times 0.137 = 357$  meters, or 1,171 feet. Local pressures in depressions may well have been several times that depth of water. Therefore in passing 374° C. pressures abruptly changed from an evenly *distributed* pressure of 252 atmospheres to one of 218 atmospheres plus *local pressures* of probably 300 atmospheres, an excess of 7 tons per square inch. This abrupt change from distributed to localized pressure was pointed out in *Science* (Oct. 1911) and further elaborated in my 1926 paper. At 300° C., two-thirds of the water was liquid and the pressure of the vapor about 85 atmospheres; at 200° C., 95 percent was liquid and the pressure 15 atmospheres.

The first oceans were therefore sizable bodies of water. Evaporation and precipitation must have been extremely rapid as was *solution* and *erosion*. Localized pressures must have caused considerable rock movements, chiefly lateral thrusts. The distribution of crustal strains must have varied considerably as the depth of the oceans increased. Some of the present elevated areas (the "positive" areas of paleogeographers) may have originated during this epoch.

The fall of mean surface temperatures below about 370° C. must have marked the beginning of the epoch of *hydration*, *solution*, and *sedimentation*—the water epoch—which is still in progress. At the higher temperatures, however, rates of solution and sedimentation must have been many times present rates. With all oceans boiling, and a continuously saturated atmosphere with copious rains of high-temperature water, all but the most insoluble rocks such as the granites, must have been rapidly eroded and redeposited. Overloaded solutions must have been abundant and violent in their activity, forming material that would later be comparable with the pegmatites. Owing to the size of the first oceans it appears doubtful whether they ever approached saturation in any constituent. Any attempt to calculate the age of the ocean on the basis of the present rate of accumulation of its salts must give results far from the truth.

Living matter and the formation of hydrocarbons from it became possible only in the

very recent thermal history of the earth when temperatures were not above 50° C. At about this stage the dense vapor blanket in the upper atmosphere, which previously had equalized polar and equatorial temperatures, probably thinned out sufficiently to permit polar regions to become cooler than equatorial. Hence, it appears probable that primitive forms of life originated in the polar regions. The carbon of all living matter, of course, all came from the CO<sub>2</sub> of the air, which is only 1 part in 30,000 of that fixed in the carbonate rocks. All this carbon is less than 0.1 percent (0.08 percent) of the earth's crust. How much more is still deeply buried as carbides we have no present means of knowing.

Attention should be called to the simple relation between the time and the temperature scales. Since the radiation (in energy per unit time) from a body is proportional to the fourth power of its absolute temperature and in this case the mass is constant, the specific heat and surface area are approximately so, and the cooling is all by radiation to space, the rate of energy loss is proportional to the rate of temperature lowering,  $dT/dt$ , which in turn is propor-

tional to  $T^4$ . Hence,

$$dT/dt = CT^4 \text{ or } T^3 = at + b, \text{ by integration.}$$

In other words  $T^3$  is a linear function of the time. The constant  $b$  depends on the chosen zero of time and  $a$  upon the time unit, years or millennia.

The writer has attempted to sketch the probable early physical history of the earth on a temperature instead of a time scale based on known physical chemical data and on the chemical composition of its surface. The subdivisions inferred are great natural epochs; all gas and vapor, the first liquid core, the first solids, the first stable silicates and the formation of the silicate crust, the formation of the first and later carbonates, the first surface water, the abrupt change in pressure distribution, and finally the formation of hydroxides and of hydrocarbons. The reasoning is speculative rather than deductive because of the lack of important data, yet the conclusions check well with known geologic facts, and it is hoped they may help to establish others. It is hoped also that it may further emphasize the value of physical chemistry in geologic studies.

OCEANOGRAPHY.—*Boundaries of the Humboldt Current.*<sup>1</sup> ELIOT G. MEARS, Stanford University. (Communicated by CLARENCE R. SHOEMAKER.)

Not until Gunther's report on the work of the *William Scoresby* became available was it possible to delineate with any degree of accuracy the boundaries of the Humboldt Current. Yet even at the present time these limits are still too indefinite to provide for the drafting of satisfactory graphs or charts. The southern boundary shifts with the seasonal march of the prevailing west wind zone; these shifts have not been determined, because the above examination occurred during the winter and did not afford data for summer, early autumn, or late spring in the Southern Hemisphere. The northern boundary vacillates with the southward approach of the warm counter-current (commonly called El Niño) during the southern summer; this advance, al-

though of annual occurrence, also has not been plotted.

Gunther's own account lacked in definition. His delimitation of the western boundary of the current proper was hindered by the invasions of warm-water wedges from the west during the time of his survey. For reasons attributed to economy, the expedition was unable to locate the western boundary of the Humboldt Current's so-called "oceanic twin" known as the Peru Oceanic Current, and, since this "oceanic twin" represents water affected by that of the Humboldt Current proper or its upwelling, naturally the westward ultimate limits of the Humboldt Current's effects have not been determined.

Furthermore, Gunther's exact data were secured in the single year of 1931. Schweigger's research, which has covered a period of

<sup>1</sup> Received March 31, 1943.

16 years, indicates that 1931 was an abnormal year; in fact, it was one of a series of three years of attempted warm water invasions of major proportions (1942, p. 37). In that one year Gunther's observations were confined to the months from May to September for the entire examination, and he laments the brevity of time allotted the work because of the impossibility it allowed for noting variations which appeared to be striking during a single month, for instance, at Callao. He pointed out that a long-continued, consistent, and more widespread investigation was necessary to interpret and correlate these variations (Gunther, 1936, pp. 169, 170, 244). Nevertheless, Gunther's report represents the most careful scientific survey of the Humboldt Current that has been made; it does afford a basis for valuable generalizations.

Gunther defines the Humboldt Current as "a narrow belt of cold water which runs up the west coast of South America roughly from Valparaiso to the Gulf of Guayaquil. . . . It is that part of the South Pacific anticyclonic circulation in which the northerly current is most conspicuous; and whose physical, chemical and biological characteristics are most affected by admixture with water upwelled from the lower layers" (p. 109). It stems from the West Wind Drift, which is a much broader portion of the same anticyclonic movement.

The origin of the water in the Humboldt Current has been a much mooted question since Alexander von Humboldt suggested that it came from the Antarctic regions (1822, vol. 2, p. 59). But since Deacon's report to the Discovery Committee in 1937, it has become known that the Antarctic Convergence, which is the northern boundary of Antarctic surface water, occurs in the eastern Pacific between 80° and 90° west longitude farther south than 60° latitude (1937, pp. 38-39). The writer has found no statement of any evidence of the Humboldt Current farther south than 47½° south latitude, and Gunther places its probable extreme southern limit at 41° south latitude (1936, p. 172). Therefore, it appears that the Humboldt Current takes its origin some 15° or more northward of the limit of Antarctic

surface water. It must be concluded that from its beginning the current is composed of subantarctic surface water.

This subantarctic surface water continues at the surface in the Humboldt Current, mixed, of course, with water upwelled at times from a warm subsurface current, until the cool current crosses the Subtropical Convergence, which Gunther located between 24° and 26° south latitude. In other words, in the southern winter of 1931, the subantarctic water remained at the surface as far north as the stretch of coast between Caldera and Antofagasta (1936, p. 159), or on about one-third of the current's early course. Over approximately two-thirds of the flow, therefore, but excluding the upwelled elements, the surface water is subtropical rather than subantarctic. Often marked by rip tides from horizon to horizon (Schott, 1935), the subtropical surface water remains at the surface until the Humboldt Current reaches its northern boundary, which is the Tropical Convergence. Here, at the surface, the Humboldt Current meets tropical water along an irregular line extending roughly from Punta Aguja to the Galapagos Islands. Since the current under discussion extends from its origin in the West Wind Drift to this northern boundary formed by the Tropical Convergence, it can be stated definitely that exclusive of upwelled elements the Humboldt Current consists at the surface of "two distinct water masses," the subantarctic and subtropical.

But since the feature that gives character to the Humboldt Current is its upwelling, Gunther assigns first importance to subantarctic water because the upwelling is drawn chiefly from subantarctic flow and comes from subsurface as well as from surface layers. At the Subtropical Convergence subantarctic water dives below the surface layer, yet it continues as a subsurface current as far as Callao. Throughout the survey of the *William Scoresby*, below the subantarctic water, indeed, below surface layers of whatever constituents, there was a southward moving, warm return subsurface current, beneath which Antarctic Intermediate water flowed northward. Normally,

the return subsurface current varied in depth from 40 to 150 meters, and reached a depth undetermined by Gunther's report, for he stated that upwelling never touched Antarctic water. Yet upwelling ranged from extremes of 40 meters to 360 meters, with a mean of 133 meters. During the period of the above examination, the surface layers and the subsurface return current were sufficiently thick to prevent the reaching of Antarctic water by the process of upwelling (1936, p. 200). This significant finding has not been accepted as yet by many leading scientists. For example, C. Vallaux (1939, p. 80), in reviewing the work of the *William Scoresby*, noted that there might be a slow rise of Antarctic Intermediate water. Sverdrup (1942, p. 189), in calculating the source of water within the Humboldt Current, includes the Antarctic Intermediate water.

Because of upwelling, Gunther's study very definitely fixes the lower boundary of the Humboldt Current at the stated 40 to 360 meters, with a mean of 133 meters, during the time of his survey; it excludes entirely all Antarctic water. Whether or not the current is deeper or shallower at other seasons and during other years remains to be shown by future investigations.

His eastern boundary appears, also, to be fixed. It is the coastline of the South American west coast between the northern and southern boundaries of the Humboldt Current. During times of normal strength and dominance of the Humboldt Current, it occupies the position inshore.

However, the writer wishes to point out that Schweigger's observations of the warm-water bands during 1939 and 1941, when the upwelling seemed to abate within the Humboldt Current, indicate a possible rise to the surface of portions of the warm, return southward-moving subsurface current. Temperatures below the surface at La Libertad, Ecuador, during 1938, point to a piling up of hot waters on the northern boundary of the Humboldt Current at the same time that the exceptionally strong Humboldt Current of 1938 reached its extreme minimum of temperature over a period of 16 years. When upwelling abated, it would appear that the pent-up, subsur-

face, warm, southward-moving current moved out more strongly. Schweigger found a warm, oceanic torrent along the outer shores of the islands in Pisco Bay during the autumn of 1939; a few miles southward of this torrent the normal Humboldt Current was encountered again. The torrent-force might be explained by the proximity of the strong Humboldt Current, which forced the return current to take its accustomed place beneath the surface.

That this theory is not entirely imaginary on the part of the writer is shown by the fact, that, when upwelling ceases along the shore washed by the California Current, the subsurface current rises to the surface and is known as the Davidson Current for the remainder of the year. But when upwelling returns in the following season, the Davidson Current disappears and there is discovered a subsurface current underneath (Sverdrup, 1941).

Therefore the writer would like to amend the statement of Gunther, and others, that the eastern boundary of the Humboldt Current is inshore along the western coast of South America between the northern and southern boundaries of that current. It is possible that it is inshore only until weak upwelling allows the rise of the warm return current to the surface.

The western boundary is far from definite. With reference again to Gunther's designation of the Peru Coastal, or more commonly called the Humboldt Current, this limit is the coastal strip of generally northward flowing water over which upwelling dominates. It must be noted that during the winter of his examination, he found it extended westward offshore approximately 30 to 130 miles from Chile, and 150 to 250 miles distant from Peru. Although he allowed considerable variation, due to the season and to warm water wedges he suspected that the modifications might exceed his appraisal (1936, pp. 109, 224). Within these longitudes, the temperature of the surface seawater dropped from 2° to 5° C. along the same parallel from the outermost stations to the innermost of those taken by the *William Scoresby*. For it is well known that the isotherms within the

Humboldt Current follow the coastline instead of assuming their normal east-west direction. The relative uniformity of the coastal cooling is caused by the upwelling, which is a distinctive characteristic of the Humboldt Current.

Therefore, the ultimate boundary of the current's influence should be along the points where the isotherms take their normal course. Since Gunther's investigations ceased before this change occurred, he pointed out that the extreme westward limits he assigned to the effects of the current were only an estimate. The area of marine, blue water affected by upwelled water from the Humboldt Current but not dominated thereby had a generally westward movement. He termed this outer flow the *Peru Oceanic Current*. He conjectured that the surface seawater, where the temperature was lowered by the upwelling along shore, extended some 300 miles seaward off the coast of Chile along the 40th parallel, and from 3,600 to 4,000 miles off the coast of Peru along the 15° parallel (1936, p. 224). The above lowered temperature limits could be detected only with a thermometer. The further westward extension of the Humboldt Current which the writer has discovered in existing literature appears in a note in *Science* (Beebe, 1926), where Dr. William Beebe reports that a captain on a United States vessel located the effects as far west as the Marquesas Islands, a distance of 3,711 miles from Callao. Perhaps it is reasonable to consider this the maximum outside limit, since this observation occurred during the most unusual year associated with the vagaries of the Humboldt Current. The date was September, 1925.

When the *Challenger* data were obtained it is assumed that conditions were not abnormal, but in the absence of records this conjecture can be questioned. It was from *Challenger* data that Thoulet (1928) reached the conclusion that the waters east of Easter Island were different in temperature, salinity, and density from those to the west. He attributed the difference to the effect of the Humboldt Current upon the waters to the east of the island; he called these waters the Easter Island Sea.

The stations of the *Challenger* were too few to enable Thoulet in 1928 to define boundaries of the Easter Island Sea other than to state that the sea was east of Easter Island. Since this island is approximately 2,000 miles westward from the South American coast in about 27° south latitude, Thoulet's finding fits roughly into Gunther's huge wedge-shaped area estimated to be affected by the Humboldt Current's upwelled waters. Indeed, Thoulet adds this one specific finding to supplement Gunther's observations and deductions.

The discovery made by Byrd's Expedition that Easter Island is situated upon the extensive Easter Island Ridge, which divides the South Pacific, appears significant to the writer because it forms the submarine demarcation between the East and West Pacific. The great submarine rise stretches from Ross Sea in the Antarctic (Roos, 1937), to the vicinity of the Gulf of California before it becomes indistinguishable from the continental shelf on the topographic map. Perhaps this ridge may be vitally related to the boundary of Easter Island Sea and to the ultimate westward effects of the Humboldt Current, for topography has a marked influence on current flow.

The northern boundary of the Humboldt Current, proper, has a seasonal variation that has not been precisely determined. Rainfall appears to be the most successful gage of the boundary's vacillation, for the dominance of the Humboldt Current is synonymous with aridity. According to rainfall records along the Peruvian coast (Eguiguren, 1894), the usual shift extends from Santa Elena Peninsula, which is the northern limit of the Gulf of Guayaquil, south to Punta Aguja. Farther west the Galapagos Islands appear to mark the normal north-south march of annual rainfall, but the data here have been secured from occasional expeditions and not from regular observations (Stewart, 1911).

Although most of the subtropical surface water is deflected westward of the Tropical Convergence, at this northern boundary of the Humboldt Current, there is evidence that some part, at least, continues as a surface current northward of that convergence.

Near the coast, according to Murphy (1939, p. 27), none of the Humboldt Current surface water reaches beyond the equator. Barlow (1938) is confident it flows at the surface northward of the Humboldt Current proper to the Gulf of Panama. Gunther (pp. 158-59) noted that a portion of the Humboldt Current surface water had sunk below the tropical water at the Tropical Convergence, and that it was still flowing north as a subsurface current at the northern extension of his survey. Fleming (1939, p. 173) found in the Gulf of Panama during the winter upwelling that the water has the character of the surface water off Peru. In other words, the extreme northern boundary of the Humboldt Current is yet to be determined.

Gunther (1936, pp. 162, 226-227) located the southern boundary during his survey on the 32nd parallel; nevertheless, he admits the possibility of an extension to the 40th parallel, in deference to Schott's chart, and he concedes a possibility of the 41st parallel as an extreme southern limit. But since Gunther actually observed the southern winter limit to be 32° south latitude, the writer prefers to retain that cold season border until further research, carried out in the same thorough manner as that of the *William Scoresby*, demonstrates the need of correction. In summer, there has been no determination comparable to the above. A characteristic feature of the Humboldt Current is the normal freedom from storms. For this reason, over a century ago Humboldt advised the use of this region for shipping, especially during such turbulent periods elsewhere (1829, vol. 6, p. 232). In January, 1939, Goodspeed's party observed that the storm-free character of the Humboldt Current protected their ship only part of the way between Valparaiso and Concepcion (Goodspeed, 1941). Thus, in the summer of 1939, the southern boundary of the Humboldt Current was between 32° and 37° south latitude. Yet it must be noted that 1939 was an unusual year of warm-water invasions.

There are other observations, but none, in the knowledge and opinion of the writer, that provide data with greater probability

of accuracy. It has seemed wise to cite these specific fragments in order to show the meagre and inconclusive character of the information regarding boundaries of the Humboldt Current. Actually, only the lower boundary has been precisely fixed, and that for but one season of an abnormal year. Until the usual boundaries are defined with greater precision, the exceptional ones, such as those of 1925 when warm water reached as far south as central Chile, can be viewed with scant profit.

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BOTANY.—*Homonyms among names of trees and fossil plants*.<sup>1</sup> ELBERT L. LITTLE, JR., U. S. Forest Service. (Communicated by WILLIAM A. DAYTON.)

The same names have sometimes been given independently both to species of living trees of the United States and to different species of fossil plants, but the number of homonyms of this type not previously corrected is relatively small. In the course of the preparation of a revised *Check list of the native and naturalized trees of the United States*, the accepted names have been checked against homonyms among fossil plants. Fortunately, only three changes in nomenclature have been necessary for the above publication, but additional names of tree species distinguished by some authors, as well as some names of fossils, are affected. It seems desirable to call attention to these homonyms among recent and fossil plants and to suggest that taxonomists working with living plants, and paleobotanists studying fossils, carefully compare their proposed new names before publication with the indexes of both groups, in order to avoid preoccupied names.

The International Rules of Botanical Nomenclature (ed. 3. 1935) apply to recent and fossil plants alike (art. 9), though a few special rules have been adopted for fossil plants. Nomenclature of fossil plants begins with the year 1820 (art. 20). A Latin diagnosis is not required for names of new groups of fossil plants (art. 38), but after January 1, 1912, names of new groups of fossil plants must be accompanied by illustrations (which serve as substitutes for duplicate specimens) in addition to the descriptions, or by references to earlier illustrations (art. 39). The rule about homonyms was changed in 1930 to reject a later homonym even if the earlier homonym is a synonym and not in use (arts. 60 (3) and 61). As a result of the change, some homonyms previously correctly used

suddenly became invalid. Also, since specific epithets long abandoned as synonyms can never be used again in the same genus, there is now a greater possibility of making unintentional homonyms in large genera of woody plants having both living and extinct species.

Names of recent plants are well indexed in standard references, such as *Index Kewensis* and its supplements and the *Gray Herbarium card-index*. Fossil plants, however, are not so thoroughly cataloged. A detailed catalog of names of fossil plants of the world, *Fossilium catalogus II: Plantae*, edited by Jongmans<sup>2</sup> is in progress. Most of the 24 parts issued since the work was begun in 1913 are about extinct groups. The following parts, however, cover seven important families of recent woody plants and should be consulted by taxonomists making new names in these groups: Pars 6, Juglandaceae (1915); pars 8, Betulaceae (1916); pars 10, Ulmaceae (1922); pars 14, Sapindaceae (1928); pars 20, Anacardiaceae (1935); pars 23, Cornaceae (1938); and pars 24, Vitaceae (1939). Additional parts of interest also to students of recent plants are: Pars 13, Muscineae (1927); pars 17, Dicotyledones (ligna), or fossil wood (1931); and pars 19, Charophyta (1933).

In 1919 Knowlton<sup>3</sup> published a catalog of the Mesozoic and Cenozoic plants of North America known at that time, which should be consulted by taxonomists making new names in genera such as woody plants also represented as fossils. All affected fossil names that were known to be later homonyms of recent species were corrected by

<sup>2</sup> JONGMANS, W., ed., *Fossilium Catalogus II: Plantae*, pts. 1-24. 's-Gravenhage, 1913-1939.

<sup>3</sup> KNOWLTON, F. H., *A catalogue of the Mesozoic and Cenozoic plants of North America*. U. S. Geol. Surv. Bull. 696, 815 pp. 1919.

<sup>1</sup> Received February 4, 1943.

Knowlton and Cockerell in Knowlton's catalog (p. 11). This catalog, however, did not cover fossils outside North America, names published after 1919, or Paleozoic fossils, though Paleozoic fossils are in extinct genera. The United States Geological Survey, Washington, D. C., has an unpublished card catalog of names of fossil plants throughout the Plant Kingdom up to the year 1933, when compilation was discontinued. This valuable and detailed card catalog is located in the division of paleontology, United States National Museum. The homonyms mentioned here are among those detected when the accepted names of native and naturalized trees of the United States were checked against names of fossils in the paleobotanical card catalog. Most of these homonyms concern European fossils, especially names published before *Index Kewensis*, and a few names appearing since Knowlton's catalog.

The three changes in nomenclature from that of Sudworth's check list required because the names were used previously for fossils are summarized below.

***Ilex amelanchier* M. A. Curt.**

SERVICEBERRY HOLLY

*Prinos dubius* G. Don, Gen. Syst. Gard. Bot. 2: 20. 1832.

*Ilex amelanchier* M. A. Curt. ex Chapm., Fl. South. U. S. 270. 1860.

*Ilex dubia* (G. Don) B. S. P., Prelim. Cat. Anth. Pter. New York 11. 1888. Not *Ilex dubia* Weber, Palaeontographica 2: 203, pl. 22, fig. 9. 1851 (fossil, Oligocene, Prussia).

Fernald (*Rhodora* 41: 424-429, pl. 559. 1939) showed by examining the type that *Ilex dubia* (G. Don) B. S. P. is the same as *Ilex amelanchier* M. A. Curt. and so took up the former name. However, as *Ilex dubia* (G. Don) B. S. P. is a later homonym of a fossil, the name *Ilex amelanchier* M. A. Curt. should be restored. This shrubby species of the Coastal Plain from New Jersey to Georgia and Louisiana becomes a small tree according to Small (Man. Southeast. Fl. 1502. 1933) and will be added to the check list.

× ***Quercus burnetensis* Little** BURNET OAK

*Quercus macrocarpa* Michx. × *Quercus virginiana* Mill.

× *Quercus coloradensis* Ashe, Bull. Torrey Bot. Club 49: 268. 1922. Not *Quercus coloradensis* Lesq., Bull. Mus. Comp. Zool. 16: 46. 1888 (fossil, Eocene, Colorado).

× *Quercus burnetensis* Little, Journ. Washington Acad. Sci. 33: 9. 1943.

× ***Quercus filialis* Little** VARILEAF OAK

*Quercus phellos* L. × *Quercus velutina* Lam.

× *Quercus inaequalis* Palmer & Steyermark, Missouri Bot. Gard. Ann. 22: 521. 1935. Not *Quercus inaequalis* Watelet, Descr. Pl. Foss. Bass. Paris 136, pl. 35, fig. 8. 1866 (fossil, Eocene, France).

× *Quercus filialis* Little, Journ. Washington Acad. Sci. 33: 10. 1943.

The two earlier fossil homonyms of *Salix lancifolia* indicated below do not invalidate the name when transferred to a variety. The variety stands as a new name, rather than a new combination (art. 16), and Andersson is not cited as original author. The same epithet may be used as a species and variety (art. 29).

***Salix lasiandra* Benth. var. *lancifolia* Bebb**

PACIFIC GRAY WILLOW

*Salix lancifolia* Anderss., Svenska Vet.-Akad. Handl. 6: 34, pl. 2, fig. 23. 1867. Not *Salix lancifolia* A. Braun, Neues Jahrb. Mineral. Geogn. Geol. Petref. 1845: 170. 1845 (fossil, Miocene, Switzerland); A. Braun ex Unger, Gen. Sp. Foss. Pl. 419. 1850. Not *Salix lancifolia* Ludw., Palaeontographica 5: 157, pl. 35, fig. 9. 1858 (fossil, Miocene, Hesse).

*Salix lasiandra* Benth. var. *lancifolia* Bebb in S. Wats., Bot. California 2: 84. 1879.

Names for several tree species recognized by some authors but not accepted in the check list are invalid as later homonyms of fossils. These include a recently described species of *Abies*, an older species of *Acer*, a new species of *Quercus*, and three hybrids of *Quercus*. Doubtless additional homonyms occur among the names of exotic and culti-

vated trees, which have not been checked. *Juglans sieboldiana* will serve as an example.

***Abies balsamea* (L.) Mill. var. *phanerolepis* Fern.** BRACTED BALSAM FIR

*Abies balsamea* (L.) Mill. var. *phanerolepis* Fern., *Rhodora* 11: 203. 1909.

*Abies intermedia* Fulling, Journ. Southern Appalachian Bot. Club 1: 93, fig. 1. 1936. Not *Abies intermedia* Saporta, Compt. Rend. Acad. Sci. Paris 94: 1021. 1882 (fossil, Pliocene, France).

***Acer rubrum* L.** RED MAPLE

*Acer rubrum* L., Sp. Pl. 1055. 1753.

*Acer stenocarpum* Britton in Britton and Shafer, North American Trees 647, fig. 598. 1908. Not *Acer stenocarpum* Ettinghausen, Denkschr. Bayer. Akad. Wiss. München 50: 20, pl. 31, figs. 10–12. 1885 (fossil, Miocene, Carniola).

Further study is needed to determine whether *Quercus grandidentata* Ewan (Bull. Torrey Bot. Club. 64: 512. 1937) is distinct. It was described from a few collections at Monrovia, Los Angeles County, Calif.; it is closely related to *Quercus engelmanni* Greene; and it may be a hybrid between *Quercus dumosa* Nutt. and *Quercus engelmanni* Greene. Also, the name is a homonym of *Quercus grandidentata* Unger (Gen. Spec. Pl. Foss. 401. 1850; fossil, Miocene, Galicia).

Another new species, *Quercus robusta* C. H. Muller (Torreya 34: 119. 1934), known only from Oak Canyon, Chisos Mountains, Tex., is not affected because the earlier homonym, *Quercus robusta* Schulze (Zeitschr. für Naturw. 60: 457. 1887; fossil, Upper Cretaceous, Baden), upon examination was found to be a *nomen nudum* (arts. 44, 45).

The name  $\times$  *Quercus dubia* Ashe (Journ. Elisha Mitchell Sci. Soc. 11: 93. 1894) should be abandoned as a name of uncertain identity as to its supposed parents and as a later homonym. Earlier homonyms are *Quercus dubia* Alm. in L. (Pl. Surinam. 15. 1775) and the fossil *Quercus dubia* Newberry (Ann. New York Lyc. Nat. Hist. 9: 31. 1868; *nomen nudum*; fossil, Miocene, Montana); *Quercus dubia* Newberry [Proc. U. S. Nat. Mus. 5: 506. 1883 (fossil; Miocene, Montana)]. The name of the fossil species

was changed to *Quercus asymmetrica* Trel. (Mem. Nat. Acad. Sci. 20: 28, pl. 12, fig. 10. 1924).

$\times$  ***Quercus ludoviciana* Sarg.** ST. LANDRY OAK

$\times$  *Quercus ludoviciana* Sarg., Trees and Shrubs 2: 223. 1913.

$\times$  *Quercus subfalcata* Trel., Proc. Amer. Phil. Soc. 56: 52. 1917. Not *Quercus subfalcata* Göppert, Tert. Fl. Insel Java 114. 1854. (*nomen nudum*; fossil, Miocene, Bohemia). Not *Quercus subfalcata* Friedrich, Geol. Specialk. Preuss. Abh. 4 (3): 257, pl. 9, figs. 4, 5. 1883 (fossil, Oligocene, Saxony).

$\times$  *Quercus ludoviciana* var. *subfalcata* (Trel.) Rehd., Journ. Arnold Arb. 7: 240. 1926.

$\times$  *Quercus ludoviciana* Sarg. is the hybrid between *Quercus falcata* var. *pagodaefolia* Elliott and *Quercus phellos* L.  $\times$  *Quercus subfalcata* Trel. is the hybrid between *Quercus falcata* Michx. and *Quercus phellos* L., and is a later homonym of a fossil. Rehder, under article 34, reduced the latter hybrid to a variety, and it seems simpler to group all the hybrids between two species, including hybrids of their varieties, all under the same name.

The relationships of  $\times$  *Quercus venulosa* Ashe (Journ. Elisha Mitchell Sci. Soc. 41: 268. 1926), described from Okaloosa County, Fla., are uncertain. Its supposed parents were *Quercus cinerea* Michx. and *Quercus caput-rivuli* Ashe, the latter originally described as a doubtful hybrid and later reduced by its author to *Quercus arkansana caput-rivuli* (Ashe) Ashe. The earlier homonym is *Quercus venulosa* (Eichwald) Eichwald (Lethaea Rossica 2 (1): 63, pl. 3, fig. 11. 1865; fossil, Russia), originally described as *Credneria venulosa* Eichwald (1853).

***Juglans ailantifolia* Carr.** SIEBOLD WALNUT

*Juglans sieboldiana* Maxim., Bull. Acad. Imper. Pétersb., sér. 3, 18: 60. 1873. Not *Juglans sieboldiana* Göppert, Tert. Fl. Insel Java 154. 1854; *nomen nudum*. Not *Juglans sieboldiana* Göppert, Tert. Fl. Schosnitz Schles. 36, pl. 25, fig. 2. 1855 (fossil, Miocene, Silesia).

*Juglans ailantifolia* Carr., Rev. Hort. [Paris] 50: 414, fig. 85–86. 1878.

It is unfortunate that the name *Juglans sieboldiana* Maxim., long in use for a species

from Japan cultivated in the United States, must be rejected because the name was given 18 years earlier to a fossil from Europe. According to Nagel (Foss. Cat. II: Plantae, pt. 6: 52. 1915), *Juglans sieboldiana* Göppert is a synonym of *J. acuminata* A. Br. A fossil variety of the Japanese species was named *Juglans sieboldiana* Maxim. *fossilis* Nath. (Svenska Vet.-Akad. Handl. 20 (2): 37, pl. 1, figs. 13-17, 18(?). 1883).

#### EXAMPLES OF DUPLICATE NAMES

An interesting example of a genus that was named among fossils before it was distinguished among living trees is *Sequoia* Endl. (Syn. Conif. 197. 1847). Though a species of living trees was named earlier *Taxodium sempervirens* Lamb. (Descr. Genus *Pinus* 2: [24]. 1824), the genus was based upon three species of fossil cones and was published with illustrations as *Steinhauera* Presl in Sternberg (Versuch Geogn.—Bot. Darst. Fl. Vorwelt. 202 illus. 1838). The more familiar name *Sequoia* Endl. has been retained by making it a *nomen conservandum*, while the older synonym, *Steinhauera* Presl, is a *nomen rejiciendum* (art. 21).

Various illustrations of homonyms that have been replaced could be cited. For example, *Juglans californica* S. Wats. (Proc. Amer. Acad. Arts Sci. 10: 349. 1875) appeared only three years before the fossil species, *Juglans californica* Lesq. (Mem. Mus. Comp. Zool. 6 (2): 34, pl. 9, fig. 14; pl. 10, fig. 23. 1878; Miocene, California). The latter was changed to *Juglans leonis* Cock. (Amer. Journ. Sci., ser. 4, 26: 543. 1908). The Miocene fossil from Alaska, *Betula alaskana* Lesq. (Proc. U. S. Nat. Mus. 5: 446, pl. 6, fig. 14. 1883) had priority over *Betula alaskana* Sarg. (Bot. Gaz. 31: 236. 1901). When the earlier use of the name was called to his attention, Sargent re-named the living species *Betula nealaskana* Sarg. (Journ. Arnold Arb. 3: 206. 1922). However, this species has since been reduced to a variety, *Betula papyrifera* Marsh. var. *nealaskana* (Sarg.) Raup (Contrib. Arnold Arb. 6: 152. 1934).

Among the more recent cases that have not been corrected is the shrubby species *Sorbus alaskana* G. N. Jones (Journ. Arnold

Arb. 20: 24, pl. 226. 1939), a later homonym of the Upper Cretaceous fossil, *Sorbus alaskana* Hollick (U. S. Geol. Surv. Prof. Pap. 159: 97, pl. 74, fig. 1. 1930).

#### FOSSILS WITH NAMES PREOCCUPIED BY RECENT TREES

The names of several species of fossils are later homonyms of names in use for recent trees of the United States. The fossils are mostly old European species that may no longer be recognized. However, if they are valid and distinct species still in the same genera and if they have not already been changed, they should be given new names by specialists familiar with them. Some of these preoccupied names of fossils that may not have been corrected are given below:

*Magnolia macrophylla* Vukotinovića, Jugoslav. Akad. Zagreb Rad 13: 202. 1870 (fossil, Miocene, Croatia). Not *Magnolia macrophylla* Michx., Fl. Bor.-Amer. 1: 327. 1803.

*Pinus resinosa* Ludwig, Palaeontographica 5: 87, pl. 18, figs. 3-4. 1857 (fossil, Miocene, Hesse). Not *Pinus resinosa* Ait., Hort. Kew. 3: 367. 1789.

*Pinus rigida* (Göppert and Berendt) Schimper, Traité Paléont. Végét. 2: 291. 1870 (fossil, Miocene, Prussia; originally in genus *Pinites*). In making this combination, Schimper remarked that there already existed a *Pinus rigida* Mill. Not *Pinus rigida* Mill., Gard. Dict. ed. 8, *Pinus* No. 10. 1768.

*Populus tremuloides* Massalongo, Piante Foss. Terz. Vicentino 146. 1851 (fossil, Miocene, Italy). *Populus tremuloides* Wessel in Wessel and Weber, Palaeontographica 4: pl. 24, fig. 2. 1855 (*nomen nudum*; fossil, Miocene, Prussia). Not *Populus tremuloides* Michx., Fl. Bor.-Amer. 2: 243. 1803.

*Quercus reticulata* (Eichwald) Eichwald, Lethaea Rossica 2 (1): 62, pl. 3, fig. 16. 1865 (fossil, Cretaceous, Russia; originally *Credneria reticulata* Eichwald (1853)). Not *Quercus reticulata* Humb. and Bonpl., Pl. Aequin. 2: 20, pl. 86. 1809.

*Rhus microphylla* Heer, Svenska Vet.-Akad. Öfv. Forh. 28: 1184. 1871 (*nomen nudum*); Svenska Vet.-Akad. Handl. 12: 117, pl. 32, fig. 18. 1874 (fossil, Cretaceous, Greenland). Not *Rhus microphylla* Engelm. ex A. Gray, Smithsonian Contr. Knowl. 3 (5) (Pl. Wright. 1): 31. 1852.

The following fossil homonym has been reduced to synonymy:

*Quercus obtusa* Knowlton, U. S. Geol. Surv. Prof. Pap. 140: 38, pl. 22, fig. 8. 1926. (fossil, Miocene, Washington). Made a synonym of *Quercus simulata* Knowlton by Brown (U. S. Geol. Surv. Prof. Pap. 186-J: 173. 1937). Not *Quercus obtusa* (Willd.) Ashe, *Torreya* 18: 72. 1918.

Though no check was made of homonyms among fossils and synonyms of recent trees of the United States, as these names would not affect the nomenclature of the check list or cause any confusion, a few later homonyms of this type were found among the fossils. An example is *Abies mucronata* (Göppert and Menge) Göppert (Schles. Ges. Vaterl. Kult. Jahresb. 48 (1870): 55. 1871; originally described in the genus *Abietites*). Not *Abies mucronata* Raf. (Atl. Journ. 120. 1832), the name upon which was based *Pseudotsuga mucronata* (Raf.) Sudw., a synonym of *Pseudotsuga taxifolia* (Poir.) Britton.

SIMILAR BUT NOT IDENTICAL NAMES

Some names of fossils and recent plants which are similar but fortunately differ slightly in spelling may be retained without confusion as distinct names (art. 70), though possibly a few might be considered orthographic variants. A partial list of these similar names follows.

FOSSIL PLANTS	RECENT PLANTS
<i>Acer grosse-dentatum</i> Heer (1859)	<i>Acer grandidentatum</i> Nutt. ex. Torr. and Gray (1838)
<i>Crataegus holmesii</i> Lesq. (1887)	<i>Crataegus holmesiana</i> Ashe (1900)
<i>Fraxinus oregonensis</i> Knowlton and Cock- erell (1919)	<i>Fraxinus oregona</i> Nutt. (1849)
<i>Juglans quadrangula</i> Ludwig (1857)	× <i>Juglans quadrangu- lata</i> (Carr.) Rehd. (1900)
<i>Pinus quadrifoliata</i> Peola (1900)	<i>Pinus quadrifolia</i> Parl. ex Sudw. (1897)
<i>Quercus neomexicana</i> Knowlton (1918)	<i>Quercus novomexicana</i> (A. DC.) Rydb. (1901)
<i>Quercus treleaseii</i> Berry (1928)	<i>Quercus treleaseana</i> A. Camus (1932)

GENERIC HOMONYMS

Apparently no generic names of living trees of the United States are later homonyms of fossil genera. However, an unimportant example of a generic name used independently in living and fossil plants is *Batodendron* Nutt. (Trans. Amer. Phil. Soc., ser. 2, 8: 261. 1843), a segregate of *Vaccinium* L., generally not used by conservative workers. The name *Batodendron* Landsborough (Ann. Mag. Nat. Hist. 13: 290. 1844) was given a year later to a Paleozoic fossil from Scotland inadequately described without specific name. An Upper Devonian fossil from Siberia was named *Batodendron* sp. Chachloff (1921).

If a detailed check of extinct genera were made with indexes of generic names of living plants, it is likely that a few homonyms would be found. Of course, if the older name is rejected as a synonym and is no longer in use, the later homonym can be retained without confusion merely by making it a *nomen conservandum* (art. 21).

An example of a generic name in use in both groups is *Berrya*. *Berrya* Roxb. (Pl. Corom. 3: 60, pl. 264. 1819; usually spelled *Berrya*, an orthographic variant by DC., Prodr. 1. 517. 1824) is a genus of one or two species of Tiliaceae. *Berrya* Knowlton (U. S. Geol. Surv. Prof. Pap. 155: 133, pl. 41, fig. 4-5. 1930), a fossil genus of uncertain position with one species, is a later homonym. This has been synonymized with *Cercidiphyllum* by Brown (Journ. Pal. 13: 492. 1939).

AVOIDANCE OF HOMONYMS

A few suggestions for avoiding the creation of additional, unnecessary homonyms among recent and fossil plants may be drawn from the examples given. Of course, persons proposing new specific names in genera having both living and extinct species, especially large genera of woody plants such as *Quercus*, should check their tentative names in the best available indexes and catalogs of both groups. Additional published catalogs or indexes of fossil plants are urgently needed by taxonomists of living plants as well as by paleo-

botanists. Schopf<sup>4</sup> has recently called attention to the desirability of continued compilation and publication of additions to the existing catalogs of American fossil plants.

Certain epithets are much more likely to be used independently for fossil and recent plants than others. Names derived from large geographical areas, such as Alaska and the States, are often repeated, but many fossils are named from a small locality where the types were collected or from the geological formation without risk of duplication. Epithets of obvious descriptive characters among certain species within a large genus containing both living and extinct species have a relatively high probability of being homonyms. Names suggesting resemblance to another species or indicating intermediate or uncertain characters may have been used before for fossils also.

As long as the number of homonyms among recent and fossil plants remains

<sup>4</sup> SCHOPF, JAMES M., *American Committee on Paleobotanical Nomenclature*. *Chronica Bot.* 7: 226-227. 1942.

rather small, the problem is not serious, and possibilities of confusion at present are slight. If the number of homonyms among the two groups should ever be greatly increased at some future date when many more species of fossils are known, possibly the same epithets could be permitted for both recent and fossil species. Most specialists do not work with both groups anyway. The greatest sources for error then would be in recent species found also as fossils in the geologically youngest deposits, such as Pleistocene. Identical names for plants and animals are permitted (art. 6), though the names repeated are mostly genera. Another possible solution would be to assign slightly different generic names to fossils that are closely related to living genera. Then the same specific epithets could be repeated in both. To some extent this practice has been followed by the use of suffixes, such as *-ites*, and *-oxylon*, and *-phyllum* in the examples *Pinites* from *Pinus*, *Araucarioxylon* from *Araucaria*, and *Sapindophyllum* from *Sapindus*.

BOTANY.—*New grasses from the Philippines and South India*.<sup>1</sup> JOSÉ VERA SANTOS, Botanical Gardens, University of Michigan. (Communicated by AGNES CHASE.)

During the progress of a study on the *Genera of Philippine grasses*, Asiatic specimens of *Garnotia*, *Isachne*, and *Sacciolepis* were found in the United States National Herbarium that were either without or with doubtful determinations. Among them is the material hitherto generally referred to *Garnotia stricta* Brongn.<sup>2</sup> At the suggestion of Mrs. Agnes Chase, studies were undertaken on the distinguishing characters of the true *Garnotia stricta* Brongn., and a comparison was made with the material formerly referred to this species. The result of this investigation led to the examination of the species of *Garnotia* and the description of a

new species. The writer is greatly indebted to Mrs. Chase, for her technical assistance in the preparation of this paper, and to Dr. Elzada U. Clover, for going over the manuscript.

***Garnotia mindanaensis* Santos, sp. nov.**

Perennis, 45-55 cm alta; culmi caespitosi, erecti, simplices, nodiis pubescentibus; vaginae glabrae, collari pubescenti et venis prominentibus; ligulae 0.2 mm longae, glabrae; laminae lineari-lanceolatae, planae, 8-25 cm longae, 4-6 mm latae; paniculae 10-18 cm longae, angustae interruptae; spiculae 4-4.5 mm longae, 0.5-0.6 mm latae, anguste lanceolatae, e dorso compressae; glumae subaequales, breviter aristatae, 3-nerves, scabrae; lemma maturum glumas aequans, lanceolatum, glabrum, 3-nerve; arista lemmate 1-2.5 plo longior; palea anguste lanceolata, membranacea, marginibus supra auriculas molliter pubescentibus; lodiculae 2, minutae, spatulatae, glabrae.

<sup>1</sup> Received February 23, 1943. Papers from the Department of Botany of the University of Michigan, no. 820. Read before the 48th meeting of the Michigan Academy of Science, Arts and Letters held at the University of Michigan, Ann Arbor, Mich., March 26-27, 1943.

<sup>2</sup> In DUPERREY, M. L. I., *Voyage autour du monde* 2<sup>e</sup>: 133-134, pl. 21. 1830.

Plants perennial, 45–55 cm tall; culms simple, tufted, erect or slightly geniculate toward the base, the nodes pubescent; sheaths glabrous, the collar pubescent, the veins prominent; ligules about 0.2 mm long, glabrous, the margin erose; blades linear-lanceolate, flat, 8–25 cm long, 4–6 mm wide, narrowed at the base, glabrous on both surfaces except for a few hairs toward the tip and the pubescence, sometimes with long hairs intermixed, above the ligule, the margins antorsely scabrous; panicles 10–18 cm long, narrow, interrupted, the branches loosely appressed; spikelets about 4–4.5 mm long, 0.5–0.6 mm wide, narrowly lanceolate, dorsally compressed, with short hairs at the base, in pairs, the members of each pair with short unequal pedicels; glumes subequal, both 3-nerved, the nerves scabrous, the middle one exerted into a short awn, the internerves glabrous; lemma at maturity equaling the glumes, lanceolate, glabrous, 3-nerved, the acute tip extending into an awn about 1–2.5 times as long as the lemma; palea narrowly lanceolate, membranaceous, enclosing a perfect flower, keeled on the back along the two lateral nerves, the margins auricled toward the base, softly pubescent from above the auricles to the tip; lodicules two, minute, spatulate, glabrous.

The type is in the herbarium of the University of Michigan, duplicate type in the U. S. National Herbarium, collected by H. H. Bartlett, no. 17235, December 6, 1940, grassland at Del Monte, Bukidnon, Mindanao Island, Philippines.

This species shows some resemblance to *Garnotia stricta* Brongn., the type species of the genus, and different collections have been referred to it. In view of this fact, a thorough study was made of the characteristics of the real *Garnotia stricta* Brongn. as proposed in 1830. Since the type specimen, which came from "Ile de Taiti," is not available, Brongniart's original description and the accompanying illustration showing the awnless lemma (pl. 21) are the only authentic bases for determining the identity of this species. The species here proposed differs from *Garnotia stricta* Brongn. in the absence of a rhizome, in the glabrous ligule, short-awned second glume, long-awned lemma, soft pubescence of the margin of the palea from above the auricles to the tip, and in the glabrous lodicules.

### *Sacciolepis glabra* Santos, sp. nov.

Annua, 40–55 cm alta; culmi graciles, erecti vel decumbentes, nodiis inferioribus radicanter; vaginae glabrae; ligulae membranaceae, 0.5 mm longae, marginibus pilosis; laminae lineares 5–12 cm longae, 3–5 mm latae, supra sparse papilloso-pilosae, marginibus scaberulis; paniculae maturae contractae, spiciformes, cylindricae, ca 2–5 cm longae, 7 mm latae; spiculae 3–4 mm longae, glabrae, a latere compressae, oblongo-lanceolatae; gluma prima quam spicula ca 3 plo brevior, subacuta, 3–5-nervis, marginibus hyalinis; gluma secunda et lemma vacuum aequalia, 11-nervia, illa gibbosa hoc basi saccatum; palea sterilis reducta; lemma fertile quam spicula ca 2 plo brevius, lanceolato-ellipticum; palea lemma aequans, utraque obscure nervosa; granum oblongo-ellipticum, subfuscum.

Plants annual, 40–55 cm tall; culms glabrous, slender, branched, erect to decumbent, rooting at the lower nodes; sheaths glabrous, slightly compressed; ligules membranous, 0.5 mm long, the margin pilose; blades linear, the tips acute, 5–12 cm long, 3–5 mm wide, the upper ones much longer than the lower, the upper surface sparsely papillose-pilose, the margins scaberulous; mature panicles contracted, spike-like, cylindric, about 2.5 cm long, 7 mm wide; spikelets 3–4 mm long, glabrous, crowded, solitary to subfascicled, laterally compressed, oblong-lanceolate in dorsal view; first glume about  $\frac{1}{3}$  as long as the spikelet, subacute, 3- to 5-nerved, the margin hyaline; second glume and empty lemma equal, both 11-nerved, the glume strongly gibbose below, the lemma more or less straight for the greater part of its length except for the saccate base; sterile palea reduced; fertile lemma about one-half as long as the spikelet, lanceolate-elliptic, pale, shining, the tip acute; palea as long as the lemma, both obscurely nerved, chartaceous-indurate; grain light brown, oblong-elliptic.

The type is in the herbarium of the University of Michigan, duplicate type in the U. S. National Herbarium, collected by L. E. Ebaló, no. 174, October 26–30, 1939, at Wawan and Dimaraga Mountains, Mansalay, Island of Mindoro, Philippines.

This species shows some relation to two Asiatic grasses, *Sacciolepis contracta* (Wight &

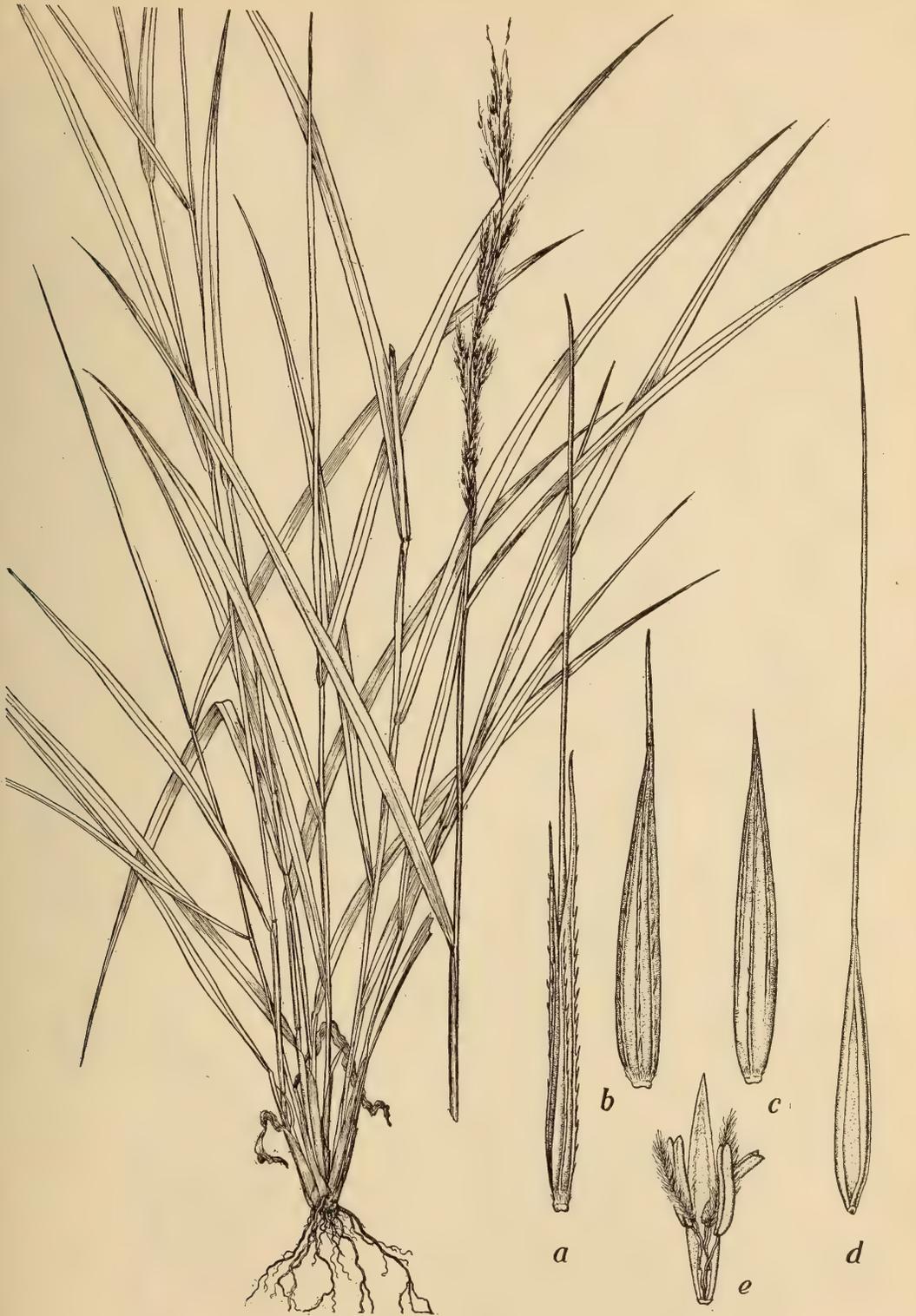


Fig. 1.—*Garnotia mindanaensis*: Habit sketch of the flowering plant,  $\times \frac{1}{2}$ . a, Side view of the spikelet; b, first glume; c, second glume; d, fertile lemma; e, palea with the bisexual flower. a-e,  $\times 10$ . (Type.)

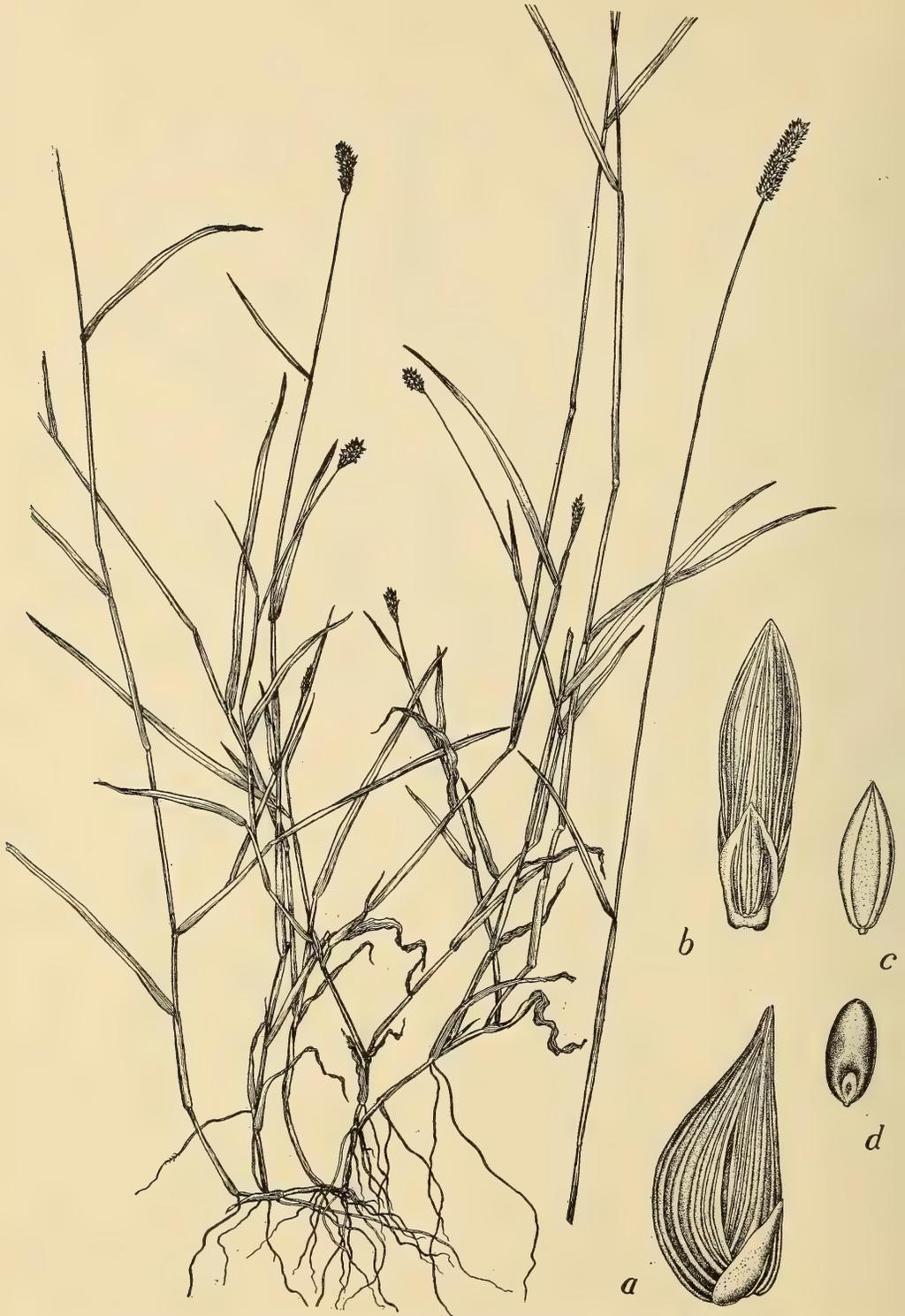


Fig. 2.—*Sacciolepis glabra*: Habit sketch of the flowering plant,  $\times \frac{1}{2}$ . *a* and *b*, Side and dorsal views of the spikelet, respectively; *c*, fertile lemma; *d*, grain. *a-d*,  $\times 10$ . (Type.)

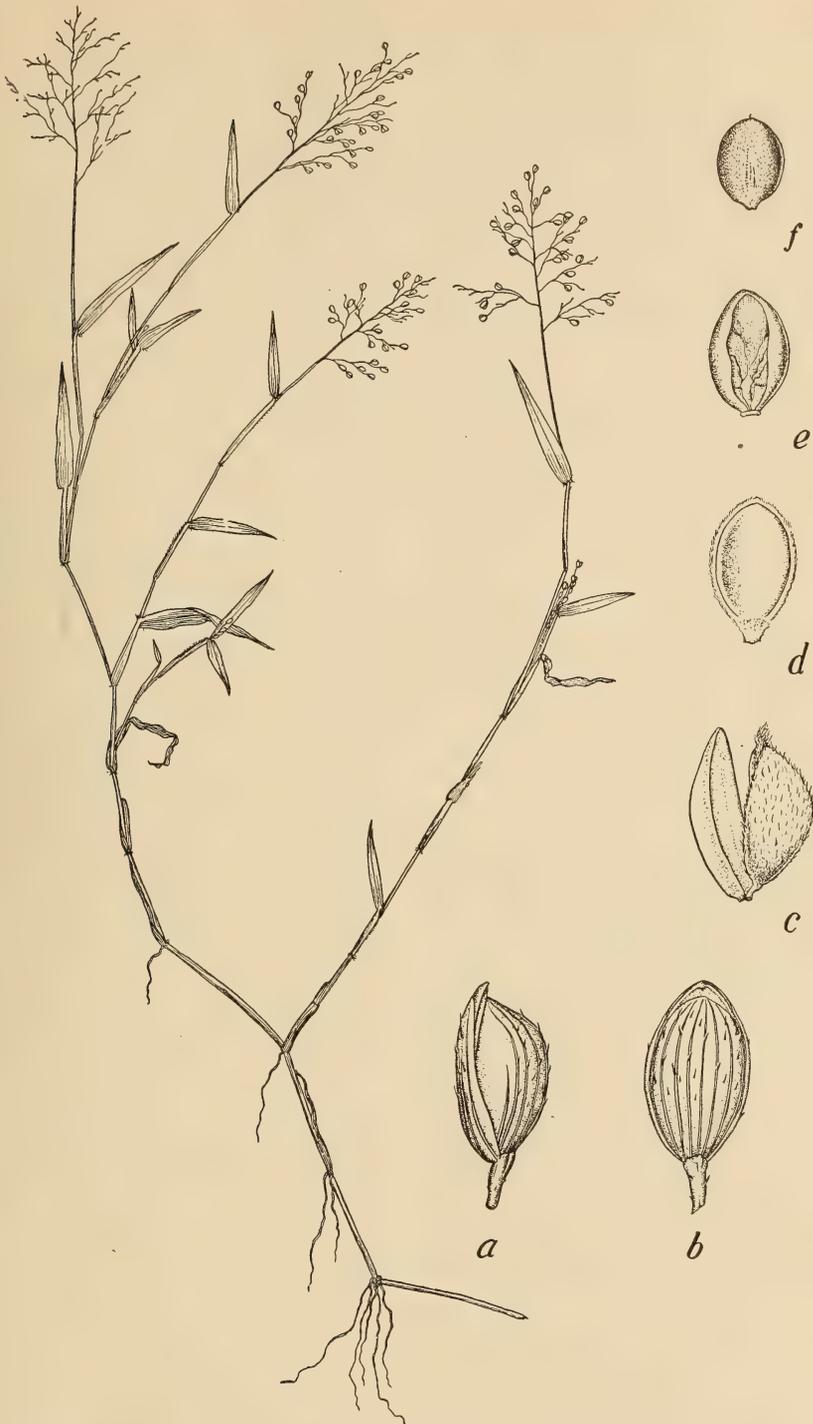


Fig. 3.—*Isachne lutaria*: Habit sketch of the flowering plant,  $\times \frac{1}{2}$ . *a* and *b*, Side and dorsal views of the spikelet, respectively; *c*, side view of the lower and upper lemmas; *d*, ventral view of the upper lemma; *e*, palea of the upper lemma enclosing the pistil, filaments, and lodicules; *f*, grain. *a-f*,  $\times 10$ . (Type.)

Arn.) Hitchc.<sup>3</sup> and *S. indica* (L.) Chase.<sup>4</sup> It differs from both in having much larger, glabrous spikelets; from *S. contracta* in its annual character, the decumbent culms, rooting at the lower nodes, the lax, sparsely pubescent blades, and shorter panicles; and from *S. indica* in its much taller habit and in the panicles, which are more than twice as long.

*Isachne lutaria* Santos, sp. nov.

Annual, ca. 30 cm alta; culmi graciles, adscendentes, ramosi, nodiis pubescentibus vel pilosis, eis inferioribus radicantibus; vaginae glabrae vel marginibus ciliatae; ligulae ciliatae pilis longis albidis; laminae lanceolatae, 2-4 cm longae, 3-5 mm latae, venis et marginibus scaberulis; paniculae ovatae, 3-5 cm longae, 2.5-4 cm latae, ramis flexuosis non glandulosis; spiculae elliptico-oblongae, 1.5-1.7 mm longae, 1-1.2 mm latae; glumae subaequales spiculum subaequant, 9-nerves, late obtusae, sparse hispidae; lemma floris masculi spiculum subaequans, membranaceum, obscure 5-nerve; lemma fertile quam spicula clare brevius, chartaceum, breviter stipitatum, obscure 5-nerve, dorso et marginibus tenuiter pubescens; palea quam lemma paulo brevior, glabra; granum orbicularo-oblongum.

Plants annual, about 30 cm tall; culms ascending, slender, branched, rooting at the lower nodes, slightly compressed, the internodes glabrous, the nodes pubescent to pilose; sheaths loose, shorter than the internodes, glabrous or the margins ciliate, the cilia gradually increasing in length toward the pilose upper portion and continuous with the fringe of long, white hairs which form the ligule; blades lanceolate, 2-4 cm long, 3-5 mm wide, the veins and margins scaberulous, the auricles papillose-pilose; panicles ovate, 3-5 cm long, 2.5-4 cm wide, the branches spreading, flexuous, nonglandular;

spikelets elliptic-oblong, 1.5-1.7 mm long, 1-1.2 mm wide, greenish to purplish; glumes subequal, about as long as the spikelet, both 9-nerved, broadly obtuse, sparsely hispidulous, the second more prominently convex than the first; staminate lemma about as long as the spikelet, obscurely 5-nerved, membranous, its palea of the same length and texture, obscurely 2-nerved; fertile lemma distinctly shorter than the spikelet, chartaceous, short-stipitate, elliptic to elliptic-obovate, plano-convex, 5-nerved, finely pubescent on the back and margin; palea slightly shorter than the lemma, ovate to elliptic-ovate, glabrous, enclosing a perfect flower; grain brown, orbicular-oblong.

The type is in the herbarium of the University of Michigan, fragment of type in the U. S. National Herbarium, collected by E. W. Erlanson, no. 5190, January 8, 1934, at the edge of a paddy field, Trivandrum, Travancore, South India.

The specific epithet refers to the muddy habitat of this grass.

While the characters of this species agree in many respects with those of *Isachne globosa* (Thunb.) O. Kuntze,<sup>5</sup> it is distinguished from the latter by the smaller spikelets, sparsely hispidulous glumes, and the short-pubescent back of the upper lemma. *Isachne globosa* (Thunb.) O. Kuntze is based on *Milium globosum* Thunberg.<sup>6</sup> Lasègue<sup>7</sup> states that Thunberg's specimens are in Stockholm, Sweden, which indicates that the type is probably in the famous herbarium of the Naturhistoriska Riksmuseet. Since present world conditions make the type inaccessible for examination, the determination of the Thunberg species is based on his original description and the topotype collected by Hisauti (U. S. National Herbarium no. 1162864), July 1921, at Yokohama, Japan.

<sup>5</sup> *Revisio genera plantarum* 2: 778. 1891.

<sup>6</sup> *Flora Japonica* 49. 1784.

<sup>7</sup> *Musée botanique de A. Benjamin Delessert* 344. 1845.

<sup>3</sup> Mem. B. P. Bishop Mus. 8: 199, fig. 90. 1922.

<sup>4</sup> Proc. Biol. Soc. Washington 21: 8. 1908.

PALEOBOTANY.—*A climbing fern from the Upper Cretaceous of Wyoming.*<sup>1</sup>

ROLAND W. BROWN, U. S. Geological Survey.

The fern described here is, so far as I am aware, the first authentic Cretaceous and earliest known species of *Lygodium* from North America. I found these specimens in a small collection made on September 29, 1913, by V. H. Barnett and J. B. Reeside, Jr., of the United States Geological Survey, in sec. 6, T. 33 N., R. 78 W., on the bank of the North Platte River, 4 miles east of Casper, Wyo. On the 1925 Geological Map of Wyoming this locality is within the area designated as Pierre shale. Shaw's (1909, pl. 9) more detailed map, depicting the Glenrock coal field, differentiates the upper part of the Pierre shale as a sandy, shaly, coal-bearing sequence, in which this locality occupies a position near coal B, which overlies what is now called the Parkman sandstone member of the Mesaverde formation, a part of the Montana group of the Upper Cretaceous. The matrix containing these specimens is a gray shale with a tinge of pink, especially when wet.

The several floras embraced by the Mesaverde formation or group and its equivalents are much in need of critical study and correlation. At most localities in New Mexico and Colorado where the Mesaverde is well developed the formation has thus far proved relatively barren, but in the vicinity of Rock Springs, Wyo., some strata associated with coal seams yield particularly beautiful, well-preserved specimens of ferns, conifers, and dicotyledons.

Besides the new species of fern, the collection from Casper, Wyo., includes several other unidentified ferns and a few dicotyledonous leaf fragments.

## SCHIZAEACEAE

*Lygodium pumilum* Brown, n. sp.

Figs. 1-5

Sterile pinnules of palmate outline, in pairs, 2 cm or less in width, generally with four lobes, which are of nearly even width

throughout but may sometimes be slightly spatulate. Tips of the lobes broadly rounded. Margins obscurely toothed. Bases cuneate to rounded, but none cordate as in some living species. Petiolules short. Primary venation the result of two dichotomies, and secondary venation generally once-forked. No fertile pinnules were found.



Figs. 1-5.—*Lygodium pumilum* Brown, n. sp.  
Natural size.

This species has the smallest pinnules of any fossil *Lygodium* known, if one rejects the very doubtful form called *Lygodium? antiquorum* Shirley (1898, p. 17, pl. 17, fig. 3) from the early Mesozoic strata of Queensland, Australia. This is a 3-lobed specimen about one-fourth the size of the pinnules of *L. pumilum*. It was thought to be a fertile pinnule, but as illustrated it is only a tantalizing outline. Consequently, judgment regarding its true identity must be reserved.

Describing the Paleocene species, *Lygodium coloradense*, from the Dawson arkose in the Denver Basin of Colorado, F. H. Knowlton (1930, p. 30) discussed the living and fossil species of *Lygodium*. It appears that the only American Cretaceous species so far reported are *L. trichomanoides* Lesquereux from the Dakota sandstone of Kansas and *L. compactum* Lesquereux from the Laramie formation of Colorado. It was Knowlton's opinion, in which I concur, that these species, founded upon single fragments neither of which can be identified with cer-

<sup>1</sup> Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received March 22, 1943.

tainty, are of little or no value. They are examples of the unfortunate practice of attaching generic and specific labels to specimens with insufficient character to warrant such distinction, with the ultimate result of bringing paleobotany into disrepute. These two specimens should be and are hereby rejected as representing identifiable species of *Lygodium*. This leaves *L. pumilum* as the only known authentic American Cretaceous species. Its diminutiveness clearly separates it from the Tertiary species.

One authentic European species, *Lygodium cretaceum* Debey and Ettingshausen (1859, p. 198, pl. 2, figs. 18-21; pl. 3, fig. 28), said to be from the Senonian of Prussia, is represented by fertile and sterile foliage. The sporangia of this species occur on the margins of leafy pinnules, a habit shown by a number of living species.

*Lygodium pumilum* resembles no living species very closely, but apparently belongs in the group that includes *L. palmatum*, the climbing fern of the eastern United States. The latter, rather rare now because it was indiscriminately collected for decorative purposes before receiving legal protection, frequents moist thickets and open woods in lowlands but may sometimes be found at elevations exceeding 2,000 feet. Most of the 40 living species of *Lygodium* now listed are tropical or subtropical. They have a lithe,

willowy attractiveness, and their dissected foliage displays great variation, which makes accurate identification of the species extremely difficult. The climbing portion above ground corresponds to the frond in nonclimbing ferns, and the foliage itself, both fertile and sterile, constitutes subdivisions of the frond, called pinnules by some and pinnae by others.

Considering that palms are also found in the Mesaverde formation, we may conjecture that *Lygodium pumilum* was a member of a floral assemblage adapted to a warmer, moister, less rigorous climate than that which prevails in Wyoming today.

I am grateful to Dr. William R. Maxon, of the National Museum, for the privilege of consultation with him during the preparation of this paper.

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ORNITHOLOGY.—*Description of a third form of curassow of the genus Pauxi*.<sup>1</sup>

ALEXANDER WETMORE, U. S. National Museum, and W. H. PHELPS, Caracas, Venezuela.

The genus *Pauxi* has been one of the least known of the interesting group of curassows in spite of the fact that the typical form was named by Linnaeus in 1766. The earliest specimens to come to the attention of students of birds apparently were obtained from Indians, and were attributed erroneously to Mexico, the Island of Curaçao, Cayenne, the upper Orinoco, and various other localities where the species is not known to exist. In 1870 Selater and Salvin recorded *Pauxi* from near Caracas, and it was determined in the years that followed that these birds inhabited the forested

mountain areas of northern Venezuela from near Caracas west to the vicinity of Mérida. Comparatively few specimens have been received in museums in the period since the latter part of the sixteenth century when Aldrovandus wrote of it under the name of the *Gallina indica alia*, until recently when its haunts have become better known. Unexpectedly, two were obtained recently by M. A. Carriker, Jr., for the Academy of Natural Sciences of Philadelphia, during work in Bolivia, in the hills above Bolívar, at 2,500 feet elevation near Palmar, in the Yungas de Cochabamba. These proved to have the casque rounded and conical instead of swollen and were described by Bond

<sup>1</sup> Received March 25, 1943.

and de Schauensee as *Pauxi unicornis*.<sup>2</sup>

From February to March, 1940, W. H. Phelps put an expedition in the field in the eastern slopes of the Sierra de Perijá, west of Machiques, in northwestern Venezuela. One of the collectors of the party purchased from Indians of the Manastara tribe living

ported a *pauji* in the adjacent forests, but none could be found during the course of the expedition. In 1942 a second necklace was received in Caracas as a gift with the assurance that it came from the Indians of the Machiques region. This second necklace was composed of beads, the bills, chest

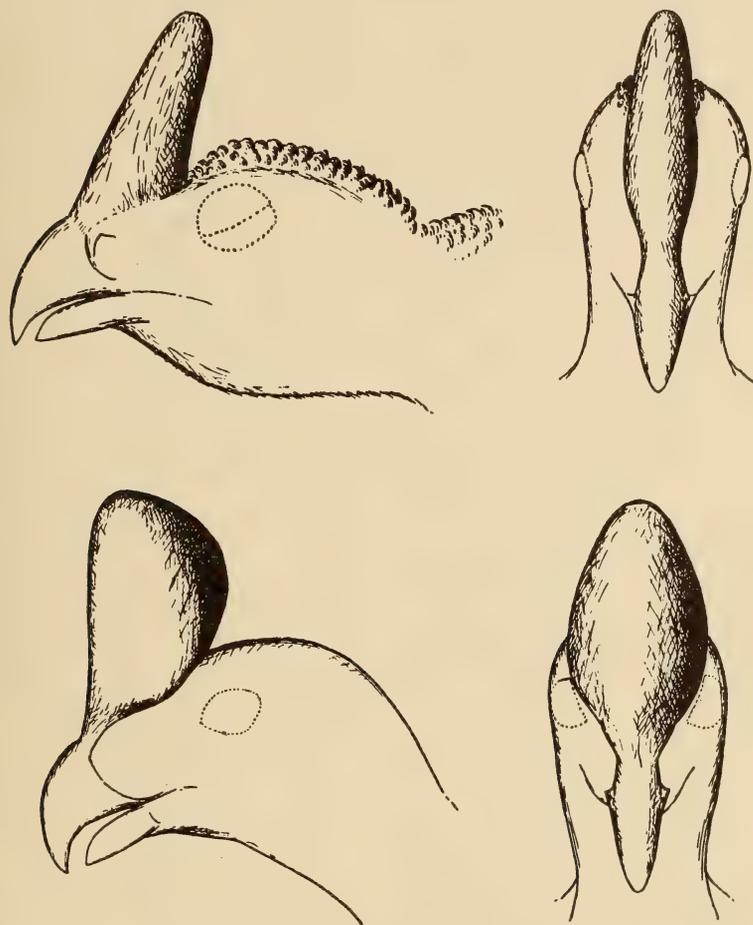


Fig. 1.—Head of *Pauxi p. unicornis* Bond and de Schauensee (above) and of *P. p. pauzi* (Linnaeus) one-half natural size, reproduced to scale, through the courtesy of J. S. Bond and R. M. de Schauensee.

at La Sabana a necklace made of beads, with decorations in the form of three head scalps of *Pauxi* composed of the upper half of the bill, the casque, and the skin of the crown down to the eyes. The Indians re-

<sup>2</sup> *Pauxi unicornis* Bond and de Schauensee, *Notulae Naturae Acad. Nat. Sci. Philadelphia*, no. 29: 1. Oct. 24, 1939.

ported a *pauji* in the adjacent forests, but none could be found during the course of the expedition.

In 1941 M. A. Carriker, Jr., collecting for the U. S. National Museum, following work with A. Wetmore through the Guajira, continued into the Sierra Negra at the northern end of the Perijá range on the Colombian side of the mountains. In this

work he secured five fine skins of *Pauxi*, a male at 1,800 feet near El Bosque back of Carriapia on June 21, a male at 1,200 to 1,500 feet near Tierra Nueva, July 21, and two adult females and one juvenile between 4,000 and 4,500 feet near Monte Elias in the same general region on August 9 and 11.

In Caracas, on comparing the scalps from the necklaces with skins from farther east in Venezuela, it was evident at once that an unknown form was concerned. After comparison there, through the kindness of Dr. William Beebe, six of the scalps, showing the variations in form, were brought to the American Museum of Natural History, where E. Thomas Gilliard made further studies with material available there and in Philadelphia, assembling much valuable information. When the series of skins in the National Museum came to his attention it seemed desirable to select one of those as type rather than one of the fragmentary heads as was first intended. As Gilliard was under necessity of undertaking other work that has taken him out of the United States, we are completing the study with the aid of additional material.

The investigation has been much assisted by the kindness of Miss Jocelyn Crane, of the Department of Tropical Research, New York Zoological Society, in photographing in Caracas the nine heads obtained from the Indian necklaces.

The hitherto unknown form may be known as—

***Pauxi pauxi gilliardi*, n. subsp.**

*Characters*.—Similar to *Pauxi pauxi pauxi* (Linnaeus)<sup>3</sup> but with the frontal casque or helmet smaller, less swollen (Fig. 2); bill smaller.

*Description*.—Type, U.S.N.M. 368540, from 1,200 to 1,500 feet elevation near Tierra Nueva, at the northern end of the Serranía de Valledupar, or Sierra Negra, slightly south of east of Fonseca, Departamento de Magdalena, Colombia. Abdomen, extreme lower breast, under tail-coverts, and tip of tail white; rest of plumage black; feathers of head and upper neck, short, thick and soft to the touch, those surrounding the eye being very small; foreneck,

breast, and sides with a greenish sheen, with each feather bordered distally with clear black, producing a dull, squamated appearance that is most prominent on the upper breast and foreneck; exposed feathers of dorsal surface, including wings and tail, also with a dull greenish cast with the wing coverts, lower hind neck, upper back, and longer upper tail-coverts margined narrowly with deep black to produce somewhat indistinct squamations; lower back and rump dull black. Bill dull red; casque blackish brown, with a wash of dull silvery gray on distal third; tarsi and toes dull reddish brown; claws blackish brown (from dried skin).



Fig. 2.—Head of *Pauxi p. gilliardi*, one-half natural size.

*Measurements*.—Males, 2 specimens, wing 354, 370, tail 305, 317, culmen from base of casque 32.1, 33.7, tarsus 110.3–112.1, length of casque (casque deformed in one bird) 58.3, width of casque 24.1, depth of casque 24.5, greatest circumference of casque 76 mm.

Females, 2 specimens, wing 336, 352, tail 290, 292, culmen from base of casque 30.4, 30.7,

<sup>3</sup> *Craz pauxi* Linnaeus, *Systema naturae*, ed. 12, 1: 270. 1766.

tarsus 102.9, 103, length of casque 53.5, 57.8, width of casque 23.9, 27, depth of casque 24, 27.1, greatest circumference of casque 76, 83 mm.

Type, male, wing 354, tail 305, culmen from casque 32.1, tarsus 110.3, length of casque 58.3, width of casque 24.1, depth of casque 24.5, greatest circumference of casque 76 mm.

*Range.*—Known from the mountain forests of the northern part of the Sierra de Perijá from 1,200 to at least 4,500 feet elevation from the region east of Fonseca, Magdalena, Colombia, around to the headwaters of the Río Negro above Machiques, Zulia, Venezuela.

*Remarks.*—It is easily apparent that the differences in the three forms of the genus *Pauxi* now known are found mainly in the casque, which varies from the cylindrical, somewhat tapering form seen in the two known specimens of *P. unicornis* to the considerably swollen, figlike shape of typical *pauxi*, with *gilliardi* coming between (Figs. 1 and 2). The feathers of the center of the crown, nape, and hind neck in *unicornis* are stiffer and are glossy, instead of soft and velvety; but tendency toward this condition is found also in *pauxi* and *gilliardi*.

Comparative measurements (in mm.) of the casque in all available material follow, those registered for *gilliardi* including the nine heads from Indian necklaces in the Phelps collection:

	11 <i>pauxi</i>	13 <i>gilliardi</i>	2 <i>unicornis</i>
Culmen, from base of casque.....	32-39	29-36	32-35
Greatest width of casque.....	28-40	19-27	20
Greatest depth of casque.....	30.5-38	21-27.1	23
Greatest circumference of casque.....	93-117	63-85	66-75

The three races will stand therefore as follows:

PAUXI PAUXI PAUXI (Linnaeus)

Mountain forests of northwestern Venezuela from near Caracas, through the Cumbre de Valencia to the Mérida region.

PAUXI PAUXI GILLIARDI Phelps and Wetmore

Forests of the Sierra de Perijá from the western slope in Colombia east of Fonseca, Magdalena, and the Montes de Oca, Guajira, Colombia, around to the head-

waters of the Río Negro above Machiques in Venezuela, probably extending much farther south.

PAUXI PAUXI UNICORNIS Bond and de Schauensee

Known from two specimens from near Palmar, Yungas de Cochabamba, Bolivia.

The form of the casque varies somewhat with age. Carriker secured a young female of *gilliardi* at Monte Elias, Magdalena, Colombia, on August 11, 1941, that apparently is not quite half grown. It already has the plumage of the adult, except that a few bright brown feathers of the young plumage are still found in the crown, some of the wing coverts and back feathers are tipped, or occasionally mottled lightly with bright brown and buff, the secondaries and tertials are mottled somewhat with bright brown and the feathers of the sides, lower breast, and legs are tipped with whitish to buffy brown. The casque in this bird is merely a rounded knob above the base of the culmen, rising about 7 mm from a base that is approximately 15 mm long and 8 mm wide. Gilliard's notes describe an immature *pauxi* in the American Museum of Natural History (no. 471586) with the casque about two-thirds developed which has the greatest circumference about 80 mm. One or two of the heads of *gilliardi* in the Phelps collection may be younger than the others as indicated by the smaller casque. The most southern race, *unicornis*, has the casque more uniformly cylindrical throughout. The two northern forms are marked by a posterior swelling that reaches its maximum development in typical *pauxi*.

Linnaeus<sup>4</sup> based the description of his *Crax pauxi* on the accounts of Aldrovandus, Willughby, Hernandez, Edwards, Brisson, and other early authors, and from these sources indicated that the bird came from "Mexico." The occurrence of the species has been in much confusion with various erroneous localities included. From present knowledge it appears probable that the few examples seen by the early writers came from Venezuela, since that is the section of the known range ordinarily accessible to the

<sup>4</sup> Systema naturae, ed. 12, 1: 270. 1766.

early travelers. We, therefore, designate the type locality as near Caracas, Venezuela, since in early days forests suitable for *Pauxi* were found near the city.

As regards the altitudinal distribution of these birds it is erroneous to limit them to the Tropical Zone. Two specimens of *Pauxi* in the Phelps collection were obtained in the Cumbre de Valencia, Carabobo at 1,440 meters (4,725 feet), and at Cubiro, Lara, at 1,900 meters (about 6,200 feet). These are in the lower edge of the Subtropical Zone.

We have pleasure in naming the new form for E. Thomas Gilliard, in recognition of his work on the material on which it is based.

*Specimens examined.*—*Pauxi p. pauxi*. Venezuela: (American Museum of Natural History) 3 ♂, 7 sex ?, Montañas del Capás, Mérida region (Briceño); 1 ♂, Limones, Río Limones, Mérida region; 1 sex?, zoo specimen; 1 sex?, "northwest Venezuela"

(mounted). (Academy of Natural Sciences of Philadelphia) 3 sex?, zoo specimens; 1 sex?, "northern South America." (Phelps collection, Caracas) 1 ♂, Cumbre de Valencia, Carabobo, at 1,440 meters; 1 ♀, Cubiro, Lara, 1,900 meters.

*Pauxi p. gilliardi*. Colombia: (U. S. National Museum) 1 ♂, El Bosque, 1,800 feet elevation, in the Sierra Negra, near Carriapia, Guajira; 1 ♂ (type) Tierra Nueva, 1,200–1,500 feet in the Sierra Negra, Magdalena; 2 ♀ adult, 1 ♀ juvenile, Monte Elias, 4,500 feet in the Sierra Negra, Magdalena. Venezuela: (Phelps Collection, Caracas) 9 heads, sex?, on the Río Negro above Machiques, in the Sierra de Perijá, Zulía.

*Pauxi p. unicornis*. Bolivia (Academy of Natural Sciences of Philadelphia) 1 ♂ (type), 1 ♀, hills above Bolívar, 2,500 feet elevation near Palmar, Yungas de Cochabamba.

MAMMALOGY.—*The systematic status of certain pocket gophers, with special reference to Thomomys monticola*.<sup>1</sup> E. A. GOLDMAN, Fish and Wildlife Service.

In various papers published during recent years the writer has made efforts to bring together in specific or near-specific groups many of the names proposed for pocket gophers during a pioneer period when systematic relationships were very imperfectly known. Our knowledge of these relationships is still far from complete, but, especially in view of the extraordinary number of names involved, some semblance of systematic order is imperative. In dealing with the names the term "group" may conveniently be used rather loosely to designate either an aggregation of subspecies or an assemblage of closely allied species.

In "Remarks on Pocket Gophers, with Special Reference to *Thomomys talpoides*" (Journ. Mamm. 20: 233. May 14, 1939), I traced the local range of the *Thomomys talpoides* series south in western Washington to the Columbia River. The apparent replacement of populations of the *talpoides* type by the *Thomomys monticola* series in the Pacific coast region south of the Columbia River was also noted, but the subspecies were not formally segregated, and such

confused combinations as *Thomomys douglasii oregonus* Merriam have remained in current literature. At the suggestion of Gerrit S. Miller, Jr. certain names are here revised in order to make them available for inclusion in a new list of North American mammals being prepared by him.

LIST OF SUBSPECIES OF THOMOMYS MONTICOLA,  
WITH TYPE LOCALITIES

*Thomomys monticola monticola* Allen: Mount Tallac, Eldorado County, Calif.

SYNONYMS.—*Thomomys monticola pinatorum* Merriam: Sisson, west base of Mount Shasta, Siskiyou County, Calif.; *Thomomys monticola premaxillaris* Grinnell: 2 miles south of South Yolla Bolly Mountain (7,500 feet), Tehama County, Calif.

*Thomomys monticola oregonus* Merriam: Ely, near Oregon City, Willamette Valley, Clackamas County, Ore.

*Thomomys monticola hesperus* Merriam: Tillamook, Tillamook County, Ore.

*Thomomys monticola niger* Merriam: Seaton, near mouth of Umpqua River, Douglas County, Ore.

*Thomomys monticola mazama* Merriam: Anna

<sup>1</sup> Received March 11, 1943.

Creek, near Crater Lake, Klamath County, Ore.

*Thomomys monticola helleri* Elliot: Gold Beach, mouth of Rogue River, Curry County, Ore.

SUBSPECIES OF THE *THOMOMYS UMBRINUS* GROUP NOT PREVIOUSLY RECOGNIZED AS SUCH

*Thomomys umbrinus quercinus* Burt and Campbell: Peña Blanca Spring, altitude 4,500 feet, near Mexican boundary, north of Monument 128, Pajarito Mountains, Santa Cruz County, Ariz.

*Thomomys umbrinus proximus* Burt and Campbell: Old Parker Ranch (Pickett's Ranch on U. S. Geological Survey topographic map, Patagonia Quadrangle, edition of August 1905), altitude 4,800 feet, west slope of Santa Rita Mountains, Pima County, Ariz.

SUBSPECIES OF *THOMOMYS BOTTAE* HITHERTO TREATED AS DISTINCT SPECIES

*Thomomys bottae magdalenae* Nelson and Goldman: Magdalena Island, Lower California, Mexico.

*Thomomys bottae martirensis* Allen: San Pedro Martir Mountains (8,200 feet), Lower California, Mexico.

Additional specimens of *Thomomys bottae collinus* Goldman, from Fly Park (9,000 feet), Chiricahua Mountains, Ariz., indicate that the characters ascribed to *Thomomys umbrinus chiricahuae* Nelson and Goldman, from Pinery Canyon (7,500 feet), Chiricahua Mountains, Ariz., are within the range of individual variation in that subspecies. The name *Thomomys umbrinus chiricahuae* should, therefore, be placed in the synonymy of *Thomomys bottae collinus*.

ICHTHYOLOGY.—*The osteology and relationships of the bathypelagic fishes of the genus Bathylagus Günther with notes on the systematic position of Leuroglossus stilbius Gilbert and Therobromus callorhinus Lucas.*<sup>1</sup> WILBERT McLEOD CHAPMAN, California Academy of Sciences. (Communicated by LEONARD P. SCHULTZ.)

This report describes the bony structures and the gross visceral anatomy of the genus *Bathylagus*, discusses its relationships, and defines the family Bathylagidae. A brief account is given of the anatomy of *Leuroglossus stilbius*, and reasons why it should be placed in the Bathylagidae rather than the Argentinidae are listed. *Therobromus callorhinus*, known only from bones found in the stomachs of the fur seals of the North Pacific, is identified as a species of *Bathylagus*.

The genus *Bathylagus* comprises at present 16 species of fishes, 8 of which have been described in the past 12 years. Representatives occur on both sides of the North and South Atlantic Oceans, in the Antarctic, off the west coast of North America from southern Mexico to the Bering Sea, and in the Okhotsk Sea. They typically inhabit deeper water layers outside the continental shelf (Norman, 1930; Parr, 1931 and 1937; Beebe, 1933; Chapman, 1939 and 1940), al-

though *B. argyrogastrer* has been taken toward the surface layers (Norman, 1930).

*Bathylagus* was originally placed by Günther (1878) in the Salmonidae. Regan (1909 and 1914) considered it to be a member of the Argentinidae, and Norman (1930), Parr (1931), Beebe (1933), and others have followed him. Jordan and Evermann (1896) placed it in the Microstomidae, as did Barnard (1925) and others. In recent years it has been placed both in the Argentinidae and Microstomidae by the compilers of the Pisces section of the Zoological Record. Gill (1884), with his usual keen insight, erected for the genus the family Bathylagidae by name only, but Goode and Bean (1895) gave a diagnosis of the family. Gill's classification has been followed by Jordan (1923), Jordan, Evermann, and Clark (1930), Fowler (1936) Parr (1937), and most recently by Berg (1940).

This study is based upon dissections of *Bathylagus pacificus* Gilbert taken by the International Fisheries Commission in the Gulf of Alaska and off the coast of British

<sup>1</sup> Received February 11, 1943.

Columbia. The illustrations are based on an adult female, with well-developed eggs, taken off the west coast of the Queen Charlotte Islands, IFC station 321c (Thompson and Van Cleve, 1936). Diagnoses have been made on specimens of *B. alascanus* Chapman and *Leuroglossus stilbius* Gilbert. Unless otherwise mentioned, references to the anatomy of *Argentina*, *Microstoma*, and *Macropinna* are based upon dissections by the writer.

It is a pleasure to acknowledge the kindness of H. A. Dunlop, director of investigations, International Fisheries Commission, in allowing me to work on their specimens of *Bathylagus* and *Macropinna*; Dr. George S. Myers, Stanford University, in providing me with a specimen of *Leuroglossus*; and Dr. Leonard P. Schultz, curator of fishes, U. S. National Museum, for the loan of specimens of *Argentina* and *Microstoma*.

#### ANTORBITAL PORTION OF CRANIUM

Ethmoid cartilage (Figs. 1-3) restricted in extent by size of ethmoid and prefrontal ossifications; extending anteriorly as broad, flat plate between dorsal and ventral ethmoid bones; thickest between prefrontals where it rises to frontals and shows between them; pierced on inner edge of prefrontals by foramina of olfactory nerves; extending unbroken under frontals to sphenotics, thus separating orbitosphenoid and alisphenoids from frontals; ventral surface flat, with palatine synchondrized along entire edge anterior to prefrontals as in *Macropinna* (Chapman, 1942b); running posteriorly for short distance along parasphenoid.

Mesethmoid (Figs. 1, 3) consisting of a nearly circular, flat plate, which forms greater part of rostral plate, and a strong buttress, which rises from dorsal surface of this plate to meet frontals.

Ventral ethmoid (Fig. 2) a thin circular plate like mesethmoid above it; shallowly concave on ventral side; perhaps homologous with similar bone in certain osmerids (Chapman, 1941b).

Frontals (Figs. 1-3) everywhere separate, with cartilage exposed between them posteriorly, anteriorly, and between orbits; lying over only a portion of edges of sphenotics and supraoccipital posteriorly; sloping evenly and gently downward from supraoccipital to mes-

ethmoid. Each bone bearing on its lateral edge a high and prominent trough in which frontal extension of lateral line system lies and to which broad, thin supraocular and postfrontal of circumorbital series are attached membranously; these structures probably special ossifications of sensory system, but indistinguishably fuse with frontals; higher anteriorly than width of frontals between them and responsible for concavity of interocular region; formed from extremely thin bone and quite separate from broad supraorbitals.

Prefrontals (Figs. 1-3) thin, broad ossifications of nearly circular shape in lateral ethmoid cartilage, with very thin lateral edges.

Parasphenoid (Figs. 2, 3) long, slender, and straight, extending from ventral ethmoid to basioccipital; concave on ventral surface under ethmoid, with broad posterior shaft of vomer lying in cavity; heaviest and widest where it reaches prootics; posterior extension of bone thin and lying flatly in shallow concavity of basioccipital. No true myodome. Parasphenoid flatly attached to prootics and heavy cartilage between those bones so ocular muscles attach in shallow concavity formed by short wings of parasphenoid and bulky ventral edges of prootics.

Vomer (Figs. 1-3) heavy and large, projecting anteriorly beyond ethmoid structures; on anterior edge bearing 30 to 32 conical teeth, which are set in sockets in bone, project slightly anteriorly as well as ventrally, and form entire dentition of upper jaw; a notch in bone at lateral corner of dentigerous area into which anterior end of palatine fits; long, broad, median shaft projects back in concavity of ventral ethmoid to end on parasphenoid.

#### POSTORBITAL PORTION OF CRANIUM

Cartilage of postorbital portion of cranium everywhere restricted in extent (Figs. 1-3); reduced to narrow bands, which disappear between supraoccipital and epiotics; expanded between supraoccipital and sphenotics, but these areas covered by parietals; somewhat expanded between epiotics and exoccipitals; greatest expansion between basioccipital and prootics, but considerable part of this covered by parasphenoid; sockets of hyomandibula lines with cartilage.

Dorsal surface of postorbital portion of

cranium with no prominent ridges or depressions, sloping gently and evenly from parietals to posterior edge of pterotics without definite temporal fossae, and sloping between conical tips of epiotics and supraoccipital down to foramen magnum.

Supraoccipital (Figs. 1, 2) broad and shield-shaped, forming prominent portion of dorsal surface of cranium; anterolateral edges of bones covered by parietals; lateral portion of anterior edge covered by frontals, but median portion exposed; bluntly pointed posterior end sloping downward, but broadly separated from foramen magnum by epiotics and exoccipitals; short, sharp vane of bone projecting from midline, on which originate two thin but tough muscles, which extend back between myomeres and along distal ends of interneurals to origin of dorsal fin.

Thin, scalelike parietals (Figs. 1, 3) widely separated by supraoccipital, partially covering sphenotics and supraoccipital and completely covering cartilage between those bones.

Epiotics (Figs. 1, 3) prominent, conical bones meeting broadly behind supraoccipitals, receiving ligament from dorsal fork of posttemporal on blunt tip of bone, and each with deep concavity on posterior surface.

Sphenotics (Figs. 1-3) prominent bones with considerable dorsal, lateral, and anterior surface. Socket of hyomandibular resting not so much on sphenotic as upon cartilage between that bone and prootic.

Pterotics (Figs. 1-3) with socket of hyomandibular angling across entire ventral surface of each bone. From dorsal surface a long, bulky column of cartilage, which joins ventral and dorsal surfaces internally, can be seen.

Alisphenoids (Figs. 2, 3) large bones providing anterolateral protection for brain; separated from prootics, sphenotics, and orbitosphenoid by slender bands of cartilage, and everywhere separate ventrally.

Orbitosphenoids (Figs. 2, 3) meeting mesially but not completely fused; from ventral edge a very thin strand of ossification extends into interorbital membrane; olfactory nerves emerging between bones anteriorly.

Ventral side of cranium marked by triangular expansion of basioccipital and prootics, in which the large otoliths lie. Otolith capsules not projecting ventrally as much as in *Macropinna* or the osmerids.

Prootics (Figs. 2, 3) largest bones of ventral surface of cranium, marked by otolith expansions and by small posterior foramen of trigemino-facial complex; these two foramina separated by thin, strongly ossified bridge, which forms sharp ridge setting off anterior from ventral surface of bone; bones separated ventrally by broad, thick band of cartilage; anterior end of this cartilage much thickened and slightly concave, with shallow concavity between it and parasphenoid. Posterior eye muscles inserted in this area.

Each exoccipital (Figs. 1-3) strongly concave on ventral side with two foramina in posterior part of concavity, the posterior of which is much the larger; posterior projection of bone lying along condyle of basioccipital, sending process dorsally, separated from similar process of other exoccipital by narrow band of cartilage; these two processes form sides and roof of foramen magnum but do not form part of condyle and do not articulate with any process of first vertebra; concavity of posterior surface of epiotic continued on posterior surface of exoccipital.

Constricted posterior end of basioccipital (Figs. 1-3), which forms occipital condyle, heavily ossified and bearing ridges of denser ossification ventrally and laterally; ventral surface of bone shallowly concave anteriorly.

Opisthotic (not shown in Fig. 3) tiny and oblong; in some specimens lying entirely on exoccipital midway between foramen of vagus nerve and lateral edge of bone, and in others lying more laterally and partially resting on cartilage between exoccipital and pterotic; curving around posterior edge of exoccipital and thus with a small posterior surface which is not visible dorsally; receiving ligament from ventral fork of posttemporal.

#### SPECIAL OSSIFICATIONS OF SENSORY SYSTEM

All bones associated with extension of lateral line system over head thin and weak, most with no tubes developed for protection of nerves, but acting merely as supports. Nasal thin, slender, semitubular, and almost flattened; lying directly over nasal capsule; by no means so big or broad in my specimens as in Beebe's (1933, fig. 37). Six bones of circumorbital series as shown by Beebe, except that in my specimens postorbital considerably larger than supraorbital. It is interesting to note the turn evolu-

tion has taken in the big-eyed *Bathylagus*, whose eyes are placed laterally and strongly protected dorsally by the expanded supra-orbital and postorbital; whereas in the big-eyed *Opisthoproctus* (Trewevas, 1933) and *Macropinna* (Chapman, 1942b), which have the eyes dorsally directed, these bones are absent and the eyes are protected by enormously expanded suborbitals, bones that are weakly developed in *Bathylagus*.

A semitubular bone, attached to sphenotic directly behind eye, bridging gap for nerve

ankylosed to that bone. Ossified tube for nerve present on mandible, securely ankylosed to both dentary and angular.

#### UPPER JAW

Premaxillary and maxillary thin and delicate, neither bearing teeth nor having gape edge thickened for that purpose (Fig. 4); upper jaw loosely bound to cranium by delicate membranes only, neither bone equipped with anterior condyle for attachment to cranium; anterior end of premaxillary lying in groove be-

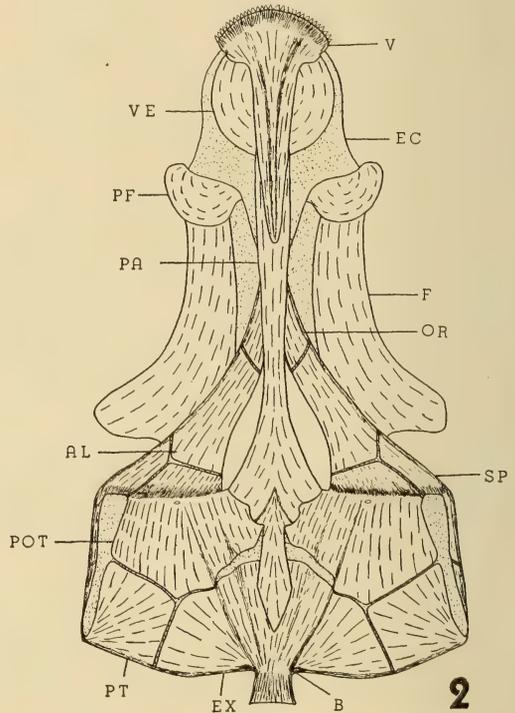
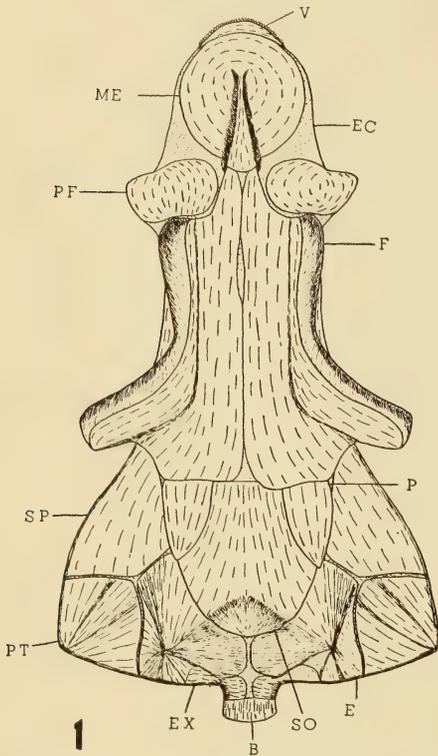


Fig. 1.—Dorsal view of the cranium of *Bathylagus pacificus*. Fig. 2.—ventral view of the cranium of the same.  $\times 3.2$ .

between sphenotic and preopercle. Nerve encased in tube on dorsal arm of preopercle, but on ventral arm this tube opens ventrally to become trough. A short tube protects nerve on lateral face of opercle, projecting downward from condyle. Protection for nerve over sphenotic and pterotic irregular, not tubular and exceedingly flimsy. Lightly ossified tissue lending some support to nerve between cranium and supraclithrum. Nerve running ventrally on supraclithrum in trough of thin bone securely

tween anterior end of mesethmoid and vomer, not meeting premaxillary of other side; bound rather loosely to premaxillary but not to palatine. No supramaxillary found in any specimen (such a bone is shown by Beebe, 1933, in fig. 36, but not in fig. 39, and is not mentioned by him in the text).

#### MANDIBLE

Mandible (Fig. 4) consisting of dentary, articular, angular, sesamoid articular, Meckel's

cartilage, and a superficial ossified tube for mandibular branch of lateral line system. Dentary forming greater part of mandible, so thin that sesamoid articular can be seen through it in stained specimens; overlying considerable portion of articular; bearing 82 teeth in specimen drawn, which are conical, small, and closely pressed together in a single series.

interior shaft of articular to a similar but slenderer shaft on inner side of dentary; not thick, but broad posteriorly. Sesamoid articular thin and of irregular shape, with longest axis anterior-posterior, and area about one-third that shown for articular (Fig. 4); lying principally on dorsal edge of Meckel's cartilage, but extending also onto articular and dentary. Thin

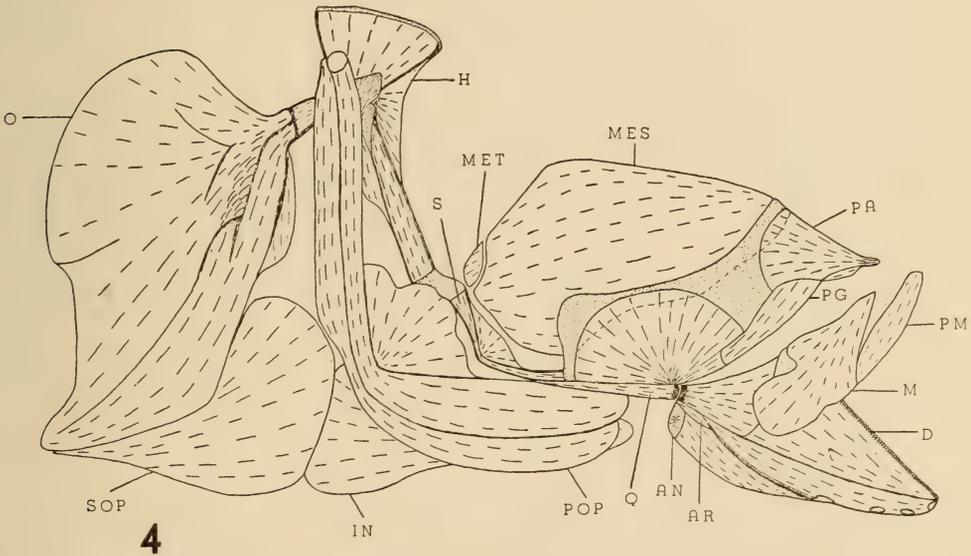
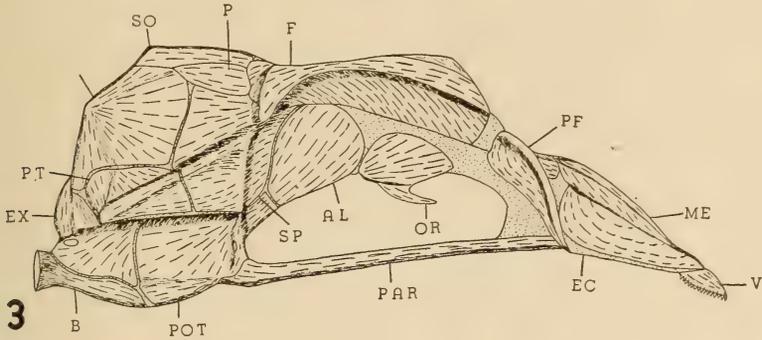


Fig. 3.—Lateral view of the cranium of the *Bathylagus pacificus*. Fig. 4.—Lateral view of the suspensorium of the same.  $\times 3.2$ .

Angular small but heavily ossified, receiving broad ligament from interopercle. Articular triangular with heavily ossified socket of articulation at apex, with strong, thick shaft of bone extending forward from socket on mesial side, presumably ossification of posterior third of Meckel's cartilage.

Meckel's cartilage about one-third length of mandible, extending from above-mentioned

ossified tube for mandibular branch of lateral line system on external side of dentary and articular, obviously a special ossification of sensory system but indistinguishably fused to the mandibular bones. Sensory canal communicates with exterior by means of four pores in the bone.

PALATINE ARCH

Palatine (Fig. 4) securely joined along entire

dorsal edge to ethmoid cartilage as in *Macropinna*, thus forming firm support between bones of oral cavity and cranium; band of cartilage behind palatine also participating in this junction. Anterior end of palatine more heavily ossified than rest of bone and inserted in cavity between vomer and ethmoid cartilage; no teeth on palatine of specimens examined, but since vomerine dentition extends posteriorly under anterior tip of palatine, the latter appears to bear a few teeth until a complete dissection is made.

Pterygoid (Fig. 4) simple, well-ossified bone joining palatine and quadrate together strongly, overlapping both bones laterally as well as mesially.

Quadrate (Fig. 4) has form of nearly half a circle, with small but heavily ossified condyle; slender process projecting posteriorly along preopercle and symplectic, thus binding palatine and hyoid arches together and binding both to preopercle.

Broad band of cartilage around quadrate forms broad patch between quadrate and palatine and extends around end of latter to synchondrize with ethmoid cartilage. This does not extend posteriorly along symplectic. Simple, thin membrane between symplectic and mesopterygoid.

Mesopterygoid (Fig. 4) broad, thin and very similar to same structure in *Macropinna* and *Opisthoproctus* (Trewavas, 1933); ventral edge lies under quadrate and palatine (dotted line in Fig. 4), and entirely mesial to cartilage of this region, to which it is tightly bound. Bone appears to be an ossification of membranes of roof of mouth and therefore not properly considered with cartilage bones of palatine arch. Metapterygoid either absent or represented by small bit of bone behind mesopterygoid (Fig. 4). Of same structure as mesopterygoid and separated from that bone by thin membrane only; doubtfully homologous with metapterygoid of other isospondylous fishes.

#### HYOID ARCH

Hyomandibular (Fig. 4) articulating along full lateral surface of pterotic and sphenotic as in *Macropinna* and *Opisthoproctus* (Trewavas, 1933). Articulation anteriorly on cartilage between sphenotic and prootic. Opercular condyle nearly as long as articular head although much slenderer, leaving considerable open

space between opercle and preopercle. High, thin wing of bone extending from lateral side of hyomandibular at level of opercular condyle attached by membranes to preopercle and adjacent bone of circumorbital series. Truncus hyoido-mandibularis facialis nerve pierces bone in large foramen which extends nearly straight ventrally from inner to outer side of bone to emerge on thin wing of bone on posterior side of shaft of hyomandibular. Wing of thin bone present in anterior angle between articular head and ventral shank of the bone.

Column of cartilage between hyomandibular and symplectic (Fig. 4) with characteristic anterior twist so that symplectic does not continue in direct line with ventral shaft of hyomandibular. A similar condition is found in *Opisthoproctus* (Trewavas, 1933). Interhyal articulates with mesial side of this cartilage.

Symplectic (Fig. 4) a semicylindrical shaft bent forward near its middle to form an approximately right angle with wing of thin bone in angle. Symplectic extends to, but not beyond, cartilage around posterior edge of quadrate.

Hyoid apparatus (Fig. 5) consisting of interhyal, epihyal, ceratohyal, two hypohyals, a glossohyal (Fig. 6, not Fig. 5), and two broad and thin branchiostegal rays, except for latter all bones sturdy and thick, being heaviest bones of skull. Branchiostegal rays inserted entirely on cartilage surrounding ventral side of epihyal. Ceratohyal constricted in its middle and with numerous irregular ridges of denser ossification there. Posterior two-thirds of glossohyal (Fig. 6) ossified; anterior broader third cartilaginous. Dental cement bone covering most of dorsal surface of cartilage and extending back onto ossified portion of element. It bears no teeth, but since it presents a hardened, fairly sharp, and slightly upturned anterior edge, it conceivably may be of considerable aid in handling live food.

#### OPERCULAR APPARATUS

All four opercular elements present (Fig. 4); all thin, flexible bones. A few rays of denser ossification radiate outward from socket of articulation of opercle. Short tube protecting portion of lateral line system running downward from articulation along exterior face of that bone. Subopercle extends into space between opercle and preopercle but does not fill it. Por-

tion of posterior edge of bone covered by opercle. Long, slender interopercle nearly covered by horizontal arm of preopercle; its anterior end attached by a broad ligament to angular and posterior end securely attached by membranes to subopercle. Broad wing of thin bone present in angle of preopercle. Sensory canal tubular on vertical arm of preopercle and with numerous small openings to surface dorsally, but ventral edge of canal separated from main

bone on horizontal arm and tube becomes a trough. An interspace present between vertical arm and lower end of hyomandibular, and between horizontal arm and symplectic, both closed only by thin membranes.

## GILL ARCHES

First three basibranchials (Fig. 6) ossified but cartilaginous on both ends; ossified portions of all three round in cross section. Last

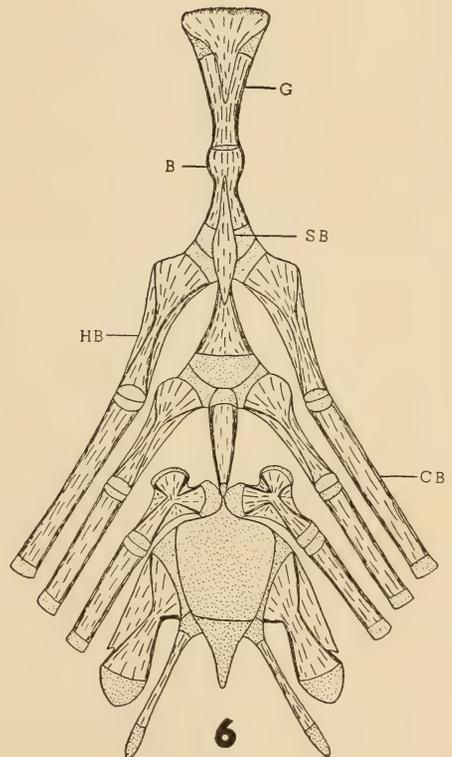
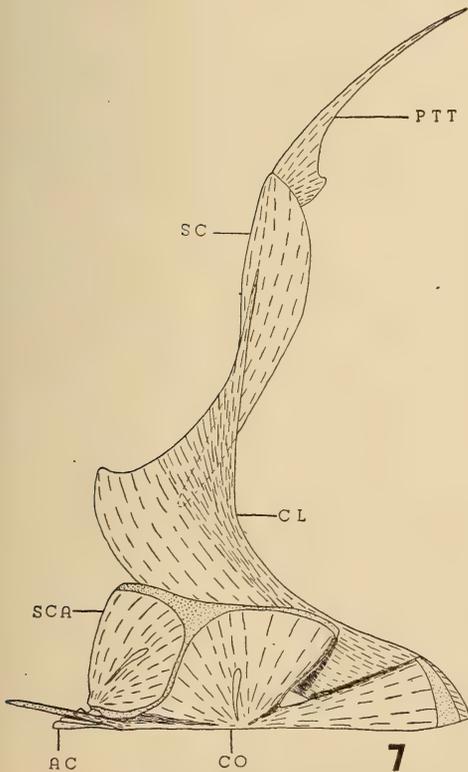
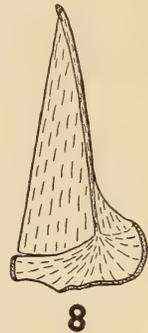
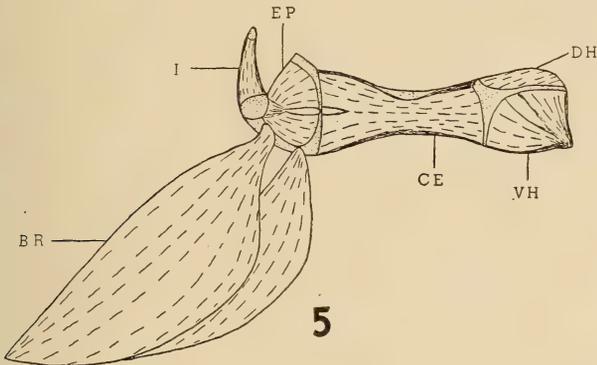


Fig. 5.—Lateral view of the hyoid apparatus of the *Bathylagus pacificus*. Fig. 6.—Dorsal view of the ventral half of the gill arches of the same. Fig. 7.—Mesial view of the shoulder girdle of the same. Fig. 8.—Dorsal view of the right pelvic bone of the same. All figures are  $\times 3.2$ .

two basibranchials entirely cartilaginous, presenting a flat dorsal surface but with a constriction marking off two on ventral surface. Dental cement bone joining dorsal surfaces of first and second basibranchials and covering a portion of cartilage between them, probably homologous with larger element in same position in osmerid fishes and *Plecoglossus* (Chapman, 1941a). It bears no teeth.

Hypobranchials (Fig. 6) present on first three arches. Those of third arch with anterior process, which projects ventrally to a slight degree. One can visualize the possible origin of the peculiar third hypobranchial of the Osmeridae and Plecoglossidae from this structure. If the posterior process (the main portion of the bone) diminished to nothing, until the ceratobranchial touched the fourth basibranchial, and the anterior process elongated and turned more ventrally until it surrounded the ventral aorta the osmerid third hypobranchial would be achieved.

Ceratobranchials (Fig. 6) on all five arches. First three bent dorsally a little at middle. Small muscle that originates on the hypobranchial inserted on slight projection from ventral side of bone at this bend. Fourth ceratobranchial broad, somewhat thickened and constricted anteriorly to an hour-glass shape. Wide shelf of thin bone present in lateral (or anterior) angle on which broad muscle extending dorsally to expanded fourth suprabranchial originates. Fifth ceratobranchial a slender, weak bone, which bears no teeth.

First three epibranchials ossified, and each bears, near mesial end of dorsal side, a cartilage-capped process that articulates with similar processes from, respectively, the second, third, and fourth suprabranchials. This process largest on third epibranchial. Fourth epibranchial entirely cartilaginous and reduced to band of cartilage attached firmly to ventral edge of expanded fourth suprabranchial.

No suprabranchial found on first arch. Second small and flat with dorsoanterior process reaching to first epibranchial and a smaller dorsoposterior process articulating with third suprabranchial. Third suprabranchial more elongate because of long anterior process. Fourth suprabranchial broadly expanded and little resembling others; turned nearly at right angles to plane of other suprabranchials and

extending dorsally until band of cartilage around its dorsal end articulates with cranium. Broad muscle inserted over entire posterior surface of bone extending directly ventrally to fourth ceratobranchial. This muscle must be of considerable importance in the movements of the gill arches. An identical apparatus is found in *Microstoma* and *Macropinna* and probably *Opisthoproctus* (Trewevas, 1933).

#### SHOULDER GIRDLE

All elements of shoulder girdle weak, thin, and more or less pliable (Fig. 7). Posttemporal consists mostly of long, thin dorsal fork, curving backward somewhat, in manner not possible to show in Fig. 7, to resemble a sickle, lying over dorsal corner of epiotic and separated from posttemporal of opposite side only by tendon from supraoccipital. Strongly attached to epiotic by a ligament, which extends forward from its attachment to epiotic to lie flatly on under side of posttemporal so that latter can be drawn backward some little bit but can not be pushed forward at all. It would thus aid somewhat in dissipating the thrust of the pectoral fin to the cranium. Ventral fork of posttemporal short, blunt, and attached to opisthotic by a fairly strong ligament.

Supracleithrum thin, pliable bone bearing lateral line nerve on outer side in trough. Whether this trough is an integral part of the bone or a special ossification of the sensory canal that has become securely fused to the supracleithrum could not be determined. Cleithrum largest bone of girdle, ending dorsally in long, sharp spike. Completely ligamentous first rib attached to this and supracleithrum, not only to bind girdle securely to axial skeleton but also to bind the two bones together. Lateral-anterior face of bone broadened for insertion of sternohyoideus muscle on outer surface, and muscles of fin on inner surface.

Primary shoulder girdle attached flatly by cartilage to inner surface of cleithrum and curving away at angle of not more than 45°. Both scapula and coracoid fairly large, but neither very strongly ossified. Scapular foramen a mere elongated slit and entirely contained within bone. Coracoid with similar foramen of about same size and shape and another, much smaller, opening near ventral end of that. Anterior process of coracoid strong and

broad with V-shaped interosseous space between it and main part of bone. Posterior process elongate and slender, projecting posteriorly well beyond actinosts. Posterior two-thirds of this spike cartilaginous and pliable. In one specimen this elongate projection was either absent or unwittingly lost in dissection. Four actinosts tiny, placed closely together and all based on cartilage between scapula and coracoid. No mesocoracoid or postcleithra.

#### PELVIC GIRDLE

Support of small pelvic fins slight and weak (Fig. 8); consisting of a single, elongate triangular bone on either side which tapers to a point anteriorly. Except for posterior side of triangle bone thin and pliable in spite of border of heavier ossification along outer side. Posterior edge thickened and cartilaginous for support of fin rays. Mesially two prongs, ventral and dorsal, project from thickened posterior end to meet similar prongs of opposite pelvic bone. Dorsal prong broad, completely ossified, except for thin band of cartilage around its edge of junction, and arching dorsomesially. Two ventral prongs, slenderer and bluntly pointed, meet mesially just under skin. For mesial third of their length both are entirely cartilaginous. Two pelvic bones rather weakly joined together.

#### AXIAL SKELETON

Forty-two complete vertebrae plus single up-turned terminal centrum present. First semblance of haemal spine, a short, sharp stub to which rib of each side attaches, occurs on sixteenth vertebra. Spine of seventeenth vertebra slender and about one-half as long as longest haemal spine. That of eighteenth vertebra longer yet and that of nineteenth of full length. Sixteenth vertebra thus first caudal vertebra, but anus placed back much farther, under twenty-sixth vertebra. Rib of sixteenth vertebra of full length. Ribs also on seventeenth, eighteenth, and nineteenth vertebrae. Each somewhat shorter than one preceding until that of nineteenth only about half length of that of sixteenth vertebra. These last three ribs very loosely attached by membranes to their respective haemal spines. All ribs are exceedingly slender and pliable and seem to give slight protection to abdominal cavity.

Both epineurals and epipleurals present; all scarcely thicker than muscle fibers. Last epipleural noted posteriorly was on rib of sixteenth vertebra and last epineural posteriorly was on twentieth neural spine, but because of their delicacy it cannot be securely stated that they do not occur farther back on the caudal vertebrae.

Centra all completely ossified, elongate, slender, hour-glass shape. Parapophyses of pre-caudal vertebrae, while broad, quite thin. Two of each centrum not joined ventrally. A considerable interspace between those of succeeding centra. Ribs flattened and slightly broadened on proximal ends and lying flat on external side of parapophyses.

Neural spines, especially of first 13 vertebrae, exceedingly slender and thin except for their broadened proximal ends where they attach to centra. Those of each side of a single centrum do not touch, even at their filamentous distal ends, on first 13 vertebrae. Those of fourteenth and all succeeding vertebrae join and become firmly ankylosed directly above spinal cord and thus form a single spine. These spines considerably heavier and stronger than those on anterior vertebrae. About eight to ten times as much of spinal cord exposed between succeeding neural spines as covered by bases of slender spines.

Nine interneurals between cranium and first baseost of dorsal fin. Each of these except ninth inserted between distal tips of succeeding neural spines. Ninth lies in same interspace as eighth, although with normal spacing between them. It appears to have been crowded out of its normal place by the enlarged, bifid, first baseost of the dorsal fin. Each interneural capped on either end with cartilage, heavier than neural spine, well ossified, and approximately round in cross section. Between all interneurals is developed an apparatus that the writer has not seen so well developed in dissection of any other fish. This consists of a rather strong ligament running from the distal end of each interneural nearly ventrally to a little below the middle of the next interneural posteriorly. This is not a single ligament but is made up of several fibers, some of which are inserted on the cartilage cap, some on the bone proper. This set of ligamentous connections between the interneurals unites them all into a

single apparatus starting with the broad ligament between the supraoccipital and first interneural, and attached lightly to the first baseost of the dorsal fin. It has the effect of dispersing any strain coming to the anterior member (the cranium) throughout the entire apparatus.

No ribs, epineurals, or epipleurals on first vertebra, and no interneural between first neural spine and cranium. In place of a rib a strong ligament of similar diameter as a normal rib strongly attached to shoulder girdle (as noted above). In my specimens ribs of second vertebra fully developed and as large as any others.

Eight baseosts for dorsal fin, each supporting a fin ray. First longest and largest, bifid ventrally but reaching only to, and not straddling, neural spine of tenth vertebra. Eighth very small and consists of little more than distal knob for insertion of fin ray. Other baseosts all similar, differing only in becoming progressively shorter from second to seventh. Each bone ends distally in heavy knob and tapers ventrally to slender proximal end. All latter widely separate. Baseosts several times heavier than corresponding neural spines. Distally each baseost connected with next one posteriorly by small hour-glass-shaped bone. Each of these bones cupped on each end and each cup lined with cartilage. Dorsal line of baseosts thus solid and strong for support of fin, but flexible by reason of 14 small ball and socket joints.

Eighteen baseosts for anal fin presenting flexible, but entire, line distally for support of fin rays by reason of small hour-glass-shaped ossicles between thickened heads of baseosts, as in dorsal fin. Baseosts decrease gradually in length posteriorly until eighteenth is little more than one-third length of first. All slenderer than corresponding supports of dorsal fin. Little if any support gained from slender haemal spines. First baseost bears on its anterior edge, near distal end, a cartilage capped knob to which are attached by tendon two muscles which extend along ventral line of abdomen to shoulder girdle and help to anchor pelvic girdle in place.

Support of caudal fin rather weakly developed. Small dorsal rays of fin extend anteriorly to level of neural spine of thirty-sixth vertebra. Neural spines of last six vertebrae extend to proximal ends of fin rays, very

slender, and in no way differentiated for support of rays. Condition essentially the same ventrally except that haemal spine of forty-second vertebra somewhat broadened and thickened distally and covered by cap of cartilage over distal edge of hypural plate to actively support fin. Haemal spine of forty-first and fortieth vertebrae also slightly thickened but lend little support to fin.

None of elements of hypural plate fused together and considerable interosseous spaces left between some. Terminal centrum cone shaped and with pointed end turned upward slightly. Slender, cartilaginous urostyle extends dorso-posteriorly into fin rays as in *Novumbra* (Chapman, 1934) and other fishes. Neural spine of terminal centrum, while thin and weak, widely broadened to fill most of space between last neural spines and urostyle, and covers base of latter. Further dorsally a slender rod of bone lies along upper side of urostyle until latter reaches fin rays. This bone tipped with cartilage distally. Lower side of urostyle sheathed with still another thin bone on which upper three hypurals inserted. Lower four hypurals based on ventral side of terminal centrum. All hypurals capped with cartilage distally and, in addition, with a continuous band of cartilage from urostyle to haemal spine of forty-second vertebra over which proximal ends of fin rays actually ride. Flanges on neural and haemal spines of last several vertebrae shown by Beebe (1933, fig. 41) not present in my specimens.

#### VISCERA

Stomach J-shaped, large, with very thick walls and covered externally with black pigment. Internally closely packed, deep, thin folds almost fill lumen of stomach so that little space left inside in proportion to size of organ. It is possible, however, that this is capable of considerable expansion, for the stomach of the only specimen cut into was completely empty except for minute flaky particles that could not be identified.

Five pyloric caeca, three moderately good sized, one smaller, and one very short and small. One of larger ones and medium sized one come off ventral side of pyloric region together, former curving upward and posteriorly along left side of pyloric end of stomach, latter curving to right and running anteriorly along py-

loric region. Other three caeca come off right side of pyloric region and lie between it and intestine. Anterior one only a short bud; other two projecting posteriorly, with largest one curving across ventral side of pyloric end of stomach to extend along left side.

Somewhat in advance of pyloric caeca intestine flexes to right and continues straight posteriorly to anus. Anterior two-thirds of intestine rather thin-walled and flabby; lined internally with irregular small folds, which do not project far into lumen and which block off wall into shallow crypts of irregular shape. About two-thirds of remaining third of intestine turgid and nearly cylindrical. It contains a typical spiral valve almost identical in size and shape with that shown by Kendall and Crawford (1922) for *Argentina*. Organ obviously functional and well developed, not vestigial remnant occasionally found in salmon. Spirals made up of spongy, thickened walls with contours as evident in external view as in *Squalus*. Remainder of alimentary tract pigmented, although not so heavily as stomach, and may be termed the rectum, although little different in circumference from spiral valve section.

Specimen examined a female with well-developed eggs. Both ovaries full of eggs and of about same size, with right extending only little more posteriorly than left. Ovaries lay along dorsal side of stomach and nearly enclose intestine clear to rectum. Two sizes of eggs present: larger size about 0.5 millimeter in diameter. Number of large eggs not counted with accuracy but estimated that two ovaries together contained less than 3,000.

Only right lobe of liver present in three specimens examined, but this well developed and covering large part of left surface of stomach. Spherical, translucent gall bladder exactly as found in *Macropinna* (Chapman, 1942b). In one specimen liver notched on ventral edge and gall bladder fitting snugly in this notch over bend of intestine. In another specimen liver covers gall bladder from external view but a bulge in its surface shows presence of bladder in same location.

Kidney similar to that of *Macropinna*; light gray in color and shot through with small black specks. No indication of double structure.

No air bladder (as in *Macropinna*).

#### SYSTEMATIC POSITION OF LEUROGLOSSUS GILBERT

Dr. George S. Myers has kindly provided me with one of Gilbert's specimens of *Leuroglossus stilbius*. The specimen is small and soft, and the bones are so lightly ossified that they did not take up the stain readily. Therefore it was not possible to give a complete account of its osteology. Definitely there are no mesocoracoids, no postcleithra, and no air bladder. There are only two branchiostegal rays. All osteological characters that can be clearly defined, such as the ethmoid and suspensorium areas (with the mouth parts and vomer), are as in *Bathylagus*. However, the liver is somewhat bilobed; there is a distinct kink in the intestine behind the greater omentum and the intestine is longer than in *Bathylagus*; there are 12 pyloric caeca all in a straight line and the whole of the alimentary tract is enfolded dorsally and ventrally in a double organ which I believe is the greatly enlarged (in proportion to the size of the fish) male sex organs. Because of the above noted characters of the viscera the generic rank should be retained until more complete study indicates otherwise. *Leuroglossus* should be removed from the Argentinidae and placed in the Bathylagidae.

The counts and measurements (in millimeters) of my specimen (*Albatross* station 2904: 1889, southern California) are as follows: anal, 11; dorsal, 10; pectorals, 9; ventrals, 9; caudal, 48. Snout to base of caudal, 48; snout to origin of dorsal, 27½; snout to insertion of ventrals, 29; snout to anal, 38; snout to adipose, 40½; length of head, 17; diameter of eye, 6; depth at pectoral insertion, 8½; length of caudal peduncle, 6; and length of snout, 4¼ mm.

#### SYSTEMATIC POSITION OF THEROBROMUS LUCAS

Lucas (1899) described the species *Therobromus callorhinus* from bones found abundantly in the stomachs of fur seals in Bering Sea. No intact specimens were available to him, and the species has never been taken alive, nor have specimens been recorded since his original description. He says of it:

"an undescribed isospondylous fish related to the Argentinidae." It has since been referred to the Osmeridae by Jordan, Evermann, and Clark (1930) and Hubbs (1925), but a study of the osteology of the osmerid fishes (Chapman, 1941b) showed that the species was not closely related to those fishes and could not be placed in that family.

Lucas says of the fish: "The species may be diagnosed as follows: Chondrocranium well developed; superior maxillary edentulous; pointed teeth on vomer and anterior portion of palatines; lower jaw very deep; pointed teeth on dentary; articular well developed. Vertebral formula 26 precaudals, 22 caudals, plus 1 hypural; last 4 precaudals with short, wide hypapophyses: other hypapophyses long; neural spines of first 22 vertebrae double, remainder confluent; an epineural present and confluent with basal part of neurapophysis on many of the anterior vertebrae; short transverse processes, directed downward from lower part of anterior vertebrae. Vertebrae simple; anterior but very little shorter than the posterior; centra not sculptured, but bearing many fine longitudinal ridges." The short description was accompanied by a plate of 19 drawings of bones.

The description, except for the number of vertebrae, could have been as correctly drawn from the specimens of *Bathylagus* used as the basis for the present report. The drawings likewise are accurate representations of *Bathylagus*. The chief differences between Lucas's drawings and those in the present report are the result of his specimen being partially digested, and the resemblances are so striking that no detailed description is necessary. The frontals in his specimen, for instance, are gone; part of the opercle is digested away; and part of the hypural plate is gone. The vertebral count given in the description of *Therobromus* by Lucas will aid in identifying his species when specimens of *Bathylagus* from the Bering Sea are available for dissection. Probably his fish was *B. pacificus* or *B. alascanus*.

The discovery that the fur seal feeds extensively on fishes of the genus *Bathylagus* is interesting because this genus in the

North Pacific is typically bathypelagic in habitat, indicating that the fur seal feeds at greater depths than is generally recognized. It may be noted that the chief feeding grounds of the fur seal while on the rookeries both on the Pribilof and Komandorskie Islands is outside the 100-fathom contour (Townsend, 1899).

#### SYSTEMATIC POSITION OF BATHYLAGUS

The affinities of the Bathylagidae are not so close to the salmonoid fishes as is generally supposed. Together with the Argentinidae, Microstomidae, Macropinnidae, Opisthoproctidae, Winteriidae, Xenophthalmichthyidae, and, probably, certain other deep sea fishes, they form a natural group that may be designated as a suborder in the Isospondyli, the Opisthoproctoidei, erected by Berg (1937) for the Opisthoproctidae alone.

Of the fishes with which *Bathylagus* has been associated in the past it resembles *Argentina* least. *Argentina* (Chapman, 1942a) has a well-developed mesocoracoid; a single row of about 30 teeth on the palatine; several heavy recurved teeth on the tongue; small teeth on the fifth ceratobranchial and fourth suprabranchial; the air bladder is large and well developed; there are seven branchiostegal rays; well-developed postcleithra (there are four in my specimen, although Kendall and Crawford (1922) say no "postclavicular" processes are found); the myodome is well developed and opens posteriorly on the basioccipital; the parietals are broadly joined on the midline, nearly occluding the supraoccipital from dorsal view, and form bony bridges across the temporal fossae laterally; and the supraoccipital is broadly separate from the frontals. In view of these differences, and others, *Bathylagus* can not be placed in the Argentinidae.

There are stronger resemblances with *Microstoma*, but that genus has an especially large and prominent air bladder; four branchiostegal rays; well-developed postcleithra; the parietals meet broadly on the midline of the skull; and there are numerous differences in the proportions and arrangements of the bones of the skull, in particular

the special ossifications of the sensory system and the bones of the ethmoid region. For these and other reasons *Bathylagus* can not be considered to be a member of the Microstomidae.

*Bathylagus* is the representative of a separate family, Bathylagidae (Gill, 1884), to which also belongs *Leuroglossus* (Gilbert, 1890). *Bathymacrops* (Gilchrist, 1922), which Jordan (1923) has placed in the Bathylagidae, should be placed in the Microstomidae as a synonym of *Nansenia*.

#### SYNOPSIS OF THE FAMILY BATHYLAGIDAE

Opisthoproctoid fishes with adipose fin and enlarged but laterally directed eyes. Supraorbital bones strongly developed and suborbital bones weakly developed. Mouth small. No teeth on tongue, gill arches, premaxillary or maxillary. Teeth on palatine absent or few. Small conical teeth on the vomer and dentary. Mesopterygoid much enlarged but not toothed. Metapterygoid minute, if present. Frontals paired. Both mesethmoid and ventral ethmoid present. Small suprabasal present on basibranchials. Parietals small and widely separated by supraoccipital, which reaches frontals. No definite temporal fossae. No myodome. No mesocoracoid. No postcleithra. Two (as far as known) branchiostegal rays. Gill membranes broadly united. Pectoral and ventral fins small and placed near the ventral outline. Pseudobranchiae well developed. Pyloric caeca few (9 to 12 in *Leuroglossus*, 5 or 6 in *Bathylagus*). Peritoneum and stomach jet black. Air bladder completely absent. Stomach with prominent leaflike projections internally. Intestine short, with well-developed spiral valve.

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## ABBREVIATIONS USED ON FIGURES

AC = actinost	E = epiotic	ME = mesethmoid	PT = pterotic
AL = alisphenoid	EC = ethmoid cartilage	MES = mesopterygoid	PTT = posttemporal
AN = angular	EP = epihyal	MET = metapterygoid	Q = quadrate
AR = articular	EX = exoccipital	O = opercle	S = symplectic
B = basioccipital	F = frontal	OR = orbitosphenoid	SB = suprabasal
BB = basibranchial	FM = foramen magnum	P = parietal	SC = supracleithrum
BR = branchiostegal ray	G = glossohyal	PA = palatine	SCA = scapula
CB = ceratobranchial	H = hyomandibular	PAR = parasphenoid	SO = supraoccipital
CE = ceratohyal	HB = hypobranchial	PF = prefrontal	SOP = subopercle
CL = cleithrum	I = interhyal	PG = pterygoid	SP = sphenotic
CO = coracoid	IN = interopercle	PM = premaxillary	V = vomer
D = dentary	M = maxillary	POP = preopercle	VE = ventral ethmoid
DH = dorsal hypohyal		POT = prootic	VH = ventral hypohyal



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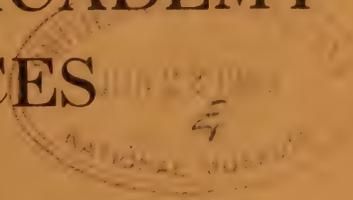
JUNE 15, 1943

No. 6

# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES



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# JOURNAL

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No. 6

ECOLOGY.—*Progress in utilization standards for western ranges.*<sup>1</sup> R. S. CAMPBELL, U. S. Forest Service. (Communicated by W. R. CHAPLINE.)

Range utilization is essential to the welfare of the West and of the United States as a whole. The western range territory provides one-third of the cattle and calves, two-thirds of the sheep, and three-fourths of the wool and mohair grown in the United States. These livestock products are important even in ordinary times. They are indispensable during war. Because of the huge armed force, millions of war workers at strenuous toil, and lend-lease aid to the Allies, the country each year is using double its domestic wool production, and civilian meat consumption has been cut by more than one-third in order to balance consumption with supply.

Within the western range territory the animals producing these requisite supplies graze part or all of the year on range forage—on the grasses, other herbs, and shrubs growing in a generally rather thin stand on land best suited to use by domestic livestock. The area devoted to this use is about 728,000,000 acres, nearly two-fifths of the entire United States. The harvesting of the edible portions of this plant growth each year requires careful management to prevent excessive damage to the range resource and to permit sustained production of forage and livestock.

Range management is the regulation, direction, and control of grazing with the object of the fullest possible use of the forage resource consistent with other range land uses. Man's main control is over the

livestock; hence the four principal features of range management are: the most appropriate kind of animals, correct seasonal use, even distribution of grazing, and proper numbers of livestock. The other three features of management are most effective only when numbers of livestock are correct—thus indicating the importance of proper utilization of the range forage each year.

Utilization standards is a term employed to designate a wide variety of information needed by the range manager in understanding and currently judging the utilization and the relative condition or productivity of the range. Utilization is a complex problem, dealing with hundreds of valuable forage plants of several life forms growing on ranges from the high rainfall mountain lands down to low value semidesert shrub areas. Involved are several stages of plant succession, considerable differences between species as to the relish with which they are eaten by livestock at different seasons, resistance to grazing and processes of growth, maintenance, and reproduction. In fact, the whole field of range plant and animal ecology is involved. The job in range utilization standards is to work out answers to some of the more pressing problems of forage utilization by livestock, to take advantage of findings from other pertinent studies, and to formulate the essential results into simple, readily applicable facts for use by busy range administrators and managers. The purpose of this paper is to describe some of the recent advances in this field.

A considerable body of range management information, much of it relating to utilization, has been accumulated during

<sup>1</sup> Paper delivered upon receipt of award for distinguished service in the biological sciences at the 318th meeting of the Washington Academy of Sciences, March 18, 1943. Received March 27, 1943.

the past few decades. The U. S. Department of Agriculture has been interested in range problems since its establishment in 1862, and early-day studies of forage plants, reseeding, and grazing brought together helpful facts on the nature and extent of the resource. National-forest range-management studies, begun in 1907 by James T. Jardine (1910) and A. W. Sampson (1909), in cooperation with F. V. Coville, of the Bureau of Plant Industry, gradually brought together biological facts on the grazing habits and forage requirements of range sheep and cattle, and the growth and use of range forage. These early studies, including both the range vegetation and livestock grazing, led quickly into practical management features such as the bedding out system of handling sheep, water development, correct seasonal grazing, deferred and rotation grazing, and forage inventory through range surveys.

Increasing attention was given the problem of forage utilization until in 1936 a special project was started, primarily to develop improved utilization standards for application on the 87,000,000 acres of national-forest range (Campbell, 1937). It was undertaken by the Division of Range Research and the six western forest and range experiment stations and administrative regions. The immediate job was to evaluate all pertinent data and formulate the best possible standards, mainly in handbook form, for immediate use. At the same time the whole utilization problem was carefully analyzed for the most urgent questions. By 1939, the project turned toward research primarily ecological. The work aimed at these important problems was seriously restricted by limited funds. This work was only in its initial stages when wartime demands for livestock products dictated an immediate program to furnish the best available standards to help both public and private agencies attain maximum sustained production.

The subject of utilization standards can best be presented under two broad headings: (1) range condition, including changes and trends in condition; and (2) range utilization, including methods of measurement and the determination of proper utilization.

#### RANGE CONDITION

Range condition is the relative state of health or productivity of the range, including both the soil and the forage, in relation to its potential state and the best practicable management. The inclusion of information on range condition in utilization standards requires answers to such basic questions as the following:

1. What are the main range types for which utilization standards are needed?
2. What should be the objective toward which management of each type should aim (in terms of plant cover and soil condition)?
3. What annual or seasonal variations are there in habitat and plant cover that can be recognized in the field?

The answers to these questions draw on practically all phases of range ecology, from vegetation surveys to studies of plant competition and succession. Broad vegetation types include the tall grass, shortgrass, Pacific bunchgrass, semidesert grass, sagebrush, etc., within which are important subtypes requiring individual consideration. Thus, within the open forest type are such important subtypes as the ponderosa pine bunchgrass, the alpine grassland, aspen-fir, mountain brush, and others.

The early studies of Sampson (1919) on plant succession in relation to range management furnished a working method of setting up the objective toward which management should aim on a specific type. He identified four vegetation types or stages that feature plant succession from a depleted condition on subalpine grasslands in central Utah; (1) early-maturing annuals growing on gravelly loam poor in organic matter and moisture; (2) perennial herbs, on soil containing moderate amounts of organic matter and moisture; (3) aggressive perennial grasses with herbs and shrubs on soil with still better organic and moisture content; and (4) deep-rooted or densely tufted perennial grasses on fine soil high in organic matter and available moisture. Sampson determined that overgrazing caused retrogression by destroying the ground cover and allowing loss of soil fertility. He also found that grassland in climax condition furnishes abundant forage, withstands grazing better, and has more

stable soil than when it is in the lower developmental stages.

More recently Pickford and Reid (1942), working on subalpine grasslands in north-eastern Oregon, identified stages similar to those of Sampson. They found that the climax stage is characterized by stable, fertile soil, ample desirable forage, and uniform, silt-free streamflow. Green fescue (*Festuca viridula*) is dominant, covering at least half the ground surface.

Subalpine ranges in the mixed grass and weed stage are in only fair condition, since they produce less than the maximum amount of forage and their watershed values are impaired. They have an open stand of vegetation that rarely covers more than one-third of the ground surface. Subclimax grasses are abundant and compete successfully with better forage species for available soil moisture. Weeds are common and accelerated erosion is conspicuous on exposed soil surfaces and pedestaled fescue tussocks.

A still poorer condition is represented by the second weed stage, in which the stand of vegetation is very open and green fescue is represented only by scant remnant plants. Low value weeds and shrubs are abundant, and the soil is clearly eroded, with deep gullies on hillsides and cut channels.

The importance of maintaining ranges in good condition is shown by the grazing capacity of the various stages. Grazing capacity of the near climax green fescue stage, having good soil condition, was more than four times that of ranges in the poor condition represented by lower stages.

Similar stages and corresponding grazing values have been worked out in greater or less detail for several other important types or subtypes throughout the West.

#### TREND OF RANGE CONDITION

The range manager must know whether his management is bettering the condition and increasing the forage production of his range, or causing it to go on the downgrade. Range trend is the direction and amount of change in range condition. Much of the range land of the West is in some stage of depletion, varying from slight to very severe. The problem of first importance on

these deteriorated ranges is to stop the retrogression and start the process of improvement. With the widely varying degree of deterioration of vegetation and soil on different ranges, the determination of range trend is not simple. Improvement or deterioration can be recognized from such features as the vigor of the principal forage species, the species reproducing and becoming established, and character of soil erosion. But it requires extraordinary alertness and ingenuity in the field of dynamic ecology to detect incipient changes and particularly to interpret the natural changes due to variable weather, and to evaluate such changes along with those caused by livestock grazing. For example, broom snakeweed (*Gutierrezia sarothrae*) is a low-growing aggressive shrub with little or no forage value. It has been shown that the occurrence of a dense stand of young thrifty snakeweed plants on range where the palatable black grama (*Bouteloua eriopoda*) has been weakened by overgrazing, represents a definite downward trend (Campbell and Bomberger, 1934). Both the snakeweed and the black grama may be injured by drought, but through careful utilization of the valuable grass, deterioration can be stopped, and at this stage recovery need not be difficult nor require more than a few years.

On the other hand, the invasion of a dense stand of snakeweed on a badly depleted, wind-blown, honey-mesquite (*Prosopis glandulosa*), sand-dune type represents a definite upward trend through stabilizing and building up the soil and affording protection for better forage plants ultimately to grow. Ranges that have reached this low ebb of productivity require many decades to restore a grass stand of reasonably good productivity. However, the occurrence of dense stands of such low value plants as snakeweed is not the final criterion of range condition—it is only one of many important features that must be interpreted in the aggregate.

Advanced deterioration is rather easily recognized by the thin stand of perennial grasses and obviously accelerated erosion, but the early symptoms of deterioration are more difficult to detect. Some of the more

striking signs of a deteriorating range developed to date include: (1) weakened vitality of the important forage plants, as shown by sickly color and reduced height and volume; (2) thinning of the perennial grass cover as indicated by accelerated dying out and disintegrating of tufts; (3) replacement of good forage plants with poor ones, as indicated by abundance of young inferior plants; and (4) accelerating erosion, as evidenced by soil washing on slopes, a distinct increase in number of recent small pencil or finger gullies, and failure of vegetation to grow in small gullies.

In general, an upward trend is indicated by:

1. Arresting of accelerated erosion, perennial vegetation established on eroded banks of drainage channels, no exposed grass roots, soil pedestals with sloping rather than vertical sides, and root crowns of perennial grasses not buried with silt, etc.

2. Vigorous appearance of the stand of forage plants.

3. Noticeable reproduction or spread of plants of the next higher succession stage.

4. Exposed mineral soil colonized with young plants of perennial species.

These and other indicators have been worked out more specifically for several types in the West, but a great deal more remains to be done, both on other types and on more accurate and reliable indicators of range trend.

#### FACTORS INFLUENCING UTILIZATION

A thorough knowledge of forage utilization is essential because livestock grazing is a major influence in causing the great differences in values between ranges in good and poor condition. Among the important factors influencing forage utilization are the kind and number of livestock; their eating habits; their forage preferences involving succulence, taste, and other qualities of the forage plants; the season of use, the plant composition, and the distribution of livestock over the range.

As to kind of livestock, cattle generally prefer grasses and shrubs, and horses choose grass, while sheep and goats prefer weeds and browse plants, although all animals like

some variety in their diet. Soil disturbance through trampling also varies with the animals and particularly with their handling. Thus, poor herding of sheep in compact, fast-moving bands can cause serious overutilization and trampling, whereas open herding and gentle handling can utilize most ranges without serious damage.

Season of grazing is very important in securing utilization of plants when they are palatable. For example, in the Southwest tobosa grass (*Hilaria mutica*) is good forage during summer when it is green and succulent, but after that time it becomes so dry and woody that livestock do not graze it willingly. Correct season of grazing is also very important in allowing the main forage plants ample opportunity to grow and reproduce. Craddock and Forsling (1938) found in southern Idaho that the start of growth on sagebrush-grass ranges was far too variable to allow grazing to begin then. They found a minimum variation in the time when perennial grasses reached a 2-inch height growth and recommended beginning grazing at that stage of development so as to assure sufficient available forage for the livestock and to permit the forage growth to keep ahead of the sheep grazing.

The effect of a number of factors on utilization of black grama by cattle is brought out in a 7-year study on several thousand acres of the Jornada Experimental Range in southern New Mexico. By means of multiple regressions applied to nearly 750 measurements, it was found that percent height utilization of black grama varied significantly with intensity of pasture stocking and distance from livestock water (Fig. 1). The average effect of each additional mile from a livestock watering place was a decrease of 10 percent in utilization of black grama, out to a maximum distance studied of 3.5 miles. When black grama in a pasture was fully utilized on the average, it was overutilized out to 2 miles from water. Under moderate or conservative pasture grazing, the grama was grazed too closely only out to half a mile from water, and rather lightly beyond 3 miles. With light pasture use, the black grama was utilized very lightly at 2 miles from water and was

too closely grazed only in the first one-fourth mile from water.

The effect of distance from salt grounds on utilization of black grama was not great—averaging only 1.3 percent utilization per mile. But improved salting in a properly stocked individual pasture increased the utilization of black grama as much as 10 to 15 percent at 3 miles or more from water.

Other factors were also important. There was higher utilization of black grama near the main roads and well-traveled trails. Also black-grama utilization on the average increased 4 percent for each 0.1 decrease in

DETERMINING PROPER UTILIZATION

Research has employed a number of ways to get at proper utilization which is really the heart of utilization standards. The maintenance of black grama on meter quadrats on range grazed to different degrees was measured by Nelson (1934) on the Jornada Experimental Range. On ungrazed plots, there was a considerable change in tuft area, increasing or decreasing from one year to the next in response to the rainfall of the preceding summer. Further, the average density of black grama over a 13-year period under conservative or moderate

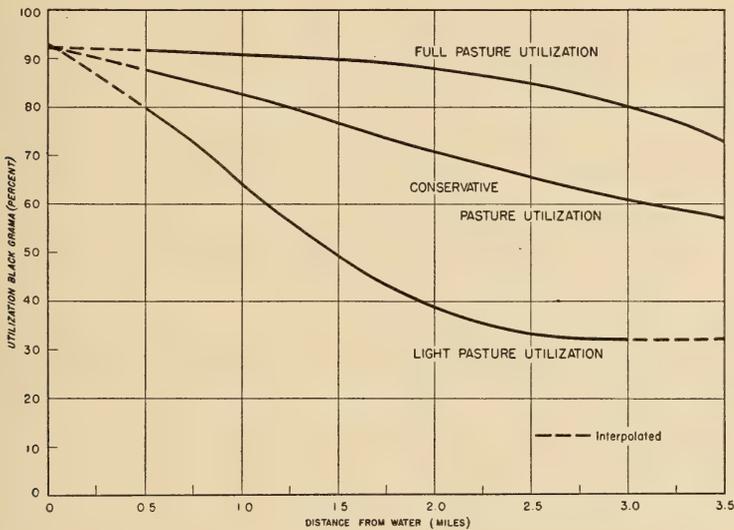


Fig. 1.—Average utilization of black grama by cattle in percent height at different distances from water under full, conservative or moderate, and light pasture utilization, Jornada Experimental Range, southern New Mexico, 1931 to 1937, inclusive.

black grama density after allowing for other factors. Thin stands or scattered plants of black grama were fully utilized out to 3 or 4 miles from water, with only moderate pasture stocking. This brings out the importance of protecting and managing the utilization of the important forage species on depleted types, if they are to be restored to their potential productivity.

Similar studies of important factors influencing utilization on pine bunchgrass range in northern Arizona by Glendening, and on mountain bunchgrass range in central Utah by Clark, are as yet unpublished.

grazing was little different from that under no grazing. Slight overuse of black grama in dry years prevented maximum development of the stand and permitted inferior associated grasses and weeds to secure a foothold on the depleted grama areas. Heavy overgrazing year after year practically killed out the black grama stand and caused very unstable soil conditions. Under moderate grazing, sufficient plant stubble and stolons remained each year to assure good growth and reproduction of the stand the next year.

Persistent clipping of all black grama herbage on plots to a 2-inch height or less

over a 10-year period was found by Canfield (1939) to result in greatly reduced yield and eventually destroyed or killed the plants. In similar studies on clipped tobosa-grass plots, cropping to 2 inches was too close, but clipping to 4 inches maintained a high forage yield and stimulated vegetative reproduction.

Clark, at the Intermountain Forest and Range Experiment Station, working with slender wheatgrass (*Agropyron trachycaulum*) and mountain brome (*Bromus carinatus*) on the Wasatch Plateau in central Utah, has marked individual plants grazed to different degrees and has followed the forage production and utilization through subsequent years. He has noted a tendency for the sheep to come back and graze closely the younger smaller plants each year. This suggests that on some ranges utilization may need to be measured on the younger plants rather than the entire stand, in order to perpetuate the important forage species.

Still another approach to proper utilization was followed by McCarty and Price (1942) who studied the growth and carbohydrate content of important perennial grasses and broadleaf herbs on central Utah mountain ranges. Critical periods in the life cycle were found to be: (1) the active reproductive period from flowerstalk formation through seed ripening, and (2) during the early carbohydrate storage period, when the plant is in a period of recuperation from the reproductive period. A system of rotation grazing in which portions of the range are grazed at a different time each year allows a periodic slackening in the intensity of grazing during these periods in the plants' life processes.

It is not a simple task to express these findings for practical application on the range. One common way is to describe the stubble height that should be left ungrazed for the important forage species. Studies both in the Northwest and in the Southwest show a considerable proportion of ungrazed plants on properly grazed range. Still another way of defining proper use is in percentage of herbage removal.

The difficulty with any statement of proper utilization, whether expressed in stubble height or in percentage removal, is

that extreme care is needed in applying it to any area other than where it was developed. Weakened forage plants on deteriorated ranges can not resist the same degree of utilization as thrifty vigorous plants on ranges in good condition. Ordinarily the better forage plants should be grazed less on deteriorated range in order to hasten restoration. Also, they should be used less on steep slopes, particularly on more erosive soils.

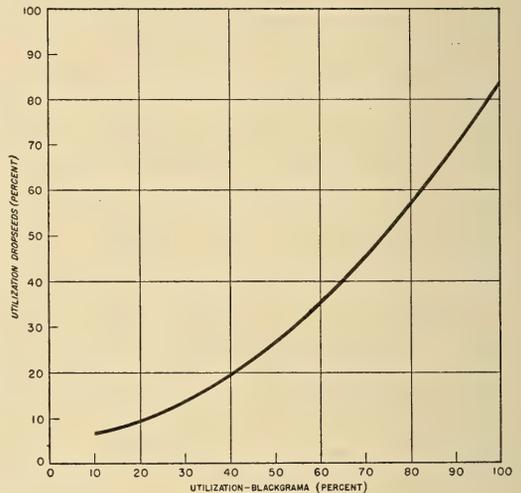


Fig. 2.—Average utilization of sand and mesa dropseeds by cattle at various degrees of utilization of black grama in percent height as determined at the end of the grazing year in June, Jornada Experimental Range, 1931 to 1937, inclusive.

In the final proper use rating, the key forage plants are assigned values mainly on their resistance to grazing, including ability to survive drought and normal competition, and with due allowance for other factors. Less important species are rated at the degree to which they are actually grazed when the key species are properly utilized. This is illustrated in the curve of utilization found between black grama and sand and mesa dropseeds (*Sporobolus cryptandrus* and *S. flexuosus*), less valuable species (Fig. 2). When the black grama was grazed at about 85 percent or proper on this scale, the dropseeds were grazed about 65 percent of their height.

All these results find direct application in the control of livestock grazing on the range. But intelligent control of numbers and distribution of animals on the range requires careful checks of actual forage utilization.

#### MEASURING RANGE UTILIZATION

Several methods of measuring range utilization have been developed, suited to various purposes and types of vegetation. The most common method now employed by range administrators is the so-called reconnaissance or ocular inspection system, in which the range is systematically examined and the utilization estimated directly, either in descriptive terms or preferably in percentage herbage removal. Frequent close examination of individual plants on small areas a few square feet in size is necessary for reasonable accuracy.

A more accurate way is the ocular estimate by plot method described by Pechanec and Pickford (1937), who tested a number of methods in southern Idaho. The examiner estimates percentage weight removal of herbage from forage species on a series of circular plots each containing 100 square feet. In training, ungrazed vegetation on plots is clipped and weighed, the utilization estimated, then the balance clipped and weighed as a check until the examiner can judge utilization with reasonable accuracy. This method has been found admirably suited for research purposes on grasses, weeds, and browse. Pickford, working in the Northwest, has recently tested the method as an administrative tool on national-forest ranges. Proposed standardized instructions for its application are being considered in the several Western Regions of the Forest Service.

Another method of determining utilization that has found widespread application is the use of grass height-weight or volume tables. The height of grazed stubble is expressed in percent and converted to percentage weight utilization by means of charts or scales showing height-weight relationships of the important forage species. This method is based on the assumption that most grasses have a reasonably constant distribution of weight throughout the plant in relation to height. Three distinct

types, all with flower stalks, are indicated in the curves shown in Fig. 3. Bottlebrush squirreltail (*Sitanion hystrix*) has a nearly straight line relationship, with weight distributed about equally through the plant from the top of the tallest flower stalk. Blue grama (*Bouteloua gracilis*) has a gentle curve, with about 80 percent of the weight in the bottom half of the plant owing to the abundance of basal leaves. Sandberg bluegrass (*Poa secunda*) has a slight "S" curve because of heavy seed heads and high concentration of weight in the basal leaves. Curves for plants without seedstalks are still somewhat different. Application of these tables in the field requires great care, because Clark (1943) has found significant differences within the same species in different years and in different altitudinal zones in central Utah.

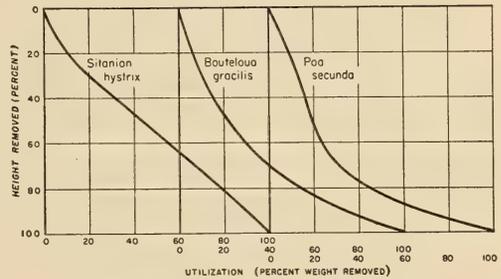


Fig. 3.—Three types of height-weight curves of range grasses, all with seedstalks: bottlebrush squirreltail (*Sitanion hystrix*) from Utah, plants processed by Ira Clark, Intermountain Forest and Range Experiment Station; blue grama (*Bouteloua gracilis*) from Colorado, processed by David F. Costello, Rocky Mountain Forest and Range Experiment Station; and Sandberg bluegrass (*Poa secunda*) from Utah, processed by Ira Clark.

The process of preparing height-weight tables consists of collecting ungrazed plants from the range, then cutting them at one inch or other convenient intervals from top to bottom, weighing the segments and converting this information into percentage height and weight.

Such height-weight tables were prepared for several species in Montana by Lommasson and Jensen (1938); in the Southwest by Crafts (1938); and in Utah by Clark. The original height-weight curves have been used in the field determination of utilization. However, Lommasson and Jensen, and

Crafts independently prepared gauges or "slide-rules" in which to carry the height-weight data in compact form and use it readily. The examiner measures both grazed and ungrazed plants of a selected key species, sets the ungrazed height in the gauge, and opposite the grazed stubble height reads the percentage utilization. In field practice, of course, this procedure requires measuring a representative sample. Reid and Pickford (1941) found that the height-weight and the ocular estimate by plot methods gave substantially the same estimates of utilization on grasses if the stubble height was rather uniform. However, they found the ocular estimate to be simpler in field use.

Still another method of determining range utilization is the measurement of stubble height along a line transect, used in research at the Southwestern Forest and Range Experiment Station (Canfield, 1941).

One final utilization method requiring mention is the visual evaluation of plant residue, developed for application on California annual type ranges (Hormay and Fausett, 1942). Since maintenance of soil fertility and forage productivity on this type depends upon a fairly complete plant cover, the relative amount of debris remaining after grazing is finished each year is judged ocularly. A particularly helpful criterion is the extent to which surface objects such as rodent mounds, pine cones, and sticks are obscured by the remaining vegetation. Systematic observation is, of course, necessary to secure average utilization over large pastures.

Regardless of method of determining utilization, the figure obtained on a range must be compared with a predetermined proper utilization percentage for the important forage species. Also very careful observation of soil erosion, disturbance, and range condition are necessary for an adequate picture of utilization and its effects on the range.

#### APPLICATION OF RESULTS

Out of all this complexity of factors, plant types, forage species, climatic variation, proper use, and methods of measuring

utilization, must come a fairly simplified procedure for application in range management by the stockman and range administrator. One of the first tasks in the Forest Service range utilization study started in 1936 was the assembly of available utilization guides into practical regional handbooks, primarily applicable to national forest ranges. An example is the handbook prepared by Swift and Fausett (1939) for California ranges. After a brief background on range condition, this handbook presents writeups for each of several major types with photographic and text descriptions of the type itself, in good and in poor condition, overutilized and satisfactorily utilized. Research has since brought out several publications embodying useful standards. In addition to several already mentioned, important contributions include Costello (1942) on short-grass ranges of eastern Colorado; Campbell and Crafts (1939) on black-grama ranges; and Crafts and Glendening (1942) on blue-grama ranges of the Southwest. It has also been necessary to standardize and simplify certain concepts such as key areas, key species, and utilization in terms of percentage weight.

As a part of the Department of Agriculture program for sustained livestock production from western ranges, useful range research results have been furnished to range managers generally. Direct assistance has been given the Agricultural Adjustment Agency by preparing and adapting height-weight tables for attaining more efficient use of forage and better management generally on private ranges. Improved procedures have been furnished to range technicians of the Forest Service and other public agencies. Especial emphasis has been given the formulation of better proper use ratings for important forage plants under different sets of conditions. Sound proper use figures for the important forage plants are basic for effective range surveys and the subsequent application of good practices through carefully prepared management plans for range units. Finally a systematic effort has been made to show range managers all through the West that sustained production is obtained only conservative grazing on ranges in good condition.

## FUTURE RANGE UTILIZATION RESEARCH

The present period of practical application of utilization standards for maximum wartime production of forage and livestock affords good opportunity to reanalyze the problem so that future research will be pointed at the most urgent features. Among these is a better evaluation of condition and trend to avoid the deterioration that has taken place in the past. A start on work of this sort was made by Ellison and Croft at the Intermountain Forest and Range Experiment Station in 1942, combining range ecology and watershed management viewpoints. A particular weakness is the lack of criteria for judging soil condition. In some instances the vegetation indicated satisfactory condition and trend at the same time that excessive trampling by livestock was causing abnormal erosion. These criteria will include such things as litter, bare soil surface, and top soil remains.

Utilization studies should be extended to additional types and species with special emphasis on deteriorated ranges in order to restore them to maximum productivity as quickly as possible. The effect on forage plants of utilization by big game and rodents is an important field in itself, still largely unexplored. More work along plant physiological lines is needed so that management can be based on a better knowledge of the internal processes of plants on grazed ranges. Gaps in present information are the mechanisms which enable some plants to better survive grazing and drought than others. Likewise, the entire utilization question needs a much better knowledge of ecology, particularly of the important forage plants in relation to the habitat. Finally, related work on nutritive values of forage plants is needed in order to secure the greatest livestock production from range lands in coordination with farm crops and other feed supplies.

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BOTANY.—*Distribution and character of Sabal louisiana.*<sup>1</sup> MIRIAM L. BOMHARD,  
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*Sabal louisiana* (Darby) Bomhard was described under the genus *Chamaerops* in 1816<sup>2</sup> by William Darby, but it escaped the serious attention of botanists until the spring of 1925, when the late Dr. John K. Small rediscovered it. He published it as a new species, *S. deeringiana*, in 1926,<sup>3</sup> for he was not then aware that an earlier name existed. In this paper Dr. Small pointed out that native arborescent palmettos were thought to be lacking along the thousand-mile stretch of the Gulf coast between St. Andrews Bay, Fla., the western limit of *S. palmetto* (Walt.) Lodd., and the lower Rio Grande River near Brownsville, Tex., where *S. texana* (Cook) Becc. is indigenous. The type locality is given as "Flat alluvial places, near Pointe aux Herbes, along Lake Pontchartrain, Louisiana."<sup>4</sup> This is indeed a very restricted area east of New Orleans and slightly northwest of the Chef Menteur (a pass between Lakes Pontchartrain and Borgne).

In a later paper, 1929, following further field work in the general region of Lake Pontchartrain and the Mississippi Delta, Dr. Small wrote: "The geographic limits of *Sabal deeringiana* are not yet perfectly known. It grows in swamps and along bayous in the lower Mississippi delta. It has not been observed east of the Pearl River, nor west of the Atchafalaya River."<sup>5</sup> In his *Manual of the southeastern flora* (1933), the distribution is given as "Flat alluvial places along the lower Mississippi River, bayous and lakes, S. La."<sup>6</sup>

About 1932 I began to make surveys of

habitats similar to those in which Louisiana palmetto was rediscovered, as well as in areas mentioned by Darby. The results for Louisiana were published in 1935 and summarized in the following statement: "Although palmettos are widely distributed over much of eastern and southern Louisiana, they attain their most luxuriant development in the southeastern portion of the State, where trunked forms occur. Trunked palmettos are much more widespread in Louisiana at the present time than has been supposed, having been found by the writer westward nearly to Opelousas and south almost to the Gulf of Mexico."<sup>7</sup>

Emphasis was first placed on trunked palmettos because the climax form with a well-developed trunk is easily recognized. For example, the arborescent *Sabal louisiana* specimens standing fairly in the open at Frenier Beach on the west shore of Lake Pontchartrain are so different from other tree-Sabals that the distinctive characters of this species in its prime are unmistakable.<sup>8</sup> Then, too, the most logical approach to an understanding of any arborescent palm species in its native habitat is through observation of the developmental series of a population in the midst of obviously mature trees. Thus, it later became possible to ascertain the identity of groups of *Sabal louisiana* which had not yet attained their prime and with which mature trees were not intermingled.

From observations in Louisiana it seemed apparent that Louisiana palmetto would be

<sup>7</sup> BOMHARD, MIRIAM L. *Sabal louisiana, the correct name for the polymorphic palmetto of Louisiana.* Journ. Washington Acad. Sci. 25 (1): 42. 1935.

<sup>8</sup> The only habit photographs of this species thus far published by others are of specimens at Frenier Beach. See Figs. 5 and 6 in SMALL, JOHN K. (1929), and Figs. 152 and 167 in BAILEY, L. H., *Sabal et ceterae.* Gentes Herbarum III, fasc. VI, art. 6, 1934. Dr. Small's Fig. 6 was republished in his article *Palms of the Continental United States.* Sci. Monthly 32: 10. 1931. A photograph of a specimen growing near Bayou Bienvenue, eastern Louisiana, was published as Fig. 1 in BOMHARD, MIRIAM L. *What palms grow in Louisiana.* Louisiana Cons. Rev., Autumn, 1937.

<sup>1</sup> Received March 22, 1943.

<sup>2</sup> DARBY, WILLIAM. *A geographical description of the state of Louisiana . . . being an accompaniment to the map of Louisiana,* ed. 1: 194. 1816.

<sup>3</sup> SMALL, JOHN K. *A new palm from the Mississippi Delta.* Torreyia 26: 33-35. 1926.

<sup>4</sup> There are no Louisiana palmettos in the marshes in the immediate vicinity of Pointe aux Herbes. Those seen by Dr. Small were a distance south of this place.

<sup>5</sup> SMALL, JOHN K. *Palmetto-with-a-stem—Sabal deeringiana.* Journ. New York Bot. Gard. 30: 283. 1929.

<sup>6</sup> SMALL, JOHN K. *Manual of the southeastern flora:* 240. 1933.

distributed throughout the Gulf Coastal Plain (including the Mississippi Alluvial Plain) wherever the physiographic and micro-climatic conditions are essentially the same. Exploration in this broader area, based on this premise, has been carried out since 1935—along the waterways of recent alluvial origin where conditions are reasonably similar to those of southeastern Louisiana and where it could almost be predicted that *Sabal louisiana* would occur.

As a result of these studies the present known range of *Sabal louisiana* has now been considerably extended. From Louisiana this species radiates out into eastern Texas, southeastern Arkansas, and at least into western Florida. The most important extension was the discovery of *Sabal louisiana* in Texas, where it had apparently not been previously observed by botanists.<sup>9</sup> The finding of well-developed arborescent palmettos in that State is especially significant and conclusive.

On a brief trip through eastern Texas in May and June of 1941, two stands of *Sabal louisiana* were discovered south of Cleveland, Tex.—on the western margin of the "Big Thicket." The first, in a local depression just below the town itself, consisted of a dense stand of palmettos, most of them in the intermediate growth stage, with a boot-aggregation of 40 cm or more, leaves 18 dm in expanse, and very robust, strongly branched inflorescences more than 45 dm tall although not yet in bud. This group is similar to many of those in southeastern Louisiana growing under the most favorable environmental conditions.

The second, 4 miles south of Cleveland, within sight from the bridge (U. S. Highway 59) that crosses the East Fork of the San Jacinto River, was a group with arborescent specimens. Perhaps 20 trees are easily accessible, scattered in a rather open portion of the flood bed on the east bank of the river. Farther back, in an area not readily accessible, the large crowns of many other Louisiana palmettos are visible. It was pos-

sible to take specimens, measurements, and photographs (Pl. 1, lower left) only of the trees in the open area. The trunk height of these did not exceed 11 dm, and the diameter, without boots, averaged 33 cm. This group is, in many respects, a replica of a stand in the Vermilion River bottomland, near Intracoastal City, southern Louisiana, where short-trunked palmettos remain in clearings nearest the newly made road and the more robust specimens are inaccessible in the midst of woody vegetation, subject to annual inundation.

Another collection of *Sabal louisiana* was found in the bottomlands of the Lavaca River, west of Lolita, Tex. Those nearest the road, although of intermediate character and of uniformly the same age, were so dense and the flood area appeared to be so broad that arborescent specimens in their prime or even old specimens might have been brought to light had there been time to give this region more than a cursory investigation.

Having seen some small groups of poor-looking palmettos (intermediate stage) near the Colorado River, in the vicinity of Wharton, and on the San Bernard River, near Hungerford (U. S. Highway 59), I later made a hasty survey of these same river areas nearer to the coast, this time following State Highway 35, that is, near Bay City and near West Columbia, and also out of East Columbia on the Brazos River. Although conditions here were favorable for arborescent palms, I did not find any in the limited time at my disposal.

However, at least one excellent stand with trunked palmettos does occur in the San Bernard River bottomland 8 miles from Brazoria, Brazoria County. Discovered by Robert A. Vines, of Houston, Tex., these palms were brought to my attention in June, 1942, by C. V. Morton, of the United States National Herbarium, to whom Mr. Vines sent photographs and notes, leaves, and portions of a fruiting stalk of an arborescent *Sabal* for identification. It proved to be *Sabal louisiana*. This discovery of a group of 20 or more of these palms is a fine contribution to the distribution pattern of *Sabal louisiana*, especially since three very old trees are in the group, one with a trunk

<sup>9</sup> See PARKS, H. B., CORY, V. L., and others. *Biological survey of the east Texas big thicket area*, ed. 1, 1936, and ed. 2, 1938. There is a photograph on page 24, captioned "Giant palmetto," but *S. minor* is the only species of this genus given (p. 33) in the list of plants of the big thicket.

height of 54 dm—the greatest height yet recorded for the bole of Louisiana palmetto. A portion of Mr. Vines's notes accompanying the specimens (*Vines* 425) reads as follows: "HABITAT.—Swampy black soil. Associated with *Sabal minor*, *Quercus virginiana*, *Ulmus crassifolia* and *Fraxinus pennsylvanica* var. *lanceolata*. REMARKS.—A palm with a distinct trunk. A handsome palm. Flowers in June and July. Fruit matures in November and December. Evidently very limited in distribution. Eighteen plants found within a half-mile radius. From the number of young plants seen, it was evidently reproducing itself satisfactorily. All the trees grow in thick tangles of vegetation, and are thus protected from excess cold during winter. Old settlers say this small isolated group of palms has been growing wild in the bottomlands as long as they can remember."

Mr. Vines has recently graciously supplied me with his negatives, from which the illustrations in the upper and lower right of Plate 1 were made, as well as with the following additional statement concerning the circumstances of his discovery and locality details:

The stand of palms grew on the land of Deputy-Sheriff Harold Graves, of Brazoria, Tex. The stand is located on the Brazoria-Cedar Lane cut-off road approximately 2 miles east of the Brazoria and Matagorda County line. The Brazoria-Cedar Lane road runs through the center of the stand. When the road was built some of the workmen dug up some of the large specimens to plant in their yards. According to Deputy-Sheriff Graves and several other of the older settlers, the palms have been there for many years. They remember them as having been in that location for 25 or 30 years. They first remember them when squirrel hunting in the bottomlands as boys, and when rounding up cattle, before the road was ever cut through.

I have also heard rumors of another stand of aborescent palms in the same region. The rumor circulated by old Negro settlers who said they used to see the big palms while fishing on the San Bernard River. None of them, however, could give me exact directions as to just where it might be. I tried several of the leads, but they always were blind ones. I still have a suspicion that at one time quite a large stand must have existed along the San Bernard River. This stand, of course, might have been destroyed, but the rumors, and stories of it, still exist. I still have hopes that I shall be able to rediscover the remnants of the stand eventually.

I first saw these palms, that is, those on the Brazoria-Cedar Lane road, during the summer of 1941, but it was not until the summer of 1942 that I collected specimens and took pictures of them.

Doubtless other arborescent stands will be found in protected areas, where optimum conditions exist, in Texas and other portions of the Coastal Plain.

Louisiana appears to be the center of distribution. Observations thus far made indicate that the greatest concentration of vigorous and thriving stands, including many individuals of arborescent character, occurs in the fertile soils of the lower Mississippi Alluvial Plain. This is partly due to the fact that habitat factors are most favorable for their development and partly because much of this region—in the wetter areas—has not yet been too greatly altered by the destructive forces of man.

The phrase "flat alluvial places" does not, however, convey the true character of the habitat of *Sabal louisiana* even in southeastern Louisiana. Although the areas where it occurs are alluvial, they are not strictly flat. The topography is varied. Account must be taken of the paired alluvial or deltaic ridges, of greater or less width and elevation, that traverse the swamps, marshes, and other low-lying areas. The ridges were formed by alluviation from a series of successively developed distributary channels of the Mississippi River, most of which are no longer active. The land is highest nearest the active or abandoned channels of distributary streams, and slopes toward the wetter areas, characterized by temporary or permanent marshes, swamps, lagoons, or lakes. Louisiana palmetto frequently occurs in the so-called "back land" zone or belt between the ridgeland and the marshes or swamps; it may actually border the wet areas; or if the ridges are of low elevation, it may occupy the ridges themselves usually forming an understory to the other arborescent vegetation. It also occurs in coulees or relict distributary channels. It is at its best in the mild climate of the Gulf coast, where there is a high water table for much of the year and where partial shade is provided by the surrounding vegetation. It is not a "swamp plant" in the

sense that baldcypress and water tupelo are considered to be swamp trees.

*S. louisiana* also occurs in the valleys of the Red and Ouachita Rivers, as well as in the Mississippi flood plain proper, where artificial levees and spillways hold the floods in check. In *Louisiana out-of-doors* Percy Viosca, Jr., writes concerning the large interior river valleys, that include hardwood valley lands, river basin swamps, and lakes above Gulf level: "As this region is the richest in the state from an agricultural standpoint, most of it has been cut over, and in place of the forests, today we find sugar cane, corn or cotton fields and truck and dairy farms. Cane is raised more toward the southern part of the state, and cotton more in central and north Louisiana."<sup>10</sup> He states further that palmetto thickets and canebreaks occur on alluvial and "bluff" soils wherever the water table is near the surface.

There is every indication that *S. louisiana* formerly occupied a much larger area than it does today and that there were countless more individuals of tree size. Indeed, William Darby wrote 137 years ago: "The land is commonly of the best quality. Much of the surface of the country low upon the Mississippi, now cultivated in cotton, maize, rice, and sugar, was originally covered with palmetto."<sup>11</sup> Extensive engineering operations, including the building of artificial levees, the closing off of certain natural waterways, the construction of roads, accompanied by clearing of the vegetation and digging of drainage ditches and canals with consequent lowering of the water level, the reclamation of land for cultivation—all have contributed to the disappearance of these palmettos.

This destruction may be witnessed today. The illustration in the upper right of Plate 2 shows the effect of road-building near Intracoastal City, Vermilion Parish, La. The area here occupied by Louisiana palmetto is still rather extensive but it was previously in much more flourishing condition. Dead trunks are lying about on the ground as the result of burning and clearing,

and many palms that are still living show charred trunks. The one-time height of the flood level in this area may be noted from the root zone on the trunk just below the "boots" of the small tree illustrated. Fortunately, a distance back of the road, arborescent specimens in their prime with inflorescences overtopping the surrounding vegetation still exist.

The illustration in the upper left of Plate 2 shows a specimen with medium-sized trunk in what was, until a few years ago, a lovely grove of Louisiana palmetto, lying between a natural levee and a cypress-tupelo swamp, near the eastern limit of New Orleans. Many palms were destroyed by clearing and burning, in the process of extensive road-construction and draining, in the general area of Bayou Bienvenue. More recently truck gardening has been initiated in the rich soil of this area, in the midst of chopped and burned palmettos.

In a report of a survey of the Rio Grande River in Texas, Arthur Schott made the following reference, in 1859, to a "gorgeous" growth of palmettos on the Mississippi River: "It is also in the lower portion of this belt (where the Palm tribe is represented by the *Chamaerops Palmetto*) that the Palmetto attains a growth as gorgeous even as that on the Lower Mississippi; it extends on the Rio Bravo [Rio Grande] up to about 80 miles from the Gulf. In addition to the Palmetto common to the lower portion of these two great rivers, . . ."<sup>12</sup>

In calling attention to Schott's statement, Dr. Small commented: "Field work in the lower Mississippi delta by the writer subsequent to the spring of 1925, has convinced him that the extensive engineering operations connected with the building of the levees along both banks of the river utterly exterminated the palm growth referred to by Schott. Arthur Schott made his observations about the middle of the last century, while extensive levee building occurred about the beginning of the last quarter of that century. It is evident that neither the engineers in charge of the levee work nor

<sup>10</sup> VIOSCA, PERCY, JR. *Louisiana out-of-doors: A Handbook and guide*: 51. 1933.

<sup>11</sup> DARBY, *op. cit.*

<sup>12</sup> SCHOTT, ARTHUR. *Substance of the sketch of the geology of the lower Rio Bravo del Norte*, pt. 2, in Emory, William H. *Report on the United States and Mexican boundary survey* 1: 44. 1857.

their associates were botanists, else some record additional to Schott's original statement would have found its way into print."<sup>13</sup> It should be mentioned here that even near the Mississippi itself a few trunked trees of *S. louisiana* occur south of Buras; they have very small crowns and are not now growing in a very favorable situation. Furthermore, the Mississippi Delta occupies a widespread area, and it can be seen from the outline map (Fig. 1) that there are still groups of Louisiana palmetto in many portions of it.

Forty-three years before Schott published the statement quoted above, Darby wrote: "Along both banks of New River, in the rear of the plantations on the Mississippi, and on the banks of the Atchafalaya, are the places where most of the arundo [*Arundinaria gigantea*] yet exists. Here, as well as in every other part of Louisiana, where the land sinks too low for the arundo, is found the *Chamaerops louisiana*.<sup>14</sup>

At the present time, there is still a good representation of Louisiana palmettos between Gonzales, just south of New River, and Sorento, in Ascension Parish. In the lower Atchafalaya Delta arborescent specimens of *S. louisiana* may also be seen today near Morgan City and east of it along Bayous Black and Chacahoula.

Darby described Louisiana palmetto as a new species because he was of the "opinion that there is a specific difference between the *Chamaerops palmetto* hitherto known to botanists, and that of Louisiana."<sup>15</sup> The mistake of Schott, Langlois,<sup>16</sup> Featherman,<sup>17</sup> and others of thinking that Louisiana palmetto was the cabbage tree, *S. palmetto* (= *Chamaerops palmetto* Michx.), does not seem to me to indicate such a serious error in judgment on the part of these observers, but it does show the astuteness of Darby. Cer-

tainly this palm could not be the stemless *S. minor* (Jacq.) Pers. To what other arborescent palmetto could it have been referred, considering that Darby's work and publication was apparently not well known and that *S. texana* had not yet been described?

Natural factors also are contributing to changes in the aspect and extent of Louisiana palmetto stands or to their complete obliteration. Two examples—the first on the southwest; the second on the north, shore of Lake Pontchartrain—are of interest. Many of the taller palmettos in the striking group of 35 or more at Frenier Beach (west shore) (2),<sup>18</sup> standing in a coulee back of the lake shore, give the appearance of having been planted for ornamental purposes. There are few transitional forms in this relatively open area, but all stages of growth occur in the low ground to the rear. This beach was built by alluvial deposits; there is a clay base, which, until quite recently, was overlaid with sand. The shore is now being cut back at a rapid rate, geologically speaking. Continued erosion will in the future change the natural habitat. The character and relative abundance of the palms will also be altered as a consequence.

On the north shore, just east of Mandeville (5), a later stage in the sequence is taking place. Here the lake, brackish at times, is encroaching upon the land and has already built up a sand ridge, 8½ feet in height, upon the shore. Similar sand-encroachments are taking place in certain other portions of the north shore of Lake Pontchartrain. The extent of swamp was formerly much greater, as attested by cypress stumps about 400 feet out in the lake and dead or dying cypress trees standing at the water's edge. A direct line from the outer margin of the cypress swamp into the lake passes in succession (1) Louisiana palmettos in flourishing condition but with an inconsiderable development of trunk; (2) specimens almost completely buried in the sand, so that only the upper portion of their trunks and crowns is free; and (3) arborescent palmettos standing in a foot or

<sup>13</sup> SMALL, JOHN K. *Palmetto-with-a-stem*—*Sabal deeringiana*. Journ. New York Bot. Gard. 30: 280–281. 1929.

<sup>14</sup> DARBY, *op. cit.*, 193–194.

<sup>15</sup> *Ibid.* 194.

<sup>16</sup> LANGLOIS, A. B. *Catalogue provisoire de plantes phanérogames et cryptogames de la Basse-Louisiane, États-Unis d'Amérique*: 17. 1887.

<sup>17</sup> FEATHERMAN, A. *Report of botanical survey of southern and central Louisiana made during the year 1870*: 25. 1871.

<sup>18</sup> The figures in parentheses in the text refer to localities on the outline map (Fig. 1).

more of water out in the lake itself. The crowns of the palmettos in the last two groups are much reduced in size, the leaves are thick and very filiferous, and the flower-stalks are telescoped. Eventually this whole stand will be no more, even though new plants will for a time continue to come up between the ridge and the ever-shrinking cypress swamp.

Dr. E. W. Berry states that "the silicified remains of palm wood are exceedingly common in the late Eocene and Oligocene deposits from Texas eastward across Louisiana, Mississippi, and Alabama, and reappear in several of the Greater and Lesser Antilles, as well as in Mexico and on the Isthmus of Panama."<sup>19</sup> Palm leaves are also preserved in certain of these deposits. Various genera are represented, but the correlation of fossils with living genera or species can only be approximate. In the palm family, leaf remains naturally provide more useful identification characters than trunks.

There are fossil deposits containing leaves and "rays" (segments) of *Sabal*-like species in the Jackson formation (Upper Eocene), especially in the Vicksburg limestones and Catahoula and Fayette sands, from eastern Texas to Georgia. Beds of Vicksburg age are notable for the abundance of palm fragments and are of especial interest. The fossil leaf species, *Sabalites vicksburgensis* Berry,<sup>20,21</sup> is described as having a maximum expanse of 120 cm, the rachis continues upward part way through the blade, and the 40 segments, up to 3.6 cm wide, become free in the outer one-third to one-half of the blade. Although the type locality of this fossil species is Rosefield, La. (Catahoula sandstone), it is also abundantly represented in sands of similar age in Fayette, Polk, Trinity, and Webb Counties, Tex. Certain other species of *Sabalites* seem to indicate close relationship with *S. palmetto* or with *S. minor*; it is not improbable that

*Sabalites vicksburgensis* may represent an ancestor of *S. louisiana*, which certainly must have been more widespread in geologic time.

Louisiana palmetto, like other species of *Sabal*, evidences a wide range of adaptability to various environmental conditions and, in common with many palms, has different aspects from youth to old age. A consideration of it in four ontogenetic stages—juvenile, intermediate, climax or mature, and senescent—should contribute to a better understanding of this species.

Apparently there are comparatively few senescent Louisiana palmettos in existence, and all that I have seen in Louisiana are, or appear to be, growing in habitats that are no longer entirely favorable. Only an approximation of their age is possible but it is known that this species grows slowly. An ancient tree, such as that illustrated in the upper left of Plate 1, may well be 200 or more years of age. Four (occasionally eight) leaves are produced by *S. louisiana* in a season; the leafscars on the trunk are very close together. It is not determinable what length of time elapses in the production of the horizontal underground stem before the erect habit is assumed.

A reduced leafcrown—smaller blades on shorter petioles—and shortened, telescoped inflorescences are indications of senescence or induced senescence. Thus, the total height of an old specimen with relatively tall trunk is often less than that of a specimen in its prime with much shorter bole. The more robust appearance of the younger palmettos in the photograph is evident as is also the contrast between the senescent tree and the young climax form at the left.

This group (Pl. 1, upper left) is part of the largest single Louisiana palmetto area of which I am aware, but I have not seen more than a half-dozen senescent specimens in it. Thousands of palmettos, the majority in the intermediate and climax stages, occupy an almost unbroken stretch of at least 20 miles from Golden Meadow to a distance south of Leeville, La., along Bayou Lafourche (14). This bayou no longer functions as a distributary of the Mississippi River, having been closed off from it in 1912. The broader alluvial regions in the upper por-

<sup>19</sup> BERRY, E. W. *The flora of the Catahoula sandstone*. (M) in *Shorter contributions to general geology*, 1916. U. S. Geol. Surv. Prof. Paper 98: 233. 1917.

<sup>20</sup> *Ibid.*

<sup>21</sup> BERRY, E. W. *The Middle and Upper Eocene floras of southeastern North America*. U. S. Geol. Surv. Prof. Paper 92: 151, pl. 29. 1924.

tion of its course are under cultivation. The palmettos are to be seen in the lower portion. They occupy a relatively narrow, almost treeless zone between the ridge-road and swamp or marsh, or they occur as an understory on the chénières. These ridges near the coast, on which live oak (*Quercus virginiana*), water oak (*Q. nigra*), and hackberry (*Celtis laevigata*) form the dominant vegetation, take their name from the French *chéne*, oak. The palmetto growth fades out together with the diminishing chénières toward the Gulf of Mexico.

The few senescent specimens in this large tract closely resemble each other; some have more boots clinging just under the crown. A dense mass of roots clothes the lower 4.5 dm or less at the base of all of them. The trunks are almost white—a modification in this saline situation, where the insolation is intense, of the normally grayish-brown tone of the bark of this species. The longitudinal fissures that cross the closely spaced leafscars lend a checkered appearance to the bark.

In Louisiana old palmetto individuals also occur near Bayou Bienvenue (3) and near the Mississippi River on Bayou Laird, south of Buras (15); the trees, partly buried in the sand ridge on the north shore of Lake Pontchartrain (5) and with only 75 cm of visible trunk, are also senescent. Measurements in these scattered localities are very similar and may be summarized as follows: TRUNK: Height, 15–26.5 dm (up to 54 dm in Texas); diameter of trunk devoid of boots, 22.6–28 cm. LEAF BLADE: Expanse, 10.5–13 dm; length in middle line, 6.5–9 dm; rachis length, 15–26 cm; number of segments, 34–40; widest segments, 3.8–5.7 cm; sparsely to very filiferous in the sinuses, depending upon the habitat. PETIOLE: Length,

50–80 cm; width near blade, 2.2–2.9 cm; width near base, 2.8–3.8 cm. INFLORESCENCE: Height, 12–27 dm; width at base of inflorescence stalk, 3.2–7.6 cm; number of sterile spathes, 10; number of fertile spathes, 7–13.

The specimen illustrated in the upper right of Plate 1 was photographed by Mr. Vines in the San Bernard River bottoms (28) of Texas. Three trees in this area are old, the tallest trunk measuring 54 dm. The diameter averages 30 cm. This locality appears to represent a more nearly normal habitat for *S. louisiana* than any of the areas in Louisiana where old trees have been observed. The crown shows reduction in size, but the leaves appear to be larger and the petioles are longer than those whose measurements have just been listed. This is to be expected where palms occur in an undisturbed wet area in "thick tangles of vegetation." Sudden lowering of the water table has apparently not occurred in this region and it is probable that complete drying out of the terrain does not take place. This venerable group should continue to be protected. It is highly desirable that certain groups of Louisiana palmetto in Louisiana should be set aside for conservation, inasmuch as stands of this sort are imminently threatened with extinction.

Louisiana palmetto evidences the full vigor of maturity in the climax stage. The few descriptions of this species thus far published apply, with some emendations, to this life-form. Ordinarily the climax stage is a bulky palm, with heavy, impressive crown, but its appearance varies somewhat with habitat just as do other phases of this species. Plate 1, lower left and lower right, illustrates typical specimens in Texas (27 and 28). The most typical specimens in

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PLATE 1.—Upper left: Senescent *S. louisiana*, surrounded by palmettos of intermediate growth stage with boot-aggregation, and young climax forms with short trunks such as that to the left of the old tree. In an open situation where the habitat is no longer entirely favorable, along Bayou Lafourche, near Leeville, La. (15).

Upper right: Senescent *S. louisiana*, with trunk height of 51 dm. In an apparently optimum habitat, San Bernard River bottoms, 8 miles west of Brazoria, Tex. (29). Photograph by Robert A. Vines.

Lower left: Louisiana palmetto of climax form. Upper portion of trunk and lower part of crown. Open bottomland, East Fork of the San Jacinto River, south of Cleveland, Tex. (27).

Lower right: Vigorous climax specimen that has retained the leaf bases in a favorable, protected habitat. Mr. Vines, who discovered and photographed this stand, is holding a leaf cut from a younger climax palmetto growing nearby. San Bernard River bottoms, 8 miles west of Brazoria, Tex. (29).



PLATE 1.—(See opposite page for explanation.)



PLATE 2.—Upper left: Typical young climax form of *S. louisiana*. Near Paris Road, vicinity of Bayou Bienvenue, La. (3).

Upper right: Climax Louisiana palmetto, showing the effects of burning and clearing in connection with road-construction. Sawed palmetto trunks in the left foreground. Near Intracoastal City, La. (16).

Lower right: "Field type" of intermediate growth stage, showing the characteristic collapse of the dying leaves. Along a fence bordering a cottonfield, Rayville, La. (35).

Bottom: A group of palmettos in intermediate growth stage toward the northern limit of the range of *S. louisiana*. The strongly branched inflorescences are not yet in bud (May 23, 1941). West of Montrose, Ark. (23).

southern Louisiana, such as that shown in the upper left of Plate 2, grow in partial shade on moist fresh-water sites that are flooded in winter and in early spring. In the lower-lying areas Louisiana palmetto is associated with willows (principally *Salix nigra*), red maple (*Acer rubrum drummondii*), and ashes (*Fraxinus caroliniana*, *F. tomentosa*, or *F. pennsylvanica lanceolata*), not far removed from the deeper swamps dominated by baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*, usually known as tupelogum) or swamp blackgum (*N. biflora*). On the ridges, dominated by live oak and hackberry and sometimes also southern magnolia (*Magnolia grandiflora*), the other arborescent associates of Louisiana palmetto include American sweetgum (*Liquidambar styraciflua*), water oak (*Quercus nigra*), willow oak (*Q. phellos*), waterelm (*Planera aquatica*), and American hornbeam (*Carpinus caroliniana*). Common honeylocust (*Gleditsia triacanthos*) or yaupon (*Ilex vomitoria*) is also frequently present.

In the interior river valleys of central and northern Louisiana tree communities of the wetter areas are, on the whole, similar to those farther south. Several additional species of oak, such as red oak (*Q. shumardi*), Nuttall oak (*Q. nuttalli*), and overcup oak (*Q. lyrata*), pecan (*Carya pecan*), winged elm (*Ulmus alata*), and other hardwoods augment the list of tree associates that occur with Louisiana palmetto on the ridges farther from the coast.

In optimum habitats a characteristic specimen of Louisiana palmetto with medium-sized trunk has large, comparatively thin, bluish-green leaves up to 20 dm broad. The length in the middle line is 9 dm or more; but this is somewhat shorter than the maximum blade length in either side of the center. The pinnati-palmate leaves are not in one plane. The blades have a characteristic "palmetto-curve," but it is not so strongly developed as in *S. palmetto* and other large-leaved arborescent Sabals. The rachis (continuation of the petiole as a midrib into the blade, along which most of the segments originate) is winged below and firmly supports the lower one-third of the blade, but, beyond it, the leaf is deeply split

into two halves. From 36-50 segments divide the outer half or two-thirds of the blade, the inner solid portion being broadly heart-shaped in outline with the notch at the top, at the end of the rachis. The broad, gradually acuminate segments stand out rather stiffly; their apices, although bifid from several to 13 cm (or even more at the sides), are usually not flaccid. A thread-like fiber hangs in the clefts of the younger leaves but only a few persist in older ones. The flat, platelike hastula, at the juncture of the petiole and blade on the upper surface of the leaf, is asymmetrical and averages 4 cm in length.

The unarmed petioles, longer than the blades, are concave on their upper and rounded on their lower surfaces; the up-turned margins are very sharp, faintly denticulate toward the base. The petiole bases split with age but only occasionally form a crisscross or lattice (so characteristic of the larger *Sabal* species). The two boot-halves remain erect or at least ascending for a considerable period. The sheaths are never prominent; in fact, they are noticeable only in the youngest part of the crown, where the petiole bases of the newest leaves are bordered by narrow, chaffy, light brown margins.

One of the most interesting characteristics of this species is the peculiar collapse of the dying leaves at the juncture of the petiole and blade, giving the effect of a half-closed umbrella. The blade may fall off at this point, or the petiole may break midway before the blade falls.

A trunk averaging 9-18 dm in height usually exhibits three zones: a region of roots at the base, a narrow girdle of bark, and a boot area below the leafcrown. Occasionally an additional root development occurs fairly high up on the trunk, indicating some previous high water level. (Compare the illustration in the upper right of Plate 2 with that in the upper left.) The actual trunk diameter (bark only) rarely exceeds 33 cm and is usually somewhat less. When the boots persist over a period of years, as often happens in the wetter situations, the trunk appears to be twice as thick as it actually is. The rough bark is usually grayish brown.

Four to six (generally four) inflorescences ("spadices" of literature) are produced in a season. They stand stiffly erect and, in the more open situations, may surpass the associated small trees. Twenty-two or more tubular, long-pointed spathes overlap each other and cover the length of the inflorescence axis. Those in the lower stalklike portion of the axis are sterile; the upper, fertile. *S. louisiana* is characterized by a thrice-compound inflorescence—the strongly developed, ascending or appressed, lateral branches that emerge from the lower fertile spathes may attain 9 dm in length in the climax form. The branches become progressively shorter until, toward the apex of the main inflorescence, the panicles emerge directly from the uppermost fertile spathes. The lower branches have five or fewer sterile spathelets at their base and the ten or fewer panicles are subtended by the upper fertile spathelets.

The young inflorescence shoots are visible in the leafcrown in November. These are elongated, attenuate-coniform structures, imbricated with the appressed apices of the lower spathes. Full development is not attained until the following spring. Flowering begins in June, or even late in May, and sometimes continues into July. In some years full flowering fails to take place, even on perfectly vigorous specimens, because of unusual infestation of the panicle buds by insect larvae. Some of the lower panicles of the branches may come into flower but the remainder are aborted. In 1933 only one palmetto tree in a stand of 40 or more bore normal inflorescences.

The flowers are white, sessile, 5–6 mm high, spirally placed about the rachillae at rather regular intervals, spaced several millimeters apart. They are subtended by two unequal bracteoles, the base of the smaller being partially enclosed by the larger. Floral characters are: calyx 2–2.5 mm high, cylindric and thick below, 3-angled, with three short, triangular, unequal, slightly carinate, thin, nerved lobes; corolla more or less united with the stamens into a short pseudotube at base; petals 3, broadly ovate, 3.3–3.5 mm high, 2 mm broad at base, thin, involute, minutely serrulate, thickened and hooded at apex, auri-

clad at based, 5–7 nerved; stamens 6, the alternate shorter than the opposite that are adnate to the petals; filaments subulate-lanceolate, dorsoventrally flattened; opposite stamens 4.5–5 mm high, the filaments 4 mm high, 1 mm broad at base; alternate stamens 4–4.5 mm high, filaments 3.5 mm high, less than 1 mm broad at base; anthers bright yellow, introrse, short-sagittate, 1–1.2 mm long, anther sacs somewhat unequal; pistil comprised of 3 carpels, 3.5–4 mm high, 1 mm or more broad at the enlarged ovarial base, stylar portion 3-angled, apex truncate. The flower buds show 18 chromosomes (plate stage).<sup>22</sup>

The fruits are suborbicular, brownish black drupes, ripening in November. They average 9–11 mm in diameter and 8–9.5 mm in height. The reddish brown, sub-lustrous seeds, enclosed in a thin integument, are 8–9 mm in diameter and 6–7 mm in height. The micropyle is lateral.

Many of the fine groups of climax specimens along Bayou Sauvage and near the Chef Menteur (1 and 4), including some of those on which Dr. Small based his original description of *S. deeringiana*, are, unfortunately, no longer extant. However, favorable localities in Louisiana where numbers of characteristically well-developed climax specimens may still be observed are at Frenier Beach (2), near Bayou Bienvenue (3), in the lower portion of the Vermilion River bottom (16), along Bayou des Allemands (11), east of Berwick Bay on Bayous Black and Chacahoula and south of it on Bayou Shaffer (15), and in some other places (1, 12, 14). Fairly isolated individuals in their prime, noted in Louisiana, near the towns of Bunkie (19), Denham Springs (17), and Rayville (22), will be discussed in connection with Louisiana palmettos of intermediate growth stage. In Alabama a good stand of representative Louisiana palmettos grows in the bottomland of the Tensas River at the head of Mobile Bay,

<sup>22</sup> Dr. A. E. Longley, U. S. Department of Agriculture, obligingly examined many samples of Louisiana palmetto flower buds that had been collected in various localities. Only those from the Chef Menteur area along Bayou Sauvage proved to be in the proper stage for chromosome counts. They were collected from both climax and intermediate forms of *S. louisiana*.

in a locality inaccessible except by descent from the Louisville & Nashville Railroad trestle (24). The best groups thus far discovered in Texas have already been mentioned as occurring in the bottomland of the East Fork of the San Jacinto River (27) and in that of the San Bernard River (28).

Measurements of the climax form may be stated as follows: TRUNK: Height 9–19.5 dm; diameter of trunk devoid of boots, 28–34 cm. LEAF BLADE: Expanse, 16.5–20 dm; length in middle line, 9–12 dm; rachis length, 25–42.5 cm (usually 30–37.5 cm); number of segments 36–50 (usually 38–42); widest segments, 4.7–7 cm; usually sparsely filiferous. PETIOLE: Length, 70–145 cm (usually 105–135 cm); width nearest blade, 2–3.8 cm; width nearest base, 4.5–5.7 cm. INFLORESCENCE: Height, 25.5–39 dm (usually 36 dm); width at base of inflorescence stalk, 4.5–6.4 cm; number of sterile spathes, 10–14; fertile spathes, 12–18; lower inflorescence branches up to 9 dm in length.

Deviations from the characteristic climax form of the shaded, fresh-water sites are especially apparent in the extensive Bayou Lafourche palmetto area (14), evidencing adaptation to a different set of environmental factors. The leafblades are thicker in texture, glaucous, stiffer, yellow- or gray-green, and abundantly filiferous; the inflorescences average 30 dm in height; and the trunk diameter is not quite 28 cm.

Under favorable conditions there is a natural transition from the climax form to those of intermediate stage. It is so gradual that the line of demarcation has been arbitrarily placed to include in the intermediate stage those specimens whose trunks usually retain the leafbases to form "boot-aggregations" of 9 dm or less, and that do not yet show a true bark area. There is also no visible root development above the ground level. The leafblades are borne on longer petioles and are frequently larger than those in the climax form; they are ordinarily 3 dm broader in proportion to their length. The tallest inflorescences with the most strongly developed lower branches (up to 15 dm in length) also occur in this stage.

Palmettos of this robust intermediate stage occur in most of the optimum areas

already given for the climax form. However, certain additional localities in which the palmetto population is predominantly or entirely composed of flourishing specimens in this and juvenile stages are of interest. These palmetto areas are indicated on the outline map by numbers 6, 7, 8, 9, 13, 18, 20, and 21 for Louisiana, 23 in Arkansas, and 26 and 29 in Texas. There is the possibility, of course, that climax forms are associated with the intermediate forms in the more inaccessible wetter portions of some of these areas but have not yet been discovered. In other populations, it is known that the larger palmettos were removed in the clearing of the forests for cultivation of sugar, cotton, or other crops. Where cultivation was later abandoned and the areas permitted to return undisturbed to forest, second growth timber has come in. In such places, provided that the water level is still near the surface, all the palmettos are of normal intermediate or younger growth stage.

Louisiana palmettos of the intermediate growth stage in normal environments have the following dimensions: TRUNK: Height, 3–9 dm. LEAF BLADE: Expanse, 12–21.5 dm; length in middle line, 8–11 dm; rachis length, 16.7–42 cm; number of segments, 34–50 (averaging 34–42); widest segments, 2.2–6.7 cm; sparsely to moderately filiferous. PETIOLE: Length, 95–160 cm; width nearest blade, 2.5–4.5 cm; width near base, 3.2–5.7 cm. INFLORESCENCE: Height, 27–46 dm; width at base of inflorescence stalk, 3.8–6.4 cm; number of sterile spathes, 9–11; number of fertile spathes, 11–17; length of lowest branch, up to 15 dm.

An unfavorable environment is reflected in the character of intermediate-stage palmetto groups subjected to adverse natural factors such as saline or brackish water, excessive direct sunlight, and the piling up about the plant bases—or removal therefrom—of soil and inundation debris. The great majority of the Louisiana palmettos of intermediate stage that grow in deep muck in exposed brackish habitats along Bayou Lafourche (14), some of those on the lake side of the sand ridge at Lake Pontchartrain (2), and the few specimens in sand on the east shore near the mouth of the Escam-

bia River, Fla. (25), show the effects of naturally trying conditions and closely resemble each other.

The character of Louisiana palmettoes in or near pastures, cultivated fields, or fields turned back to pasture is also associated with unfavorable environmental conditions, but these have been mainly brought about by the clearing of forests together with lowering of the water level, plowing or other methods of cultivation, and cattle-grazing. High insolation and long dry periods following brief or only occasional high water levels are contributing adverse factors. In the more northern latitudes the cooler winter temperature also exerts a retarding influence upon growth.

The growth form of all these palmettos in the intermediate stage is compact—the crown is less open and smaller than in those in optimum habitats, and the aggregation of boots at the base is very dense, probably because elongation of the upright trunk proceeds very slowly. The “palmetto-curve” of the thick, more or less glaucous, yellow or gray-green, abundantly filiferous leaves is more prominent, as is the inclination of the two halves of the blade away from the middle line. The segments are relatively wider in proportion to the size of the blade. The characteristic umbrella-collapse of the dying leaves is pronounced (Pl. 2, lower right). From a distance, pastures and cut-over areas of palmettos resemble fields of shocked wheat. The thick, branched inflorescences are shortened and compressed, often being very similar to those of senescent trees. The lower branches are so close together in many of the field and pasture palmettos that the inflorescences have a bushlike appearance. Failure to develop inflorescences is not infrequent in palmettos that are exposed to grazing, plowing, etc., but those along fence rows and the margins of fields that border woods succeed in putting forth inflorescences in occasional years, if not annually.

Although the palmettos in naturally adverse habitats (2, 14, and 25) have somewhat larger leaves and boot-aggregations (3–6 dm) in contrast to the smaller leaves and boot-aggregations (about 3 dm) of the intermediate stage of fields and pastures

(30, 31, 32, 33, 34, 35, 38, 39), the overall dimensions fall within the same range: TRUNK: Height of boot-aggregation, 3–6 dm. LEAF BLADE: Expanse, 12–15 dm; length in middle line, 6.7–9.2 dm; rachis length, 13–22 cm; number of segments, 32–40 (usually 32–38); widest segments, 3.8–5.7 cm; very filiferous. PETIOLE: Length, 45–95 cm; width nearest blade, 2–4.5 cm; width near base, 2.8–5.7 cm. INFLORESCENCE: Height, 20–28.5 dm; width at base of inflorescence stalk, 3.2–5 cm; number of sterile spathes, 9–12; number of fertile spathes, 10–17; length of lowest branches, up to 4.5 dm.

The palmettos, with boot-aggregations and branched inflorescences, that grow in certain cultivated alluvial areas of Louisiana have not previously been identified as *S. louisiana*, but they represent an intermediate stage just as surely as do the luxuriant specimens of intermediate form in favorable localities where the relationship is more obvious.

The stocky specimens growing in the open in pastures or abandoned fields, especially in central and northern Louisiana, frequently occur in large numbers. A succession to more vigorous palmettos of intermediate stage but still of the “field type,” may sometimes be traced from these open palmetto areas to the lower-lying, wetter margins of the pastures or fields, neighboring woodlands, or up to the edge of small streams.

The discovery of three arborescent palmettoes in widely separated localities in Louisiana, where most of the surrounding countryside has long since been cleared and put under cultivation, not only suggests that arborescent Louisiana palmettos were formerly more common than now, but also, in my judgment, has a vital bearing upon the relationship of the intermediate-stage palmettos that grow in pastures and fields.

The first of these three individuals occurs in a deep woods just east of Denham Springs (17). When I last saw it several years ago, the trunk height was 14 dm, the leaves were 13 dm broad, and the inflorescences attained 36 dm in height—a typical climax specimen. It grew near a bayou branch of the Amite River that is consider-

ably lower than the highway along which intermediate-growth palmettos of the "field type" occurred.

The second lone individual of tree size has a trunk height of 13.5 dm, and a diameter of 29 cm. It grows in the water of a small

coulee that courses through a pasture and is visible from the road (U. S. Highway 71), south of Bunkie (19). This specimen was flanked at the water's edge by other Louisiana palmettos of intermediate stage in good condition, but the palmettos ranging into

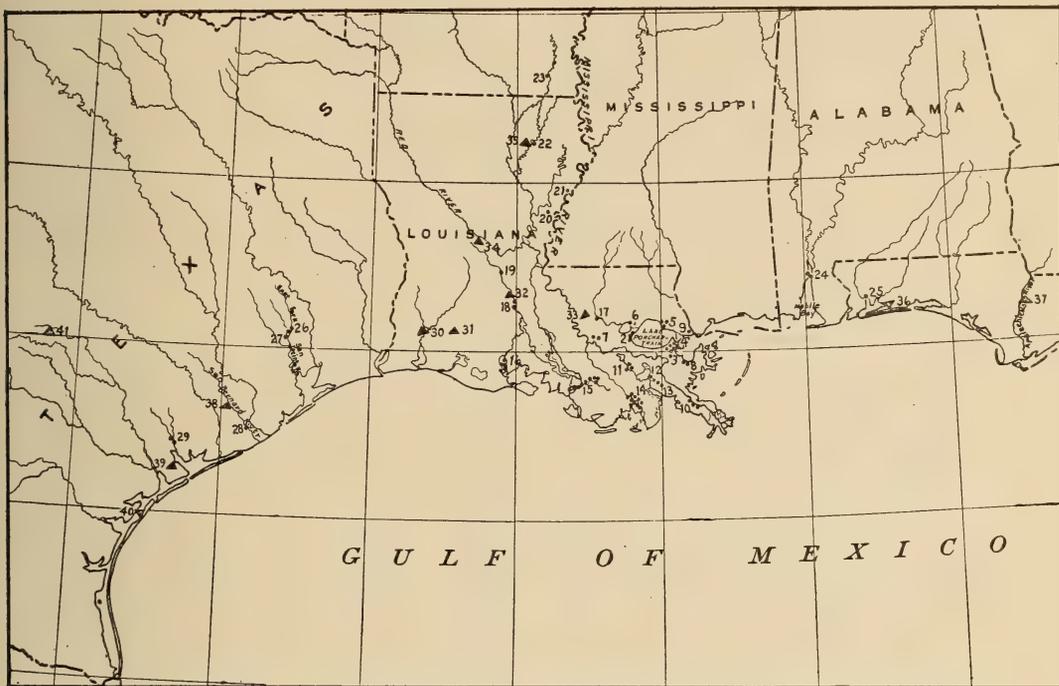


Fig. 1.—Distribution of *Sabal louisiana*. The dots on the map represent the more significant and typical stands or individuals of senescent, climax, or intermediate growth-form in the following localities: LOUISIANA—1, Along Bayou Sauvage, north of the Chef Road. 2, Frenier Beach, west shore of Lake Pontchartrain and northwards between Lakes Maurepas and Pontchartrain. 3, Near Paris Road, New Orleans, and the general vicinity of Bayou Bienvenue. 4, Along Bayou Sauvage, from Micheaud to the Chef Menteur Pass. 5, East of Mandeville, north shore of Lake Pontchartrain. 6, Manchac and other stations on the northwest shore of Lake Maurepas. 7, Between Gonzales, along New River, and Sorrento. 8, West of Shell Beach (on Lake Borgne) along Bayous Yscloskey and La Loutre. 9, West Pearl River, near Indian Village. 10, South of Buras and not far from the Mississippi River, vicinity of Bayous Grand Liard and Petit Liard. 11, Bayou des Allemands, near Des Allemands Station. 12, Bayou Villars, near the upper end of Bayou Barataria. 13, Bayou Dupont. 14, From Golden Meadow to a distance below Leeville, along Bayou Lafourche. 15, East of Berwick Bay and Morgan City along Bayous Black and Chacahoula (Chacahoula swamp), and southward along Bayou Shaffer. 16, Near Intracoastal City, Vermilion River. 17, East of the Amite River along a small bayou near Denham Springs. 18, Between Port Barre and Opelousas, in the vicinity of Bayou Teche. 19, Eight miles south of Bunkie. 20, Near the Tensas River, 8½ miles west of Ferriday. 21, North of U. S. Highway 65, northwest of St. Joseph. 22, East of Rayville. ARKANSAS—23, Bayou Bartholomew, west of Montrose. ALABAMA—24, Tensas River delta north of Mobile Bay, west of Hurricane. 25, Eastern shore of Escambia River, at head of Pensacola Bay. TEXAS—26, East of U. S. Highway 59, just south of Cleveland. 27, East Fork of the San Jacinto River, about 4 miles south of Cleveland. 28, San Bernard River bottom, 8 miles west of Brazoria. 29, Lavaca River bottom, west of Lolita. The solid triangles indicate large groups of the "pasture or field type" (intermediate stage); the cross-hatched triangles, palmettos of reduced "field type" that require further study: LOUISIANA—30, West fork of Calcasieu River, near Westlake. 31, Near Welch, not far from Bayou Lacasine. 32, An area roughly bounded by Beggs, Palmetto, and Port Barre. 33, Between Comite and Puckett. 34, Between Bayou Boeuf and the Red River, near Alexandria. 35, Various localities, near Rayville. FLORIDA—36, Near Holley, south of the Yellow River. 37, Apalachicola River, east of Blountsville. TEXAS—38, San Bernard River, north of Hungerford. 39, Hog Bayou, about 8 miles south of Port Lavaca. 40, North of Rockport, eastern shore of Copena Bay. 41, On the Blanco River, south of Blanco. Map prepared by Leta Hughey.

the pasture had only short boot-aggregations and diminished crowns. Willows, a few baldcypress trees, American honeylocust, and giant cane are associated with them in the pasture. The large baldcypress trees at the margin of an extensive swamp can be seen in the distance.

The third arborescent specimen occurs near Rayville (22), along a small stream in a mixed woodland, bounded by a cottonfield on one side and passing gradually into a cypress-tupelo swamp on the other. It is not so well developed as the two just mentioned. The palmettos along the nearby fence row (Pl. 2, lower right) are of intermediate "field type." In the cottonfield on the other side of the fence row, and in countless areas round about, the palmettos are regarded as troublesome weeds. Following plowing, cotton is frequently planted in the midst of palmettos, which are not only low and impoverished in appearance but unable to put forth inflorescences.

The complete range of *S. louisiana* is, even with the additional data herein presented, imperfectly known. The dots on the accompanying map (Fig. 1) represent localities in which I have studied arborescent or near-arborescent specimens (senescent, climax, or intermediate forms) of *S. louisiana* as well as the group discovered in Texas by Mr. Vines. The solid triangles indicate localities where the "field or pasture type" of *S. louisiana* is predominant and where sufficient study of the individuals in the field and of the flowers and fruits in the laboratory leaves no question as to their identity. It is not possible to give, on such a small-scale map, an accurate picture of the density of the palmetto populations in the respective areas. A dot may represent a single tree or a group. Several dots indicate extensive continuous or discontinuous stands. A solid triangle in all cases represents a tract of palmettos. The cross-hatched triangles indicate localities (36, 37, 40, and 41) where palmettos have been observed that appear to be *S. louisiana* but require further

investigation of their flowers and fruits. Similar plants also occur in an alluvial area west of Charleston, S. C., and in a few other places not shown on the map.

There are numerous other palmetto areas, both within and beyond the known range of Louisiana palmetto, in which it is difficult to distinguish between the acaulescent *S. minor* and juvenile or dwarfed forms of *S. louisiana*, especially specimens that do not come into flower or fruit. Although much field work has already been done throughout the purported range of *S. minor*, further observation and a somewhat different approach through morphological studies is necessary for a better understanding of these two species.<sup>23</sup>

<sup>23</sup> My interest in native palmettos began in the New Orleans area while I was a member of the faculty of Tulane University (until 1932). A survey of Louisiana and some neighboring regions was made from May to November, 1933. Thereafter additional surveys and rechecking of areas previously visited were carried out during vacation periods from Washington, D. C., either in June or November (the flowering and fruiting seasons of *S. louisiana*). Grateful acknowledgment is made to former students and coworkers at Tulane University, especially Anna L. Haas, who accompanied me on many field trips and rendered assistance in the collection of material, measurement of specimens, and pH determinations of soil samples; to Mrs. J. R. Fowler, Dr. Mike Wright, and Dr. John W. Bick for help on various expeditions; and to Dr. Harley N. Gould and Dr. W. T. Penfound for extending the facilities of their respective laboratories to me subsequent to 1932. I am also indebted to G. D. Cain, County Agricultural Extension Agent, for information in connection with the palmettos of Richland Parish (Louisiana) and neighboring cotton-growing regions; Eloise R. Bomhard, who accompanied me on several surveys; E. L. Demon, director of the Southern Forest Experiment Station (New Orleans), as well as a number of present and former Station staff members for numerous courtesies and assistance; Dr. B. C. Tharp, University of Texas, for cooperation and aid on field trips near Austin; and to various persons, who made prompt and helpful replies to my inquiries, especially Eula Whitehouse, Texas Memorial Museum.

The kind cooperation of Mr. Vines and Dr. Longley has already been mentioned. Thanks are also due Percy Viosca, Jr., of New Orleans, W. A. Dayton, U. S. Forest Service, and Dr. Penfound for reviewing the manuscript.

BOTANY.—*Two new basidiomycetous fungi parasitic on nematodes.*<sup>1</sup> CHARLES DRECHSLER, Bureau of Plant Industry.

Among several fungi set forth in an earlier paper (4) as attacking nematodes after the usual manner of parasites, by intrusion of hyphal elements arising through germination of adhering conidia, were included two species which from their production of clamp-connections were obviously to be reckoned among the Basidiomycetes. The two species, it was clear, were intimately akin to one another; yet owing to somewhat incidental differences in the make-up of their sporulating apparatus they could not both be assigned satisfactorily to any one mucedinaceous genus then available. Accordingly a new genus, *Nematoctonus*, was erected in which they were described under the names *N. tylosporus* and *N. leiosporus*. Subsequently two other forms, similarly parasitic on free-living nematodes, and similarly provided with clamp-connections, have been observed in transparent Petri-plate cultures. These two forms, which like those presented earlier have more than ordinary interest, since they represent basidiomycetes habitually subsisting on animals that normally remain in a motile state from the time of hatching until the approach of death, are described herein as additional species of *Nematoctonus*.

One of the two species came to light on September 1, 1942, in a maize-meal-agar plate culture that on August 24, 1942, had been planted with the softened stem of a newly damped-off tomato seedling from a greenhouse at the Bureau of Plant Industry Station near Beltsville, Md. The fungus, when first observed, was barely visible to the naked eye as a very delicate arachnoid web festooned over a portion of the decaying tomato material. It failed to spread to other areas of the original culture, apparently for the reason that in its initial development all individuals of the susceptible species of nematode had been exterminated. However, when a small quantity of the delicate web was transferred to another Petri-plate culture, which likewise had been

started on August 24, from a damped-off tomato seedling, and which likewise had afforded ample development of free-living eelworms soon after the agar substratum became permeated with mycelium of *Pythium irregulare* Meurs, the arachnoid fungus resumed its destructive activity on a larger scale. Everywhere in the second culture it parasitized a single nematode species that manifestly was identical with the species it had exterminated in the original culture. The eelworm in question was determined by Dr. G. Steiner to belong to a group of forms that have been cited in the literature rather indiscriminately under the binomial *Rhabditis monhystera* Bütschli.

During the earlier stages of invasion the assimilative mycelium within an infected nematode is usually obscured very badly by the globulose materials resulting directly from degeneration of the host tissues. Later, when these globulose materials have in large part been appropriated by the fungus and have been utilized for the production externally of conidiophorous filaments (Fig. 1, A, a, b), the assimilative hyphae are better discernible. In some instances the empty membrane of the conidium (Fig. 1, A, c) that initiated the attack may then still be seen attached to the outside of the host integument, its prolongation in the empty germ hypha visibly communicating with the mycelium inside. Occasionally the empty envelopes of several conidia operative in accomplishing infection may be seen attached to the dead animal. The quantity of assimilative mycelium, however, would seem little influenced by the number of adhering spore envelopes, for multiple hyphae are readily produced by branching. Frequently branches arise directly from, or in close proximity to, clamp-connections, though some clamps having no special positional relationship to branches are usually present. Occurrence of clamps without relationship to branches or to any other lateral outgrowths could be noted also in external hyphae that happened to lie submerged for considerable distances under the surface of

<sup>1</sup> Received March 24, 1943.

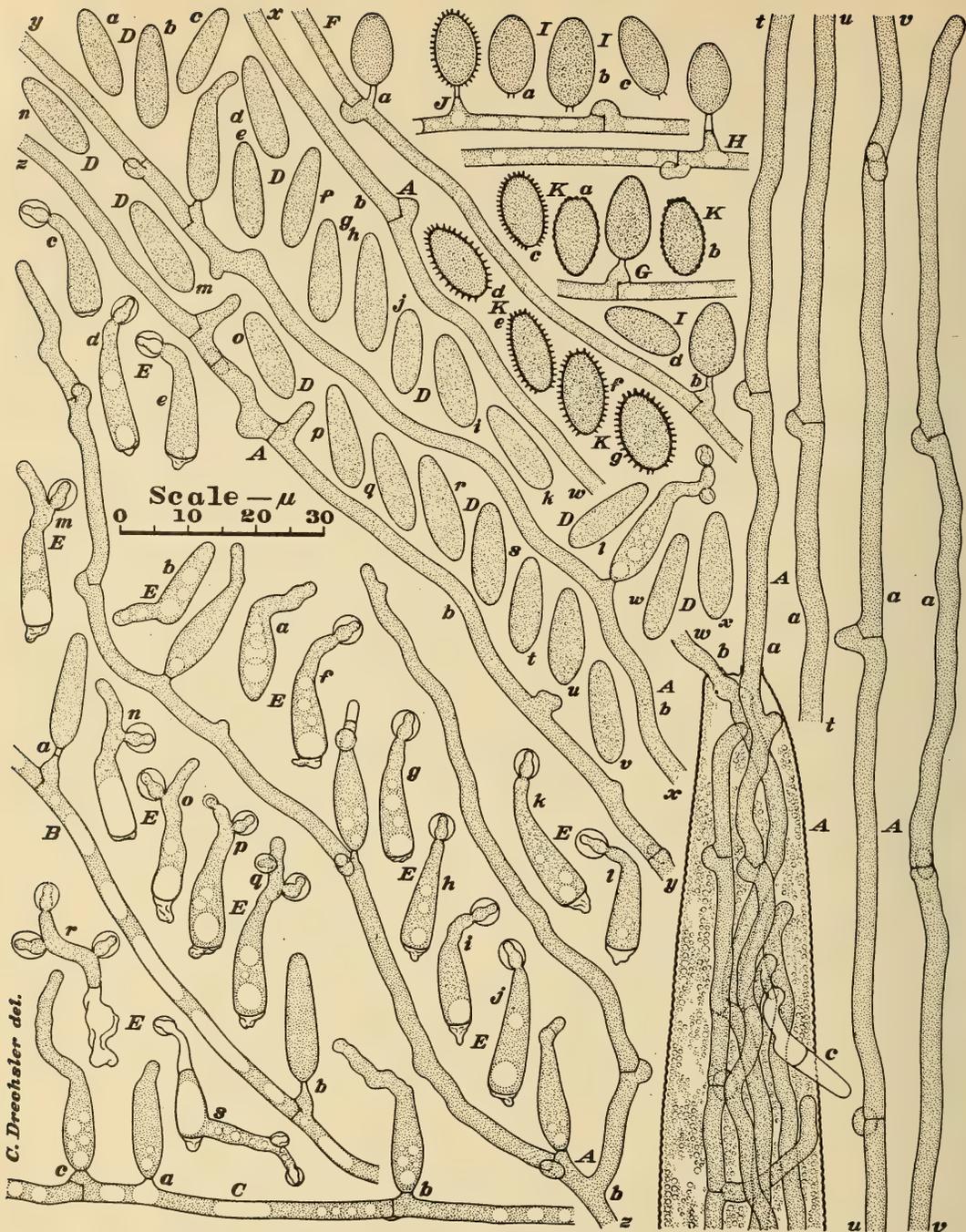


Fig. 1.—*Nematoctonus pachysporus*, drawn to a uniform magnification with the aid of a camera lucida;  $\times 1,000$  throughout. A, Anterior portion of nematode host permeated with assimilative mycelium from which one hypha, *a*, has been extended into the surrounding agar culture medium, while another hypha, *b*, has been extended into the air; the two external hyphae, from want of space, being shown in sections whose proper continuity is indicated by the two sequences of paired letters, *t-v* and *w-z*, respectively; *c*, empty envelope of conidium, attached externally, from which the assimilative mycelium had its origin. B, Portion of conidiophorous hypha, bearing conidia on two longish sterigmata, *a* and *b*. C, Portion of conidiophorous hypha bearing solitary conidia on three short sterigmata, *a-c*. D, Conidia, *a-x*, showing variations in size and shape previous to germinative development. E, Conidia, *a-s*, showing variations in germinative development. F, Portion of conidiophorous hypha with two sterigmata, *a* and *b*, whereon are borne solitary ovoid spores destined for conversion into resting spores. G, H, Portions of conidiophorous hypha, each with an ovoid spore soon to be converted into a resting spore. I, Three ovoid spores before conversion into resting spores. J, Portion of conidiophorous hypha showing an echinulate resting spore borne on a sterigma. K, Resting spores, *a-g*, showing variations in size, shape, and echinulation.

the agar culture medium (Fig. 1, A, a).

A submerged position, of course, is not a usual one for the external, conidiophorous filaments. Most often they grow out somewhat ascendingly into the air to attain lengths ranging from 1 to 1.5 mm. As their development continues they sooner or later decline to the substratum, so that eventually they come to lie prostrate in areas where the surface is smooth, or are draped loosely over prominences in more rugged areas. Occasionally a conidiophorous filament may grow out in a procumbent posture.

Whatever their posture may be, the aerial filaments become studded at intervals with clamp-connections, which often give rise, on short narrow sterigmata, to erect strobiliform conidia (Fig. 1, A, b; B, a, b). Conidia may, however, arise without any close positional relationship to clamp-connections (Fig. 1, C, a). Sometimes a conidium is borne almost sessile on the parent filament in close proximity to a clamp-connection (Fig. 1, C, b); or, again, it is attached, without any noticeable sterigma, directly to the dorsal side of a clamp (Fig. 1, C, c). Ordinarily its original strobiliform shape (Fig. 1, D, a-x) is soon modified as the result of germinative development. A short broad process is extended usually from the distal end (Fig. 1, E, a) or, in rare instances, from the basal end (Fig. 1, E, b). This process gives rise at its tip to a globose adhesive body, measuring usually 3 or 4 $\mu$  in diameter, and consisting apparently of a narrowed hyphal termination together with a layer of glutinous secretion (Fig. 1, E, c-l). Thereupon the outgrowth may resume elongation (Fig. 1, E, m-o) to produce terminally a second adhesive body (Fig. 1, E, p, q). Elongation may then be resumed again, with eventual development of a third adhesive body (Fig. 1, E, r). In some instances where a germ outgrowth is put forth from the basal end as well as from the distal end, one of the outgrowths may form a single adhesive body while the other may produce two such bodies (Fig. 1, E, s). The transfer of protoplasmic materials required for such incipient germinative development is accompanied by vacuolization and evacuation usually of the basal portion of the conidium, and by collapse of the emptied

portion of conidial envelope. Occasionally the entire protoplasmic contents may migrate into the stout germ outgrowth (Fig. 1, E, r).

In addition to the colorless thin-walled conidia discussed so far, the fungus produces resting spores. These likewise are mostly borne on short sterigmata arising from clamp-connections or in close proximity to clamp-connections (Fig. 1, F, a, b; G; H). During their earlier stages of development they resemble conidia, though usually they may be distinguished even then by their broader ovoid shape (Fig. 1, I, a-d). In their ripe condition (Fig. 1, J) they have a perceptibly yellowish coloration, and individually are surrounded by a thicker wall, which sometimes is modified externally with bullate sculpturing (Fig. 1, K, a, b), but oftener is closely beset with slender spiny protuberances (Fig. 1, K, c-g). As these resting spores have never been seen to germinate, it may be presumed that like the resting spores of *Nematoctonus tylosporus* they are adapted for tiding over unfavorable periods.

The greater thickness of its conidia relative to the conidia of the three known congeneric species suggests the epithet proposed for the fungus.

#### *Nematoctonus pachysporus*, sp. nov.

Hyphae assumentes incoloratae, irregulariter ramosae, plerumque 2-3.5 $\mu$  crassae, in modum Hymenomycetum septato-nodosae, intra vermiculum nematoideum viventem crescentes, post mortem animalis aliquot hyphas fertiles extra emittentes; hyphis fertilibus incoloratis, simplicibus vel parce ramosis, primo plerumque ascenduntibus postea procumbentibus, medio-criter septato-nodosis, vulgo 0.5-1.5 mm longis, 2.2-3.2 $\mu$  crassis, conidia vel sporas perdurantes quandoque protinus ex nodis quandoque ex sterigmatibus singulatim gerentibus; sterigmatibus erectis, 0.5-5 $\mu$  longis, basi 1-2.5 $\mu$  crassis, apice 0.6-1 $\mu$  crassis; conidiis incoloratis, primo continuis et erectis, levibus, elongato-ellipsoideis vel strobiliformibus, plerumque 12-19 $\mu$  longis, 4-5.5 $\mu$  crassis, ex apice vel rarius ex basi hypham germinationis brevem erectam emittentibus; hac hypha 1-3 corpora glutinosa 2.5-5.5 $\mu$  crassa deinceps proferente. Sporae perdurantes continuae, ovoideae, flavidae, verrucosae

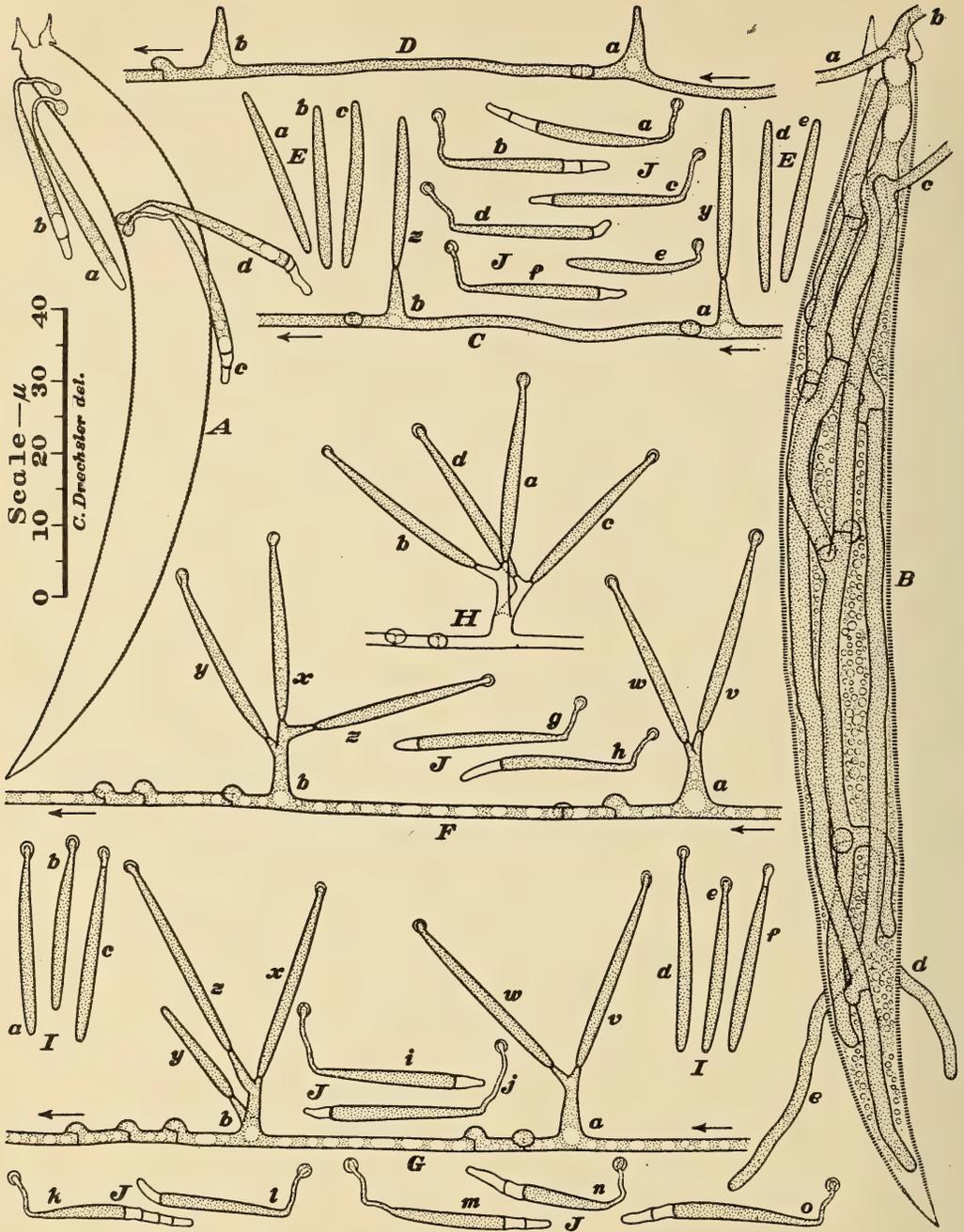


Fig. 2.—*Nematoctonus leptosporus*, drawn to a uniform magnification with the aid of a camera lucida;  $\times 1,000$  throughout. A, Young specimen of *Bunonema* sp. to which are attached four germinating conidia whose vacuolate condition indicates that each may be extending an infective hypha into the animal. B, Nematode host permeated with a mycelium from which five hyphae, *a-e*, have begun to grow externally. C, Portion of conidiophorous hypha with two sterigmata, *a* and *b*, each bearing a single conidium that shows no apical adhesive modification. D, Portion of conidiophorous hypha with two denuded sterigmata, *a* and *b*. E, Detached conidia, *a-e*, showing variations in size and shape before undergoing apical modification. F, G, Portions of conidiophorous hypha, each with two branching sterigmata, one of them, *a*, bearing two spores, *v* and *w*, while the other, *b*, supports three spores, *y-z*. H, Portion of conidiophorous hypha with a branched sterigma bearing four conidia, *a-d*, all modified at the apex. I, Conidia, *a-f*, each of which formed an adhesive knob at its apex before becoming detached from its sterigma. J, Conidia, *a-o*, that after falling on moist agar culture medium have each sent up a delicate apical process terminating in a small adhesive knob.

vel crebre echinulatae, 10–13 $\mu$  longae, 5.5–7.5 $\mu$  crassae.

*Vermiculum nematoideum* *Rhabditis monhystrae* adfinem *enecans* habitat in radicibus *Lycopersici* *esculentibus* prope Beltsville, Maryland.

Assimilative hyphae colorless, irregularly branched, mostly 2 to 3.5 $\mu$  wide, provided with clamp-connections, developing within living nematodes, after death of host animal giving rise externally to several conidiophorous hyphae. Conidiophorous hyphae colorless, simple or somewhat branched, at first usually ascending, later prostrate or festooned on the substratum, commonly 0.5 to 1.5 mm. long, 2.2 to 3.2 $\mu$  wide, at moderate intervals (mostly 10 to 75 $\mu$ ) forming clamp-connections, producing solitary conidia or solitary resting spores sometimes directly on clamp-connections and at other times on sterigmata 0.5 to 5 $\mu$  long, 1 to 2.5 $\mu$  wide at the base, 0.6 to 1 $\mu$  wide at the apex. Conidia erect, colorless, smooth, at first continuous, elongate-ellipsoid or strobiliform, mostly 12 to 19 $\mu$  long, 4 to 5.5 $\mu$  wide, before or after disjunction usually becoming partly evacuated of contents in giving rise at the apex or more rarely at the base to a short erect process whereon are borne successively 1 to 3 globose adhesive bodies 2.5 to 5.5 $\mu$  in diameter. Resting spores aseptate, yellowish, ovoid, at maturity warty or strongly echinulate, measuring mostly 10 to 13 $\mu$  in length and 5.5 to 7.5 $\mu$  in width.

Destroying a species of nematode belonging to the *Rhabditis monhystrae* group, it occurs in decaying roots of *Lycopersicon esculentum* near Beltsville, Md.

The other species of *Nematoctonus* to be presented herein was found developing abundantly in Petri plates of maize meal agar, which after being permeated with *Pythium* mycelium had been further planted with pinches of friable leaf mold taken from deciduous woods near Fairfax, Va., on November 10, 1942. In these cultures it subsisted exclusively on a species of *Bunonema* introduced with the forest refuse. Invasion of the small eelworm was manifestly initiated by continued germinative development of adhering conidia (Fig. 2, A, a–d), though owing to optical difficulties arising from globulose degeneration of the host tissues, not to mention further difficulties at-

tributable to pronounced sculpturing of the host integument, the progress of mycelial advance could not be followed. However, after the granular materials had been largely appropriated the assimilative mycelium was revealed, though often only rather indistinctly, as a branching system of hyphae studded here and there with clamp-connections (Fig. 2, B). Usually before this somewhat transparent condition came about, conidiophorous filaments were being extended over the surface of the adjacent substratum (Fig. 2, B, a–e).

These filaments, while still elongating, give rise at moderate intervals to erect tapering sterigmata (Fig. 2, C, a, b; D, a, b), each bearing at its tip a slender, slightly tapering, rod-shaped conidium (Fig. 2, C, y, z) whose apex in the beginning shows no special modification (Fig. 2, E, a–e). Sometimes a sterigma grows directly from a clamp-connection but more often it arises some little distance backward from a clamp, that is, some little distance nearer the origin of the filament (Fig. 2, C, a, b; D, a, b). After the individual sterigma (Fig. 2, F, a; G, a) has produced its first conidium (Fig. 2, F, v; G, v), it ordinarily continues in its reproductive function by putting forth a short lateral spur on which a second conidium is formed (Fig. 2, F, w; G, w). Many sterigmata thereupon will put forth a second lateral spur, and thus will come to support three conidia (Fig. 2, F, x–z; G, x–z). In mature portions of conidiophorous hyphae some sterigmata can be found bearing as many as four conidia, each, of course, borne on a separate sterigmatic tip (Fig. 2, H, a–d).

Branched sterigmata bearing two or three conidia are nearly always to be found in proximity to a corresponding number of clamp-connections (Fig. 2, F, G). Apparently the clamps of later origin are formed in successively more distal positions.

Soon after they have been cut off by a basal septum, the conidia undergo noticeable germinative development. Those that remain supported on their sterigmata produce at the tip a globose knob consisting of a glandular part thinly surrounded with adhesive secretion (Fig. 2, F–H; I, a–f). Those that become detached and fall on a

moist surface produce a similar adhesive knob terminally on a delicate, erect or ascending process extended from the tip (Fig. 2, *J*, *a-o*). The materials required for this germinative development are supplied through evacuation of protoplasm from the basal portion of the conidium. To separate the living portion of the spore from the emptied portion at least one retaining wall is laid down. In instances where presumably the movement of protoplasm takes place rather slowly, two (Fig. 2, *J*, *a, b, m, n, o*) or even four (Fig. 2, *J*, *k*) retaining walls may be laid down successively.

Comparable development of adhesive knobs on delicate processes arising from fallen conidia has not been noted in *Nematoctonus tylosporus*. The fungus differs further from *N. tylosporus* in its markedly stronger tendency toward production of conidia plurally on branching sterigmata. Its conidia, moreover, are appreciably narrower and longer than those of *N. tylosporus*, and, of course, pronouncedly narrower and longer than the conidia of *N. leiosporus* and *N. pachysporus*. A term having reference to its slender spores may therefore serve as an epithet sufficiently descriptive to set the fungus apart from the three known congeneric forms.

#### *Nematoctonus leptosporus*, sp. nov.

Hyphae assumentes incoloratae, plus minusve ramosae, plerumque 2-3.5 $\mu$  crassae, in modum Hymenomycetum septato-nodosae, intra vermiculum nematoideum viventem crescentes, post mortem animalis aliquot fertiles hyphas extra emittentes; hyphis fertilibus incoloratis, saepius procumbentibus, modice septato-nodosis, vulgo 250-750 $\mu$  longis, 1.6-2 $\mu$  crassis, conidia ex erectis sterigmatibus gerentibus; his sterigmatibus inter se saepius 35-65 $\mu$  distantibus, 5-10 $\mu$  altis, basi 2.5-4 $\mu$  crassis, sursum attenuatis, apice .5-1 $\mu$  crassis, primo simplicibus, postea 1-3 ramusculos emittentibus, itaque vulgo 2 vel 3 etiam quandoque 4 conidia proferentibus; conidiis incoloratis, bacillaribus, sursum leviter attenuatis, utrinque obtusulis vel rotundatis, 21-28 $\mu$  longis, 1.7-2.2 $\mu$  crassis, primo continuis et protoplasmatis omnino repletis, mox in parte infera vacuis et apice tuberculo glutinoso circa 2 $\mu$  crasso praeditis, postea tuberculum ejusmodi in apice hyphae

erectae vel ascendentis 3-10 $\mu$  longae .6 $\mu$  crassae ferentibus.

Vermiculum nematoideum speciei *Bunonematis necans* habitat in humo silvestri prope Fairfax, Virginia.

Assimilative hyphae colorless, provided with clamp-connections, somewhat branched, mostly 2 to 3.5 $\mu$  wide, developing within living nematodes, after death of host animal producing several conidiophorous hyphae externally; conidiophorous hyphae colorless, usually prostrate, commonly 250 to 750 $\mu$  long, 1.6 to 2 $\mu$  wide, forming clamp-connections at moderate intervals, giving rise to conidia on erect sterigmata; the sterigmata spaced mostly at intervals of 35 to 65 $\mu$ , at first simple, commonly 5 to 10 $\mu$  high, 2.5 to 4 $\mu$  wide at the base, tapering upward, mostly 0.5 to 1 $\mu$  wide at the tip, later usually putting forth 1 to 3 lateral spurs and by producing a conidium on each spur eventually coming to support 2 or 3 or sometimes even 4 conidia; the conidia colorless, staff-shaped, tapering slightly toward apex, somewhat obtuse or bluntly rounded at both ends, mostly 21 to 28 $\mu$  long and 1.7 to 2.2 $\mu$  wide, at first continuous, later often empty at the base and provided at the tip with a globose adhesive knob about 2 $\mu$  wide, or after falling off producing such a knob terminally on an erect or ascending process, 3 to 10 $\mu$  long and 0.6 $\mu$  wide, that is extended obliquely or perpendicularly from the tip.

Parasitic on a species of *Bunonema* in leaf mold near Fairfax, Va.

With respect to outward shape the knob-bearing outgrowth commonly produced by the conidium of *Nematoctonus leptosporus* after falling on a moist surface offers curious similarity to the empty basal appendage on the conidium of *Euryancale sacciospora* Drechsl. (3) as well as to the proximal portion of the conidium of *Harposporium oxyroracum* Drechsl. (4). This similarity would seem in large measure illustrative of convergence, since the three fungi, remote from one another taxonomically, all subsist as obligate parasites on nematodes of the genus *Bunonema*. The adaptive modifications here concerned may well have been developed to facilitate attachment of the conidia to the strongly sculptured integument so characteristic of the host animals in their adult condition.

In *Nematoctonus pachysporus* the development of adhesive bodies plurally, together with the frequently pronounced exhaustion of the spore, makes for an appearance not wholly unlike that offered in the development of basidiospores on basidia. The homologies thus suggested can not readily be dismissed until adverse cytological evidence has been brought forward, or until structures have been discovered more closely corresponding to basidia than any I have observed hitherto. The plural adhesive bodies, it is true, are almost certainly of the same character as the single adhesive knobs formed in the three congeneric species; but the possibility remains that these single knobs, however commonplace their appearance, might yet represent abortive basidiospores modified for adhesion. Nevertheless, the thin-walled aerial spores still seem best interpretable as conidia, especially since in their manner of formation they offer strong parallelism with the binucleate conidia described by Nobles (5) as being produced on clamp-bearing mycelia of *Corticium incrustans* Höhn. & Litsch. If the four parasitic species so far described all produce typically straight conidia, the Hawaiian nematode-capturing fungus to which reference was made earlier (4, p. 780) and which almost certainly is intimately related to the parasitic species, produces conidia that re-

semble those of *C. incrustans* in being of curved allantoid shape.

Their constant production of clamps rather definitely removes all five of the fungi habitually subsisting on eelworms from close kinship with *Septobasidium* Pat., a large genus of basidiomycetes whose parasitism on scale insects, affirmed by Reinking (6) in 1919, has more recently been set forth in detail by Couch (2). On similar grounds they must be considered taxonomically remote from *Uredinella* Couch, likewise a genus of basidiomycetes parasitic on scale insects, since at least in *U. coccidiophaga* Couch (1), just as in all species of *Septobasidium*, clamp-connections are absent.

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ORNITHOLOGY.—*A new race of the sharp-tailed grouse*.<sup>1</sup> HERBERT FRIEDMANN, U. S. National Museum.

Snyder's papers on the sharp-tailed grouse,<sup>2</sup> in spite of certain faults, may be said to have furthered our knowledge of this bird more than any that went before. A recent study of this species, based on over 200 specimens, indicates, however, that parts of Snyder's arrangement of races needs alteration. These changes, herein proposed, have to do, firstly, with the birds of

the far Northwest, which he calls *kennicottii*, and secondly with the ranges of *jamesi* (which includes the *campestris* of Snyder's first two papers) and of *campestris* (with which Snyder's *campisylvicola* is synonymized).

To take the northwest Canadian and the Alaskan birds first, we find that a series of topotypical *kennicottii* from Fort Rae and Fort Simpson, differ markedly from a long series (40 specimens) from Alaska southward to Tagish Lake on the Yukon-British Columbia border and to extreme Northern Alberta. Inasmuch as there seems to be no name available for the Alaskan birds, it is proposed to call them—

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received April 3, 1943.

<sup>2</sup> SNYDER, L. L., *A study of the sharp-tailed grouse*. Univ. Toronto Stud., Biol. Ser., 40 (2). 1935; *A revision of the sharp-tailed grouse with a description of a new race*. Occ. Pap. Roy. Ontario Mus. Zool., no. 2. 1935; *Great Plains races of the sharp-tailed grouse*. *Auk* 56: 184-185. 1939.

***Pedioecetes phasianellus caurus*, n. subsp.**

*Type*.—U.S.N.M. 298189. ad. ♂, collected at Fairbanks, Alaska, October 19, 1921, by O. J. Murie.

*Subspecific characters*.—Differs from *kennicottii* in having the feathers of the upperparts much more broadly and abundantly barred with brown and, on the mantle, with white, and with the white spots larger, the feathers of the breast white, edged with dark olive-brown (instead of dark buffy brown with only a narrow white shaft stripe); from *jamesi* (as understood in this paper—the bird of the Great Plains from central Alberta to northeastern Colorado) this form differs in being much darker, more black showing above, the brown barrings darker, and the edgings of the breast feathers darker; from *columbianus* it differs in being darker and larger.

*Description of type*.—Forehead fuscous to fuscous-black, the feathers tipped with dark snuff brown; feathers of the crown and occiput similar but crossed with widely spaced whitish bars and tipped with cinnamon-buff; the pale bars more abundant, less widely spaced on the lateral coronal feathers, and blending into a fairly definite whitish or buffy whitish superciliary stripe on each side; nape like the sides of the crown but washed with pale ochraceous-buff; "mantle," i.e., interscapulars, fuscous-black broadly barred with white, the more distal bars, especially on the more posterior feathers, washed with pale ochraceous-buff; feathers of sides of neck and of breast similar to anterior interscapulars; back, rump, and upper tail coverts fuscous-black, broadly but incompletely barred with cinnamon-buff to tawny-olive, the latter color often sparsely vermiculated with fuscous-black and broadly tipped with pale cinnamon-buff to pinkish buff, darkest on the back and becoming paler on the rump and upper tail coverts; scapulars and inner median and greater upper wing coverts like the upper back but with the brownish areas more extensive (at the expense of the blackish parts) and each feather with a large terminal white wedge-shaped spot; rest of the upper wing coverts and the secondaries grayish olive-brown externally incompletely and sparsely barred with white, the coverts with terminal white spots on their outer webs, the secondaries completely edged with white on the tips of both webs; primaries grayish olive-brown with white

spots on the outer webs; median rectrices pinkish buff longitudinally and transversely marbled with fuscous-black; the next pair largely fuscous-black tipped with white and with their outer webs mixed with white; lateral rectrices white with dusky smudges along the shafts; circumocular region fuscous-black; lores, subocular stripe, cheeks, and auriculars pale ochraceous-buff dappled with dusky, the dusky markings concentrating on each side to form a fairly distinct malar stripe; the auriculars tipped with fuscous-black; chin and upper throat whitish suffused with pale ochraceous-buff and with many small pale clove-brown spots; lower throat white, the feathers narrowly edged with dark olive-brown; breast feathers white with heavy margins of dark olive-brown; feathers of sides and flanks white barred with dark olive-brown, the more posterior of these feathers with considerable tawny-olive on their outer webs and with the dark bars darker—clove-brown to almost fuscous; upper abdomen and sides of lower abdomen white with a few small dark olive-brown subterminal V-shaped marks; center of abdomen and under tail coverts white, sometimes tinged with pale ashy buff; thighs pale light cinnamon-drab, the distal tarsal plumes paler, more whitish and very long, covering all but the claw of the middle toe.

Females in comparable (autumn and winter) plumage are like the male but their median rectrices are more strictly transversely barred, less longitudinally marbled with blackish than are those of the male.

*Measurements of type*.—Wing 207; tail 114; culmen from anterior end of nostril 11.8; tarsus 43; middle toe without claw 38.2 mm.

Thirteen adult males measure as follows: wing 196–212 (203.2); tail 113–125 (118.7); culmen from anterior end of nostril 10.3–11.8 (10.9); tarsus 40.4–44.3 (42.3); middle toe without claw 36–39.2 (38.1); height of bill at base 10.3–12.4 (11.5 mm).

Thirty-three adult females measure: wing 190–202 (196.3); tail 107–119 (111.9); culmen from anterior end of nostril 9.9–11.9 (10.8); tarsus 39.2–42.8 (41.2); middle toe without claw 35.7–39.3 (37.5); height of bill at base 10.9–12.5 (11.8 mm).

*Range*.—This form occurs from north-central Alaska (Circle, Fairbanks, Tanana, Tanana Crossing, north Fork Kuskokwim River, Delta

and Taklat Rivers) to the southern Yukon Province (Tagish Lake on the Yukon-British Columbia border) and to extreme northeastern Alberta (Fort Chipewyan, Smith Landing, Fort Smith, Peace Point).

The separation of this new form leaves *P. p. kennicotti* with a much restricted range, occupying merely northern Mackenzie (Fort Rae to Fort Simpson). This form is very distinct from *caurus*; in fact it is nearer to, but easily told from, typical *phasianellus* of the Hudson Bay region.

Turning now to the birds of the Great Plains and the Prairies, we find, if we take birds in fresh autumn plumage, that specimens from the Prairies (Illinois, Wisconsin, Minnesota, and southern Manitoba) are more rufescent (ochraceous-tawny to almost hazel) on the upper parts, while birds from the Great Plains (north-central Alberta, central Saskatchewan, most of Montana, the Dakotas, Wyoming, western Nebraska, and northeastern Colorado) have the upperparts buckthorn brown or grayer. The prairie birds are obviously *P. p. campestris* (type locality—Illinois), while for the less rufescent birds of the Plains the name *jamesi* (type locality—Castle Rock, Colo.) is available. In the latter race there is a slight paling in the southern part of the range, but on the whole it seems ill-advised to attempt to separate Alberta birds from specimens from Wyoming and Colorado. Northern *jamesi* shows an approach toward *caurus*. Good series of both *jamesi* (86 adults) and of *campestris* (18 adults) have been examined in this connection. The characters on which *jamesi* was originally proposed do not seem to mean much, but the name is nevertheless applicable to the group as here defined. It is the most variable of all the races of the sharp-tailed grouse.

The ranges of typical *phasianellus* and of *columbianus* are essentially correctly given by Snyder, but the range of the latter should be extended to the Modoc region, northern California.

KEY TO THE FORMS OF PEDIOECETES PHASIANELLUS

a. Darker above, the black or dark fuscous areas predominating, giving an appearance of a

dark bird barred with buffy brown and spotted with white.

b. Upperparts very dark, the brownish barrings and edges and tips of the feathers of the mantle and upper back much reduced, the marks in the inner portions of the vanes very narrow or absent; feathers of the breast dark buffy brown with only narrow white shaft stripes (central and northern Mackenzie)..... *Pedioecetes phasianellus kennicottii* Suckley

bb. Upperparts less dark, the brownish barrings and edges and tips of the feathers well developed.

c. White spots on the upper parts much reduced; feathers of breast pale buffy brown with fairly broad white shaft stripes (Hudson Bay region).. *Pedioecetes phasianellus phasianellus* (Linnaeus)

cc. White spots on the upper parts large and prominent; feathers of breast white, merely edged with dark olive-brown (Alaska, the Yukon District to extreme northern British Columbia)..... *Pedioecetes phasianellus caurus*, n. subsp.

aa. Paler above, the brown areas larger, the blackish ones more hidden, giving the appearance of a brownish bird mottled with blackish.

b. Brown of upperparts more rufescent—ochraceous-tawny to almost hazel (Illinois, Wisconsin, Minnesota, and southern Manitoba)..... *Pedioecetes phasianellus campestris* Ridgway

bb. Brown of upperparts less rufescent—buckthorn brown to tawny-olive.

c. Smaller and paler; tail averaging less than 110 mm; height of bill at base averaging 12 mm; brown of upperparts tawny-olive (from north-central British Columbia to northern California (Modoc region), Nevada, Utah, and southwestern Colorado)..... *Pedioecetes phasianellus columbianus* (Ord)

cc. Larger and darker; brown of upperparts buckthorn brown; tail averaging over 115 mm; height of bill at base averaging 13 mm (Great Plains and from north-central Alberta, central Saskatchewan, to (all but extreme western) Montana, the Dakotas, Wyoming, western Nebraska, and northeastern Colorado)... *Pedioecetes phasianellus jamesi* Lincoln

## Obituary

HARRY JOHN McNICHOLAS was born in Plymouth, Wis., on October 29, 1892, and died in Washington, D.C., on July 23, 1942, of heart failure.

Mr. McNicholas graduated from the Plymouth High School in 1910, entered Ripon College in 1911, and "worked his way" to the A.B. degree in 1915. During his last two years in college he defrayed his expenses by acting as assistant mail carrier. For diversion he played a trumpet in the Ripon College Band. This is mentioned because it played a part in shaping his subsequent career. The writer, having previously played a trombone in this band, joined the staff of the Bureau of Standards in 1914, and for amusement organized a small orchestra, but no trumpet player could be found on the staff. In 1915 we wrote to Professor Barber at Ripon College suggesting that the pending Civil Service examination be called to the attention of his best physics student, especially if he played a trumpet. Mr. McNicholas took this examination and promptly accepted an appointment as laboratory assistant in the Colorimetry Section, where he worked on color standardization until 1926. He was then transferred to the Textile Section to initiate researches on the physical structure of cellulose and rubber, including Röntgen-ray analysis. When depression curtailed this work in 1933, Mr. McNicholas was detailed for a year to investigate optical properties of glass and other materials used in identification lights on airplanes, then appointed to work on the utilization of wasteland products, and finally on pH standards in the Chemistry Division. In February 1941 he was engaged in defense work on methods of establishing acidity of lubricating and transformer oils and gasolines. His ability, industry, and scientific work were rewarded by successive promotions from laboratory assistant to full physicist.

Being studious by nature, Mr. McNicholas

enrolled for many graduate courses in physics and mathematics given at the Bureau of Standards from 1915 to 1937. In 1924 he received an M.A. degree and in 1926 a Ph.D., both from the Johns Hopkins University. Unlike the men who think their formal education is completed when the Ph.D. is awarded, Dr. McNicholas continued to attend classes for specialized study of such topics as the interpretation of data, probability and statistics, and chemical thermodynamics.

His name appears on a score of scientific papers published since 1919. In a series of important papers of which he was sole author he demonstrated that he had exceptional talents for instrument design, for analysis of scientific observations, and for lucid literary exposition. The following, published as research papers in the Journal of Research of the National Bureau of Standards, deserve special mention: Absolute methods in reflectometry (RP3), Equipment for routine spectral transmission and reflection measurements (RP30). The visible and ultraviolet absorption spectra of carotin and xanthophyll and the changes accompanying oxidation (RP337), Equipment for measuring the reflective and transmissive properties of diffusing media (RP704), Color and spectral transmittance of vegetable oils (RP815), and Selection of colors for signal lights (RP956).

Dr. McNicholas possessed a quiet, modest, and unassuming but genial disposition, and he had a large number of friends who always called him by his nickname, "Pat." After many years of sedentary life in crowded apartments he purchased a home and yard and took great pleasure in landscaping and gardening activities, which he liked to begin at daybreak.

In 1916 he married Gertrude M. Weingarten of Ripon, Wis. He is survived by his mother and four sisters, his wife and daughter, Mrs. Kathryn Fitzgerald, and four grandchildren.

WILLIAM F. MEGGERS



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JULY 15, 1943

No. 7

# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES



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# JOURNAL

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*Thomas Jefferson and science.*<sup>1</sup> AUSTIN H. CLARK, U. S. National Museum.

### VIRGINIA IN JEFFERSON'S TIME

The career of every man is largely a product of his time and environment, of his birth, early surroundings, education, and associates, especially the associates of the formative period of his youth. No true appraisal of any man can be made without some knowledge of his background and of the influences that surrounded him, especially in his early years.

In Jefferson's time, Virginia had already acquired an enviable scientific tradition as a result of the work of Harriott, White, Hamor, Rolfe, the Claytons, Bannister, Mitchell, Glover, Catesby, Tennent, Carter, Lee, and others. Unfortunately the printed records do not give a complete picture of science in Virginia in the early colonial days, partly because of the scarcity and cost of paper, most of which was imported from Europe, chiefly from the continent. Nearly all the paper mills in America were situated in Pennsylvania and New Jersey, and their output was for local consumption.

In Jefferson's early days Virginia was to a considerable extent a feudal state, more or less on the English model, most of its best land being held by large landed proprietors. With the rapid opening up of the Piedmont, on which great estates worked by slave labor were not so practicable as they were on the flat and rich Coastal Plain, various social problems were beginning to arise. At the same time Virginia, now fairly well settled, was beginning to feel herself quite competent to manage her own affairs and was becoming restive under the domination of the English parliament, for she

regarded herself as a sister rather than as a child of England.

Jefferson was a product of the Piedmont area, then almost a frontier region, and, though peculiarly fortunate in the circumstances of his birth and education, he did not view social conditions in the same light as did his aristocratic friends of the great estates on the rich and long settled Coastal Plain, with whom, however, he was always on the best of terms.

His sympathetic appreciation of the attitude both of the southern aristocracy and of those who, living in the wilder portions of the great new country, were trying to settle, cultivate, and organize the great wilderness, and his ability to harmonize their two viewpoints, can be really understood only in the light of his early environment and upbringing.

### EARLY ENVIRONMENT, EDUCATION, AND ASSOCIATES

Peter Jefferson lived at Shadwell in Goochland, now Albemarle, County, Va., an unusually beautiful region of mountains, rolling hills, and river bottoms, its plant and bird life as diversified as its scenery, its lowlands with abundant relics of the former Indian inhabitants. He was a surveyor, and one of ability, for to him belongs the credit for preparing the first accurate map of Virginia, the so-called Jefferson and Fry map, published in London in 1775 under Jeffreys, the Royal Geographer. His wife was the former Jane Randolph, eldest surviving child of Isham Randolph of Dungeness, Goochland County, a well-known lover of plants, who corresponded with Peter Collinson in England and with other famous botanists of that time.

<sup>1</sup> Received April 16, 1943.

Their son Thomas had a great respect for his father's map, and from him, as suggested by Dumas Malone, he doubtless acquired much of his zest for exploration and drawing, and his liking for untrodden paths. From him, perhaps, he also acquired his fondness for mathematical subjects. From his mother's side he may have inherited that love of plants that throughout his life was so very characteristic of him, and his interest in birds.

On the death of his father in 1757 Thomas was placed under the guardianship of a neighbor, Thomas Walker, physician, soldier, and explorer, who had been with Braddock at Fort Duquesne in 1755 and who had traveled extensively in that vast area which at that time was included in western Virginia. According to Thomas P. Abernethy, Thomas Walker was typical of that company of bold spirits who explored and exploited the early frontiers—a man of action rather than of words.

In 1760 young Thomas entered the College of William and Mary, unusually well prepared by long attendance—since the age of five—at an excellent school, the so-called "English School," of which he personally had formed a poor opinion. At Williamsburg he found surroundings that for a keen young man with the widest possible interests were ideal. At that time the titular governor of Virginia was John Campbell, Earl of Loudoun, but the government was administered by the lieutenant governor, Col. Francis Fauquier, a true friend of Virginia and the Virginians, a devotee of the sciences who had been elected a Fellow of the Royal Society in 1753, and a director of the South Sea Company in 1751. With Colonel Fauquier there had come to Virginia in 1758 Dr. William Small, of Birmingham, who first held the chair of mathematics at William and Mary, and later that of philosophy, *ad interim*. These two delighted in the society of young men, and at Colonel Fauquier's table, where Dr. Small was a constant attendant, the youths of Virginia, Thomas Jefferson, John Page, John Walker, James McClurg, and others, "learned their lessons in the rights of men." In later years Jefferson referred to Dr.

Small as the man who had fixed the destinies of his life, and John Page eulogized him as "the illustrious professor of mathematics . . . the darling friend of [Erasmus] Darwin." He might have added that he was also an intimate friend of James Watt.

At William and Mary, Jefferson and Page became fast friends, sharing their ideas and confidences. It was to Page that Jefferson wrote the letters that reveal his youthful romance with "the fair Belinda," who later married Jacquelin Ambler. The correspondence between Jefferson and Page covered 50 years without a trace of discord, and 30 years after their William and Mary days Jefferson declared to Albert Gallatin that he loved Page like a brother. In the election for governor of Virginia in 1779 Jefferson and Page were pitted against each other. Jefferson was denounced as a radical and Page as a tool of the Tories. The two candidates announced their platforms and retired to their estates, leaving the campaigning to their partisans. After the election, when Page sent congratulations to his victorious opponent, Jefferson replied that he derived special satisfaction from the fact "that the difference of the numbers which decided between us, was too insignificant to give you a pain, or me a pleasure, had our dispositions towards each other been such as to admit those sensations." Page, who was lieutenant governor under Patrick Henry and later (1802-5) governor, spent much of his time in scientific investigations. With his friend David Jameson he was interested in astronomy and made experiments in the accurate measurements of the fall of rain and dew. He also suggested, as early as 1779, the identity of magnetism and electricity. For a time he was president of the Virginia Society for the Promotion of Useful Knowledge, at Williamsburg, a group that sought to play in Virginia the role of the Royal Society in London. In later years he confessed that he did not think he had made great proficiency in any study, for he was too sociable to shut himself off in solitude as did his friend Jefferson.

John Walker was a son of Thomas Jefferson's guardian, Thomas Walker. He subsequently served on the staff of General

Washington as an extra aid with the rank of colonel, and also served in the United States Senate, by appointment from the Governor of Virginia, to fill the vacancy caused by the death of William Grayson. He was elected a member of the American Philosophical Society in 1770.

James McClurg was a more serious student than either Jefferson, Page, or Walker. After graduating from William and Mary he attended the medical school at the University of Edinburgh, from which he graduated as a Doctor of Medicine in 1770. While there he was a prominent member of the Virginia Club, an organization composed of Virginians studying at the school. After graduation he devoted some time to post-graduate medical studies in Paris and London, returning to Virginia in 1773. During the Revolution he was active as a surgeon in the Virginia militia, being referred to in the official records as physician-general and director of hospitals for the State. He was professor of anatomy and medicine at William and Mary from 1779 to 1783, after that living in Richmond. He was elected a member of the American Philosophical Society in 1774, and was also a member of the Virginia Society for the Promotion of Useful Knowledge. He was a member of the Philadelphia Convention, and later of the Executive Council for Virginia during the early years of Washington's administration. He was regarded as one of the most eminent physicians in the State and was president of the State medical society in 1820 and 1821. The first volume of the *Philadelphia Journal of Medical and Physical Sciences* published in 1820 was dedicated to him. According to James Madison, Dr. McClurg's talents were of the highest order, but he was modest and unaccustomed to exert them. Possibly his interest in his profession precluded any pronounced ambition toward a political career. Jefferson maintained a close friendship for McClurg, for whom he seems to have had great respect.

Such were the favored associates of young Jefferson at William and Mary, mature men of exceptional ability, sympathetic with, and fond of, the young, and young men of unusual promise. He graduated in

1762 at the age of 19 with a reasonably thorough reading knowledge of Latin, Greek, and French, and a familiarity with the higher mathematics and with the physical sciences rarely possessed by young men of his age. Fortune favored him still further, for after graduation he entered the law offices of George Wythe, then the leader of the Virginia bar, whom he described as "the best Latin and Greek scholar in the State," and as a "faithful and beloved mentor in youth and most affectionate friend through life."

He was admitted to the bar in 1767 after five years of study. After his admission to the bar he practiced law with more than usual success, and was elected to the House of Burgesses in May, 1769, and appointed surveyor of the County of Albemarle in 1773. From this time on he became more and more intensively interested in politics; though his interest in science never diminished, he was seldom able to devote much time to it.

#### PERSONALITY

At the time of his admission to the bar he was described as 6 feet 2 inches tall, slim, erect as an arrow, with angular features, a very ruddy freckled complexion, an extremely delicate skin, full deep-set hazel eyes, and sandy hair. Known to his friends as "Long Tom," he was a gay companion, an expert musician, the violin being his favorite instrument, a good dancer, a dashing rider, and proficient in all manly exercises. He was then, and continued to be throughout his life, frank, earnest, cordial, and sympathetic in his manner, full of confidence in men, and sanguine in his views of life. He seems to have been a recognized member of the closely knit social group made up of the children of the great families of Virginia.

As a mature man he had by nature a scientific mind, and he once remarked that "the tranquil pursuit of science" was his "supreme delight." He also wrote that he was "for encouraging the progress of science in all its branches, and not for raising a hue and cry against the sacred name of philosophy." He regarded "freedom and science"

as the prerequisites of progress, and said that he had "sworn upon the altar of God eternal hostility against every form of tyranny over the mind of man."

His legal training made him cautious in drawing conclusions from a series of isolated facts, and therefore impatient of all theories not logically deduced from adequate premises. In a letter to Charles Thompson written from Paris on September 20, 1787, he said "I wish that the persons who go thither [to the western country] would make very exact descriptions of what they see of that kind [*i.e.*, fossil bones], without forming any theories. The moment a person forms a theory, his imagination sees, in every object, only the traits which favor that theory. But it is too early to form theories on these antiquities. We must wait with patience until more facts are collected."

He was essentially of a reflective type, and it was his habit to seclude himself from time to time, while he diligently studied some branch of science as a relief from the grim realities of political and other worries. This habit of letting his mind lie fallow, so to speak, and thus to clear itself of unimportant details, probably had much to do with the brilliant manner in which he viewed all subjects in the light of their essential features, without being led astray by superficial emotional aspects.

In everything he did his custom was to sow the seed carefully, nurse it for a while, and then, when its successful growth seemed assured, turn it over to others for its further development and ultimate fruition, usually under his stimulation and guidance. In science, as in everything else, he followed this line. And so it happens that, judged from the record, his main scientific interests were in those lines that were most backward and in which vigorous and intelligent leadership was most needed, especially those lines that would ultimately prove of greatest value to the people.

Perhaps the most remarkable and outstanding feature of Jefferson's character was his complete freedom from personal jealousy. Freedom of thought was no mere political phrase with him. Everyone, according to him, was entitled to his own

ideas. Naturally, he differed with many people, but these differences he never took personally. A good illustration of this is seen in his attitude toward the contest between himself and John Page for the governorship of Virginia. He had an immense number of loyal friends, many of whom disagreed with his political outlook, though they never distrusted his sincerity. Dr. George Gaylord Simpson rightly says that "it is a measure of his greatness that Jefferson continued his powerful aid to paleontology and his warm friendship with its students even when it became evident that this aid and these students were revealing the falsity of views that he had vehemently and almost religiously expressed and maintained during the greater part of a long life."

#### JEFFERSON'S SCIENTIFIC INTERESTS

As a scientific man Jefferson was interested in all lines of science, but in all rather as an enthusiastic, highly appreciative, and intelligent amateur than as a professional. He had no time to make himself thoroughly proficient in any one line. The working out of the details he left to others, whom he assisted and encouraged to the best of his ability. His tremendous enthusiasm, which continued unabated, or perhaps even increased, during his term of office as President of the United States, was a most important factor in bringing before the people the value of science.

Tangible evidence of Jefferson's many and varied scientific interests is furnished by his contributions to the proceedings and collections of the American Philosophical Society in Philadelphia, of which he was elected a member, together with George Washington, in 1786, after the death of David Rittenhouse succeeding him as the third president of the Society on January 6, 1797. His contributions to the Society's program and collections were in the fields of meteorology, chemistry, economic entomology, archeology, vertebrate paleontology, and applied mechanics in reference to agricultural operations.

On December 17, 1779, there was recorded in the Society's proceedings a letter

from Rev'd Wm. Maddison (*sic*), president of William and Mary College, containing "a series of Meteorological Observations by His Excellency Governor Jefferson and himself separately, for a year and a half; likewise a set of Experiments on what are called 'Sweet Springs'." On April 15, 1791, on motion of Jefferson, a select committee (consisting of Jefferson and four others) was appointed to collect materials for forming the natural history of the Hessian fly and determining the best means for its prevention or destruction "and whatever else relative to the same may be interesting to agriculture." On August 19, 1791, he presented to the Society "a curious piece of Indian sculpture, supposed to represent an Indian woman in labor, found near Cumberland River, Virginia." On August 19, 1796, his letter to Rittenhouse (deceased) describing bones of extraordinary size found beyond the Blue Mountains in Virginia [in a cave in Greenbrier County, W. Va.] "appearing to be of the Tyger-lion & Panther species" was read by Dr. Barton. Under date of March 10, 1797, we read: "Jefferson's memoir 'On the Discovery of certain Bones of a Quadruped of the [space of four lines left blank].' A resolution was passed ordering the memoir to be put in the hands of the Committee of Selection of Publications, drawings of the bones to be made by a proper person. Mr. Peale was requested to put the bones 'in the best order for the Society's use'." These were the bones of the famous *Megalonyx*, the first giant sloth found in North America, and formed the subject of the only scientific memoir ever published by Jefferson, which appeared in 1799. On January 19, 1798, he presented to the Society bones of a mammoth "some time ago found in Virginia." On April 20, 1798, he presented a hand threshing machine invented by T. C. Martin of Virginia, "which he had procured to be made." On May 4, 1798, a "Description of a Mould Board of the least resistance, &c.," by Mr. Jefferson was read and referred to Mr. Patterson. This is the first mention of his famous plow. On May 7, 1804, W. Lewis, of Campbell County, Va., donated a bone and some rocks through

Jefferson. On April 27, 1805, William Bartram sent some bones to be forwarded to [Jefferson at] Monticello.

Much more detailed evidence of his extensive interests is furnished by his famous book on Virginia. In June, 1781, he was injured by a fall from his horse, and he occupied the leisure forced upon him by this accident in organizing the abundant and accurate memoranda that he had accumulated over a series of years. These memoranda were arranged in the order of a series of questions that had been submitted to him by M. Barbé de Marbois, Secretary of the French Legation. During the winter of 1782-83 he revised and expanded them and had them published in Paris in 1784 under the title of "Notes on the State of Virginia." The date of this work is given as 1782, which is probably the date of the completion of the manuscript, as he did not reach Paris until 1784. Two hundred copies were privately printed, as the work was not intended for general distribution. According to Sabin, a copy presented to M. Malherbe has the following note in Jefferson's hand writing: "Mr. Jefferson having had a few copies of these notes printed to present to some of his friends, and to some estimable characters beyond that line, takes the liberty of presenting a copy to M. de Malherbe, as a testimony to his respect to his character. Unwilling to expose them to the public eye, he begs the favour of M. de M. to put them into the hands of no person on whose care and fidelity he cannot rely, to guard them against publication."

This work, however, did not long remain confidential. A French translation, with a map, entitled "Observations sur la Virginie, par M. J\*\*\*. Traduit de l'Anglais," was published in Paris in 1786, and an English reprint of the original was published in London in 1788. The first American edition was published in Philadelphia in 1788. In the *Virginia Independent Chronicle* (Richmond) for Wednesday, December 12, 1787, we read that "the work will be comprised in a handsome octavo volume, with an elegant type and good paper, and delivered to the subscribers neatly bound and lettered at the very moderate price of one dollar.

The price to non-subscribers will be seven shillings and six pence Virginia currency . . . Subscriptions are taken in at Mr. Davis's Printing-Office in Richmond, where a specimen of the work is left for inspection." A second edition was printed in Philadelphia in the same year. This was followed by many other American editions—Philadelphia, 1792, 1794, 1801, 1812, 1815, 1825; Baltimore, 1800 (two editions); New York, 1801, 1804; Newark, 1801; Boston, 1801, 1829, 1832; Trenton, 1803, 1812; and Richmond, 1853. There was also a German translation entitled "Beschreibung von Virginien," published at Leipzig in 1789.

This was the first comprehensive treatise to be published on any section of the United States. In it were discussed the boundaries of the State, the rivers, the seaports, the mountains, the cascades, the mineral, vegetable, and animal productions, climate, population, military force, marine force, aborigines, etc. It was the precursor of that great library of more or less similar reports that have been issued by the State and Federal Governments. Measured by its influence, it was the most important scientific work published in America up to this time. It laid the foundation for Jefferson's high contemporary reputation as a universal scholar, and for his enduring fame as a pioneer American scientific man.

Further evidence of his interests is given by various printed reports, such as his report of July 4, 1790, presented to Congress on July 13, in which he made suggestions regarding a plan for establishing uniformity in the coinage and in the weights and measures of the United States, the first suggestion of the idea that was subsequently expanded into the National Bureau of Standards, and his scholarly report on the history and economics of the cod and whale fisheries made to the House of Representatives on February 1, 1791, and published on January 8, 1872.

Then there are the manuscript notes left by him, among which are the extensive meteorological records kept at Monticello, his notices of the first appearance of the birds and flowers in spring, and his comparative notes on Indian languages.

But by far the greater part of what we know regarding Jefferson's scientific interests is gathered from the great number of letters that he wrote to various friends and that were published after his death.

Applied science appealed to him quite as much as pure science. He was much interested in horticulture and in every form of agriculture. Botany was always a favorite subject with him, and he had one of the best botanical libraries in America, though on this he never published anything further than the lists of plants in his "Notes on the State of Virginia," which includes the first description of the pecan, written in 1781 or 1782.

Jefferson was an inventor of great ingenuity, as is made evident at once by a visit to his home at Monticello. He also had a keen interest in the inventions of others, especially those of practical application. When he was in France he wrote dozens of letters about inventions. When on a visit to England in 1786 he made careful notes on English domestic gardening and on mechanical appliances. He went to northern Italy in 1787 to inspect machines for cleaning rice, and in 1788 he made other observations in Germany. At the time of the creation of the Patent Office, Jefferson was Secretary of State. As such, he became *ex officio* the Keeper of the Records of the Patents, and according to Dr. Frederick E. Brasch was the most active examining member of the board, and therefore its first administrator. Dr. Brasch says that the scientific foresight that he exercised at this time must be considered the cornerstone of our patent system and patent laws.

#### SPECIAL SCIENTIFIC INTERESTS

Jefferson's keen interest in inventions more than anything else gives the key to his interest in science in general, which was the ultimate practical application of scientific discoveries for the good of man. No matter what line of scientific investigation he undertook, this idea of ultimate practical application seems always to have been in his mind. He seems never to have followed any line through mere pointless curiosity. Even in his study of fossils he appears to have had the idea that some time, somehow, a

knowledge of them would prove of value.

Of his numerous and varied scientific interests, three deserve special mention. First and foremost was his interest in man in general, evidenced not only by his political philosophy but also by his detailed study of the native Indians and his efforts to improve their relations with the Europeans, and by his sympathetic study of the Negroes; second was his interest in the exploration and description of the country; and third was his interest in paleontology.

The French historian and philosopher Guillaume Thomas François Raynal, usually called the Abbé Raynal, a leader of the French freethinkers who was exiled from France in 1781, had maintained, among other things, that Europeans had degenerated in America, and that the American Indians were a degenerate race. Jefferson denied this, and he also denied that the American Indians are inferior to Europeans in the same state of culture. He also said he has supposed that the black man, in his present state, might not be equal to the European, "but it would be hazardous to affirm that, equally cultivated for a few generations, he would not become so." In his "Notes on the State of Virginia" he gave an excellent account of the Indians and described the "barrows of which many are to be found all over in this country," listing the contents of one in the Rivanna River bottom. He also described the characteristics of the Negroes in dispassionate detail.

He was greatly interested in the multiplicity of radically different Indian languages and contrasted this with the lack of diversification among the red men of eastern Asia. He said that "the resemblance between the Indians of America and the eastern inhabitants of Asia, would induce us to conjecture, that the former are the descendants of the latter, or the latter of the former; excepting, indeed, the Eskimaux, who, from the same circumstances of resemblance, must be derived from the Greenlanders, and thus probably from some of the northern parts of the old continent."

In his "Notes on the State of Virginia" he wrote: "Were vocabularies formed of all the languages spoken in North and South America, preserving their appellations of

the most common objects in nature, of those which must be present to every nation, barbarians or civilized, with the inflections of their names and verbs, their principles of regimen and concord, and these deposited in all the public libraries, it would furnish opportunities to those skilled in the languages of the old world to compare them with the new, now or at any future time, and hence to construct the best evidence of the derivation of this part of the human race." He compiled comparative vocabularies of various Indian tribes, which were unfortunately stolen; but some fragments of these are deposited in the American Philosophical Society's archives.

Dr. Clark Wissler has pointed out that at about the same time the Empress Catharine the Great of Russia had adopted the same approach to the study of languages and had written to President Washington for lists of Indian vocabularies.

Jefferson's practical and sympathetic interest in the Indians is perhaps best illustrated by the instructions given by him to Capt. Meriwether Lewis in 1803 when the Lewis and Clark Expedition was about to be organized. These were as follows: "The commerce which may be carried on with the people inhabiting the lines you will pursue renders a knowledge of these people important. You will therefore endeavour to make yourself acquainted, as far as a diligent pursuit of your journey shall admit, with the names of the natives and their numbers; the extent and limits of their possessions; their relations with other tribes or nations; their language, traditions, monuments; their ordinary occupations in agriculture, fishing, hunting, war, arts, and the implements for these; their food, clothing, and domestic accommodations; the diseases prevalent among them, and the remedies they use; moral and physical circumstances which distinguish them from the tribes we know; peculiarities in their laws, customs, and dispositions; and articles of commerce they may need or furnish, and to what extent. And considering the interest which every nation has in extending and strengthening the authority of reason and justice among the people around them, it will be useful to acquire what knowledge you can

of the state of morality, religion, and information among them, as it may better enable those who may endeavour to civilize and instruct them to adapt their measures to the existing notions and practices of those on whom they are to operate . . .

"In all your intercourse with the natives, treat them in the most friendly and conciliatory manner which their own conduct will admit; allay all jealousies as to the object of your journey; satisfy them of its innocence; make them acquainted with the position, extent, character, peaceable and commercial dispositions of the United States, of our wish to be neighbourly, friendly and useful to them, and of our dispositions to a commercial intercourse with them; confer with them on the points most convenient as mutual emporiums, and the articles of most desirable interchange for them and us. If a few of their influential chiefs, within practicable distance, wish to visit us, arrange such a visit with them, and furnish them with authority to call on our officers on their entering the United States, to have them conveyed to this place at the public expense. If any of them should wish to have some of their young people brought up with us, and taught such arts as may be useful to them, we will receive, instruct, and take care of them. Such a mission, whether of influential chiefs or of young people, would give some security to your own party. Carry with you some matter of the kine-pox, inform those of them with whom you may be of its efficiency as a preservation from the small-pox and instruct and encourage them in the use of it. This may be especially done wherever you winter."

Dr. O. F. Cook wrote that the traditional sponsors of the repatriation and colonization of the Negroes in west Africa were Thomas Jefferson and George Washington. Jefferson studied the racial problem from many sides, including the need of educating the more capable Negroes so that they might furnish the necessary skill and leadership for the new communities in Africa. Washington instructed his executors to provide such education for some of his freedmen.

Almost immediately after his inaugura-

tion as the third President of the United States Jefferson began to make preparations for developing his long-cherished plans for the exploration of the great and unknown West and the discovery and description of its vast resources. His secretary, Capt. Meriwether Lewis, of Albemarle County, Va., who had long wished to go on an exploring expedition, was appointed leader of the first party to be sent out—partly at Jefferson's personal expense. Captain Lewis chose as his chief associate Capt. William Clark, also of Albemarle County, a younger brother of Gen. George Rogers Clark. The choice of these two leaders was a most fortunate one, and the expedition, which was in the field from 1803 (the year in which the territory extending from New Orleans to British America and westward to the Rocky Mountains known as Louisiana was purchased from Napoleon) until 1806 was highly successful. This was the first of a long series of more or less similar expeditions by which a detailed knowledge of our great West and of its resources and products was gradually accumulated. These expeditions, at first individual enterprises, were later consolidated under the United States Geological Survey.

Jefferson's interest in exploration was not confined to the land areas. Dr. Brasch writes that in 1806 he made a recommendation for a Coast Survey to Congress, which took favorable action on February 10, 1807, and authorized the President to cause a survey to be made of the coasts of the United States, including islands, shoals, and all other physical features deemed proper for completing an accurate chart of every part of the coast. This project was later organized as the United States Coast (now Coast and Geodetic) Survey. Dr. Brasch adds that during Jefferson's second term the idea of establishing longitude 0° through Washington (77°03'58" west of Greenwich, England) was much discussed. Jefferson's thorough knowledge of astronomy and mathematics, together with navigation, enabled him to give much encouragement to members of Congress who wished to establish this standard American longitude. This discussion, according to Dr.

Brasch, eventually led to the establishment of the Naval Observatory and the Hydrographic Office.

Enthusiasm for vertebrate paleontology seems to have been awakened in Jefferson before 1781, after which time he lost no opportunity for securing and examining bones. He was always especially interested in the mastodons, or "mammoths," and in the great sloth that he had called *Megalonyx*. As in other branches of science, his interest in paleontology was chiefly that of an enthusiastic amateur, and a stimulator of interest in others. Dr. Henry Fairfield Osborn has pointed out that in developing his scientific opinions in regard to paleontology he at first quoted the current tradition, later becoming a more serious and independent investigator.

The Lewis and Clark Expedition had brought back a few interesting fossils, which had whetted Jefferson's desire for more. In the summer of 1807 Captain Clark was sent on another expedition to Louisiana that took him through the region of Big Bone Lick, in Boone County, Ky. In obedience to President Jefferson's desires he stopped there and, employing ten laborers for several weeks, made a large collection of about 300 bones, which he shipped to Jefferson at the White House. Here they were laid out in the then unfinished East Room, the "mastodon room," where, at Jefferson's invitation, and later at Philadelphia, they were examined by Dr. Caspar Wistar.

Jefferson's interest in paleontology while President, as remarked by Dr. George Gaylord Simpson, helped to make it a respectable and honored pursuit, and he was largely responsible for bringing together the materials necessary for its advancement. He greatly encouraged the study of vertebrate paleontology by the American Philosophical Society while he was president of it. He also acted for a time as president of the board of trustees of Peale's Philadelphia Museum, which included the first public exhibition of fossil vertebrates, and the first mounted fossil skeleton in America. As the foremost citizen of the young nation, Jefferson's outspoken and excited interest in fos-

sils conferred on their study the dignity and prestige inseparable from his personality and position. But it also brought down upon him the ridicule and wrath of many of his countrymen to whom scientific investigation meant wanton and deliberate neglect of one's proper duties, if not, indeed, atheism. This attitude is well illustrated by a poem written by William Cullen Bryant at the age of 13, which runs in part as follows:

Go, wretch, resign thy presidential chair,  
Disclose thy secret measures, foul or fair,  
Go, search with curious eyes for hornéd frogs,  
'Mid the wild wastes of Louisianian bogs;  
Or where the Ohio rolls his turbid stream  
Dig for huge bones, thy glory and thy theme

It is only fair to Bryant to say that this poem, entitled "The Embargo," was published not by himself but by his father, Dr. Peter Bryant, and that he did his best to suppress it.

#### JEFFERSON AND HIS VIRGINIAN COLLEAGUES

It must not be supposed that during his brilliant and eventful career Jefferson was neglectful of his scientific colleagues in his native State of Virginia. Before the American Philosophical Society had elected more than a very few members from Virginia there was organized at Williamsburg on November 20, 1773, "The Virginia Society for the Promotion of Useful Knowledge." The charter was signed by six prominent Virginians, including the Hon. John Page, then lieutenant governor, who was elected vice-president, the president being John Clayton. Of the six who signed the constitution, John Walker was already a member of the American Philosophical Society, which James McClurg joined in the following year, and Mann Page later.

The notices regarding the activities of this Society were published in the *Virginia Gazette* at Williamsburg. There is no reference to Jefferson in any of them, but he was presumably a member, for in a letter written in 1787 in answer to one from John Page, who had urged him to accept the presidency, he wrote that "he should feel himself out of his true place to stand before McClurg," who was probably president at the time.

In its early years the society seems to

have been well received by the people of the colony; but after 1774 there are few published notices of it, although it appears to have kept up an organization for a considerable time.

#### JEFFERSON IN FRANCE

Jefferson was in France from August 6, 1784, to October, 1789, succeeding Benjamin Franklin as Minister in 1785. Dumas Malone writes that, rightly regarded in France as a savant, he carried on the tradition of Franklin, but until the end of his stay he was overshadowed by Franklin's immense reputation. His attitude toward Franklin, whom he regarded as the greatest American, was one of becoming modesty, without a tinge of jealousy.

At that time France was regarded as the leader in the biological sciences; but Jefferson thought little of French science. He vigorously combated what he considered the disparagement of the American fauna by Georges Louis Leclerc, Comte de Buffon, who maintained that the animals common to both the Old and the New Worlds are smaller in the latter; that those peculiar to the New World are on a smaller scale; that those which have been domesticated in both have degenerated in America; and that, on the whole, America exhibits fewer species. In order to correct these impressions, Jefferson procured from America at his own expense and presented to the Comte de Buffon the bones and skin of a moose, the horns of another individual of the same species, and horns of the caribou, the elk, the deer, the spiked horned buck, and the roebuck of America. Buffon also maintained, much to the annoyance of Jefferson, that the American mastodon, or "mammoth," was the same as the elephant of Africa and Asia.

He does not seem to have had a very high regard for Buffon. In a letter to President Madison of William and Mary he wrote: "Speaking one day with M. de Buffon on the present ardor of chemical inquiry, he affected to consider chemistry but as cookery, and to place the toils of the laboratory on a footing with those of the kitchen. I think it, on the contrary, among the most

useful of sciences and *big* with future discoveries for the utility and safety of the human race."

#### CONCLUSION

Dumas Malone writes that Jefferson became associated with an extraordinary number of important societies in various countries of Europe, as he had long been with the chief learned, and almost all the agricultural, societies of America. Much, but by no means all, of this recognition was due to his political prominence. On December 26, 1801, he was elected an "associé étranger" of the Institute of France; if this was by virtue of his position at all, it was because of his presidency of the American Philosophical Society. Mr. Malone says that this signal honor, which during his lifetime was shared by no other man of American birth and residence, may be attributed to his reputation in France as the most conspicuous American intellectual. He himself modestly interpreted it as "an evidence of the brotherly spirit of science, which unites into one family all its votaries of whatever grade, and however widely dispersed throughout the different quarters of the globe."

Modern scholars, according to Mr. Malone, have recognized Jefferson as an American pioneer in numerous branches of science, notably paleontology, ethnology, geography, and botany. Living long before the age of specialization, he was a careful investigator, no more credulous than his learned contemporaries, and notable among them for his effort in all fields to attain scientific exactitude.

But Jefferson saw all these branches of science not as independent units but as integral parts of an all-embracing whole that should be developed for the sake of the future happiness and prosperity of mankind, for the ultimate good of his fellow men was always in his thoughts. It was this scientific foresight that led him to advocate so vigorously the idea that science would be the cornerstone of our Republic. In 1789 he wrote to President Willard of Harvard: "What a field we have at our doors to signalize ourselves in. The botany of America is far from being exhausted, its mineralogy

is untouched, and its natural history or zoology totally mistaken and misrepresented . . . It is for such institutions as that over which you preside so worthily, Sir, to do justice to our country, its productions, and its genius. It is the work to which the young men you are forming should lay their hands. We have spent the prime of our

lives in procuring them the precious blessings of liberty. Let them spend theirs in showing that it is the great parent of science and virtue, and that a nation will be great in both always as it is free."

Such was the opinion of Thomas Jefferson, the most versatile and the most influential of our American scientific men.

ETHNOLOGY.—*Pacific Coast Athapaskan discovered to be Chilcotin.*<sup>1</sup> JOHN P. HARRINGTON,<sup>2</sup> Bureau of American Ethnology. (Communicated by WILLIAM N. FENTON.)

The purpose of this paper is to announce a discovery of great importance to ethnology made on my recent field trip to the Pacific Northwest. This consists of the disclosure that the so-called Pacific Coast Athapaskan, about which much has been written in the past and which has been compared to Sarcee, Navajo, etc., is composed of a string of Chilcotin languages straggling down, and near, the west coast of the United States proper from what is now southern British Columbia to almost within sight of San Francisco, Calif.

The interior of Alaska and of most of northwesternmost Canada is occupied by a number of languages of the so-called Athapaskan stock. In the forties of the past century Hale recognized Umpqua, of what is now Oregon, as belonging to this stock, and in the fifties Turner added the Apachean-Lipanan of the southern deserts and southwesternmost Great Plains of the United States to this stock. It became gradually clear through further study that the main body of the Athapaskan stock is that of the far northwest of the North American Continent, and that from there two linguistic prongs have extended southward: (1) a Pacific Coast prong like the letter i (the dot would represent the Chilcotin), and (2) a

more easterly prong accomplished via the "Great North Trail" along the eastern base of the Rockies south to where these mountains break down and thence west, or else via the intramontane region south, like the letter j (the dot would represent the Lipanan). In case of intramontane accomplishment, the j would have been executed hook first. The present study has succeeded in eliminating from the general Athapaskan problem the Pacific Coast prong by discovering it to be a unit, having as its northern head part of the Fraser River drainage of British Columbia, Canada, and as its southern extent the zigzag watershed which bounds to the south Eel River's Southfork, in Mendocino County, Calif. The expression in the Chilcotin languages is just the opposite of this; in the manner of Chilcotin languages Indian talk, the peoples in their migrating layer on layer southward were working a language-substitution from the tail of the earth, which is located at what is now called Alaska and westernmost Canada, toward the earth's head, which is located in the far south. Genetic relationship of the Athapaskan languages with the Tlingit (language of Sitka and Juneau, Alaska) and the Haida (language of the Queen Charlotte Islands) was shown by Sapir years ago. Work done by me a few years ago showed how close this relationship is, likeness extending to some 300 features.

Five detached bodies of Chilcotin languages were worked on:

(1) The most northerly of these was the Chilcotin proper, which takes its name from Chilco Lake, just east of the Cascade Range of mountains, in an easterly direction

<sup>1</sup> Received April 12, 1943.

<sup>2</sup> For important assistance in the consummation of this work, I wish to express my thanks to the following: The late Prof. Franz Boas, Prof. Melville Jacobs, Bess Langdon Jacobs, Mrs. James A. Teit, Prof. Edward Sapir, Prof. P. E. Goddard, Robert W. Young, Dr. Fang-Kuei Li, and the Missionaires Oblats de Marie Immaculée, as well as to various Indian informants who spoke the languages involved and remembered fragments of disused ones.

across the Strait of Georgia from the central part of Vancouver Island, and one of the sources of the Fraser River.

(2) The fragmentarily remembered language, closely resembling Chilcotin proper, of the Nicola and Similcameen Valleys, British Columbia, which had been sketchily made known by Dawson toward the close of the past century from information furnished to him by J. W. MacKay, formerly Indian agent of Indian Affairs Branch, Department of Mines and Resources, of the Canadian Government, stationed at Kamloops, British Columbia. A generation or two before this variety of Chilcotin would inevitably have become replaced by English, it became supplanted, in the latter half of the nineteenth century, by Indian languages of the Salishan stock. Working separately with eight different informants, I swept their memory clean of the former language and obtained a sizable and important list of vocables, the best results coming from the aged chief Ernest Billy and from his sister Matilda.

The information not only showed that the all-but-vanished language was Chilcotin, but details were volunteered that the speakers were called Stuwix-mux (Stuwix, Athapascan name of the Nicola Valley; Thompson -mux, person), that they made their last linguistic stand at what is now spoken of as the reserve at the southwest end of Nicola Lake, that the spring beside the Nicola Valley Brewery at the western end of the city of Merritt was magically created by them as a never-freezing drinking water supply and bathing place for the neighboring village of Teszulle, that these people used to steal children in order to augment their tribe, and that they formerly at times had clashes with the Thompson and other Salishan speaking bands that surrounded them. Best of all, came the information that the Chilcotin are called in the Thompson language Yuunxanii, a tribal name that has never been obtained or published on. This Chilcotin body was an enclave amid Salishan.

(3) The next Chilcotin language to the south was Kwahioqua, occupying the Willapa River drainage and the adjacent drainage of the southern heads of the Chehalis

River, in what is now southwestern Washington, centering about Pee-Ell Prairie (so called from the Indian pronunciation of Pierre, first name of a one-eyed Frenchman who used to farm the flat). This body was a second linguistic island, surrounded by alien Salishan and Chinookan.

(4) Another inland island of language consisted of the Tlatskanai (native pronunciation Laats'qhanayu), who held, in upper, central, and lower divisions, the valley of the Claskanie River, a southern tributary of the Columbia, west of the present city of Portland, in what is now northwestern Oregon.

(5) The fifth and last Chilcotin division, as yet without a general name, was a great bloc of languages extending from Roseburg, Oreg., to Laytonville at the head of Eel Southfork, Calif., cut linguistically only by the Klamath River and unlike the divisions mentioned above in that it held many miles of coast, although the central part of its coastal holding, from Wilson Creek mouth, Del Norte County, California, to just north of False Cape, Humboldt County, Calif., was in Algonkin family linguistic ownership. This great southernmost Chilcotin group constituted seven languages: (1) Umpqua, or more precisely Upper Umpqua, who call themselves T'yuutaneeyuu (prairie person); (2) Tututunne, from the head of the Coquille River to include the lower part of the Rogue River, Coquille and Shastacosta being perhaps the leading languages; (3) Galice, spoken on Galice and Applegate Creeks, southern tributaries of the Rogue River, remarkable for its appearance of *ŋ*, *n*, *m* as *g*, *d*, *b*, respectively; (4) Smith River, including Chetco; (5) Hupa, including Chilula and Whilcut; (6) Mattole, including Bear River; and (7) Wailaki, including Saya, Lassik, Sinkyone, and Kato. The farthest south extent of Chilcotin languages on the coast took in Usal Creek mouth. The Kato, at the head of Eel Southfork, abutting the Russian River watershed, were a little farther south than the Sinkyone co-speakers on the coast to their northwest, and again than the Wailaki co-speakers on Eel River proper to their northeast.

Even the Chilcotin is in many features

very Hupa-like, Kwalhioqua still more so, and in Umpqua to Kato one has practically straight Hupa grammar. For this southern division, therefore, perhaps a term Hupoid or Hupan would be practical.

According to meaningful consideration, the Chilcotin languages consist of the inherited morphom (meaningful form or element) and its inherited sequencing. The morphom may conveniently be considered as having two weights: (1) the theme (main or lexical meaningful form or element), to be written, with absence or presence of its crements, without spacing, and for indicating its crementless form always without hyphenization (the verb in these languages does not occur crementless); (2) the crement (subsidiary meaningful form or element), consisting of firmly attached affix or loosely attached clitic, to be written attached to its theme without spacing or hyphenization, but sometimes with hyphenization for perspicuity or weight indication. The theme minus or plus its crement or crements is termed the etymon (word or vocable), and it is the etymon that is dictionarized. The term base is a shortcut for standardized or extended theme.

There are in the Chilcotin languages four distinct, differently handled classes of etyma, or "parts of speech" to retain the terminology of the Greek grammarians. Retaining the Greek grammarian order of presentation, these are: noun, pronoun, verb, and particle. These four etymal classes reduce into two philosophical classes: noun, denoting entity, and verb, denoting action. The pronoun is a mere category carrier, appearing where the noun would be a more definite painter, or in addition to the noun. The verb is the equivalent of a pronoun-plus-verb-European-sentence. There are also copula and posture verbs and the like, which are to the verb as the pronoun is to the noun. They are handled as verbs, just as the pronoun is largely handled as a noun. The particle consists largely of adverbs of etymon rank of many formations, which definitize or add to the painting accomplished by the verb, and some of which, or their counterparts, can also be prefixed to the verb. These four etymal

classes can be listed and characterized as follows:

(1) The noun is the label of entity. It admits of only certain adnominal prefixes and postfixes.

(2) The pronoun is handled mostly like the noun, but merely denotes unit of category, usually combinatory unit. The pronoun is cut into personic and demonstrative-numeroid divisions. Only the personic can be prefixed to noun and verb, one set of prefixes being used before the noun, and another, split into objective and subjective, before the verb, with the objective coming first if both are present. When prefixed to the noun, the personic becomes modificatory, as does the first member of a noun plus noun compound, and this modification has settled into possessive meaning. Numeroid pronouns suggest that numerals belong to the pronominal etymal class.

(3) The main part of the anatomy of any one of these languages is the verb, the base of which constitutes the last syllable, if there is no postfix syllable or syllables (compare the position of the verb at the end of the Latin sentence). Some of the verb bases assume as many as five phonetically different forms, but the principal ones for presenting slighter and fuller<sup>3</sup> form are the nonintegral and integral, which two forms of the verb base are the ones given in the present paper and in the order of nonintegral first and integral second. Some of the forms, both nonintegral and integral, of the verb base show a postfix or the remnant or reflex of one, as was detected by Goddard years ago. The nonintegral appears in the present indefinite and the imperative forms of Goddard and is the weaker or more reduced form of the verb base according to him, the imperfective of Li, in contradistinction to the integral, Goddard's past definite, Li's perfective, which is a stronger form. Some verb bases have according to closing consonant a slight and a full form, and this of nonintegral, or integral, or of both. Immediately before the verb base may come one or another, or in one instance even two together, of four classifiers (taking

<sup>3</sup> Or light and heavy, as Indo-Germanic ablaut forms are termed.

this terminology from Tlingit and other grammar), better called causo-agentive prefixes—four in number if we regard zero, or lack of classifier, as one of the four. The force of these prefixes is largely obscured in the Chilcotin languages. The most contractional part of the verb is the personic belt, consisting of personic objective prefix followed by personic subjective prefix with mode and aspect prefixes jammed in between these, a region of contractions comparable in complexity to the vowel contractions of the Greek verb. This order carries out the general word order of the languages of modificatory before main. Starting the verb, when occurrent, and preceding all pronominal prefixes, are the many adverbial prefixes of two positions, even including incorporated nouns used as adverbial modifiers.

(4) As the fourth and last etymal class, there can be lumped together adverbs, conjunctions, interjections, etc., all of etymal rank, under the blanket term anonymon, or particle. This class was Frachtenberg's catch-all, but the various groups of which it consists do have common characters.

Etymal classes 1, 2, and 4, in contrast to the verb, have comparatively few possible forms, and are therefore simple.

Some of the etymal forms have cremental counterings. Again, the postposition, which appears in these languages only as a category of postfixed transitive adnominal adverbs, may in other languages or writings have etymal, dictionary weight.

#### COMPARISON OF SOUNDS

The Chilcotin languages not only constitute a unit of linguistic development but also contain in Hupa, Mattole, and Wailaki, three of their members, preservation of sounds not even secondary to that of Tlingit and Haida in uniqueness for the reconstruction of the phonetic system of all Athapascan languages, including Tlingit and Haida. The Chilcotin languages, as well as Tlingit and Haida, evidence two back-of-the-tongue series.

The phonetic structure of the Chilcotin languages is, like that of language in gen-

eral, an alternation of opener sounds called vowels, and closer sounds called consonants, comparable to slap-yelling—a procedure in syllables. Syllables are termed open or closed, open when having zero after the vowel of the syllable, closed when having a consonant after the vowel of the syllable, the consonant of course belonging to the same syllable. In actuality, most Chilcotin syllables are closed, either by a postvocalic consonant different from the one that starts the next syllable or by the doublish pronunciation of what would be otherwise a single intervocalic consonant whether within or between words. One can furthermore in all the Chilcotin languages divide the syllable closing consonants, into light and heavy closers, the light being on the whole slighter and including zero, and the heavy having fuller closing.

Language suffers changes and splittings. Changes, especially of sound, can be termed processes.

Reconstruction of a sound, morphological element, or word, won through comparison, of necessity synchronic in North America north of Mexico, is a device surely wrong in actuality, but nevertheless one that serves a temporary purpose. No amount of comparing of Romance forms would win back Latin with certainty even to the extent of a single word, though Italic dialects, Keltic, and Greek and careful procedure were to guide. The reconstruction of pre-Chilcotin is ephemerical but is comparable to a setting up of linguistic stocks in South America temporarily advantageous to the ethnologist.

The reconstruction of sounds is simpler than that of vocables in that vocables consist mostly of more than one sound. Taking a clue from the patent traveling backward of t to k in Lipanan (a group of Athapascan languages of the southwesternmost Great Plains), I spent considerable time in working out the assumption that Hupa k, x<sup>w</sup>, etc., are frontals in antiquity that traveled toward the rear (like Swedish maskin, engine, becoming macin, and in dialect max<sup>w</sup>ina), but two indications made it plain that this assumption was wrong: (1) Related bunches of vocables in the lan-

guages themselves proved back-of-the-tongue origin; (2) the genetically related Tlingit and Haida proved back-of-the-tongue origin. It became apparent that the traveling of sounds has been in the same outward direction which in several centuries turned popular Latin *k* into the *s*-sound of French.

Of course, all reconstruction takes us back only one jog, only to the extent of one chunk of time.

The assuming of a definite reconstruction form of any kind is by necessity more or less arbitrary. Even such a matter as to whether *kh*, *x*, or *k* is more ancient as a starter of the word for fire, must remain forever unsettled. It would not even be safe to guess that the more complex, which is *kh* in this instance, has been reduced.

Writing employs to a large extent different symbols for voiceless and for voiced consonants, and this tends to make the sounds in writing appear more different than they actually are in the mouth. For instance, English Siwash, and the French word *sauvage*, from which it comes, really have last sounds the same except for the matter of voicing, but the spelling makes these last sounds look very different.

Abbreviations of language names, such as Chil. for Chilcotin, used in presenting forms, do not require explanation. But Shastac. is used for distinguishing Shastacosta from Shasta.

#### VOWELS

As in Semitic, differences in vowels in the Chilcotin languages are not so important as differences in consonants.

A tendency is that a short vowel of an open syllable in the north appears largely as long in the south: Chil. *si*, I; Wai. *cii*. Chil. *tʰhe*, stone; Wai. *tshee*.

There are several ablauts, or vowel mutations, notably that of *o* alternating with *a*, and that of *e* or *i* alternating with *a*.

Vowels occur short or long, as do consonants. Since the length of long consonants is conditioned by the simple rule that intervocalic consonants are long, all consonants are to be written short. But long vowels must rigidly be written long.

A nasalized vowel is, as in French, the result of an original syllable-closing *-n*, which nasalized more or less its preceding vowel, and was retained, changed to *ŋ*, or disappeared altogether, even the nasalization it produced disappearing in certain forms. Or a nasalized vowel is the result of a preceding nasal consonant.

#### *a*

Chil. *-na*, eye. The quality of *a* is more open than that of *a* (a modification of *i*), with which it ablauts for instance in some verb bases.

#### *o—u*

*o* and *u* are variations of the same sound. There is a tendency to pronounce a glide *w* between a dorsal consonant and this vowel (as for instance in Russian *kʷómnata*, room). It is a trait of several of the Northwest linguistic stocks and also of the Chilcotin languages that *o* labializes following dorsal consonant even through *h* preceding that consonant: Coq. *c-xe'*, my foot; neenuh-*xwe'*, our feet. In Tlingit, in some instances, even the *a*-sound labializes a following dorsal consonant.

In addition to inherited *o—u*, Chilcotin also shows *a* transformed from *o* after a labialized dorsal: *kwat*, knee (for *\*kʷot*); *khwan*, fire (for *\*khʷon*).

#### *e*

Chil. *ta-ne*, person. *e* and *i* are kept distinct. Occasionally in a setting that would turn *i* to *a*, I have heard *e* almost so turned, e.g., Navajo Tshé-khooh, Chaco, literally stone canyon, i.e., box-canyon, almost tshá-khooh.

#### *i*

I have mentioned under *o* above one source of Chilcotin *a* from ancient *o*. Another and still commoner source of *a* is from *i*, conditioned to this extremely open form by contiguous consonant or consonants. Chil. *lat*, smoke.

#### VOWEL DIPHTHONGS

Vowel diphthongs are as in Tlingit and Haida of the class known as false, consisting of mere juxtaposition of two vowels of differing quality (Frachtenberg's *au* or *aww*, as in English *hooley* in rapid tempo, in con-

tradistinction to his a<sup>u</sup> or aw). Any occurring vowels of qualities different from each other may come together to make such a diphthong. Especially when one of the vowels is long, the false diphthong hovers on the border of being pronounced as two syllables. Nasalization of one vowel diphthong member is infectious to the other. Vowel triphthongs rarely occur.

#### SYLLABO-INITIAL CONSONANTS

Originating consonants travel different roads of development as to whether they start or close a syllable. It is therefore practical to prepare two lists of consonants, one of syllabo-initial consonants, the other of syllabofinal consonants, both drawing on the main or lexical elements of the languages. For restoring the originating consonants, Hupa, and to some extent Mattole and Wailaki, are important, since they postulate a palatalized or forward dorsal series reminding one of the separate forward series of Tlingit and Haida. For writing Tlingit and Haida, *k*, *χ*, etc., are employed for the rearward series, *k*, *x*, etc., for the forward; however, mere *k*, *x*, etc., for the rearward-related and *k̄*, *χ̄*, etc., for the forward-related are used in writing Hupa.

#### LARYNGEALS

ʔ

In the Chilcotin languages nearly all vocables that would begin with a vowel have before this a momentary laying together of the moist glottal cords identical with the hamzated alif of Arabic and written by the apostrophe. Chil. 'a-thi, non-human trail. A few vocables begin directly with vowel, for instance, Chil. s-at, my wife.

*h*-

*h*- is rare, but occurs as the consonant of interjections, including the particle yes, and of song padders.

#### DORSALS

*k*-

Chil. -ket, -ket, to spear (fish).

*k'*-

Chil. k'a, arrow.

*kh*-

Kwal, khasxee, chief; Coq. xasxee.

When the original following vowel was *e* or *i* after a dorsal, the rearward of two back-of-the-tongue series is to be postulated, for all the languages retain *kh*- or the like. Chil. khe, foot; Hupa -khe'. Tlingit *χ'ùs*, foot, is a rear series cognate, but Tlingit *khè*, *khèn*, to track, also occurs.

*x*-

Though *kh*- largely appears as *x*- in the southern languages through declusivizing, when an originating *x*- is assumed there is no proof that *x*- was ever anything but a fricative.

Hupa is the only Chilcotin language, the only Athapascan language in fact, that still forms the word and prefix meaning I, my, on the back of the tongue, as Tlingit does, even Mattole and Wailaki presenting only forms leveled to *c* and the like. Hupa *x<sup>w</sup>e*, I; *x<sup>w</sup>i*-, my. Tlingit *χà*, I; 'a*χ*-, my. Chil. *si*, I; Wai. *cii*. It is only upon referring to other stocks that we find *k*-, etc., meaning I, my.

When the original following vowel was *o*, glide *w* developed before it after a dorsal: Chil. *su'*, all right; -*zu*, to be good; Hupa -*x<sup>w</sup>oŋ*, to be good.

When the original following vowel was *e* or *i* after a dorsal, there is no way to tell whether the consonant belonged to a separate palatalized series, since the appearance in Hupa both of \**x*- and of \**χ*- is *x<sup>w</sup>*-. Chil. *can*, -*yan*, song; Hupa *x<sup>w</sup>iŋ*.

*r*-

Chil. -*ra*, bodyhair. Tlingit *χàw*, bodyhair.

When the original following vowel was *o*, glide *w* developed before it after a dorsal. Chil. -*r<sup>w</sup>u*, tooth. Tlingit 'ú*x*, tooth.

When the original following vowel was perhaps *i*, there is no way to tell whether the consonant belonged to a separate palatalized series. Chil. *yaθ*, snow; -*χaθ*, -*χaθ* to snow.

#### DORSALS LABIALIZED

*rw*-

Chil. -*rwit*, -*rwat*, to break intransitive-w is in these languages lowered from *rw*.

#### DORSALS PALATALIZED

*k̄*-

Chil. -*χat*, -*χat*, to fear; Hupa -*kit*, -*kit*.

Chil. -k'uł, -k'al, to tear transitive;  
Hupa -k'it, -k'il.

*kh-*

When the original following vowel was o, no glide <sup>w</sup> develops. Chil. -tcho, large, augmentative postfixed particle (but Chil. -tchoh, to become large, with retention of original -x as -h); Hupa -k̄hoh.

When the original following vowel was e or i after a dorsal, the forward of two back-of-the-tongue series is to be postulated, because only Hupa, and to a partial extent its neighbors to the south, retain kh- or the like. Chil. -tche, tail; Hupa -k̄he. Chil. tchan, stick; Hupa k̄hiŋ. (The word meaning stick is also used meaning tree in all these languages, with which agrees the use of English stick meaning both stick and tree in English local vernacular and in Chinook jargon.)

*k̄x-*

Some ancient affricative such as \*k̄x- may lie behind such appearance as in Chil. tshan, excrement; Shastac. sa', Hupa tch<sup>w</sup>aŋ. Chil. -tsha, -tshe, to cry; Hupa -tch<sup>w</sup>a, -tch<sup>w</sup>e. Chil. tshaz, firewood; Hupa tch<sup>w</sup>ite.

## FRONTALS

*t-*

Chil. taδ, driftwood.

*t'-*

Chil. t'es, charcoal, to becharcoal; Coq. t'ec, black paint; to mark with black paint; Hupa t'ex<sup>w</sup>, charcoal. to becharcoal.

*th-*

Chil. thuu, water; Ump. thuu.

## FRONTAL LATERALS

*ł*

Chil. łi, dog; Kwal. łen; Hupa łiŋ; Tlingit khèł, dog.

*l*

Chil. -la, hand.

*tl*

Chil. tlat, rivergrass; Hupa lah, sea-lettuce (with tl- and l-).

*tł*

Chil. t'łuł, string; Coq. ditto.

*th-*

Chil. thho, salve.

## FRONTAL SIBILANTS

*ts'*

Chil. ts'ii, canoe; Kato ditto.

*tz-*

Chil. tzah, gum; -tzeh, -tze, to stick with gum; Hupa tjeħ, gum. Chil. tzii, heart; Coq. se'; Wai. tjii. Chil. tzin, day; Wai. tjiŋ. Haida siŋ, day. For appearance in some of the languages as a complete s, compare e.g. Greek méssos, mésos, adj., middle, for \*méðhyos.

## FRONTAL LISPINGS

Chil. -ðe, mouth.

*tθ'-*

Chil. tθ'an, bone; Shastac. ditto.

*tθh-*

Chil. tθhe, stone; Shastac. θee; Hupa tshe. Tlingit thè, stone. Chil. -tθi, head; Kato si'. Tlingit cá, head.

*n-*

Chil. -nai, -nai', to drink; Hupa -naan, -naa'n.

## LABIALS

*p-*

Chil. pan, roof; Coq. ma'n, house.

*m-*

The Chilcotins think of the Sekany tribe, which lives northeast of them, as substituting m- for p-, and do not know that their far southern linguistic cogeners do the same. The alternation p with m is widespread in American languages.

## SYLLABOFINAL CONSONANTS

The Chilcotin languages have in general about a dozen consonants that can be syllabofinal. Only Hupa and Wailaki indulge in clicked affricatives of this position, e.g., Hupa and Wai. -t'ats', to cut, integral. Hupa also shows an affricative at the end of several forms where other languages would suggest a fricative, e.g. Hupa tch<sup>w</sup>ite, firewood (the common diminutive in Hupa is in -te, compare man-te, hut, literally houselet).

-ʹ

Syllable-closing -ʹ is in part original. It is sometimes the mark of the possessional form of the noun, of the perfective form of the verb base. It is also sometimes a reduction of older -k or -t; for instance, Navajo ka'nijii, white spruce, is for \*kat-nijii.

-h

Syllable-closing -h is in part original. It is also largely a reduction of syllable-closing -x, as can be proved where it alternates with -r. Sometimes -h is entirely leveled out, as in Chil. -tcho, large. Sometimes -h stands for a former -k, -t, or the like.

-hθ

Not having listed the several syllable closures in -ʹ plus a buccal consonant, -hθ should not be separately listed, but its appearance is curious. Chilcotin has merely yaθ, snow; xaθ, xaδ, to snow; yet Kwal. yahθ, snow, Coq. yahs, Kato yahs.

-k

Shastac. 'ak, cloud; Hupa 'ah, Wai. 'ah, show nicely -k having been preserved and having become -h.

-t

Chil. ɬat, smoke; Shastac. ditto; Mat. hih. Chil. -khoh, river; Kato khot, creek. The hardening of the preceding syllable results in a different history for this -t: Chil. -pat, belly; Hupa -mit', Mat. -pa't.

-s, -z

Chil. pas, bank; Coq. maθ. Chil. xaz, pus; Coq. xaθ. Chil. syllable-closing -s has in the languages down the coast very different appearances from Chil. syllabo-initial s-.

-n

In syllables originally closing with -n, four different grades of non-reduction and reduction can be easily distinguished in the languages: (1) complete -n; (2) appearance of -n as -ŋ; (3) appearance of -n as nasalizing of the vowel which formerly preceded it; (4) complete disappearance of nasalization. Sometimes two of these grades appear as distinguishing features in the forms of a verb base.

-m

-m appears as a syllable-closer in a few

Chilcotin forms, but has gone over into the more limber -n and its developments in the other languages.

## DISSYLLABIC ALTERNATION

A curious alternation between two-syllable and one-syllable forms, accomplished factually by thrusting -r- into the middle of the one-syllable form, appears in:

Shastac. θaraθ, black bear (compare perhaps with the last syllable Chil. caθ, grizzly); Chil. sas.

Chil. t'aras, snake; Kwal. t'as-khan'e, eel, literally river snake. Hupa lux<sup>w</sup>, snake; lux<sup>w</sup>-xan, eel, show Hupa l- for t' (compare for instance Hupa l- for tl- in the Hupa word for sea-lettuce; pre-Hupa for snake should be \*t'ix<sup>w</sup>).

Mat. k'arax, alder; Chil. k'as, Hupa k'ux<sup>w</sup>.

## DECLUSIVIZING, DEASPIRATING, DEALIFIZING, DEBUCCALIZING, ALIFIZING

Certain consonants in Athapascan languages, including Tlingit and Haida, have been encountered that just about run the gamut of homopositional type, and even that straddle articulation position, reminding one of Italian basso, low, Spanish bajo. The five processes mentioned as the caption of this section, all of them except the last mentioned accomplishing an easing, are encountered, and can be listed and exemplified here.

Perhaps the commonest of these processes is declusivizing, for instance, kh- in its emphatic or overaspirated form is kx- and is leveled solely to this appearance in some of the languages, just as Siouan kh- becomes solely kx- in Teton Sioux, and indeed in conformity for instance with the reduction of tθh- to θ-. I have even heard Navajo -ko, when, if, in standard tempo talk reduced to -xo. Chil. -khe, foot; Coq. xe'; Shas. xee.

Deaspirating is, in one way of looking at it, the opposite of the above process, whereby for instance an earlier kh- becomes k-. Mat. ke'-, foot, for pre-Mattole \*khe'-.

Dealifizing is well exemplified by Chil. -tluh, -tluk, to do by means of string; Chil. -t'uh, -t'u', to fasten with string.

Debuccalizing is again the opposite of the

just mentioned process. Chil. 'a-, something or someone objective, verb prefix; Hupa k'i-

An example of alifizing is shown between Chil. -k'aih, -k'an, to burn, and Chil. khwan, fire.

#### SPECIAL DEVELOPMENTS OF SOUND

There are many special or irregular developments of sound in the Chilcotin languages. Some of these changes are differentiations to avoid ambiguity. But throughout the languages one notices that special developments consist largely of easings of consonants in prefix syllables or in other much used forms. Thus Chil. ts'i-, someone, verb prefix (never a noun prefix), appears in Mattole as tji-, -'tji-, someone, verb prefix, someone's, noun prefix—with easing out of the clicking, just as a Zuni schoolchild will say tz for ts'; Kwal. tantc'e, 4; Coq. tantc'i; Hupa tɪŋk'; but Chil. taŋke. These changes are also suffered by bases and have been listed as the processes of de-clusivizing, etc., but prefixes and postfixes in the Chilcotin languages are especially prone to what may be termed special development. One can compare, for instance, the irregular verbs met with in many languages, special development of sound and form being caused by commonness of occurrence in various settings.

#### LACK OF TONAL ACCENT

Inherent tone of syllables is a morphological and lexical as well as phonetic feature and is a characteristic of the northern, eastern, and southeastern Athapascan languages, but it does not occur, except as rare vestiges or as the cause of reflexes, in any of the Chilcotin languages. In coming from the inherent-tone Beaver, Chippewyan and Sarcee languages, which lie to the east of the Chilcotin languages, one is struck at once that the Chilcotin languages are not tonal, so much so that in these a noun may be distinguished from a phonetically equal verb form by signaling the syllable or syllables of the noun by raising of tone. This lack of tonality is another common feature that makes for the unitizing of the Chilcotin languages.

In all the Chilcotin languages noun and

verb form identical with noun can be distinguished by raising and loudening of voice for the nominally used form.

#### GRAMMATICAL AND VOCABULARIAL COMPARISON

The Chilcotin languages are characterized by large preservation of the possessive form of the noun; certain same nouns throughout the languages require someone's to be prefixed for not personally possessed form or when in certain meaning (Chil. -tche, tail; but tche, stream mouth); the same prioritive is common to a number of the languages; lack of addressative; the same postpositions with appositive personic plus postposition readier than noun plus postposition; the same personic plurals of the pronoun (we, ye); k'i- (and from this 'i-, 'a-), someone or something objective, verb prefix (not \*'a-); the same demonstratives (Chil. -ti-, this; Chil. -yu-, that); verb base vriddhied by ablaut, orinasal umlaut, vowel lengthening, postfixation of syllable-closing consonants, as a maximum to five different forms and with k- to kw-, k'- to k'w- and kh- to khw- as a maximum of syllabo-initial consonant change; verb bases having the vowel consist of i prone to have one or few forms; nonintegral and integral action, nearer perfect and remoter perfect, immediative and future sometimes distinguishable by verb base change alone; certain verb prefixes and postfixes prescribe verb base forms; a separate class of verb postfixes outside of and after the verb base constantly and vitally in use even largely for tense distinguishment; verb base classification of entities such as earth, fire and water as well as according to shape or plurality; formation of passive from integral base; noun incorporation not confined to special forms but pretty largely practicable, in the adverbial belt; customary a secondary formation; nouns, pronouns, and particles, painters appositive to verb elements of vagueness; yi- (related to the remoter demonstrative) largely as adverb prop and as partial originator of the relational; cardinal direction terms largely interlaced with stream and slope terms.

In addition to grammatical features *sui generis* these languages have the same pe-

culiar vocabulary, unitary inheritance of morphoms and etyma as well as their treatment; we point, for instance, to the numeral *taŋke*, 4, which runs down the coast from British Columbia to Laytonville, to peculiar plant names, animal names, etc.

#### WIDER COMPARISON

A sensing of phonetics, morphology, and lexicality still wider than that gained from Athapascan, Tlingit, and Haida will be obtained by a comparison with genetically related stocks. A perspective even wider than this will be obtained by following out the suggestions given by the semantics of stocks whose genetic relation with Athapascan, Tlingit, and Haida can never perhaps be proved. For instance, the Algonkin stock, and again the Yuman stock, have bundles of vocables including the meanings to be white and to dawn. In Athapascan there occurs a verb to be white represented in very original form by Wai. -kai, to be white, and a verb to be daylight, to dawn, appearing for instance as Chil. *khaih*, *khai*, to be daylight, to dawn. Unconnectable, we say at present, yet surely connected.

#### INTERLINKING TRADITIONS

Hardest to get of all, and at the same time most satisfactory, were actually remembered traditions corroborating the linguistic evidence, which, although in part shading off into the mythical, are clearly indicative that there has been a southern spread of language-bearing ancestors, accomplished in war, opportunism, and peace, resulting in linguistic supplanting in large just-inland and coastal regions, and that the spread has been piecemeal, consisting of the throwing off of more southerly linguistic neighbors by more northerly adjacent ones. These tying traditions are 10 in number.

(1) Although in the Nicola Valley I obtained volunteered information that the Stuwix-mux language is Chilcotin, a more detailed account of this, presenting information transmitted to Dawson by MacKay, formerly Indian agent at Kamloops, British Columbia, is to be found in Dawson, "Notes on the Shuswap People of British Columbia" (Proc. and Trans. Roy. Soc.

Canada 9 (sect. 2): 3-44. 1892). The first paragraph quoted presents information obtained by Dawson from MacKay, the second tells of Dawson's visit to an Indian in the Nicola Valley:

A long time before the white man first came to the country, a company of warriors accompanied by their women from the neighborhood of the Chilcotin River made their appearance in the Bonaparte valley. . . . This happened during the salmon fishing season. . . . At that time it was customary for the Shuswaps who lived on the banks of the Thompson between Kamloops and the mouth of the Bonaparte valley to take their winter stock of salmon from the Fraser River at the western base of Pavilion Mountain. . . . The strangers from Chilcotin . . . continued their advance southward down the Bonaparte and Thompson valleys till they reached a position opposite the mouth of the Nicola River. At this place they were discovered by some scouts. . . . The intruders . . . took advantage of the night to cross the Thompson and proceeded to ascend the Nicola valley. . . . The strangers were driven into the Similkameen valley, where they took a firm stand. . . .

An Indian named Joyaska, who lives in the Nicola valley, below the lake, and who is probably sixty years old, informed me [Dawson] . . . that he, with seven other men and some women and children belonging to them, were now the only remaining true natives of the Nicola region. . . . I asked him if the old language was like that of the Tsilkotin . . . to the north, and he said it was the same.

One may discredit this story, which is given even in more detail that I have quoted above, but I got enough information in the field to convince me that it has some basis of fact in the remote past.

(2) The Kwalhioqua tradition that they spoke the language of the land-otter and migrated far from the east, apparently contains dim handed-down memory blended with a standardized linguistic metaphor. I have recorded elsewhere Indian language metaphors that a foreign people talks the language of ducks, or again of blackbirds.

(3) The Kwalhioquas also have a tradition concerning the Tlatskanai. They tell that the Tlatskanai are an offshoot of their own people. Some Kwalhioqua youths, borrowing and misuing a fire-drill, started a great forest fire and, when this subsided, followed the tracks of an elk easily discernible in the ashes south through alien terri-

tory to the nearby Columbia River. On crossing this river they found good elk hunting in the region of the Claskanie River on the south side and sent a messenger back with a lot of dried elk meat. The messenger succeeded in persuading many of the Kwalhioqua to migrate to the Claskanie Valley, which they did, thus initiating the Tlatskanai tribe.

(4) A third Kwalhioqua tradition is that the Umpquas are, like the Tlatskanais, a body of Kwalhioqua who migrated south. This tradition is of the utmost importance since the Umpquas belong to the southernmost group of Chilcotins.

(5) The Tututunne, whose great village was on the north bank of lowest Rogue River at what was later called Bagnell's Ferry, have a tradition that they migrated to that site.

(6) The Mikonotunne, whose village was on the north bank of Rogue River about seven miles above that of the Tututunne, have a tradition that they migrated upriver.

(7) There was a place somewhere up the Rogue River above Shastacosta village called Maanesta. At Shastacosta village two chiefs quarreled. One of these chiefs wandered upriver and established Maanesta in a narrow place of the river full of hazelbrush. People climbing the mountain sides at Maanesta would see the smoke of Shastacosta village far downriver toward the coast and would say to their accompanying youngsters, "Those are our people, we came from there."

(8) There is a tradition among the Smith River Indians telling that the Hupas are Smith Rivers in origin, though the Hupas are now separated from the latter by the alien-speaking tribe of the lower Klamath River, and the differences between Smith

River and Hupa must have required long separation to attain. It is said that ten boys and ten girls left Burnt Ranch village on Smith River, that the trail magically opened up before them so that they walked without crossing water to Hoopa Valley and became the Hupa Indians. The Hupa Indians in their language today sometimes refer to the Smith River Indians as little Hupas, which implies recognition of relationship.

(9) A somewhat similar Smith River Indian tradition states that the Whilkuts of Blue Lake, speaking a language closely related to Hupa, originally lived at South Bend on the Smith River, and that ages ago they migrated south, fighting off enemies as they went, until they finally reached Blue Lake.

(10) The Hupas have the tradition that the Saya, also called Nongatl (saya in the Chinook jargon means far off), who used to adjoin the Whilkut in the hills east of Humboldt Bay, are Hupas who moved south long ago. As proof of this, the information was volunteered that a Hupa can understand the Saya language after hearing it for a while.

#### CONVERSION OF LINGUISTIC CHANGE INTO CHRONOLOGY

One may ask, after all the above, the practical question: How long have the Chilcotin languages been developing asunder? To this question no answer can probably ever be given. Linguistic change has had for various features various and varying rates, and no amount of study will convert as a whole the duration of the linguistic change sundering these languages to time reckoning, even to the extent of a good guess.

ENTOMOLOGY.—*New species of flies of the genera Baccha and Rhinoprosopa* (Syrphidae).<sup>1</sup> F. M. HULL, University of Mississippi. (Communicated by ALAN STONE.)

In recent studies of syrphid flies, some new species of *Baccha* and *Rhinoprosopa* from the neotropical regions were discovered and are described in this paper. The types, except where designated, are in the collection of Dr. C. L. Fluke, of the University of Wisconsin, whom I wish to thank for the loan of this material. Paratypes, where available, are in the author's collection.

***Baccha minima*, n. sp.**

Abdomen with a pair of widely separated yellow rectangles in the basal corners of the fourth segment. Third segment with a pair of basal vittae on each side. Related to *sativa* Curran.

*Male*.—Length 8 mm. Head: face and front yellow, the latter with a black dot on lunula. Pile sparse, black. Antennae orange, third joint missing. Thorax: mesonotum brassy black with a pair of wide, yellowish-gray vittae running nearly to the scutellum. Humeri and lateral margins widely yellow; a medial spot adjacent to the humeri, yellow. Pleura yellow, brownish on the metapleura and hypopleura. Scutellum yellow with a few black hairs and one or two black fringe hairs. Abdomen: slender, shining black; the sides of first segment are yellow, the remainder brown. Third segment with a pair of narrowly separated yellow vittae in the middle of each side. Fourth segment with a large, rectangular yellow spot on the lateral margins and base of the segment, the two spots not widely separated. Fifth segment shining black. Legs: yellow, the hind femora with a brown subapical annulus, their tibiae with the middle yellow and proximal to it a dark brown annulus and the distal third brown. Hind basitarsi yellowish brown, the apical joints dark brown. Wings: pale brown, the stigmal cell quite dark; costal cell clear; alulae absent.

*Holotype*, male, Nova Teutonia, Brazil, Fritz Plaumann. (Fluke collection.)

***Baccha delicatissima*, n. sp.**

Characterized by the dark aeneous-brown

mesonotum and scutellum. Hind femora and tibiae brown, yellow centrally. Related to *macer* Curran.

*Male*.—Length 7.5 mm. Head: face and front yellow, the former with a black spot on lunula and black pile, facial pile yellow. Antennae orange, blackish above. Thorax: mesonotum brassy brown, the margins obscurely yellow without apparent vittae. Scutellum concolorous with four or five long black hairs, no fringe or collar. Halteres black, squamae pale. Pleura wholly yellowish. Abdomen slender, brownish black; second segment light brown on the basal corners, with small, oblique, widely separated, light-brown spots just past the middle. Third segment with a similar oblique middle spot on each side. Fourth segment with a wide, separated vittate spot beginning some distance from base and near the middle of the segment proceeding diagonally to the margin. Fifth segment with a pair of oval vittate spots. Legs: yellowish, the middle femora except at base, all of hind femora and tibiae pale brown. Femora with subapical bands and tibiae dark brown basally and apically. Wings: pale brown; stigmal cell dark, costa lighter; alulae absent.

*Female*.—Similar to the male, front with a slender brown stripe; spots of fourth segment form well-marked, short, inverted V's.

*Holotype* male and *allotype* female, Nova Teutonia, Brazil, Fritz Plaumann. (Fluke collection.)

***Baccha zilla*, n. sp.**

Related to *virgilio* Hull. The front is wholly pale, the third and fourth segments of the abdomen with two vittae on each side, each pair basally confluent. Scutellum and pleura, except the metapleura, pale yellow.

*Female*.—Length 8 mm. Head: face and front pale yellow, the latter with sparse black hairs, the vertex as far as the first ocellus blackish; lunula with a black dot, antennae orange, the third joint missing. Thorax: greenish shining black, with a pair of pale gray-brown, anteriorly wide vittae reaching over the anterior half. Pleura except the metapleura, the humeri, the wide lateral margins and scutellum, all pale yellow. The scutellum has five or six pale hairs

<sup>1</sup> Received March 13, 1943.

on the ventral fringe and a very few hairs on disc. Abdomen: elongate; slender; about the same length as wings; the first segment is yellow on the sides, with yellow pile; second segment with a long, narrow, medial black vitta, the apical fifth black, the sides yellowish; third segment with a long, slender pair of yellow vittae reaching to the base and basally fused on each side of the segment. They cover nearly three-fourths the length of the segment. Fourth segment similar, the vittate spots shorter. Fifth segment with a pair of short, reddish vittae. Legs: yellow, the hind femora brownish subapically, their tibiae pale brown, yellow in the middle, their tarsi dark brown. Wings: pale brown; stigma dark; alulae absent.

*Holotype*.—Female, Nova Teutonia, Brazil, Fritz Plaumann, and a *paratype* from Nova Teutonia and one also Puyo, Ecuador, December 1938, F. M. and H. H. Brown. (Fluke collection.)

***Baccha nerissa*, n. sp.**

Related to *columbiana* Curran. The pleura are steel-blue. Hind femora and tibiae black. Third to fifth abdominal segments trivittate.

*Female*.—Length 11 mm. Head: face yellow laterally, its middle and the cheeks blue-black and white-pollinose; the front is black, black-pilose, narrowly yellow on the sides and linearly white-pubescent. Antennae dark brown, the third joint orange below, blackish brown above, and rather elongate. Thorax: mesonotum dull black, with a faint bronze cast and a pair of wide, narrow, gray vittae reaching almost to scutellum. Pleura steel-blackish; scutellum dark brown, with sparse black pile and long, mixed, ventral fringe. Abdomen: petiolate, the first segment metallic black and extending onto base of second. Second segment orange laterally and brown apically with opaque central triangles; third and fourth segments reddish brown, with a medial black vitta and a lateral black triangle, all apically confluent, the postmargins brown. Fifth segment trivittate; sixth trapezoidal, basally flattened and black, laterally compressed apically. Legs: first four brown, dark at base of femora, pale yellow at base of tibiae; hind femora and tibiae black, tibial base narrowly yellow. Hind basi tarsi basally black; remainder of tarsi pale. Wings: pale brown, dark brown on anterior border, almost as far as end of stigmal cell. Alulae wide.

*Holotype* female, Pinas, Ecuador, 1,200 meters, July 21, 1941, D. B. Laddey. (Fluke collection.)

***Baccha nigrocilia*, n. sp.**

All the legs jet black, with similar pile, longer on the hind pair, the hind tarsi in part yellow. Wings brown on basal half, anterior tarsi dilated. Related to *hirta* Shannon.

*Female*.—Length 9 mm. Head: face and front steel-blue, the former narrow yellow on the sides, the latter protuberant anteriorly, widely shining black in the middle, with black pile; lunula and antennae black. Thorax: mesonotum and scutellum shining black, with black pile and ventral fringe, the notapleura bluish, the humeri sepia, the pleura steel-blue with vertical silver pubescence and silver pile and black-pilose on posterior half. Squamae and fringe black. Abdomen: strongly petiolate; first segment shining black and steel-blue posteriorly; second segment steel-blue on the basal third and side margins, with in the middle a pair of oblique black spots meeting above. Third segment reddish in the anterior corners, with large, central, opaque black triangle, which is postmedially indented; the posterior and anterior margins are shining. Fourth segment steel-blue, with, on each side, a large, opaque triangle posteromedially connected to a median black vitta that does not reach the base. Fifth segment with three black vittae on steel-blue ground. Sixth segment flattened, trapezoidal. Legs: jet black and pilose, the pile quite long on the hind pair; apex of hind basi tarsi and next two segments whitish. Anterior tarsi dilated, wings brown on basal half. Alulae very large, stigmal cell pale.

*Holotype* female, São Paulo, Brazil, February 18–26, 1940, Ilha Seca; one *paratype* female. (Fluke collection.)

***Baccha nigrocilia inclusa*, n. var.**

In this variety, from Colombia, the vittae are slender and isolated and contained within the triangles of opaque black upon the abdominal segments.

***Baccha nigrocilia hirtipes*, n. var.**

In this variety, from Colombia, there are large yellow-brown triangles in the lateral corners of the second to fifth segments; the vittate spots are also yellow.

*Rhinoprosopa lucifer*, n. sp.

Related to *aenea* Hull but the pleura are chiefly black, the facial stripe is wider. Hind tibiae black.

*Male*.—Length 11 mm. Head: the cheeks and sides of face are widely pale yellow; middle of face widely jet black. The sides of the front are orange, broadly opaque black down the middle, expanding to reach the sides of the shining black lunula. Face produced considerably beyond the antennal apex, with a low tubercle below the antennae. Antennae reddish brown, the third joint blackish except at the ventral base; arista black. Pile of front black and long and confined to the top and sides. Vertex black with black pile. Thorax: mesonotum brassy brownish or black, the anterior half brownish-gray pollinose, without definite vittae and with long yellow pile. Humeri, the whole of notopleura, postcalli, and a sharp wide basal margin on the scutellum yellow. Remainder of scutellum dark brown, lighter on the margin, its pile long, sparse, and black, with longer marginal bristles and

no fringe. Only the posterior half of the mesopleura is yellow. Abdomen rather slender, especially at the end of second segment, black with yellow markings as follows: all but the posterior margin of the second segment in the middle yellow. Second segment with a pair of long, oblique, anteriorly approximated, bright, central, yellow stripes upon the sides of the segment, each stripe margined anteriorly with opaque black and posteriorly with an opaque triangle. Third segment with similar pattern, the stripes almost confluent anteriorly. Fourth segment with larger, similar stripes which are fused throughout most of their length in the middle. Fifth segment with oblique, transverse, short fascia fused medially. Legs: yellow, the hind femora dark brown on more than the apical half, their tibiae and tarsi very dark brown. Wings: wholly deep brown with slender alulae, equally developed throughout.

*Hobotype* male, Pinas Ecuador, 1,600 meters, July 25, 1941, D. B. Laddey. Two *paratype* males, same data. (Fluke collection.)

ZOOLOGY.—*A folliculinid associated with a hermit crab*.<sup>1</sup> E. A. ANDREWS, Johns Hopkins University, and E. G. REINHARD, Catholic University of America.

The folliculinids are a small group of ciliated Protozoa living in colored, chitinoid tests, scarcely visible to the naked eye and firmly attached to various objects in all the oceans of the world. When the animals leave these tests to make others, the old ones persist and are recognizable as representing species and genera.

Hermit crabs drag about deserted snail shells, within which their soft spirally grown hind bodies are protected. That certain folliculinids live attached to the soft bodies of hermit crabs, within the shells of snails, was observed in 1888 by Giard, in France. He saw them as little black spots on the hind body, near the limbs or near the end of the hermit crab *Pagurus bernhardus*, then called *Eupagurus bernhardus*. These specks proved to be groups of folliculinids, which he thought to be well placed to receive currents of water along the hind body. The

shape of each test was so peculiar, being pinched in with an upper and lower part, something like a double gourd or gourd-shaped piece of pottery, that he made them representatives of a new genus, *Pebrilla*.

No other mention of this association was made for nearly 50 years, and then, in 1936, Fauré-Fremiet on the coast of France found these same folliculinids associated with the same hermit crab, but also with another, *Clibanarius misanthropus*. He found them standing solitary or in groups of four to seven on the hind body of the crab only, and never upon the inside surface of the snail shell.

Though the pinched-in shape of *Pebrilla* suggests some outside force, Fremiet observed the animal secreting its test in two efforts, first the posterior part and then, with change of shape and of secretion zone, the anterior part, entirely from within and with no external compulsion. This folliculinid, *Pebrilla paguri* Giard, is known only as

<sup>1</sup> Received March 26, 1943.

occurring upon the above two sorts of hermit crabs and as observed by the above two naturalists.

In studying the hermit crab *Pagurus pubescens* Kröyer, living in the shells of the snails *Littorina litorea*, *Thais lapillus*, *Buccinum undatum*, and some others and collected from shallow water in Frenchman's Bay, coast of Maine, between Mount Desert Island and the mainland, one of the authors in 1939, 1940, and 1941 observed blackish spots, which proved to be tests of some folliculinid, scattered over the hind bodies of these crabs. After preliminary study of these objects, involving the preparation of whole mounts and some serial sections of crab abdomens, he turned over this material together with preserved crabs fixed in Gilson's fluid to the senior author for detailed investigation.

This association of folliculinid and hermit crab proves not to be the same as observed in France. The folliculinid is a different species and genus, and the hermit is also a different species from either of those mentioned in France. There are no records of folliculinids on other sorts of hermit crabs, but on one out of a dozen specimens of *Pagurus longicarpus* from Woods Hole, Mass., three or four tests of a folliculinid were found near together on the right side of the antepenultimate segment. These seemed to be *Lagotia viridis*, which is one of several folliculinids that occur in that region. It is common on algae and hydroids, and the few found on the hermit crab may have been stray experimenters.

Examination of a dozen *Pagurus pollicaris*, also from Woods Hole, failed to reveal any folliculinids, and *P. acadianus* from Maine seems likewise free of these Protozoa. However, on five out of six *Pagurus hemphilli* received for examination from the U. S. National Museum and dredged in Cuylers Harbor, San Miguel Island, Calif., in July 1939, there were folliculinids much resembling those on *Pagurus pubescens* from Maine, both in general appearance and in distribution on the abdomen, but they prove to be *Lagotia simplex* Dons as understood by Fauré-Fremiet in 1936. It is not every specimen of *Pagurus pubescens* from

Maine that bears folliculinids. Fifty-five adult females, not hosts of *Peltoaster*, showed folliculinids on 39 and none on the rest. Some of the latter were no doubt recently molted crabs and accordingly could not be expected to have attached commensals. The little tests (Fig. 1) stand fixed only to the dorsum and the sides of the hind body and are strikingly more numerous toward the posterior end.

Thus, dividing the abdomen into swollen anterior segments and the terminal part (the latter consisting of the last segment with uropods and telson), we found that in the above 39 there were 89 folliculinids on the swollen region and 237 on the terminal region.

This crowding toward the hind end, which lies far within the spiral of the snail shell, is just the reverse of the distribution of the little bivalves, juvenile *Mytilus edulis*, that were found abundantly attached by byssus threads to the rough anterior free parts of the crab, but very seldom on the hind body.

Why the folliculinids find the terminal region of the crab's body more suitable for attachment than any other arouses speculation. The answer, we believe, may be found in the fact that the apices of the shells inhabited by hermit crabs are generally choked with organic refuse, including fecal material, which must be a rich culture medium for various microorganisms. Since this is pocketed in a relatively stagnant environment, the folliculinids on the terminal portion of the crab's abdomen seem particularly well located to have an abundance of food always at hand.

These folliculinid tests are scattered here and there, often as solitary and quite often as grouped individuals (Fig. 1). The groups are made up of 2, 3, and up to 17 individuals (Fig. 2) and suggest that the swimmers that settle and build have some methods of reaction to one another and are to some extent social. Like many species of folliculinids, these may group themselves in depressed areas of the surface, and often we find them in aggregates along the grooves bounding the last segment, where the largest groups were seen (Fig. 2). Here the swimmers must have settled about the same

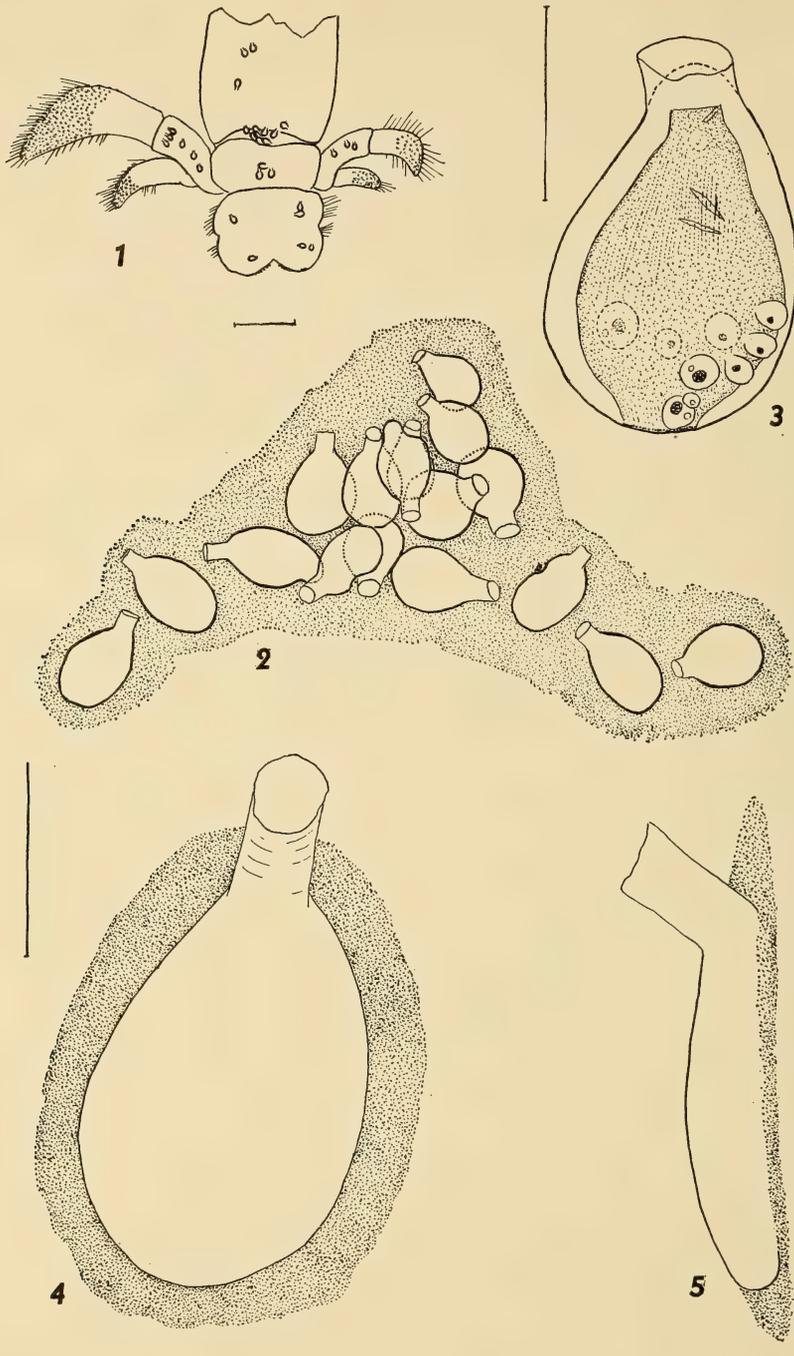


Fig. 1.—Dorsal view of end of abdomen of *Pagurus pubescens* showing distribution of about 30 folliculinid tests. Fig. 2.—Largest group of 17 folliculinids extending in groove outlining telson, all tests connected by basal colletoderm, some built on top of others with outlines distorted from crowding. Fig. 3.—Folliculinid with nine *Pottsia infusorium* parasites projecting from rear portion, and few diatoms in front part. Fig. 4.—Top view of folliculinid test surrounded with halo of cement. Fig. 5.—Profile view of same specimen as Fig. 4.

Each side line represents 100 $\mu$  except in Fig. 1, where it represents 1 mm.

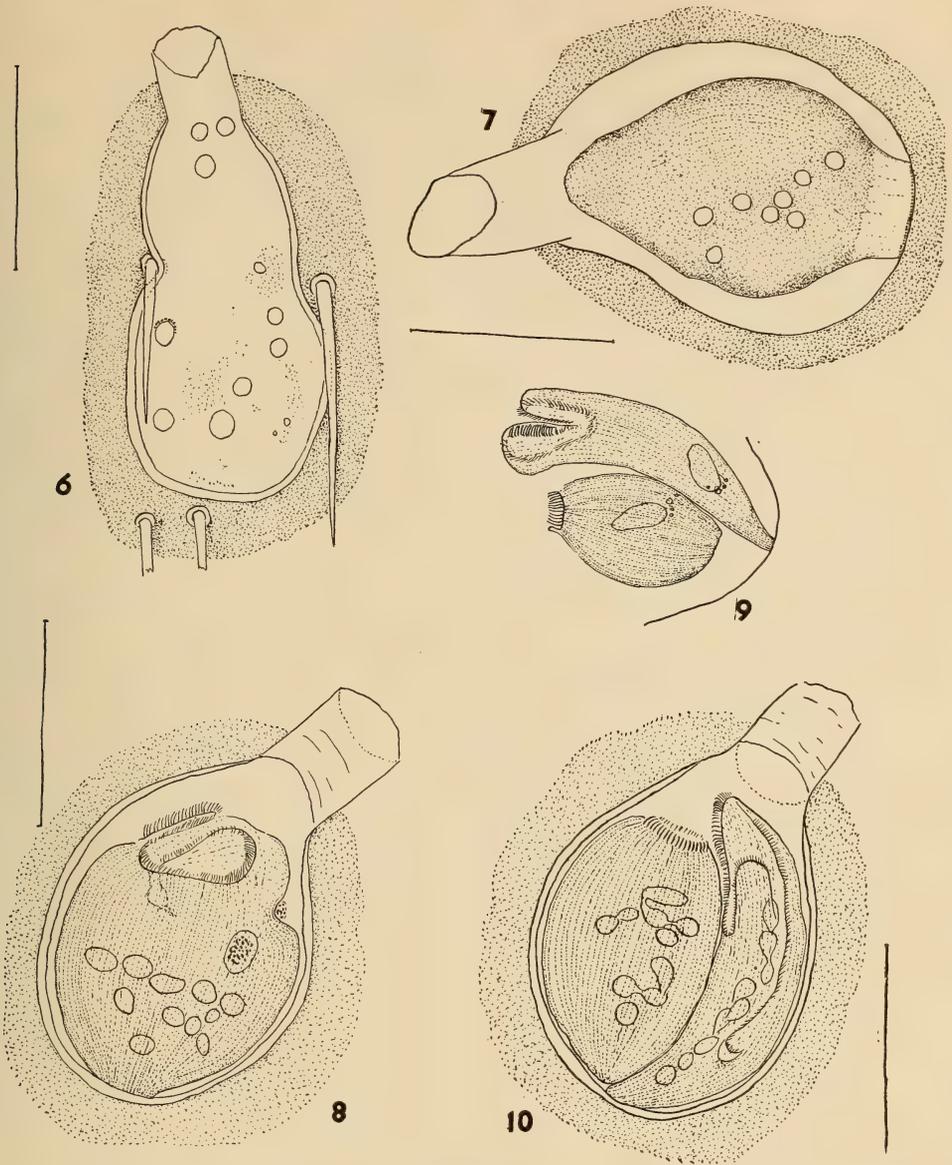


Fig. 6.—Dorsal view of folliculinid test distorted by pressure against setae of surface of last pleopod of *Pagurus pubescens*. Contents of test reduced to scattered nuclei, chiefly. Outline suggests that of *Lagotia*. Fig. 7.—Partly preserved folliculinid with wide base of attachment to test. The wide stalk abnormally cleared of granules except at the attaching surface. Eight nuclei in view. Fig. 8.—Ventral view of folliculinid fixed in Gilson's liquid, showing unequal peristomial lobes, pharynx, and part of gullet; with 11 unequal nuclear lobes and large fecal vacuole approaching small remnant already discharged. Fig. 9.—Two folliculinids fixed in Gilson's liquid in partly destroyed test, each with one macronucleus and several micronuclei. They are the separated anterior and posterior halves of one that divided crosswise; the one on the right retains its contact with the test and is developing unequal lobes; the one on the left was the anterior half and is free from the test; its terminal membranella crown is that of a free-swimmer, but there is a small protoplasmic protrusion near it. Fig. 10.—Ventral view of folliculinid test containing two results of recent fission; the anterior part to the left has terminal crown of a swimmer and 10-lobed nucleus; the posterior part, to the right, retains basal attachment, has a 9-lobed nucleus and two unequal peristomial lobes, with the nascent pharynx still at the posterior third of the body.

Each side line represents 100 $\mu$ . All figures (1-10) are of *Platyfolliculina paguri*, n. sp.

time and crowded as close as possible to others, and some even settled on top of those already in place. Such overlying individuals show irregular outlines, since the sides of their tests were hampered by contact with the necks of the tests they sat upon. It will be noted that the colony has a dense center where they parked so closely as to leave no vacant spaces, just as is the habit of *Metafolliculina andrewsi*.

These tests show no common orientation; even in closely crowded groups the members that stand side by side have axes in various directions. Each test is a very flat simple flask with short neck, and it is surrounded by a halo of cement that fastens it to the surface of the crab (Figs. 4, 5). When two or more settle near together the cement of all binds them together by a flat membrane called colletoderm by Wright in 1859. Peeling this from the crab removes a group as one mass.

It is notable that many of these tests are empty, so that good specimens of the animal are not readily found. One group of ten had eight empty. To be sure, it is known that folliculinids may swim away and leave empty tests, but here we find evidences of death of the animal, such as remnants of protoplasm with groups of nuclei (Fig. 6). That some of the many empty tests may be the results of attacks by parasites is suggested by facts to be presented later on in this paper.

Proceeding now to a detailed description of these folliculinids associated with *Pagurus pubescens*, we consider first the test and then the animal, not observed in life.

By reflected light the tests are soot-black, but by transmitted light pale green. Each is a flat, wide sac with insignificant neck that lacks a special collar at its mouth. The floor of the sac is quite flat and the roof but slightly arched. The sac adheres by a thin layer of cement under its floor and extending 20–50 $\mu$  as a halo around the floor of the sac. The underlying cement may rise up posteriorly to the top of the sac roof. The short simple neck has a thin wall, while the sac seems to have a thick wall, but this is the optical effect of the curvature of the sides, which in a horizontal distance of 5–6 $\mu$

descend 25–30 $\mu$ , the top and bottom views suggesting outer and inner boundaries of the wall. That is, where the greatest diameter of the sac is 125 $\mu$  the diameter of the floor is 115 $\mu$ —the overhanging sides simulating a thick wall.

As the sac is so flat, top and bottom views are readily seen but profiles scarcely ever. In bottom views the sharp line of junction of side and floor is striking. Actual longitudinal sections of the test give the appearance of a test tube with blunt bottom and upturned mouth end. The material of the test looks homogeneous except that in the cement and sometimes in the walls of the neck there are minute particles, some of which are the original subpellicular granules (protrichocysts of Klein) discharged and more or less swollen and fused to make all the test and cement.

The flimsy necks show various lengths and angles of rise from the floor of the sac, but as side views are rarely seen the measurements of neck length are not exact. Views down the neck sometimes suggest valves, but none was demonstrated. Rarely is the thin mouth edge thickened slightly as a 5 $\mu$  rim.

The range in size in 25 measured tests is as follows:

Total length.....	188–238 $\mu$
Sac length.....	138–188
Neck length.....	35–75
Sac width.....	90–150
Neck width.....	38–60
Mouth width.....	30–63

As estimated by focusing, the depth of the sac is often but 25 $\mu$  and rarely 50 $\mu$ , while in paraffin sections it was measured as 25, 28, 35, and 38 $\mu$ .

The tests are not so strictly symmetrical as in many other folliculinids, and there are some monstrosities. One had a neck from a sac of 125 $\mu$  length extended to a total length of 113 $\mu$ . This resulted from the fact that its first portion of 50 $\mu$  length was followed by a secondary extension of 63 $\mu$  off at a large angle.

Straight extensions of necks are common in some folliculinids. The sides of the sac are not infrequently indented, and usually this has arisen from resistance of setae on the

shell of the hermit crab, or from necks of other tests, as in Fig. 2. When, as in Fig. 6, the swimmer settled between setae too near together its test was distorted on opposite sides so as to somewhat suggest the pinched-in form of *Pebrilla paguri* found on hermit crabs in France.

Knowledge of the animal within the test is hampered by effects of parasitism and methods of fixation of the crabs. Though one remnant had a length of 250 $\mu$ , most were strongly contracted down into the sac with the peristomial lobes but poorly preserved. The left lobe was considerably bulkier than the right. What was seen of the pharynx was not deep and possessed few spirals.

Nuclei appear clear in dead remnants and as dark-stained spherules after borax-carmin or haematoxylin. Generally 9, but up to 13 in number, are present. Rarely seen connected, they are of unequal mass, 5-15 $\mu$  in diameter. Each nuclear lobe is closely surrounded by a layer of granules. Accompanying these macronuclei were sometimes darkly staining unequal spherules about 1-2 $\mu$  in diameter and deemed to be micronuclei. Longitudinal pigment bands were counted as 30-35 in dorsal view. Food vacuoles were seen and some diatoms within the protoplasm, anteriorly; also fecal vacuoles. What is of import is that where the animal had not been separated from the sac it was attached posteriorly by a broad base, 25-45 $\mu$  wide (Fig. 7).

Seeking a name for this folliculinid associating with *Pagurus pubescens*, we find that its multiple nucleus places it in the Eufolliculininae where its wide flat sac, short neck, and broad base of attachment of the animal bring it near to what Hadzi, in 1938, called *Platyfolliculina sahrhageana*. Hadzi found in the Adriatic two undescribed forms in the subfamily Semifolliculininae with broad bases of attachment; thinking this important he worked over the illustrations given in 1917 by Sahrhage when describing division in what he thought *Folliculina ampulla* (a name applied to many different species). Hadzi concluded that Sahrhage's illustrations should be taken as representative of a new genus,

*Platyfolliculina*, to be called *P. sahrhageana*. He estimates the dimensions to be:

Total length of test.....	137-237 $\mu$
Breadth of sac.....	91-109
Breadth of neck.....	34-50
Width of mouth about.....	43

The extended animal was 243-250 by about 30 but when retracted 85-132 by 59-33 $\mu$ . The macronuclei were generally six in number and up to 17 $\mu$  in diameter; and the micronuclei up to five in number.

Sahrhage's species came from algae and piles in Kiel Harbor, but ours on *Pagurus pubescens* has much resemblance to it. Moreover, in one of these crabs fixed in Gilson's liquid, two tests were found containing stages soon after division, as described by Sahrhage.

In the first (Fig. 9) two animals occur side by side, each with one macro- and several micronuclei. This is evidently a stage immediately after the moniliform nucleus condensed into a rod that divided into anterior and posterior halves, as the protoplasm pinched in ventrally to separate an anterior from a posterior half. Of these the posterior stands attached, while the anterior has slipped down along the side of the posterior half and stands beside it and free.

In the later stage (Fig. 10) the macronuclei have increased to the normal number while the original anterior half still remains alongside the posterior half preparatory to swimming free; the posterior half, on the right of the illustration, is perfecting its unequal membranella-bearing lobes, though as yet the opening of the infundibulum is far back in the posterior third of the animal and will need to be brought forward to function. In general, as here, the ontogeny of any folliculinid starts as a rodlike form, *I*, then this splits deep to form almost a *V*, and later elongates the stalk to fashion a *Y*-form the arms of which are of different lengths in different species and in different phases.

Provisionally, we assign this folliculinid on *Pagurus pubescens* to the genus *Platyfolliculina*, but as the nuclei are more numerous, the necks longer, and the sacs wider than in *P. sahrhageana* it seems to belong

to a new species here named *Platyfolliculina paguri*.

These platyfolliculinids associated with *Pagurus pubescens* live well protected in the restricted, dark spaces of the snail shell, yet as they multiply there it is evident that adequate food is present for them and for other ciliates also residing there, such as the large branched colonies of vorticellids and up-standing tube dwellers seen in 7 $\mu$  sections as 45 $\mu$  long *Cothurnia*.

When the animals are present in their tests they frequently bear at the posterior part (Fig. 3) several spheroidal protrusions, 4–30 $\mu$  in diameter, each with a large nucleus 4–10 $\mu$  wide and often also with a smaller embryo cavity 2–5 $\mu$  wide, external to the nucleus.

That these projecting cells are actually parasites fastened to the folliculinid is certain when they are compared with the results of Chatton and Lwoff, who in 1927 described a new and remarkable suctorian that lives as parasite upon two species of folliculinids and two species of vorticellids. When mature these parasites project just as in the folliculinids we find upon *Pagurus pubescens*.

These authors, in 1924, found that *Folliculina ampulla* was badly infested with these parasites in the aquaria at Monaco, while the rare *F. elegans* had none. Also *Folliculina ampulla* brought from Samoa and from Woods Hole, Mass., by F. A. Potts, lecturer at Cambridge, showed these parasites. These suctoria, named *Pottisia infusorium*, are peculiar in the group of acinetans in that the embryo released from the cavity of the adult in which it was formed by budding has three bands of locomotor cilia as well as terminal sucking tubes by which it anchors itself to the body of the folliculinid and grows to maximum size by drawing out liquid from the host. As many as 22 were seen on one folliculinid, and these authors think that greater numbers kill the host folliculinid, after which they gradually perish within the host's test. This may account for the many emptied tests seen on *Pagurus pubescens*.

Finding *Pottisia infusorium* as parasite on these folliculinid associates of the hermit, *Pagurus pubescens*, thus adds Maine to

their previously recorded geographical distribution, Samoa, Monaco, and Woods Hole, and also adds to the previously recorded hosts they attack, i.e., *Folliculina ampulla*, *F. elegans*, *Cothurnia ingenita*, and *C. socialis*, this folliculinid on *Pagurus pubescens*. Moreover, this same parasite was seen on a few *Parafolliculina amphora* and *Metafolliculina andrewsi* in September, 1941; on the west shore of the Chesapeake Bay, north of Baltimore.

In passing, we note that Chatton and Lwoff previously discovered a flagellated organism, *Sporomonas infusorium*, living as a parasite in *Folliculina elegans*, as well as in *Vorticella*, in the aquaria at Banyuls and in *F. ampulla* from Woods Hole. In the folliculinid this *Sporomonas infusorium* grows to be a mass of 70 $\mu$  diameter before it escapes from the folliculinid to sporulate inside the test.

The folliculinid these authors call *F. ampulla* is a multinucleate form with long spirally reinforced neck and may well be what Hadzi later called *Metafolliculina andrewsi*.

Whether *Platyfolliculina paguri* occurs also in other habitats remains to be found out. It is not the only folliculinid in this habitat, for on one specimen of *Pagurus pubescens* there were found two long, slender folliculinids of some other kind. One was fast to the right side of the fourth segment of the hind body, pointing downward, and the other was well protected on the chela closely surrounded by heavy conical spines. These two seem to represent some undescribed form.

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ZOOLOGY.—*On a species of pycnogonid from the North Pacific*.<sup>1</sup> JOEL W. HEDGPETH. (Communicated by CLARENCE R. SHOEMAKER.)

The species of pycnogonid here described is based on specimens named and designated as types by the late Dr. Louis Giltay, and deposited as such in the United States National Museum. After this paper was submitted for printing, Dr. William A. Hilton published preliminary diagnoses of some new species in *Colossendeis*, the genus concerned, including one under the same name.<sup>2</sup> Although the diagnosis is vague, and incorrect in one detail ("ocular tubercle . . . not pointed," p. 3), the specimens consulted undoubtedly are the same species and were evidently labeled by Dr. Giltay. As it may be many years before descriptions and figures of these numerous preliminary species are published, I have deemed it wise to proceed with this paper in order to clarify the status of at least one of these species. Inasmuch as all the material examined appears to have been labeled by Dr. Giltay, his type designation, supported by the description and figure herein, should not be abandoned in favor of that in a brief diagnosis. Although it is impossible, of course, to credit Dr. Giltay with the authorship of this species, it is unfortunate that his label name was not acknowledged in the preliminary diagnosis. The type specimens were taken by the U. S. Bureau of Fisheries steamer *Albatross*.

Genus *Colossendeis* Jarschinsky  
*Colossendeis tenera* Hilton<sup>2</sup>

*Holotype*.—Male; *Albatross* station 3346, 44°31' N., 124°52' W., 786 fathoms, September 22, 1890.

<sup>1</sup> Received March 30, 1943.

<sup>2</sup> HILTON, W. A. *Pycnogonids from the Pacific*. Pomona Journ. Ent. and Zool. 35 (1): 2–4. 1943.

*Paratypes*.—Male; *Albatross* station 3074, 47°22'00" N., 125°48'30" W., 877 fathoms, June 29, 1889. Three females; *Albatross* station 2859, 55°20' N., 136°20' W., 1,569 fathoms, August 29, 1888.

*Description*.—Trunk slender, unsegmented, lateral processes separated by spaces somewhat narrower than their own diameter, except the posterior pair, which appears to be more widely separated than the preceding pairs. The eye tubercle is very high, narrowly conical, and tapers to a small blunt point. The eyes are basal, large, but indistinctly pigmented. The anterior pair is larger than the posterior.

Proboscis slender, straight, slightly dilated near the distal third and slightly expanded at the tip. It is markedly longer than the trunk.

Palpus covered with minute setae, especially the distal joints. Basal joint much broader than long; second joint straight, sticklike; third joint not much longer than wide, slightly curved; fourth joint little more than half as long as second; fifth joint shorter than sixth; seventh shorter than wide; eighth about three times as long as seventh; ninth joint slightly longer than eighth.

Abdomen papilliform, directed upward at an angle and longer than the last lateral processes.

Oviger: First and second joints subequal; third joint about half again as long as first; fourth and sixth long, nearly straight, subequal, or sixth slightly longer than fourth in the male; fifth joint about half as long as fourth. Terminal segments diminishing in length distally, with 7 to 10 flat, finely denticulated spines in the largest rows. Terminal claw heavy, curved, about four times as long as basal width.

Third leg: Coxae subequal. Femur slightly

longer than first tibia, which is slightly longer than the second tibia. Tarsus longer than propodus, terminal claw longer than propodus but not as long as tarsus. The legs are straight, slender, and without marked swellings or protuberances.

*Remarks.*—This species resembles *Colossendeis angusta* in size and general appearance, but it can readily be separated from that species by its much longer proboscis. The eye tubercle is much higher (although in most specimens this is the first part to be damaged) and eyes are present. It is also similar to *Colossendeis megalonyx* but differs from both *C. megalonyx* and *C. angusta* in the character of the denticulate spines on the oviger. *Colossendeis tenera* appears to be a North Pacific basin species; all known localities are off the northwestern United States.

MEASUREMENTS		
	Paratype, ♂	Paratype, ♀
Proboscis.....	8.5 mm	9.75 mm
Trunk.....	6.5	7.0
Cephalic segment.....	1.8	1.9
Width, second lateral process	3.0	3.0
Abdomen.....	0.8	1.0
Eye tubercle.....	x (tip broken)	2.0
Third leg:		
First coxa.....	1.0	1.0
Second coxa.....	1.5	1.25
Third coxa.....	1.5	1.5
Femur.....	18.0	20.0
First tibia.....	15.0	17.0
Second tibia.....	11.0	11.5
Tarsus.....	4.75	4.0
Propodus.....	3.5	3.0
Terminal claw.....	4.0	3.75
Oviger:		
Basal joints.....	1.5	1.4
Fourth joint.....	8.0	9.0
Fifth joint.....	3.0	4.0
Sixth joint.....	9.0	9.0
Terminal joints coiled, not measured.		

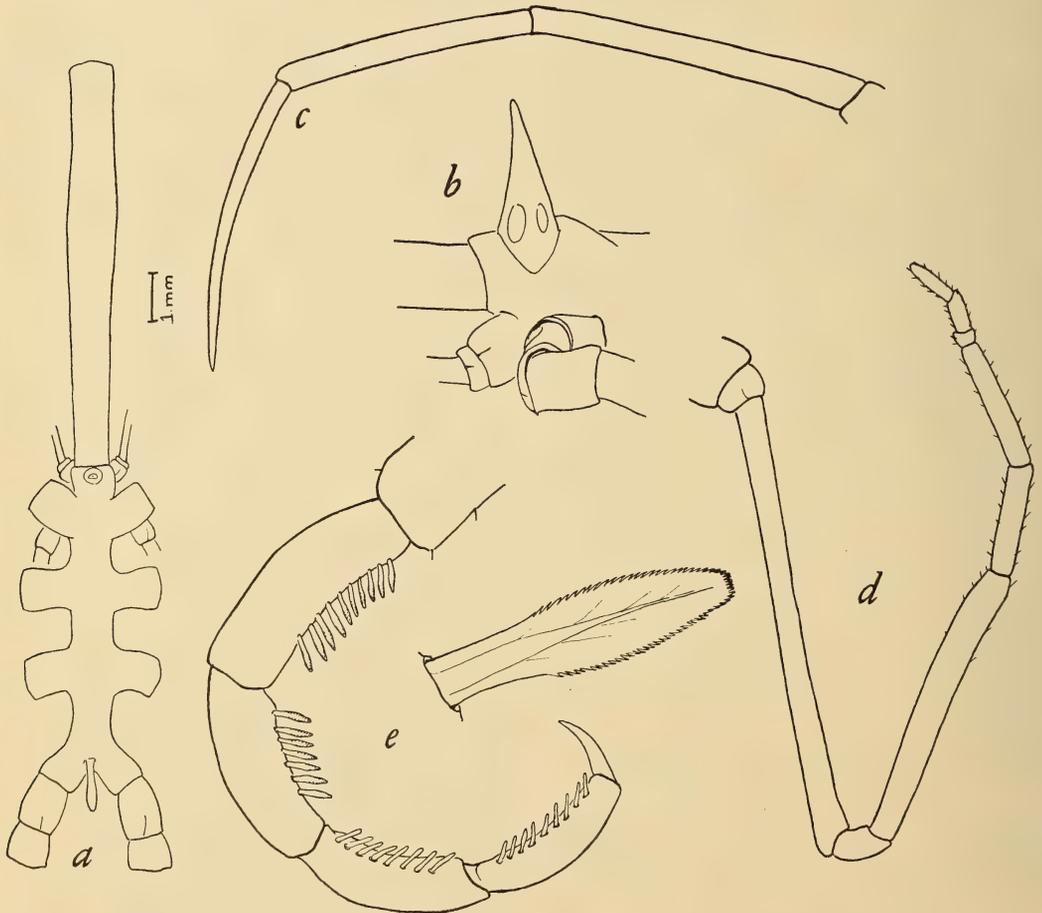


Fig. 1.—*Colossendeis tenera* Hilton, drawn from paratypes in the U. S. National Museum: a, Dorsal view of paratype, ♂; b, sketch of cephalic region of paratype; c, terminal joints of leg of paratype, ♀; d, palpus of paratype, ♀; e, terminal joints of oviger of paratype, ♂, with denticulate spine from seventh segment.

All drawings except b and denticulate spine made with the aid of a camera lucida.



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AUGUST 15, 1943

No. 8

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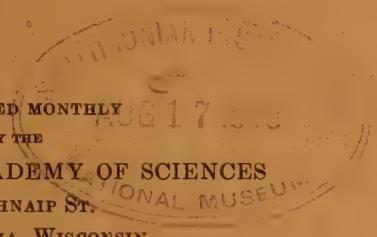
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# JOURNAL

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No. 8

GEOCHEMISTRY.—*Clays and soils in relation to geologic processes.*<sup>1</sup> CLARENCE S. ROSS, U. S. Geological Survey.

The importance of clays and soils can hardly be overemphasized, for no materials play a wider and more varied role in geologic processes than do the clays and related minerals. These have in the past been so little understood, indeed were long looked upon as such hopeless materials, that geologists tended to avoid the problems on which they had a bearing and missed much of the information that they were capable of giving after intensive study. However, advances in the knowledge of clays and the development of efficient techniques for studying clay and soil materials have already contributed to this branch of geology, and the way has been opened for new advances. This paper presents and illustrates by specific studies certain geologic problems on which clay and soil materials have a bearing—problems some of which have been clarified in the course of mineralogic research and others on which tentative conclusions have been reached.

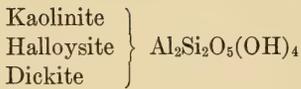
During the meetings of the First International Soil Congress in Washington in 1927, soil mineralogy was an almost totally neglected subject, but interest began to grow almost immediately afterward. However, the writer presented at these meetings a paper that was based on studies in the laboratories of the United States Geological Survey in which it was pointed out that many soils are characterized by minerals of the montmorillonite group. These studies

have since been carried forward in collaboration with others, including Sterling B. Hendricks, of the U. S. Department of Agriculture. Contributions have come from many sources in this and other countries. Some of those making noteworthy contributions are Paul F. Kerr, of Columbia University; John Gruner, of Minnesota; W. P. Kelley and associates, of California; Grim and associates, of the Illinois Survey; C. E. Marshall, of Leeds, England, but more recently of the University of Missouri; Harrison and Hardy, of the Imperial College of Tropical Agriculture, Trinidad; Nagelschmidt, of Rothemstead; Hofmann and his associates, in Germany; Edelman and Noll, of Germany; and Favejee, in Holland.

Work remains to be done on the mineralogy of clays, but the studies have progressed until we have a fairly adequate knowledge of the minerals involved, their compositions, and their physical properties. The full details of clay mineralogy are unnecessary here, but a few of the minerals whose properties have a bearing on geologic relationships may be briefly mentioned.

Three main groups of minerals are found among the clay minerals: the kaolinite group, the montmorillonite group, and the group variously called hydrous mica, bravaisite, or illite. All have a platy or micaceous structure. Kaolinite and halloysite are the only minerals of the kaolinite group that are known to be present in soils, but dickite occurs in hydrothermal deposits. These three minerals differ in the arrangement of the lattice sheets but not in chemical composition, and have the following common chemical formula:

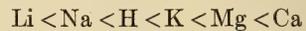
<sup>1</sup> Address of the retiring President of the Geological Society of Washington delivered at the 611th meeting of the Society on December 9, 1942. Published by permission of the Acting Director of the U. S. Geological Survey. Received April 8, 1943.



This formula indicates that kaolinite is characterized by a high alumina-silica ratio. The valency is completely balanced within the crystal structure, and hence no balancing ions (exchangeable bases) are present. There is little or no tendency for iron, magnesium, or other ions to proxy aluminum in the crystal structure. Kaolinite appears to be the stablest of the clay minerals.

The members of the montmorillonite group, typically developed in bentonite, have an extremely wide range in chemical composition. Clays are commonly assumed to be essentially hydrous aluminum silicates, and yet within this single group ferric iron, magnesium, and even chromium may proxy aluminum in part or even completely, and a wide variety of ions, including lithium, ferrous iron, manganese, and nickel, may be present in minor amounts. Ions with a valency of 1, 2, or 3 may take the place of trivalent aluminum, and aluminum may take the place of at least one silicon ion out of four, thus playing two distinct roles in the crystal structure. The substitution of even small amounts of bivalent magnesium for trivalent aluminum, and of trivalent aluminum for tetravalent silicon, results in a valency deficiency within the crystal lattice. This deficiency is compensated by ions that are held between the crystal sheets and are the so-called exchangeable bases; that is, members of the montmorillonite group are characterized by the presence of cations which may be exchanged for other cations on treatment with water or other solvent carrying the second cation. The position of these cations between the crystal sheets permits base exchange without affecting the crystal structure of the clay. This stoichiometric exchange of cation for cation distinguishes base exchange from adsorption, although the two are commonly confused. These bases are associated with the interlayer water (the water film present between each molecular sheet), the association that gives bentonites and related clays their peculiar physical properties.

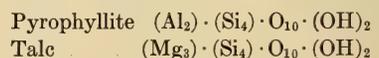
Experimentally, almost any base or hydrogen may be exchanged for bases occurring naturally. Those occurring most widely are calcium, which is almost completely exchangeable, and sodium, which is usually exchangeable but not always completely so. Small amounts of potassium, magnesium, and even aluminum may be replaceable, as is hydrogen, which gives the clay an acid reaction. These ions differ greatly in their relative ease of replacement, which is represented by the following series:



This relation indicates the reason for the preferential fixation of calcium in most montmorillonite even in the presence of sodium.

The dominance of replaceable calcium provides a readily available source of that element in soils characterized by montmorillonite minerals. The preferential fixation of calcium also has a particularly favorable effect on soil texture in that it promotes flocculation, whereas sodium tends to bring about extreme colloidal dispersion.

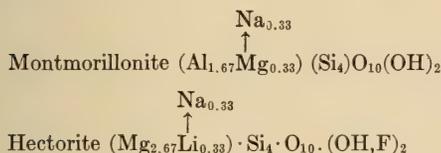
In the formulas below, the ions occupying octahedral positions within the crystal structure (those proxying aluminum) are grouped together within the first parentheses. Silicon, which occupies tetrahedral positions, follows and is also enclosed in parentheses if partly proxied by aluminum. The component ions are expressed as decimal fractions where necessary in order to keep the total of those in tetrahedral positions at the constant value of 4, making all the formulas directly comparable. The replaceable ion is placed above the ion that it balances, the two being connected by an arrow. A discussion of minerals of the montmorillonite group may be preceded by discussions of pyrophyllite and talc, two minerals related to the clay minerals, although differing markedly in physical properties. Their formulas are as follows:



The chemical formulas quoted below will serve to illustrate the relations within the montmorillonite group, although they are not intended to represent the ranges in

composition fully. Complete representation would require at least eight formulas together with rather detailed discussions, but those included will illustrate geologic relationships. In pyrophyllite and talc there are no appreciable substitutions of the other ions for Al or Mg or of Al for Si; the valency is completely balanced within the crystal structure, and these minerals, like kaolinite, show little or no base exchange.

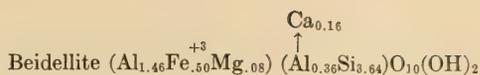
Two minerals of the montmorillonite group showing characteristic substitution of ions are



The foregoing formula of montmorillonite differs from that of pyrophyllite in that 1 Al ion out of six is being proxied by Mg. The valence deficiency that has been introduced into the crystal lattice by this substitution of a bivalent for a trivalent ion is balanced by Na, which is situated between the sheets. In the formulas this replaceable base is given as Na, but it is commonly Ca, plus small amounts of other bases. The montmorillonite represented here, if containing in addition the normal content of interlayer water, differs from pyrophyllite only in containing about 3.23 percent of MgO and 2.55 of Na<sub>2</sub>O. This small change in composition has introduced the property of base exchange, and the interlayer water that brings about the markedly different physical properties of these minerals.

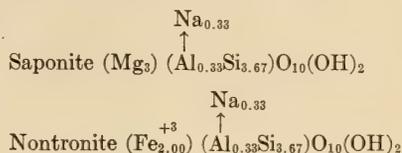
The relations between hectorite and talc are similar to those between montmorillonite and pyrophyllite. The substitution of about 1 percent of univalent Li for bivalent Mg, together with the Na required for balancing the valency, has again made the difference between talc and hectorite with remarkably complete colloidal dispersion.

The clays of the montmorillonite group in which Al proxies Si in essential amounts have been called beidellite. The formula given below represents closely the clay from the type locality, Beidell, Colo.:



Here ferric iron and a small amount of Mg take the place of part of the Al, so this formula is more representative of soil-forming members of the group than other formulas presented. The exchangeable base is represented as Ca rather than Na, and the ions in octahedral positions exceed 2 by a small amount.

Formulas representing two other members of the group are given below:



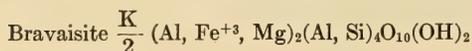
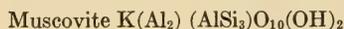
In both of these formulas Si is being proxied by Al and is balanced by Na between the lattice sheets.

Within the same crystal structure there may be substitutions of other ions for Al in the octahedral group, and also of Al for Si in the tetrahedral group. Where the trivalent ions, Al<sup>+3</sup> and Fe<sup>+3</sup>, are dominant in the octahedral group, the number of ions in that group is close to 2 but may exceed that number slightly, and where bivalent ions such as Mg are dominant, their number is close to 3 but can not exceed that number. Three octahedral positions are available but are not necessarily all occupied. In none of these formulas has the highly variable water been included; it would, if necessary, be represented by (+nH<sub>2</sub>O).

The members of the bravaisite group require further study, but they are known to be widely distributed. They have a relatively small base-exchange capacity, and in some of their properties are intermediate between micas and montmorillonite. In the micas and bravaisite the potassium lies between the crystal sheets, forming bonds that tie sheet to sheet, and hence is locked in a nonexchangeable position, in contrast with the exchangeable bases of montmorillonite, which are held on only a single surface in a manner that permits their ready displacement.

The bravaisite type of mica is not well

enough known to justify more than a general formula to represent its range of composition, but its relation to the true micas can be represented as follows:



Fe and Mg are present in subordinate amounts in bravaisite but are commonly present in greater amounts than in true muscovite. The K has been represented as one-half of that in micas, but it may range down almost to zero. A typical formula for bravaisite would be



An unusual clay mineral, but one forming extensive deposits of fullers earth in the Florida-Georgia region, has been called altapulgite. This is characterized by a fibrous rather than a platy structure and seems to be related to the so-called mountain leather (paligorskite). The seemingly very specialized conditions that produced so unusual a sedimentary material present a real problem, but the high content of magnesium tells something of the genetic environment.

The opallike, noncrystalline clay material known as allophane may be present in some soils.

A few of the physical and chemical factors that are most important in controlling clay formation should be mentioned. The alteration of any parent material to a clay or soil aggregate takes place in a physical-chemical system whose varied factors, taken one at a time, are approximately known. There are, of course, many varying sets of conditions that may dominate the development of a clay material, but in general it is the combined effect of difficultly evaluated interrelationships, more than the unknown effect of any one factor, that introduces the complexity that characterizes many clay problems.

In reality there is only one fundamental factor in clay formation—the chemical character of the reacting system. This may be divided into two secondary factors: the chemical character of the parent material

and the chemical character of the altering solutions. These factors will be most conveniently illustrated by specific studies to be mentioned later. The other factors are complex and varied but serve only to impede or accelerate reactions in the system. Varying physical conditions such as permeability affect the access of solutions and hence the rate, but not the final character, of the reaction. Time is a factor only in that it permits reactions that proceed with extreme slowness.

Organic materials have a marked effect on soil texture, water retention, and fertility, but the chemical effects are in general due to their reducing action (essentially the reduction of ferric to ferrous iron) and to the solution and removal of bases by organic acids. In humid and especially in cool humid climates, and in swamps where peaty and lignitic materials collect, the effect of organic materials is a dominant factor; in desert regions, or where there is rapid oxidation of organic materials, their effect may be small or absent.

Living organisms play an important role in soil processes, some of them modifying physical relations, as when they facilitate the access of air or water to the system. Bacteria and other micro-organisms play a very important role, and their use of such materials as oxygen, nitrogen, and sulphates contributes chemical factors to the soil- or clay-forming system.

The mineralogic, chemical, and physical processes discussed above provide a basis for a general outline of the manner in which they interact to form the three different groups of clay minerals—montmorillonite, bravaisite, and kaolinite.

The four distinctive relationships of members of the montmorillonite group may be restated: the essential role of magnesium in the chemical composition, the entry of iron in all proportions into the crystal structure, the replaceable bases, and the interlayer water between each molecular sheet. Montmorillonite and other members of the group have been synthesized in the presence of alkalis and alkaline earths, but montmorillonite has been formed under the widest range of conditions in the presence of mag-

nesium. Other work indicates that alkaline conditions may not be absolutely necessary, especially if magnesium is present, but montmorillonite probably does not form under acid conditions.

Experimental evidence does not cover the effect of other bases, but chemical composition and conditions of formation indicate their effect rather clearly. Ferric iron enters the crystal structure of members of the montmorillonite group but forms no part of the kaolinite structure; hence the presence of ferric iron in the clay-forming system favors the formation of montmorillonite. Ferrous iron plays the same role as magnesium in silicate minerals, so it too would tend to favor the formation of montmorillonite. Even where little or no ferrous iron enters the crystal structure, its mere presence, owing to its higher solubility, would increase the availability of iron in the clay-forming system. The presence of organic materials in association with suitable bacteria gives reducing conditions, and, therefore, reduction or even the absence of active oxidation, would tend to favor the formation of montmorillonite. The lithium of hectorite would exert the same effect as magnesium. Other bases including calcium and sodium tend to give alkaline conditions and in this way promote the formation of montmorillonite.

Chemical composition, experiments on synthesis, and the interrelations of ions as revealed by X-ray studies of crystal structure, combine to explain the tendency for solid rock and detrital materials rich in ferromagnesian minerals and calcic feldspars, to alter to montmorillonite.

The soils of the Piedmont region are under investigation by L. T. Alexander and associates of the Department of Agriculture, and some of the interpretations by S. B. Hendricks of the relations between parent rock and the resulting clay minerals are about to be published. This interpretation shows that the soils derived from Triassic diabase are in general composed essentially of montmorillonite, whereas some of the other ferromagnesian rocks of the region under similar physical and climatic conditions have weathered to kaolinitic soils. It

seems evident that in the diabase the ferromagnesian minerals and feldspar break down together, releasing iron (part of it ferrous), magnesium, alumina, and silica, giving conditions favorable for the formation of montmorillonite or beidellite. In these other rocks the ferromagnesian minerals break down first, the magnesium is removed by solution, and the iron is either removed or is altered to oxides. The feldspars break down later, and in the absence of magnesium, and with the iron absent or effectively isolated from reaction by oxidation, kaolinite forms.

The alteration of basaltic rocks to montmorillonite under suitable conditions has been described by Hosking (1940), who has made a study of the origin of a group of Australian soils. According to him, "It is evident that granite types of parent material will weather to kaolinite or halloysite under a very wide range of climatic conditions . . . In the case of basaltic soils, the internal moisture conditions . . . appear to play an important part in determining the mineral clay type formed . . . The first two profiles (developed on basalts) are characterized by good drainage conditions, allowing of complete oxidation, whereas the third is subject to a certain degree of waterlogging. The soils with good internal drainage, whether formed on granite or basic rock, are both characterized by a clay mineral of the kaolinitic type . . . In the clay where waterlogging is apparent and free oxidation restricted, montmorillonite is formed to the exclusion of kaolinite. The absence of crystalline iron (oxide) minerals, despite the high content of iron in the clay is undoubtedly due to the restriction in oxidizing conditions, a fact reflected in the greenish color of the clay."

Glacial materials are composed of feldspars, other aluminous and ferromagnesian silicates together with sedimentary materials derived from calcareous beds, shales, and sandstones. On weathering aluminum, silicon, iron, magnesium, calcium, and alkalis are released and a chemical system favorable for the development of montmorillonite is formed.

Lamar, Grim, and Grogan (1938) give

the following description of the soils formed from glacial materials: "Gumbotil is derived from glacial till by weathering . . . Gumbotil does not occur on glacial drift as young as the Wisconsin drift, but is common on the older drifts—the Illinoian, Kansan, and Nebraskan. It formed under conditions of poor drainage usually just below the soil layer over broad, flat upland tracts . . . The conversion of till to gumbotil in nature involves oxidation, leaching of carbonates, and chemical decomposition of the silicate materials . . . The original till contained large amounts of clay minerals of the illite group and in general the processes of weathering have tended to remove alkali, particularly potassium, and to alter the illite minerals to those of the montmorillonite group."

Bentonites, whose essential mineral is montmorillonite, have a world-wide distribution and show no observable relation to climatic zones. Their derivation from glassy volcanic ash has long been established and needs no discussion. This ash seems to have fallen on land, in fresh-water lakes, in saline lakes, and in marine embayments. The failure to show a clear mineralogical relationship to these various environments is not easily explained, but perhaps leaching was in some places a subsequent process brought about by ground water after burial. Such a genetic environment has been indicated by the work of Bramlette on the bentonites in the Monterey shales of California.

The exact composition of the volcanic glass from which bentonite was derived is known for only a few occurrences, but the associated minerals show that it was most commonly the latite type of rock—that is, essentially a feldspathic rock. More rarely it was rhyolitic. In a few occurrences the resulting bentonite is known to be higher in magnesium than the glass from which it was derived, indicating that magnesium was derived from magnesium-bearing marine or ground waters. Marine waters are slightly alkaline and ground waters are alkaline or neutral.

The need for more detailed information about the mineralogic relations of the bravaisite group has been mentioned, and the same is true of their geologic relations.

Minerals of this group are dominant materials in marine shales, and in soils derived from such shales. Over wide areas, especially in the east-central United States, they are major soil-forming materials.

The Ordovician of the eastern half of the United States contains bentonitic beds that are characterized by a clay mineral of the bravaisite type; it therefore differs from the more normal montmorillonite type of bentonite. So far as known, this type of bentonite is confined to the Ordovician, a restriction in occurrence that has not been explained. The wide distribution—from Georgian Bay, Canada, on the north to Alabama on the south, and from Pennsylvania on the east to Minnesota and Missouri on the west—is one of its interesting features. Over these wide areas, the bravaisite bentonites contain over 5 percent of potash, or about one-half of that of muscovite.

Some, if not all, of the Ordovician bentonites represent marine deposits, and it seems probable that these, like the marine shales, derived their potash from ocean waters. However, some of the montmorillonite bentonites that are essentially potash-free contain marine fossils and must have formed in marine embayments, although we do not know that leaching took place in the presence of ocean waters.

Geologists have long known that where potassium in solution in river, ocean, or saline lake comes in contact with clay materials there is a preferential fixation of potassium. Potassium salts are commonly minor constituents of such waters and sodium salts are dominant, even where the two were originally supplied in nearly equal amounts. Spencer and Murata in an unpublished paper have shown that preferential adsorption of potassium from sea water is not an adequate explanation of this relationship.

The gradual inversion of montmorillonite to bravaisite or mica-like minerals seems to offer an explanation of this preferential fixation of potassium and the dominance of potassium minerals in marine deposits. The formulas representing mineral compositions indicate the chemical similarity between the mica minerals and montmorillonite, and X-ray work shows that the crystal struc-

tures of the two minerals are very similar. There is the physical difference that the potassium of micas is linked between the sheets in a nonreplaceable condition. In montmorillonite, sodium and calcium are readily replaceable, but experiments on soils show that potassium, even where initially replaceable, gradually becomes nonreplaceable. It seems probable that under favorable conditions potassium comes to occupy positions tying sheet to sheet—that is, positions characteristic of the micas. Thus potassium may gradually become fixed at the expense of replaceable bases.

Kaolinite is the common end product resulting from several geologic processes and is especially characteristic of areas of deep and thorough weathering and of areas where leaching has been unusually effective. Its occurrence as an end product of such rigorous geologic processes is no doubt related to its high degree of stability and its common association with the most stable minerals. These are commonly quartz, iron oxides, and hydroxides, and in some occurrences aluminous hydroxides. The red or red-brown color imparted to kaolinitic soils by associated free iron oxides is in contrast to the greenish, blue-gray, or pale-yellow colors of montmorillonite in which ferric iron forms a portion of the crystal structure.

The association of kaolinite with iron oxides in many deposits shows that it formed under oxidizing conditions. In other deposits, from which iron had been removed, the kaolinite formed in the presence of organic materials which gave reducing conditions. Reduction and solvent action by organic acids favor the removal of bases, including magnesium, calcium, and alkalis as well as ferrous iron. The tendency for acids derived from organic materials and oxidizing sulphides to form kaolinite is well known. It seems evident, therefore, that the removal of bases from the clay-forming system is the essential factor in kaolin formation and that the kaolinizing action of acids is due to their efficiency in removing bases rather than to their effect as acids. Long-continued leaching in essentially neutral waters may remove all bases, except where active oxidation inhibits the removal of iron. Feldspar pegmatites in the southern

Appalachian region have been altered to kaolinite to a depth of a hundred feet or more. The penetration of acid solutions to such depths during the course of weathering is improbable, and such kaolin bodies have undoubtedly been due to the leaching action of essentially neutral waters.

The common association of iron oxides and kaolinite should be considered in connection with the earlier statement that iron may favor the formation of montmorillonite. The effect of ferrous iron in promoting the formation of montmorillonite, as already pointed out, would be destroyed by oxidation. Under extreme oxidizing conditions iron would be leached from silicate minerals and immediately redeposited as oxide; in this form it would be removed from the reacting system almost as effectively as when removed by solution.

Soils formed from limestone are commonly characterized by kaolinite, and since this mineral has a low base exchange capacity, such soils are commonly deficient in calcium. On the other hand, volcanic ash low in calcium will alter to montmorillonite containing essential calcium.

Harrison, and later Hardy and Follett-Smith (1931) who cited the work of Harrison, studied the soils of British Guiana. The former author reports: "Under tropical conditions, the katamorphism of basic and intermediate rocks at or close to the water table, under conditions of more or less perfect drainage, is accompanied by the almost complete removal of silica, and of calcium, magnesium, potassium, and sodium oxides leaving an earthy residuum of trihydrate (in its crystalline form gibbsite). . . . This residuum is termed primary laterite. . . . The process of primary lateritisation is succeeded by one of resilication. . . . Under tropical conditions acid rocks do not undergo primary lateritisation, but gradually change . . . to more or less quartziferous and impure kaolins . . . On well drained mountain plateaux, where rainfall is very high and more or less continuous throughout the year, primary laterite appears to be permanent . . . On badly drained low-lying areas on the other hand, primary laterite appears not to be permanent but gives rise to argillaceous earths . . .

"During the passage upwards by capillary attraction in dry seasons when evaporation exceeds rainfall, the silica-bearing solutions derived from underlying rock forms surface films of moisture in the spongy primary laterite where some of the silica reacts with some of the finely divided gibbsite to form a hydrated aluminum silicate principally a crystalline kaolin."

Alexander, Hendricks, and Faust (1941) report that, "Gibbsite has been shown to be a component of a number of soil colloids from continental United States. It is a major component of some of them."

"The primary weathering products of norites, amphibolites, an epidote greenstone schist, a diabase, and muscovite-biotite schists, have been shown to contain gibbsite . . . Where silica is being liberated by mineral weathering in close proximity to the gibbsite, resilication to kaolinite takes place."

The bauxite deposits of Arkansas, the Gulf coastal region, and the valley of Virginia show an invariable association with the more abundant and widespread kaolin beds from which they are believed to have been derived. The relations in all these areas indicate that the formation of these deposits is not comparable to the usual picture of laterization, where ferric iron is concentrated together with aluminous minerals. In most of these areas no iron-free parent material is available for the formation of white, commonly very pure kaolinite, as where kaolin is derived from feldspar pegmatites. In widely separated areas there is an association of kaolinitic materials with lignitic beds, or with horizons characterized by widespread swampy conditions. The relations between bauxite and lignite beds in Arkansas has been discussed by Behre (1932). Almost without exception ferrous iron carbonate has been deposited in underlying or closely associated beds. Siderite concretions are not rare within the beds themselves. Thus iron has been removed, a removal normally possible only after reduction; ferrous iron carbonate is a constant associate; and there is a widespread association with swamps or lignitic beds, which provide a most efficient source of reducing

agents and organic acids that dissolve and remove bases. The control that this group of interrelations has exercised in the production of the kaolin beds in these particular regions seems obvious. This, however, leaves many problems that require intensive study, in particular the genetic relations between the bauxite and the kaolin beds.

In the presence of mineralizing solutions or volcanic vapors, the pressure, temperature, and concentrations commonly favor the formation of ferromagnesian silicates, feldspars, and micas more commonly than clays. In the later stages of activity, however, as temperatures decrease there is an increased tendency for clay minerals to form and clays have been reported from numerous veins and other mineral deposits, all three types of clay materials having been identified. Dickite, the hydrothermal member of the kaolinite group, is very widespread and is commonly associated with vein quartz. Bravaisite is probably reported as sericite in most lists of minerals as the two are very difficult to distinguish. If montmorillonite is observed only in thin section, it too may be mistaken for sericite; however, its low mean index of refraction clearly distinguishes it.

The relative temperatures of formation of these three clay groups are not definitely known, but perhaps dickite forms at higher temperatures than montmorillonite. The common association of dickite with quartz and a seeming absence of associated ferromagnesian silicates is no doubt significant, and the absence of iron and magnesium may be necessary for its formation. On the other hand, it is evident that montmorillonite forms in the presence of the bases, ferric iron and magnesium, and under alkalic if not alkaline conditions. The alteration of the feldspar of pegmatites to kaolinite under leaching conditions has been mentioned, but a number of pegmatites have been described in which hydrothermal alteration has produced montmorillonite. In these, introduction of bases has predominated over their removal, and montmorillonite has been produced.

The genetic processes revealed in two in-

teresting occurrences of clay minerals illustrate the relations between kaolinite and montmorillonite. Studies of the hot springs of Yellowstone National Park by Allen and Day indicate that acid waters are the result of oxidation of hydrogen sulphide near the surface, and that the primary waters or vapors are all alkaline in depth.

Fenner (1936) in his detailed studies of the materials encountered in drill holes put down in selected parts of the hot-spring areas of the park, gave special attention to the relation of these materials to depth, pressure, and the chemical character of the escaping vapors. He says: "The effect of acidity is thus apparent in the formation of kaolinite as far down as 95 feet, . . . at greater depths the alteration produced beidellite only." That is, below the zone of acid solutions a clay of the montmorillonite group formed. The highest pressure measured was  $277\frac{1}{2}$  pounds at a depth of  $246\frac{1}{2}$  feet, where the temperature was  $205^{\circ}$  C. Thus a mineral of the montmorillonite group may form at rather high temperatures and pressures in the presence of alkaline solutions. Fenner observes that pyrite commonly accompanies beidellite in the Yellowstone materials.

The conclusions by Fenner about the origin of clay minerals at Yellowstone coincide with relationships at Magnet Cove, Ark. (Ross, 1941). Steam-shovel operations connected with rutile mining have shown the existence of a volcanic neck filled by an agglomerate made up of various rock types and enclosed in a matrix of clay minerals. Abundant rutile and pyrite are associated with these materials. A nearly pure feldspathic rock shows various degrees of alteration to montmorillonite. The matrix material around rock fragments was originally glassy volcanic ash, but this has been altered to montmorillonite, which has been in part later altered to kaolinite. The relationships indicate that volcanic waters and vapors carrying bases and rich in sulphides, rose through the porous agglomerate altering both feldspar and glass to montmorillonite. It seems evident that as volcanic activity waned, these sulphide-bearing vapors were in part condensed and oxidized in con-

tact with air. This resulted in sulphuric-acid-bearing solutions, which percolated back into the porous agglomerate, partly altering the montmorillonite to kaolinite.

The foregoing outline presents a much generalized picture of soil-forming processes in which many of the factors discussed have been qualified as trends or tendencies. Detailed studies of individual occurrences will no doubt show many apparent exceptions, which will be cleared up only by intensive geologic work involving correlation between mineral composition and the physical and chemical factors that interacted to produce the clay material.

The relationships between many different parent rocks and their products of weathering need to be studied. Information is especially needed about the clay minerals in fine-grained sedimentary rocks, and the resulting product, where these are exposed by erosion and themselves undergo weathering. The relative effects of leaching in the presence of solutions of differing chemical character have not been determined in adequate detail. Alternate wetting and drying probably is more destructive than either continued aridity or humidity, but this question has never been fully investigated. Intermediate or transitory products may intervene between the parent rock and the end product, and may influence the character of that product. The effect of base exchange on the quality of ground water is being studied, but the effect of salts carried in solution upon the sedimentary materials is too little known. Is the clay or soil the result of reactions in a single physico-chemical system or have there been changes that make it the result of several genetic episodes? Is the clay material in equilibrium with its environment or not; that is, to what extent may clay minerals be in a metastable condition? Has there been admixture with materials from several sources that developed under distinct environments? What were the conditions of final disposition, was it in fresh or salt water? How have all these processes been modified by associated organic materials? Numerous soil types from many parts of the world have been described, and soil specialists

have given particular attention to the different horizons of the soil profile, and those geologists particularly interested in soil problems are under obligation to consider this work and understand the geologic significance of soil types and soil profiles. Much of this needed information will be attained only by detailed studies of selected areas where the greatest number of controlling factors are determinable; but also much more may be determined and recorded as incidental results during the course of general geologic studies of a region. This is needed because the science of soil geology is in many ways in the early stages in which the mere accumulation of information by workers in many fields is necessary as a basis for future progress. Here are problems for the mineralogists, geologists, soil specialists, chemists, and physicists—in particular geologists and physical chemists.

Dr. W. P. Kelley, of the University of California, one of our most far-seeing soil scientists, presented as a part of a symposium on clays at the University of Chicago in 1941 a paper entitled "Modern clay researches in relation to agriculture" (1942), which should interest all geologists. In this he said: "A knowledge as to the kind of clay minerals found in soils bids fair to throw important light on soil formation processes, that is, on soil genesis . . .

"Modern researches on the clays are, therefore, placing the subject of soils on a new footing. They have served to emphasize the close relationship between soil science and geology and mineralogy . . . There is simply no point where you can separate geological from soil processes . . .

"That clay research is drawing soil science into closer contact with geology is one of its important by-products. In my opinion the closer the cooperation between soil workers and geologists the better. In fact I look upon several of the important phases of soil science as aspects of geology."

Dr. Kelley has made himself the leading advocate among soil scientists of the necessity of the geologic and mineralogic approach to many soil problems and of the inadequacy of purely chemical methods.

However, he and other leading soil workers feel, seemingly not without some reason, that geologists have not given all the help for which their training fits them.

Clay studies are not without their bearing on the broader problems of geology—the problems of those geologists who are not primarily interested in soils and related materials. The promptness with which clay materials react to changes in environment is a measure of the information they may hold. Clays respond to acid or to alkaline conditions, to swamps or to aridity, to oxidizing or reducing conditions, to fresh water or to marine deposition, to the presence or to the absence of organic materials. No one can see all the possibilities that may come of any research, but some of the results may be suggestive.

The bentonites have told us much. These clays are the only record of the ash showers that fell so widely in Ordovician seas. They are also evidence of the volcanic activity that ringed the Gulf of Mexico in Cretaceous and Tertiary time, with a dozen or more ash showers recorded in the clays of Mississippi. They seem to present evidence that certain embayments were of fresh or at most brackish water, whereas other embayments of the same general region were marine. Clays have presented very definite evidence as to the chemical character of mineralizing solutions and no doubt will present much more as they are intensively studied.

The clays hold a story that will grow as we know them better. Should we not heed the earnest plea of men like Dr. Kelley that geologists accept as their own some of the problems of soils?

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PHYSICS.—*The scientific significance of ferromagnetism.*<sup>1</sup> FRANCIS BITTER, Massachusetts Institute of Technology. (Communicated by R. E. GIBSON.)

Half a century or so ago theoretical and experimental investigations were undertaken that revealed the main facts about ferromagnetism. On the one hand, they made possible the formulations of ideas that are basic in an understanding of the subject and, on the other hand, led to technical developments that made possible the enormous electrical industry of today. It would be interesting to follow both of these developments simultaneously, but I have chosen to concentrate on the scientific rather than on the engineering aspects of the subject. Ewing, Weiss, and Curie showed us that a ferromagnetic substance owed its peculiar properties to the interaction of elementary magnets of atomic dimensions, that these interactions were not entirely of magnetic origin, and that the transition from ferromagnetism at low temperatures to paramagnetism at high temperatures was not a real change of phase, as melting for instance, but a new sort of transition associated with a discontinuity of specific heat rather than a latent heat. Weiss showed that to a first approximation, at any rate, ferromagnetism could be understood as a special case of paramagnetism in which Langevin's fundamental equation relating magnetization to the dimensionless quantity  $\mu H/kT$  had to be modified only by assuming that the field acting on each elementary particle was not the externally applied field alone, but the resultant of this field and an internal field resulting from the interaction of the elementary magnets

with each other and on the average proportional to the intensity of magnetization itself. Thermodynamically the results achieved were sound and satisfying, except perhaps that stress and strain tensors were omitted from the theory, and all phenomena related to magnetostriction and thermal expansion were omitted. These are, however, not fundamentally important and can be incorporated into the theory at the expense of simplicity. Statistically, the results were not satisfactory. Although the Boltzmann constant appears, this is due only to the incorporation of the theory of paramagnetism, and the real problem of interpreting the atomic interactions is avoided altogether by the simple assumption of an internal field. From the point of view of atomic physics, one important result was achieved: namely, the specification of the order of magnitude of atomic magnetic moments. On the other hand, the actually observed values of Curie temperatures of the order of 1,000° K. could not be explained on the basis of known interatomic fields, and the origin of these fields was a major mystery for many years.

One last item remains to be mentioned to complete the picture prior to the advent of the quantum theory and more recent developments in atomic physics. The Weiss theory, because of its simplifying assumptions regarding atomic interactions and the internal field, predicted spontaneous magnetization of an entire sample to saturation at all temperatures below the Curie point. This was completely contrary to fact, and left unexplained the origin of hysteresis, and all the phenomena related to magnetization—of such great technical impor-

<sup>1</sup> The twelfth Joseph Henry Lecture delivered before the Philosophical Society of Washington at its 1210th meeting on December 19, 1942. Received April 13, 1943.

tance. Ewing's work on models consisting of many small magnets free to rotate near each other indicated that Weiss's spontaneous magnetization existed only in small regions and that the magnetic interactions of these regions was probably sufficient to account for the main features of the process of magnetization. This was capable of direct experimental observation, and it is interesting to note that, although all the means for making such observations were at hand, more than a quarter of a century elapsed before these observations were actually made. This brings us to an entirely new aspect of the subject, which I should like to discuss briefly by way of digression from the main argument of this lecture. The physics of crystals has been developing most satisfactorily wherever theoretical interpretation was possible, and the advent of X-rays helped to emphasize the fundamental regularity which so much facilitated theoretical treatment. There is, however, a stage between the atomic and the truly macroscopic, which has great importance and which has properties peculiar to itself. Crystallographers have, of course, made many observations bearing on this point, and ferromagnetism contributes but one more of the many aspects of the problem to be studied. By using very fine magnetic powders the stray fields on ferromagnetic crystals have been studied, and the existence of a complex and often highly symmetrical magnetic structure has been revealed, varying in shape and design in a most intriguing manner. This may be related to a more fundamental submacroscopic or "block" structure of crystals, and so to the mechanical properties of strength, plasticity, fatigue, etc. Much work, however, remains to be done before real progress in these fields is to be expected.

The discovery of the spinning electron, as well as the recognition that it was the primary source of the magnetic moment in most ferromagnetic substances, was a necessary preliminary to the advances in our understanding of the subject due to Heisenberg. Of the two great advances for which he is responsible, only one is usually emphasized, and that is the interpretation of the

internal field in terms of short-range forces postulated in quantum theory to explain a wide variety of phenomena. The mystery of the high Curie temperatures was satisfactorily solved.

The other important contribution, however, in no way depended on the quantum theory. It was an attempt to give a satisfactory statistical background to the internal field assuming short-range forces and interaction between only nearest neighbors in a crystal. The difficulty of this problem, essentially the definition of the entropy, or the number of states associated with any given energy, is largely responsible for our failure to make real progress in understanding cooperative phenomena. We know far more about the atoms themselves than about the manner in which they "cooperate" to produce macroscopic matter. Even for the simplest conceivable elementary particles the treatment of interacting aggregates breaks down except for special cases (the linear chain), which do not have the discontinuous properties of particular interest in actual substances. It seems that the kind of mathematical functions we use are inherently unsuitable and that mathematicians must develop for us some new treatment of discontinuities of various sorts before we can handle phases and their transitions with anything like the satisfying elegance with which we describe simpler atomic processes. Since it was not possible to derive the entropy function, Heisenberg assumed that it could be adequately described in terms of a suitably chosen function containing parameters that could be calculated for the particular kind of atom assumed. This led to equations essentially similar to those first presented by Weiss, but with two relevant modifications. These were, first, that the equations were consistent with the idea of short range forces, and, second, that ferromagnetism could exist only in certain types of crystals, and probably not in simple cubic lattices. The equations broke down at low temperature, however, because of the limitations of the approximation used. They also gave some indication of why ferromagnetism appeared only in certain ones of the transition ele-

ments, but the treatment was inherently too complicated to allow detailed analyses of particular substances to be made. It was a tantalizing prospect to interpret the behavior of alloys with various degrees of order and disorder and in concentrations ranging from dilute solutions exhibiting only feebly magnetic properties to pure ferromagnetic substances. Heisenberg's treatment can, in principle, take into account the particular arrangements of atoms among each other, and may yet be of great value in helping to interpret many purely metallurgical phenomena. Although no such applications of the theory have as yet been carried through, a qualitative study has shown that many unfamiliar magnetic phenomena are to be expected. Experimental results, which I shall review briefly at the close of this lecture, indicate that these predicted anomalies do in fact exist and that the investigation of the properties of certain alloys and compounds at low temperature may be expected to throw considerable new light on the theory of atomic interactions in solids.

It is now known that ferromagnetism is due to electrons that are neither so tightly bound to atomic cores as electrons in the lower energy levels nor so loosely bound as the conduction electrons. This intermediate condition between tight and loose binding seems particularly difficult to describe adequately. In addition to the approach from the atomic side described above, another attempt was made, primarily by Bloch and Slater, starting with the electron theory of metals. This recognizes the fact that the atomic energy levels are split up into overlapping energy bands in solids and that the main features of metallic phenomena are due to the extent of the population of the energy bands by electrons. Thus the main differences between copper and nickel are due not to changes in the possible energy states, but to the fact that copper has more electrons to fill these states. The ferromagnetism of nickel is, then, due to the fact that a certain "band" of states is not completely occupied, and some of the properties, particularly the saturation value of the magnetization of copper-nickel and of other

alloys, can be interpreted simply in terms of the number of electrons available to fill the energy bands. The treatment, however, does not lend itself to the interpretation of many of the observed phenomena, particularly those depending on the arrangement of atoms among each other in alloys.

So much for the theoretical aspects of the subject. Experimentally, the scope of magnetic phenomena investigated has been fairly limited. The common ferromagnetic elements have been thoroughly studied, and certain alloys and compounds that are easy to prepare have been investigated in conveniently available ranges of fields and temperatures. During recent years there have been several attempts to expand our knowledge experimentally. I shall describe briefly one that I have been associated with at M.I.T. Drs. A. R. Kaufmann, Chauncey Starr, and S. T. Pan and other members of the student body and of the faculty were to a large extent responsible for the results obtained. The aim was to explore new fields rather than continue the investigation of known phenomena in greater detail. This has been done by extending the available range of temperatures, fields, and substances to be studied as much as possible. Up to the time that work had to be abandoned, temperatures ranging from that of freezing hydrogen to the melting point of common metals had been used. Fields up to 100,000 gauss of adequate constancy for long periods of time had been produced in sufficiently large volumes for investigations in the above temperature range. These fields were not used in the investigations mentioned above, but can be had when wanted. The measurements made used fields up to 30,000–40,000 gauss. The use of more intense fields at even lower temperatures offers attractive possibilities, not only because of the new phenomena to be expected, but also because it should make a direct measurement of atomic magnetic moments possible—a quantity of fundamental importance which now has to be deduced with considerable uncertainty from other measurements. Finally measurements were made not only on readily available pure metals and alloys but also on some of

the rare earths, and on anhydrous salts of the transition elements. In general greatest interest lies in the substances having incomplete inner electron shells and in physical aggregates in which the separation of atoms and their geometrical arrangement are subject to variation.

The investigations carried out can not be considered more than a preliminary survey, but they do indicate the direction in which more work would be profitable. It was found that, in addition to typical paramagnetic and typical ferromagnetic substances, there is an intermediate class that is neither the one nor the other. In alloys the transition from the one to the other is not sharp, and the nature of the transition requires further investigation. It is also qualitatively different in different alloy systems, as, for instance, Cu-Ni and Cu-Fe. The limited solubility of iron in copper limits the experiments, and other systems, such as Au-Ni and Au-Fe, may be expected to clarify the situation further. The rare earths have interesting anomalous properties especially at low temperatures. The main difficulty in investigating these lies in the preparation of sufficiently pure samples. This is technically difficult and very important, since at low temperatures small quantities of magnetically active impurities can completely mask the normal behavior of a substance. The salts of the transition elements, especially when the atoms are not separated too much by water molecules, may be expected to show interesting properties, in part because of their crystal structure, which makes possible more compli-

cated interaction patterns than the cubic metals. This is borne out not only by the temperature dependence of the susceptibility, which is quite anomalous in some cases, but also by the magnetization curve itself which in some substances has been found to have an "S" shape as in ferromagnetic materials, but without hysteresis. Fields at least as intense as those used are necessary for the study of this phenomenon. The interpretation of the magnetic moments of atoms in various states of aggregation is also very incomplete, in large measure because of the difficulty of defining it adequately in terms of measurements so far made, as previously pointed out. The study of very dilute solutions of magnetic atoms in magnetically inactive metals at low temperatures and high fields should produce very valuable results.

Summing up, then, we may say that although theory has made very considerable progress in the interpretation of ferromagnetic phenomena, it has so far been confined to a limited class and a considerable expansion of the ideas involved is needed. Recent experiments have shown that much more complicated phenomena exist than had been suspected. Finally, it seems that the next move is up to the experimentalist—to survey the field and define the magnetic properties of matter in such a way that the theorist has something definite and reasonably complete to work on. All the tools for doing this are at hand, or at least can be had when we once again return to our laboratories to resume the work that, for the present, has had to be abandoned.

ANTHROPOLOGY.—*The relocation of persons of Japanese ancestry in the United States: Some causes and effects.*<sup>1</sup> JOHN F. EMBREE,<sup>2</sup> War Relocation Authority. (Communicated by WILLIAM N. FENTON.)

#### BACKGROUND OF EVACUATION

In ten new communities from California to Arkansas, there live today 107,000 persons of Japanese ancestry, two-thirds of whom are American citizens. These people

<sup>1</sup> Based on a talk given before the Anthropological Society of Washington, March 16, 1943. Received May 10, 1943.

<sup>2</sup> On leave from the University of Toronto.

were all evacuated from the West Coast as a result of the war and are now living under conditions of "protective custody." This situation presents a number of important problems both political and sociological. Politically, most of the issues of war and of the peace to follow are bound up in these "relocation centers." For instance, is the United States fighting a racial war as Japan

claims, or is she fighting an ideological war; if administrative problems involving a hundred thousand people can not be intelligently and democratically solved, how are we to solve the complex postwar problems of, say, Southeast Asia with its mixed population of a hundred million? Sociologically, some of the important problems raised by the situation are the social effects on the people who have been relocated. How are these people living? What have evacuation and life in relocation centers done to the social organization and set of social sanctions that had grown up in the Japanese communities on the West Coast?

In order to gain some understanding of present attitudes and social developments, it is necessary to look briefly at the history of the people since December 7, 1941. The first effect of Pearl Harbor on the Japanese population in California was one of shock. The stunning effect was even greater for the resident Japanese than for the rest of the West Coast population. This was the beginning of the much-talked-of, much-feared war between the land of their parents and the land of their children.

When nothing drastic happened after the initial internment of a number of Japanese by the intelligence agencies, people relaxed somewhat and went about their business. It looked as if nothing further would occur as long as the people of Japanese ancestry remained law-abiding and did their bit in the war effort by buying war bonds and volunteering to join the Army.

Then things gradually began to happen. Civil Service dropped Japanese-Americans from its rolls, and the Army ceased to accept Japanese-American volunteers. To the *nisei*, as Japanese-American citizens are called, these were bitter pills to swallow. Then rumors from Hawaii of sabotage and fifth-column activity began to drift into California via returning Navy wives and others. In spite of the fact that these rumors were specifically branded as untrue by national intelligence agencies operating in Hawaii, they gained wide currency on the West Coast and added to the fears of the people both military and civilian—fears that what was said to have happened in

Hawaii could happen all up and down the West Coast. Newspaper columnists such as Pegler and McLemore began to beat the drum for internment of all Japanese regardless of citizenship. McLemore, for instance, wrote, "Let us have no patience with the enemy or with anyone whose veins carry his blood,"<sup>3</sup> and Pegler shouted, "To hell with habeas corpus!"<sup>4</sup> Economic interest groups and professional anti-Oriental groups realized that in this situation there was a golden opportunity for carrying out some of their rather undemocratic policies.

Finally and decisively, the Army became worried by Japanese victories in the Pacific and by the rising tension in California. They asked for the right to move people as they saw fit from vital West Coast areas. On February 19, 1942, the President issued an Executive Order authorizing General DeWitt, as Commander of the Western Defense Command Area, to move any persons or groups of people as he felt necessary to protect the military security of the area.

On March 2, a restricted area was delineated from which all persons of Japanese ancestry, regardless of citizenship or past behavior, were to be evacuated. By March 29, 8,000 persons had "voluntarily" moved eastward. As might have been predicted, opposition arose in the inter-mountain States to any mass migration into their territory, and finally it became impracticable for any further movement of this sort. Consequently the voluntary migration was called to a halt, and it became necessary to provide some sort of Federal control and protection.

The War Relocation Authority, which had been established on March 18, 1942, to assist évacués financially or otherwise in their movement eastward, was now faced with the problem of having to establish areas where the people could go and live until the crisis was passed. Thus came into existence the relocation centers, not as a part of any original plan to detain all the people, but rather as a practical expedient made necessary as a result of the war emergency. It was necessary in locating sites for

<sup>3</sup> Column of January 29, 1942.

<sup>4</sup> February 16, 1942.

and establishing relocation centers to enter into agreements, not only with the Army in regard to internal security, but also with the governors of the States concerned. Since all this took time it was necessary to establish in the meantime a number of temporary "assembly centers" in various parts of California, Washington, and Oregon. These assembly centers were run by the Wartime Civil Control Administration, a branch of the Army. Being largely made-over parks or race tracks, they were not intended originally for housing large numbers of people; and even in this emergency period it was not intended that they house people very long. However, they functioned for several months, and the living conditions within them have had serious effects on the people concerned.

The people, workers, business men, college students, priests—all were herded together in what they regarded as degrading conditions and humiliated by being penned behind fences and guarded by military guards. A deep sense of shame was created by the circumstances of induction to these centers. The long uncertain waiting period, during which people had little opportunity or incentive for reorganizing community life, had a demoralizing effect.

The relocation centers were long in building, owing to problems of location and priorities, and most of them were incomplete when trainloads of 500 évacués at a time came into them. The trip was by coach, usually during very hot weather. On arrival the évacués, hot, tired, and worried, went through "intake" where a nurse looked at each throat and someone else took down names and assigned housing space without much attention to the needs and desires of the people to be housed. The housing was inadequate at first and meals were disorganized. The centers were guarded by military police, and later barbed-wire fences were built.

#### EFFECTS OF RELOCATION CENTER LIFE

*Halting of the assimilation process.*—Each center houses 6,000 to 17,000 people, all of Japanese ancestry. In fact, this ancestry is the only thing in common to the whole

group. Many individuals who had formerly lived in non-Japanese communities in California felt very strange in this all-Japanese community. There is the now familiar story of the child who after a few days in a center said to her mother, "Let's go home now. I don't like it in Japan." One of the effects of this situation was the increase in the use of Japanese language and also an increase of the influence of older Japanese. In California, before the war, young Americans 18 to 20 years old were gradually becoming independent of their parents and following American patterns of life. In the relocation centers the only older people to guide them were the Japanese, and because of the breakdown of various social and community organizations the average person was thrown back to a greater dependency on his family as the only stable group left.

*Effects of housing conditions.*—Housing in the centers consists of army-type barracks divided into four or five rooms or "apartments." These structures were made by the Army and are more suitable for housing single men than for housing families. Owing to overcrowding in many centers, members of more than one family are frequently housed in one room. Toilet and bathing facilities are in a separate structure, in each block of 12 barracks. In both the wash rooms and the apartments there was at first no provision whatever for privacy. Eating was in mess halls, one for each block of barracks. There is no special provision for family eating, so that individuals sit down more or less as they arrive in the mess hall. Parents have been worried by the effect of this type of eating on the manners of their children. The whole housing situation has had a demoralizing effect on family standards of living and on family controls over children's behavior.

*Anxieties.*—As a result of evacuation a great many anxieties afflict the people living in relocation centers. They are worried as to the effect of relocation on their children; they are worried as to their future and the future of their children in the United States. Fears in regard to food, in regard to citizenship rights, in regard to all sorts of things both large and small are prevalent. This

feeling of insecurity is reflected in numerous alarmist rumors—rumors that they will be left and forgotten in the desert, contrary rumors that they will be moved again to another center, rumors that there is not enough food in the storehouse for more than 24 hours, rumors that the hospital facilities are dangerously inadequate.

*Breakdown of community controls.*—Because of the fact that people in the centers come from various social and economic backgrounds and owing to the disorganizing effects of evacuation and assembly center life, most of the usual community controls on behavior are lacking. There has been a breakdown, for instance, of the economic position of fathers as heads of the family. Some of the results of this loss of community solidarity and control over its individuals are to be seen in the growth of truancy among the children. Delinquency of various sorts and other antisocial conditions are in striking contrast to the usual law-abiding well-regulated manner of living of the Japanese of California before the war. For instance, there was no provision for the making of furniture, with the result that it became necessary for individuals to pick up scrap lumber wherever they could find it. People who never would have thought of such petty thievery before relocation were forced into it by circumstances of center life. Another element in this situation is a lack of motivation for doing things that one does in a normal community. Why work for \$16 a month? Why study in a barracks school with no future ahead of one?

*Family dependency.*—Most of the familiar sources of social security have been lost—the neighborhood group, the occupational group, business or farm, and home. One result of this has been an increased dependency on the family as the only stable unit left. Many *nisei* who before the war were drifting away from their parents and entering other social groups now put great store by family unity—so much so that many are reluctant to leave the center if a job is available because it would mean separation of the family.

*Magnification of minor issues.*—Owing to the restricted conditions of living behind

barbed-wire fences and under the control of an administration whose acts often appear arbitrary, many things that in an ordinary community would cause little comment often become magnified in importance. As already mentioned, rumors are very common, most of them of an alarmist nature. Numerous small and violently antagonistic cliques have grown up within the centers. Lengthy discussion and argument over what in normal life would be regarded as inconsequential is typical.<sup>5</sup>

*Developments of caste attitudes.*—Practically all the évacués are of Japanese ancestry, while the Government officials are Caucasian. The administration has better eating and housing facilities, and members of the administrative staff have much greater social security than have the evacuees. Such a social situation where one racial group does the administering and another is administered leads inevitably to a caste distinction.

*Disillusionment in American democracy.*—Most of the younger évacués have been brought up in American schools and indoctrinated in the ideals of American democracy, which teaches, among other things, that racial discrimination is undemocratic. To many of these people the evacuation from the West Coast was a shocking contradiction on the part of the Government of this basic teaching. The fact that no distinction was made even for war veterans or families with sons in the United States Army led to the embitterment of many people. One man, for instance, who was a veteran of the last war and who was formerly a very patriotic American citizen gradually got to brooding over his treatment as a result of the evacuation order and eventually became the leader of an anti-American group.

*Wardship.*—People in the centers are provided with food and shelter, however inadequate they may be. They are also relieved of all responsibility for making decisions affecting the community, since these decisions are made by the Government. As

<sup>5</sup> Similar social conditions are typical of the internment camp for British and Americans in Hong Kong. See Alsop's articles in the Saturday Evening Post for January 9 and 16, 1943.

a result there is beginning to grow up an attitude of dependency on the Government, a loss of individual initiative on the part of some individuals. The centers also represent security in contrast to the insecurity of the outside world. This is perhaps one of the most significant developments of life in the centers, because it means that many of the people now in the centers may never leave regardless of what opportunities may be offered to them. It is easier to sit back and let someone else provide the food and shelter and make the decisions than to undertake the burden of life in a competitive society.

PRESENT POLICY OF WAR RELOCATION  
AUTHORITY

The War Relocation Authority came into the picture of evacuation shortly after the original evacuation order. The original plan of the Authority was to assist persons excluded from certain areas in finding work and to provide food and shelter for those who could not. The work was not (and is not) restricted to persons of Japanese ancestry. However, as is indicated in the first

part of this paper, the relocation centers for Japanese came into existence through a number of unforeseen factors. Since last summer, however, the Authority has been concerned with the problem of how to get people out of the centers and back into American life. In this connection, a number of specific things have been done. Last October a special leave policy was developed whereby individuals could apply for leave from the center if they had a job or some other means of support. In February, 1943, the Army reopened its ranks to a limited number of Japanese-Americans.

In connection with the general policy of resettlement now of primary concern to the Authority, there are a number of special problems that are rather difficult to overcome. American public opinion does not always distinguish between our Japanese enemies in the Pacific and the Japanese-American minority group in this country. The growth of wardship and institutionalization in the relocation center residents themselves is another factor that tends to perpetuate the existence of centers.

BOTANY.—*Killipiella*, a new Colombian genus of *Vacciniaceae*.<sup>1</sup> A. C. SMITH,  
Arnold Arboretum, Harvard University. (Communicated by WILLIAM R.  
MAXON.)

Among many plants of unusual interest from the Chocó region of Colombia, E. P. Killip obtained in 1939 a specimen of the family *Vacciniaceae* that apparently represents a new genus. At first glance this plant, with its stiff parallel-veined leaves and 1-flowered bracteate inflorescences, resembles the family *Epacridaceae*, which is scarcely to be expected from the region. Examination of the flowers proves it to belong to the *Vacciniaceae*, in which it is only remotely related to described genera. It is a pleasure to dedicate the new genus to the collector, my colleague and friend, in appreciation of his invaluable work on the flora of Colombia. The accompanying illustration has been prepared by Gordon W. Dillon.

*Killipiella* A. C. Smith, gen. nov.

Calyx cum pedicello minuto articulatus, tubo

conico-cupuliformi, limbo erecto quam tubo longiore fere ad basim 4-diviso, lobis papyraceis textura bracteis similibus. Corolla cylindrico-conica, lobis 4 sub anthesi conspicuis lanceolatis demum valde reflexis. Stamina 8 similia corollam subaequantia sub anthesi exserta, toro basi corollae inserta, filamentis liberis vel inter se basi leviter cohaerentibus, antheris basim versus dorsifixis gracilibus rigidis erectis, thecis minute granulosis basi conspicue appendiculatis, tubulis quam thecis fere duplo longioribus gracilibus copiose sed minute tuberculatis per rimas introrsas apicales plus minusve elongatas dehiscentibus. Ovarium inferius, loculis 4, dissepimentis ut videtur demum evanescentibus, placentis parvis basim angulorum versus dispositis, ovulis maturis paucis plerumque 1-3 in quoque loculo (aliis abortivis) conspicue reticulatis. Discus ovarium coronatus pulvinatus apice depressus, stylo filiformi corollam subaequante sub anthesi exserto, stigmatate truncato.

<sup>1</sup> Received May 1, 1943.

Frutex epiphyticus, ramulis gracilibus elongatis, stipulis nullis. Folia alternata parva breviter petiolata nervis subimmersis copiosis subparallelis. Inflorescentia axillaris uniflora abbreviata, rhachi brevi bracteis imbricatis adpressis concavis obtecta, flore solitario terminali apice rhachis sessili.

**Killipiella styphelioides** A. C. Smith, sp. nov.

Frutex epiphyticus, ramulis 1–2 mm. diametro saepe nodis inferioribus radicanibus dense tomentellis (pilis brunneo-stramineis 0.5–0.7 mm. longis) demum glabrescentibus basi petiolorum incrassatis; petiolis 1–2 mm. longis sub- vel semiteretibus circiter 1 mm. diametro primo ut ramulis pilosis; laminis coriaceis anguste oblongis, 15–32 mm. longis, 4–8 mm. latis, basi rotundatis vel obtusis, apice acutis et saepe callosomucronulatis, glabris vel basi et margine basim versus pilosis, costa supra plana vel leviter impressa subtus prominula, nervis secundariis numerosis e basi adscendentibus venulis inconspicuis conjunctis interdum subtus prominulis; rhachi subtereti glabra 3–4 mm. longa circiter 0.7 mm. diametro bracteas 7–10 gerente; bracteis papyraceis in sicco stramineis oblongis vel ovatis, apice acutis vel subacutis, margine pilis crispatis 0.15–0.3 mm. longis dense ciliato excepto glabris, bracteis inferioribus minimis, superioribus ad 6.5 mm. longis et 3 mm. latis basim calycis circumdantibus; pedicello circiter 0.15 mm. longo inconspicuo; calyce 7.5–8.5 mm. longo, tubo 2–2.5 mm. longo et circiter 1.5 mm. diametro pilos paucos minutos brunneo-glandulosos gerente, limbo lobis inclusis 6–6.5 mm. longo, lobis oblongis basim versus 1.3–2 mm. latis superne gradatim angustatis, apice subacutis vel obtusis et inconspicue callosis, ut bracteis ciliato-marginatis, glabris vel interdum extus obscure brunneo-glandulosis; corolla glabra tenuiter carnosae circiter 10 mm. longa et 2 mm. diametro ante anthesin apicem versus gradatim angustata, lobis 5–7 mm. longis et basim versus circiter 1.5 mm. latis, ad apicem subacutum angustatis, margine leviter inflexo tenuioribus et obscure undulatis; filamentis ligulatis tenuiter carnosis 3–3.5 mm. longis circiter 0.3 mm. latis margine parce pilosis, antheris 7.5–9 mm. longis, thecis 2.5–3 mm. longis, appendice basali conspicua 0.2–0.5 mm. longa saepe subspathulata, tubulis 5–6 mm. longis; disco glabro circiter 0.5 mm. alto et basi 1 mm. diametro.

Type in the U. S. National Herbarium, no. 1771962, collected in dense forest of the Corecovo region, upper Río San Juan, ridge along Yeracuí Valley, Intendencia El Chocó, Colombia, altitude 200–275 meters, April 24 or 25, 1939, by E. P. Killip (no. 35222).

Although the curious plant here described is obviously a member of the Vacciniaceae, I am unable to refer it to any described genus. At first appearance it does not suggest the known members of the family, its stiff leaf-blades, striate with copious ascending veins, and its 1-flowered profusely bracteate inflorescences giving it a very distinctive aspect. The superficial resemblance of *Killipiella* to the family Epacridaceae is striking; its foliage is remarkably similar to that of *Styphelia* spp., while its inflorescences are precisely matched, in general aspect, by those of certain species of *Epacris* and *Styphelia*. Examination of the flower, with its inferior ovary and typical vacciniaceous stamens, indicates the true place of the Colombian plant. The deeply lobed calyx-limb, which is similar to the bracts in texture, the corolla with elongate reflexed lobes, the slender stiff anthers with appendaged bases and tuberculate tubules, the conspicuous pulvinate disk, and the few and reticulate ovules are all highly noteworthy features.

In the most recent general revision of the Vacciniaceae, Sleumer (Bot. Jahrb. 71: 375–510. 1941) does not emphasize the traditional distinction of two tribes, the Vaccinieae and the Thibaudieae, although he does base the major divisions of his key upon this cleavage. In 1932 (Contr. U. S. Nat. Herb. 28: 320), I briefly discussed the intangible nature of the two tribes, and since then I have been forced to the conclusion that such tribes are entirely artificial. Such a genus as *Killipiella*, for instance, demonstrates relationships with members of both tribes, although it has no close relatives in either. An ultimate revision of generic lines in the Vacciniaceae will probably be based primarily upon staminal characters rather than upon such indefinite features as size and texture of corolla.

*Killipiella* appears to be a very isolated genus. Possibly *Disterigma* (Kl.) Niedenzu is its closest relative, but in that genus the pedicel is obvious and bears two large clasping bracteoles at its summit. The inflorescence bracts of *Killipiella* are somewhat suggestive of these,

but they apparently arise from the rachis, the actual pedicel being reduced to an inconspicuous length. I have interpreted the inflorescence of *Killipiella* as consisting of a short rachis, bearing several imbricate bracts and a terminal subsessile flower. If this interpretation is correct, such an inflorescence is probably a reduction from the racemose several-flowered type which is common in the family. The deeply cleft

calyx-limb and corolla of the new genus are unlike these organs in *Disterigma*, while the proportionately short filaments, the basal anther-appendages, and the conspicuous disk further differentiate it. The copiously tuberculate anther-tubules of *Killipiella* are not matched in any other vacciniaceous genus known to me, the tubules elsewhere being smooth, or in some cases obscurely tuberculate at the very base.

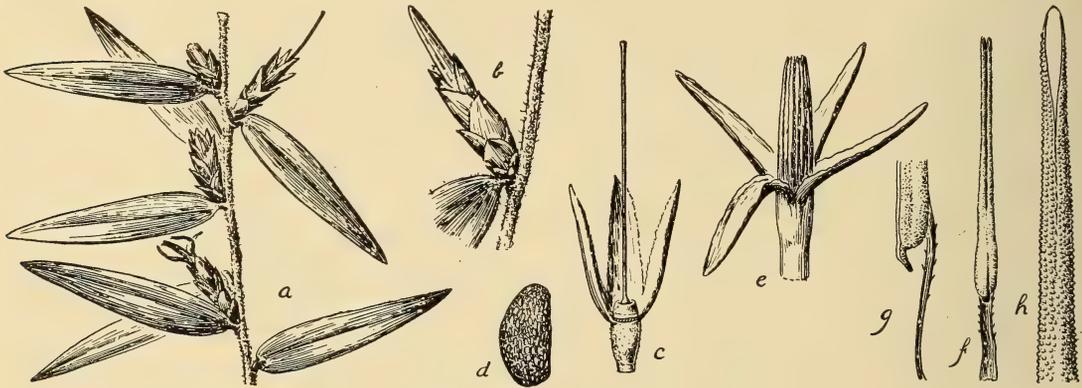


Fig. 1.—*Killipiella styphelioides*: a, Portion of branchlet, with four inflorescences, the lowermost with corolla in position,  $\times 1$ ; b, an inflorescence, with projecting corolla-bud,  $\times 2$ ; c, calyx, with one lobe removed, showing disk and style,  $\times 3$ ; d, ovule,  $\times 12$ ; e, corolla and stamens,  $\times 3$ ; f, stamens, introrse view,  $\times 4$ ; g, detail of base of stamen,  $\times 6$ ; h, detail of apex of tubule,  $\times 50$ .

BOTANY.—*Stem and foliage scab of sweet potato* (*Ipomoea batatas*).<sup>1</sup> ANNA E. JENKINS, Bureau of Plant Industry, Soils, and Agricultural Engineering, and AHMÉS P. VIÉGAS, Instituto Agrônômico do Estado de São Paulo, Brazil.

New findings in widely separated parts of the world of a previously little known but destructive disease of sweet potato (*Ipomoea batatas* Poir.), including the discovery of a hitherto unknown stage in the life history of the pathogen *Sphaceloma batatas* Saw., are here reported. It seems desirable also to review the two sole accounts<sup>2</sup> of this disease, since these earlier records, in Japanese, are not readily available to occidental readers.

#### HISTORICAL

In 1931, Sawada (6) reported the occurrence in Formosa of what he termed the

<sup>1</sup> Received March 30, 1943.

<sup>2</sup> For a translation of these two articles the writers are indebted to K. Katsura.

“bud stunting disease” of sweet potato. This had been present in Formosa since as early as 1910, as shown by the 19 specimens cited in connection with the description of the pathogen. The first of these, as well as five others, were gathered by R. Suzuki. It has been learned, however, from correspondence with Sawada (1938) that Suzuki did not realize at the time that a new disease was concerned. “When the disease is severe,” Sawada states (6), “it is impossible to correct it.” He continues:

“The disease is severe in localities where rain, dew, or mist is abundant. In high mountainous regions sweet potatoes grown at high elevations are easily attacked, because of abundant mist; also those grown in shaded places because of dews. Among

sweet potato varieties 'Red Skin' is the most susceptible."

In 1937, K. Goto<sup>3</sup> reported (2) severely diseased sweet-potato vines from Kagoshima-Ken, Amami Islands, as affected by Sawada's bud stunting disease. He noted: "The writer received a specimen of diseased potato stems and leaves from Mr. Taro Hōko of Kagoshima-Ken, on September 23 of this year (1937), with a note by him stating that there is an outbreak of the disease every year in the Amami Islands, and asking the author's opinion regarding the disease. He was of the opinion that the disease is caused by a fungus belonging to *Sphaceloma*, since it resembles anthracnose of grapes." (Fig. 1, C.)

Goto referred to the vine disease of sweet potatoes as "shoot scab." It is here called "stem and foliage scab."

#### GEOGRAPHIC RANGE

In September, 1937, R. G. Oakley, of the United States Bureau of Entomology and Plant Quarantine, found this same disease on the island of Guam; he sent specimens to his Bureau, whence they were referred to the senior writer, who made the diagnosis. The symptoms represented (Fig. 1, B) were entirely in agreement with the description. A specimen from Guam was then sent to Sawada, who was of the same opinion and who contributed part of the type specimen of *Sphaceloma batatas* (Fig. 1, A).

In 1938 and 1939 Oakley again sent specimens of the disease from Guam. In transmitting the specimen of 1938 (Guam 726) he wrote<sup>4</sup> that "the appearance of sweet potatoes affected by the disorder is very unusual as they, in some cases, grow straight upwards a foot higher than vines growing normally." He has furnished a summary of the prevalence of the disease in Guam during 1937-1939 as follows:

"The disease was plentiful in 1937 when patches of infected vines could be discerned at a distance of 25 yards by the straight

and high growing shoots," these extending "above the normal growth. Field infections in 1938 were less plentiful, and in 1939 diseased vines could rarely be found and then only after extended search."

In Guam, where sweet potatoes have long been cultivated, only two previous references to diseases of the crop have been found. During Weston's (7) plant-disease survey of the island in 1918, he reported white rust (*Albugo* sp.). Several years earlier, when David T. Fullaway, entomologist of the Hawaii Agricultural Experiment Station, made an entomological survey of Guam (1), he found "sweet potatoes badly blighted by a fungus disease." In 1938, replying to an inquiry, accompanied by a photograph of a specimen from Guam (Fig. 1, B), he wrote that he believed this disease was the same as that discovered by Oakley in 1937, although it was difficult to remember over so long a period. About this time replies to similar inquiries were received as follows: O. H. Swezy, of Hawaii, who made an insect pest survey in Guam in 1936, wrote: "My recollection is that the leaves [of sweet potatoes] were always in good condition, except for a small amount of caterpillar work, which was distinctly different from the condition shown in your photos." G. O. Ocfemia stated that so far as he knew, stem and foliage scab had not been found in the Philippines. G. K. Parris, who catalogued the plant diseases of Hawaii (4), wrote that the disease had not been recorded in that Territory.

In Brazil stem and foliage scab of sweet potatoes was discovered on plants growing on the experiment farm of the Instituto Agronômico at Campinas, first in January, 1939, by A. S. Costa, and again in February, 1940, by O. Boock. Diseased specimens gathered at Campinas are similar to those from Pacific regions. A specimen of diseased sweet-potato leaves from Alagoinhas, Baía, Brazil, collected in March, 1937, by H. S. Fawcett and A. A. Bitancourt resembles closely the specimen from Campinas and evidently represents the same disease. It was collected as a possible *Sphaceloma* disease, but upon microscopic examination in São Paulo no organism was distinguished,

<sup>3</sup> Laboratory of Black-rot Control, Agricultural Experiment Station, Tiba, Japan.

<sup>4</sup> Letter dated June 5, 1938, addressed to E. R. Sasser, Division of Foreign Plant Quarantine.

nor was any isolated.<sup>5</sup> Such a situation is not unusual in the case of infection by species of *Sphaceloma*. *S. batatas* was scant on the material from Guam examined microscopically; the specimens sent in 1938 were picked fresh and forwarded by clipper mail but cultures from them yielded negative results as did those made from specimens sent by Sawada in August, 1938. Goto, however, succeeded in isolating the organism.

#### SYMPTOMS

Symptoms of the disease on leaves as described by Sawada are as follows:

"On leaves, veins are mostly attacked; spots small, round or oblong, slightly concave, cinnamon or vinaceous tawny, 1–2.5 mm in diam., mostly in groups, which later coalesce; outer surface of more or less corky appearance, depending on the degree of the attack; leaves become curled or their growth checked, petioles curled, veins shrunken."

Sawada did not describe stem cankers, although these are present on specimens that he sent (Fig. 1, A).

Goto states that the disease appears to attack young organs, and that the growth of leaves and stems becomes irregular and produces many abnormal shapes, as well as stunting of petioles and blades. The following description of stem cankers is from Goto's account:

On the extreme tip of the shoot and somewhat below, spots appear as flat or somewhat raised purple brown dots, depressed at the center, with a gray or light brown border. The marginal region appears water-soaked when the weather is damp. Farther downward the diseased spot becomes gradually larger, 0.5–3 mm, and is circular, oblong, or spindle-shaped, or intermediate between these shapes, somewhat depressed, gray or brown, and somewhat roughened or scablike. Where the stem is green, the spot is surrounded by a narrow purple margin, which is sometimes depressed. Dark brown spots also appear on the attacked area. Where cankers are numerous they coalesce,

forming a large scab. Spots on petioles are of similar appearance to those on stems; however, they seem a little larger, over 5 mm in length. All the spots become whitish with age.

The stem cankers on the specimens from Brazil agree with those described by Goto. On the leaves, however, interveinal spots are fully as numerous as those on veins.

#### THE PATHOGEN

Sawada's illustration of *Sphaceloma batatas* is reproduced in Fig. 2, D, and his description of the fungus is given below:

#### *Sphaceloma batatas* Saw.

Mycelium scanty, penetrating the cell walls of the diseased tissue, colorless, septate, 2–2.5 $\mu$  in diameter, acervuli colorless, forming under the epidermis and later become exposed by rupturing the epidermis, 12–25 $\mu$  in diameter, with 1 or 2 layers of stroma, cells polyangular, about 4 $\mu$  in size, upon which many conidiophores are produced. Conidiophores short, single celled, 6–8 $\mu$  in length, conidia oblong, colorless, single celled, smooth, 6–7.5 $\mu$  by 2.5–3.5 $\mu$ .

On the material that Goto studied he found the acervuli to arise subcuticularly. He gave the following measurements: acervuli, 14–61 $\mu$  in diameter, with some of those that have united once reaching over 109 $\mu$ ; conidiophores, about 10 $\mu$  long and 3 $\mu$  wide; conidia 4.2–9.3 by 2.4–3.3 $\mu$ , or about the same as those of the Formosan type.

Referring to the fact that *Sphaceloma* fungi are difficult to isolate because of their slow growth, Goto reported that he was able to isolate *S. batatas* by placing a piece of diseased stem upon onion agar after it had been dipped in mercuric chloride (1:1000) for about one minute and washed. In the first set of cultures one out of eight tubes showed growth after seven days; in the second, two tubes out of eight. This growth was similar to cultures of *S. rosarum* from rose, *S. tsugii* from *Paulownia*, and *E. fawcettii* from *Citrus*. The cultures grew slowly and gradually became reddish brown and raised in the form of a crust.

*Sphaceloma* was not detected on specimens of stem and foliage scab from Campi-

<sup>5</sup> Data furnished by A. A. Bitancourt, Instituto Biológico, São Paulo, Brazil, who contributed the specimen from Alagoinhas.

nas, but on stem cankers an ascomycete of the genus *Elsinoë* (3) was present. Means are not available at this time to show whether the *Elsinoë* is the perfect stage of *S. batatas*. It is here suggested that it may well be; for in all species of *Sphaceloma*

where the life history is known, *Elsinoë* has proved to be the ascogenous stage. It thus seems feasible to treat *S. batatas* as the conidial stage of the *Elsinoë* discovered on sweet potato stems in Brazil. This is described as follows:

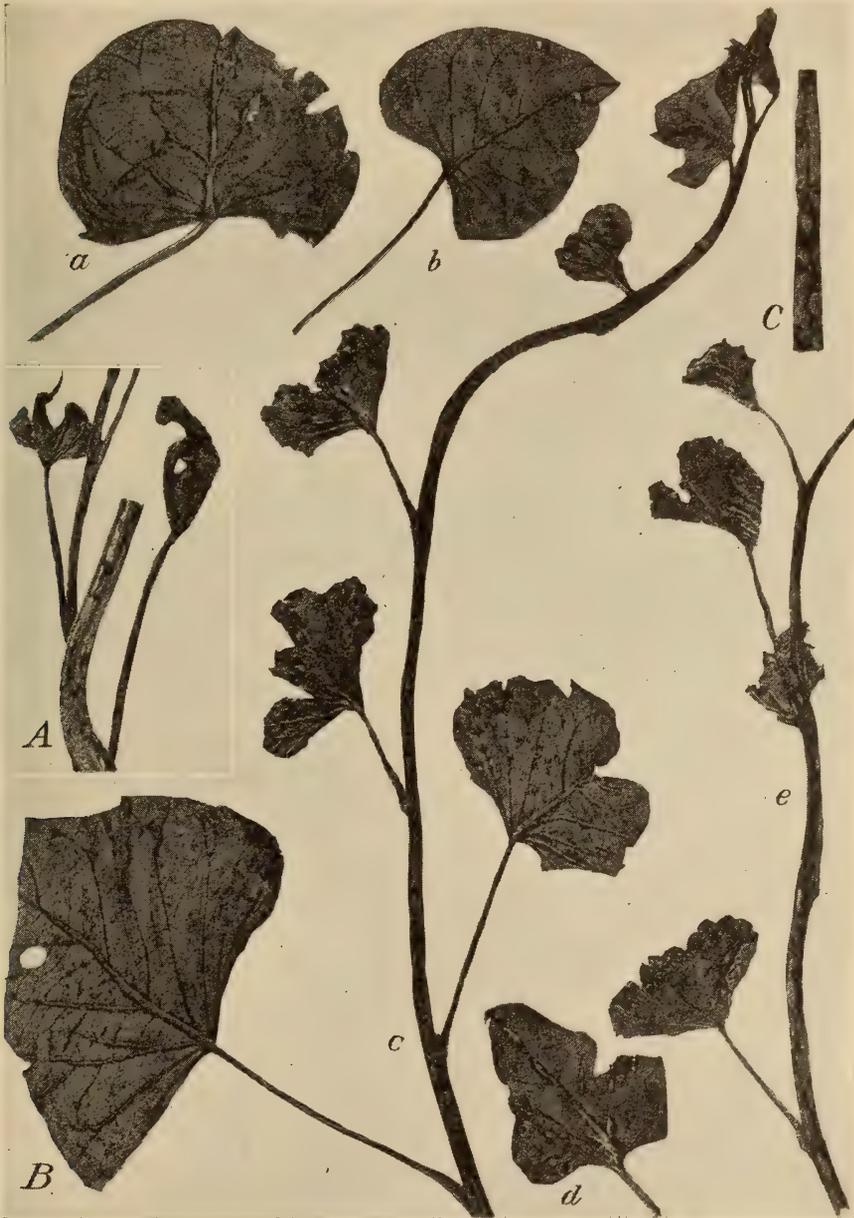


Fig. 1.—Stem and foliage scab of sweet potato caused by *Sphaceloma batatas* Saw.: A, From Taihoku, Formosa, June 25, 1925, K. Sawada, part of the type specimen, received from Sawada in August, 1938,  $\times 1$ ; B, from Radio Hill, Guam, September, 1937, R. G. Oakley,  $\times 1$ ; C, from Amami Islands, Japan, September, 1937, T. Tamotu, received from Goto, September, 1939,  $\times 1$ .

*Elsinoë batatas* Viégas and Jenkins, sp. nov.

Fig. 2, A-C

Maculae in foliis plerumque circulares, parvae, cinnamomeo-brunneae; cancri in caulibus circulares, elliptici vel elongati, purpureo-brunnei interdum centro pallidiores; hyphae intraepidermicales vel subepidermicales demum fere superficiales, atro-cinereae, stromata  $20-60 \times 16-20 \mu$  formantes; asci in stratum singulum dispositi, globosi, 4-(6?) sporici,  $15-16 \mu$  longi,  $10-12 \mu$  lati; ascosporae hyalinae,  $7-8 \mu$  longae,  $3-4 \mu$  latae, septatae, curvatae.

On leaves, spots on interveinal regions, veins, and petiole, generally circular, small, on the dry specimen "mikado brown"<sup>6</sup>; on stems, circular, elliptical or elongate, "Hays brown," often with "wood brown" center; mycelium at first intraepidermal, later passing to the subepidermal tissue, i.e., to the cortical parenchyma, which becomes hypertrophied, the cells dividing actively in different planes, lower cells of this tissue divide longitudinally, collen-

<sup>6</sup> The color readings given in quotations are based on Ridgway's color standards (5).

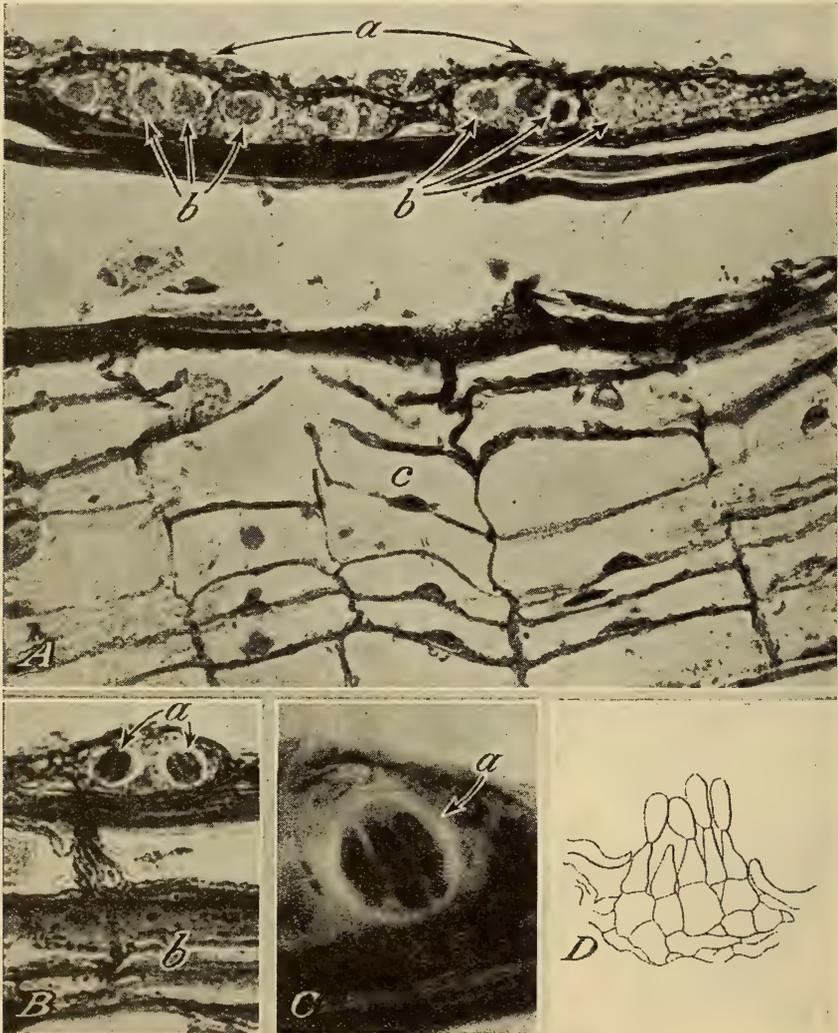


Fig. 2.—*Elsinoë batatas* on stem cankers of sweet potato from Campinas, São Paulo, Brazil: A and B, Sections showing fruiting layer of the *Elsinoë*, with asci (A, b and B, a) in a single series,  $\times 500$ ; A, c, and B, b, hypertrophied parenchyma in longitudinal sections; C, ascus from B,  $\times 1,800$ ; D, acervulus of *Sphaceloma batatas*, after Sawada.

chyma also hypertrophied, and soon the entire mass of tissue collapses, and the walls of the necrosed tissue darken; during this alteration of the tissue, hyphae of the fungus develop stromatically, at maturity they are external or practically so, dark gray, 20–60 by 16–20 $\mu$  with a single row of asci; asci globose, with 4–(6 ?) spores, 15–16 by 10–12 $\mu$ ; ascospores hyaline 7–8 by 3–4 $\mu$ , septate, curved. Conidial stage, *Sphaceloma batatas* Saw.

On leaves and stems of *Ipomoea batatas* Poir., Alagoinhas, State of Baía, and Campinas, State of São Paulo, Brazil.

Type specimen: Campinas, São Paulo, Brazil, January 14, 1939, A. S. Costa (Herb. Inst. Agron. de São Paulo 2726 and Myc. Coll. Bureau of Plant Industry 74289).

While it is likely that *Elsinoë batatas* might be introduced into new regions on slips of sweet potatoes, there is no indication as to whether it might be carried also on dormant tubers, which seems less plausible.

#### SUMMARY

Stem and foliage scab of sweet-potato vines was first reported from Formosa in 1931 by Sawada, for the period 1910–1928. In 1937 Goto identified the disease from the Amami Islands. Their accounts of the disease are the only ones previously published.

Specimens collected in Guam in 1937 by Oakley are diagnosed as affected by stem and foliage scab. In the field the disease could be recognized by the upright growth of the vines, as compared with their normal growth. Sweet potatoes in Guam "badly blighted by a fungus disease" in 1911 may have been affected by this malady.

Stem and foliage scab was discovered in Campinas, São Paulo, Brazil, by Costa in 1939, and by Boeck in 1940, and also in Alagoinhas, Baía, Brazil in 1937, by Fawcett and Bitancourt.

Symptoms of the disease as described on leaves by Sawada and on stems by Goto are given, as well as Sawada's description of the pathogen which he named *Sphaceloma batatas*.

An ascomycete of the genus *Elsinoë*, discovered on cankers of stem and foliage scab from Campinas, is regarded as the perfect stage of *S. batatas* and is described as *E. batatas*.

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ORNITHOLOGY.—*A new honey-guide from Cameroon*.<sup>1</sup> HERBERT FRIEDMANN, U. S. National Museum.

W. E. C. Todd, of the Carnegie Museum, Pittsburgh, has recently forwarded to me for study and identification three little honey-guides from Cameroon. Two of these are *Indicator exilis exilis*, but the third one

does not fit any known species. It is apparently an adult bird and seems sufficiently different from the first two to warrant naming. Because it occurs in the same general area as *I. e. exilis*, it can not be described as a race of that species and must therefore be treated as a distinct species. It is proposed to call it—

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received May 6, 1943.

**Indicator propinquus**, n. sp.

*Type*.—Carnegie Mus. no. 118425, ♀, collected at Donenkeng, Bafia, Cameroon, April 25, 1934, by Jacob A. Reis, Jr.

*Description*.—Similar to *Indicator exilis exilis* but with the forehead, crown, occiput, nape, and interscapulars more greenish and definitely streaked with dusky; the lores, cheeks, auriculars, and entire underparts paler and more greenish, less olive-gray, and the bill slightly more swollen. Forehead, crown, and occiput olive lake, the crown and occiput streaked with dusky olive (the streaks formed by dark shaft stripes); "mantle," i.e., interscapulars, similar but with the dusky streaks wider; back, lower back, rump, and upper tail coverts very dark olive-brown, the feathers conspicuously edged with olive lake tinged with olive-ocher (as in *exilis*); upper wing coverts and remiges dark olive-brown, the coverts completely edged with olive-ocher, the remiges externally so (as in *exilis*); tail as in *exilis*—the median rectrices very dark olive-brown to clove brown, the others whitish merely externally edged and terminally broadly tipped with dark olive-brown to clove brown; lores, cheeks, auriculars, and sides of neck pale citrine-drab; chin and upper throat whitish streaked with pale citrine-drab; lower throat, breast, and sides deep olive-buff streaked with citrine-drab (shaft streaks); upper abdomen slightly paler and buffier and with the streaks ashier; lower abdomen, thighs, and under tail coverts pale creamy cartridge buff; bill chaetura black (when fresh); feet water green (when fresh).

*Measurements of type*.—Wing 72, tail 42.5; culmen from the base 8; height of bill at angle of gape 4.8, tarsus 14; middle toe without claw 11 mm.

*Remarks*.—It may seem hazardous to describe a new honey-guide from a single specimen when the differences between it and the fairly similar *Indicator exilis exilis* are rather slight, but we may recall that a parallel situation is to be found in the larger species *I. maculatus* and *I. feae*. Thus, in speaking of the for-

mer species, Bannerman (*The Birds of Tropical West Africa* 3: 408. 1933) writes that "unless handled, this honey-guide is impossible to distinguish from *Indicator feae*, and even then the greatest care must be exercised." The two species apparently occur together, as do also the two small forms *I. exilis* and *I. propinquus*.

The possibility of the type of *I. propinquus* being a seasonal variant of *exilis* is ruled out by the fact that I have compared it with specimens of the latter species taken in January, March, April, July, August, October, and December. There is no seasonal plumage variation in *exilis*.

Unfortunately I have had no opportunity to examine material of the recently described *Indicator appelator* Vincent (Bull. Brit. Orn. Club 53: 130. 1933), known so far only from the Mozambique-Nyasaland border, a couple of thousand miles to the southeast of Cameroon. However, in the description of *appelator* it is stated that it has the "upper parts uniform and not heavily striated . . .," although "the dark centres to the feathers are evident in striations on the forehead and crown, but do not extend on to the nape . . ." The bill appears to be very similar to that of *propinquus*, "shorter and narrower than any *minor*—in fact, of similar length to *exilis*, but more swollen." Additional information and material may some day demonstrate the conspecificity of *appelator* and *propinquus*, but it would be mere guess work to claim any such degree of relationship now. Chapin (Bull. Amer. Mus. Nat. Hist. 75: 540. 1939) writes that "*appelator* . . . must be a very close ally" of *exilis*.

I am indebted to Mr. Todd for permission to study his material and to describe the new form included; to J. T. Zimmer, of the American Museum of Natural History, and to Dr. H. C. Oberholser, of the Cleveland Museum of Natural History, for generous loans of pertinent material. Through the cooperation of these institutions I have been able to study a series of 10 specimens of *Indicator exilis exilis* as well as a good series of the larger but less pertinent *Indicator conirostris*.

ICHTHYOLOGY.—*Descriptions of a new genus and a new species of Parodontinae, characinid fishes from South America.*<sup>1</sup> LEONARD P. SCHULTZ, U. S. National Museum, and CECIL MILES, Escuela Superior de Agricultura Tropical, Cali, Colombia.

During the latter part of 1942 we were comparing a specimen of a characinid fish from Colombia with *Apareiodon dariensis* Meek and Hildebrand. The Colombian fish had a color pattern almost exactly like the Panamanian species, but upon making further studies we found it differed in several respects and decided to describe it as new.

When Dr. Carl H. Eigenmann described the genus *Apareiodon* (Ann. Carnegie Mus. 10: 71. 1916; genotype: *Parodon piracicabae* Eigenmann), he referred *Apareiodon dariensis* Meek and Hildebrand to it. This latter species, from the Río Cupe at Cituro, Darién, Panamá, was based on three specimens, 105, 120, and 135 mm in length. The second specimen, U.S.N.M. 78379, has been carefully studied by us, and we must conclude that it belongs to the genus *Saccodon* Kner and Steindachner.

Since we desired to understand more thoroughly why Eigenmann would refer *A. dariensis* to the genus *Apareiodon*, we studied all the fishes of this subfamily available in the United States National Museum, and, in addition, Dr. W. M. Chapman, curator of fishes, California Academy of Sciences, kindly lent most of their specimens of this group for study by the senior author, who appreciates this courtesy exceedingly. While working with the material, it soon became obvious that a new genus should be recognized and that the generic relationships needed further examination. This new genus is described below.

Subfamily PARODONTINAE

*Parodontops*, n. gen.

*Genotype*.—*Parodon ecuadoriensis* Eigenmann and Henn, in Eigenmann, Henn, and Wilson, Indiana Univ. Stud., no. 19: 12. 1914 (Vinces, Ecuador; Colimes, Río Daule, Ecuador).

This new genus is based on paratypes of

*Parodon ecuadoriensis* Eigenmann and Henn from Vinces, Ecuador, U.S.N.M. 76974, and on another specimen of the same species, U.S.N.M. 83535, from Ecuador, measuring 117 mm in standard length.

After careful study of the 67-mm type (Indiana Univ. Mus. 13104) of *Parodon terminalis* Eigenmann and Henn (in Eigenmann, Henn, and Wilson, Indiana Univ. Stud., no. 19: 12. 1914) from Vinces, Ecuador, we conclude that it represents the young of *P. ecuadoriensis*.

*Parodontops* may be recognized from the other genera in the subfamily Parodontinae by its teeth, the two simple pectoral rays, i, 8 pelvics, along with the wide inner second sub-orbital and narrow interopercle.

The following key will aid in separating the various genera related to *Parodontops*, as well as indicate some of the generic differences that we have observed in this study.

KEY TO THE GENERA OF PARODONTINAE

- 1a. Teeth in upper jaw 0+6+0 and not in a straight line; edge of thin upper lip free and crossing middle of teeth on premaxillaries; no teeth in lower jaw, the edge of which is 5-lobed; pectoral rays ii, 12 to 16; pelvics usually i, 8 (Fig. 1).....*Saccodon* Kner and Steindachner
- 1b. Teeth in upper jaw normally 2+8+2 (2 teeth on each maxillary); upper lip not free but forming part of flesh between bases of teeth on premaxillaries.
  - 2a. Pectoral rays ii, 14 to 17; pelvics i, 8; no teeth on lower jaw....*Parodontops*, n. gen.
  - 2b. Pectoral fin rays i, 11 to i, 16; pelvics i, 7, rarely i, 8.
  - 3a. No teeth on lower jaw.....*Apareiodon* Eigenmann<sup>2</sup>
  - 3b. Teeth at sides of lower jaw normally 3+3, but one or more may be lacking in young.....*Parodon* Cuvier and Valenciennes<sup>3</sup>

<sup>2</sup> As near as can be determined from the descriptions, supplemented by specimens in the U. S. National Museum and from the California Academy of Sciences, we think the following species should be referred to this genus: *Parodon piracicabae* Eigenmann, 1907 (genotype); *Parodon affinis* Steindachner, 1879 (= *Parodon paraguayensis* Eigenmann, 1907); *Apareiodon davisi* Fowler, 1941; *Apareiodon hasemani* Eigenmann, 1916; and *Apareiodon itapicuruisensis* Eigenmann and Henn.

<sup>3</sup> As near as can be determined from the de-

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received April 9, 1943.

**Saccodon caucae**, n. sp. Figs. 1, 2.RAYADO; MAZORCO<sup>4</sup>

*Holotype*.—U.S.N.M. 121285, a specimen, 109 mm in standard length, collected in the upper Río Cauca north of Cali, Colombia, by Cecil Miles during October, 1942.

*Paratypes*.—All the paratypes bear the same data as the holotype and are deposited in the following institutions: United States National Museum, No. 120166, 130 mm in standard length; Escuela Superior de Agricultura Tropical (E.S.A.T.), Cali, Colombia, a specimen 145 mm in standard length, numbered 17 in their collection, Instituto de Ciencias Naturales, Bogotá (I.C.N.B.), a specimen 115 mm; Museum of Comparative Zoology (M.C.Z.), a specimen 135 mm.

These specimens usually occur in slowly flowing streams, lazily at rest on the bottom, frequently lying in groups of three or four and perfectly visible. When disturbed, they dart away extremely fast, often hiding among rocks or seeking protection by brush along the banks. They are difficult to catch.

*Description*.—The description is based on the holotype and paratypes listed above. Certain detailed measurements and counts were made, and these data are recorded in tables 1 and 2 along with similar data on the paratype of *S. dariensis* (Meek and Hildebrand) and for other species.

The head is a little depressed, the snout

descriptions, supplemented by numerous specimens in the U. S. National Museum and from the California Academy of Sciences, we think the following species should be referred to this genus: *Parodon suborbitalis* Cuvier and Valenciennes (genotype); *Parodon apolinari* Myers, 1930; *Parodon bifasciatus* Eigenmann, 1912; *Parodon buckleyi* Boulenger, 1887; *Parodon caliensis* Boulenger, 1895; *Parodon carrikeri* Fowler, 1940; *Parodon caudalis* Fowler, 1940; *Parodon gestri* Boulenger, 1902; *Parodon hilarii* Reinhardt, 1866; *Parodon nasus* Kner, 1859; *Apareiodon pongoense* Allen, 1942, which has two small teeth on each dentary of the type, as found when examined by the senior author; and *Parodon tortuosus* Eigenmann and Norris, 1900.

The holotype of several species listed here should be examined to determine with greater certainty whether each of these species really belongs in the genus *Parodon*, except the genotype, *P. suborbitalis*. In the young of *Parodon* the teeth on the lower jaw are often undeveloped, and probably *Apareiodon* and *Parodon* should not be separated generically.

<sup>4</sup> Corunta and Tusa are the common names of *Parodon suborbitalis* in the Magdalena Basin of Colombia.

rounded, caudal region a little compressed; nasal openings separated by a valvular flap and located just in front of the eye; gill membranes joined with a wide free fold across isthmus; no teeth on lower jaw, the lower lip 5-lobed; premaxillaries with six teeth, arranged in a broad V-shape, the two inner ones located farthest forward, no teeth on maxillaries; a fold of the upper lip covers pediculate bases of teeth;

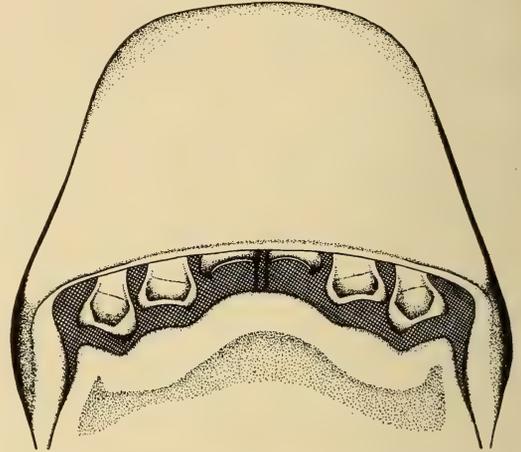


Fig. 1.—Underside of head, with enlargement of teeth and lips.

groove at sides of snout ending opposite posterior ends of dentary bones and not continuing opposite outer ring of suborbital bones; posterior margin of pupil in center of head; anus equal distance from rear base of pelvics and anal origin; insertion of pelvics equal distance from front of eye and midcaudal fin base; distance from pelvic insertion to anal origin 3.6 and snout to dorsal  $2\frac{1}{4}$ , depth 4.3, head 4.2, all in standard length; least depth of caudal peduncle 1.9 in head; second simply ray of dorsal not quite so long as first branched ray, posterior margin of this fin a little concave; first and second branched anal rays longest, rear margin of anal fin truncate; margin of pectoral fin a little rounded, that of pelvics truncate; caudal fin deeply forked, lobes pointed; adipose fin small, inserted over middle of base of anal fin; pelvics inserted under rear edge of dorsal fin base; five or six scales between anus and anal origin; the anterior rays of dorsal, anal, and paired fins have free membranes developed along the posterior edge of the rays that extend backward and partially cover the next ray, thus further increasing the stream-

line nature of this species and lessening resistance in rapidly flowing mountain streams; accessory pelvic scale present; the postcleithral process is broad and curves behind base of pectoral fin, more or less enclosing it dorsally and posteriorly; breast, belly, and all of body except head fully scaled.

Color: The general color is darker above, paler below, with three distinct rows of elongate black blotches on sides, the lower one be-

ginning behind head below lateral line consisting of five elongate black blotches; along lateral line are six black blotches; above the lateral line is a row of six or seven blackish blotches that are connected across the back by the same number of dark saddles, these more or less obscure anteriorly; lower surfaces of pectoral fins white, but upper surfaces with a wide darkish band distally and similar coloration on pelvics but less distinct; anal with a

TABLE 1.—COUNTS MADE ON VARIOUS SPECIES OF PARODONTINAE

Species	Number of fin rays																		
	Dorsal			Anal		Pelvics		Pectorals											
	iii, 9	ii, 9	ii, 10	ii, 6	ii, 7	i, 7	i, 8	i, 11	i, 12	i, 13	i, 14	i, 15	i, 16	ii, 12	ii, 13	ii, 14	ii, 15	ii, 16	ii, 17
<i>Apareiodon affinis</i> .....	—	3	6	8	—	16	1	5	8	3	—	—	—	—	—	—	—	—	—
<i>A. itapicuruensis</i> .....	—	—	1	1	—	2	—	—	—	2	—	—	—	—	—	—	—	—	—
<i>Parodon hilarii</i> .....	—	—	5	—	5	10	1	—	—	1	5	3	1	—	—	—	—	—	—
<i>P. suborbitalis</i> .....	—	1	12	—	13	24	—	—	—	7	9	8	—	—	—	—	—	—	—
<i>P. pongoense</i> .....	—	—	1	—	1	2	—	—	—	1	1	—	—	—	—	—	—	—	—
<i>P. apolinari</i> .....	—	—	8	—	8	16	—	—	—	—	4	7	4	—	—	—	—	—	—
<i>P. caliensis</i> .....	1	2	3	6	—	10	—	—	1	7	2	—	—	—	—	—	—	—	—
<i>P. nasus</i> .....	—	—	1	—	1	2	—	—	—	1	1	—	—	—	—	—	—	—	—
<i>P. tortuosus</i> .....	—	—	2	—	2	4	—	—	—	—	3	1	—	—	—	—	—	—	—
<i>Saccodon dariensis</i> .....	—	—	2	—	2	—	4	—	—	—	—	—	—	3	—	—	—	—	—
<i>S. cauae</i> .....	—	—	5	—	5	—	2	—	—	—	—	—	—	—	—	—	6	2	—
<i>Parodontops ecuadoriensis</i> .....	—	—	8	—	8	—	16	—	—	—	—	—	—	—	—	1	9	7	1

Species	Number of scales before dorsal fin							
	11	11½	12	12½	13	13½	14	14½
<i>Apareiodon affinis</i> .....	1	—	—	2	3	—	—	—
<i>A. itapicuruensis</i> .....	—	—	1	—	—	—	—	—
<i>Parodon hilarii</i> .....	—	—	—	2	—	—	—	—
<i>P. suborbitalis</i> .....	—	3	8	1	—	—	—	—
<i>P. pongoense</i> .....	—	—	—	1	—	—	—	—
<i>P. apolinari</i> .....	—	2	2	4	—	—	—	—
<i>P. caliensis</i> .....	—	—	—	—	—	1	2	2
<i>P. nasus</i> .....	1	—	—	—	—	—	—	—
<i>P. tortuosus</i> .....	—	—	—	1	—	—	—	—
<i>Saccodon dariensis</i> .....	2	—	—	—	—	—	—	—
<i>S. cauae</i> .....	—	—	1	—	2	2	1	—
<i>Parodontops ecuadoriensis</i> .....	—	—	1	2	—	—	—	—

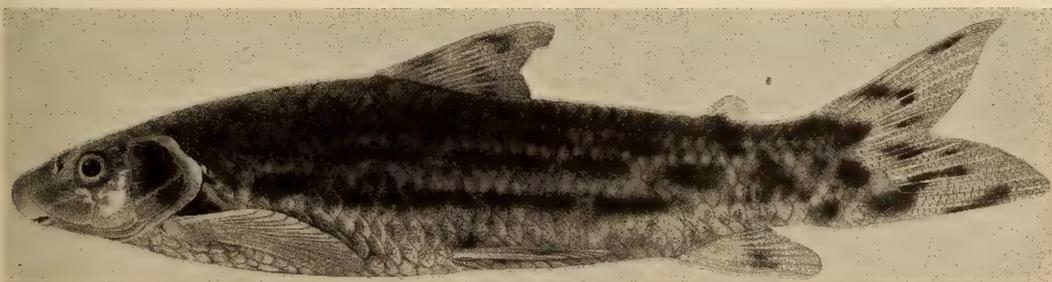


Fig. 2.—*Saccodon cauae*, n. sp.: Holotype (U.S.N.M. 121285), 109 mm in standard length. Photograph.

TABLE 2.—COUNTS AND MEASUREMENTS (IN HUNDREDTHS OF THE STANDARD LENGTH) MADE ON SPECIMENS OF SACCODON

Characters	<i>dariensis</i>		<i>caucae</i>			
	U.S.N.M. 78379	U.S.N.M. 121285	U.S.N.M. 120166	I.C.N.B. 63	E.S.A.T. 17	M.C.Z.
Standard length in millimeters.....	93.5	109	127	115	145	138
Length of head.....	22.3	23.9	22.8	22.2	—	22.7
Greatest depth of body.....	23.7	24.1	24.0	24.4	—	21.0
Diameter of eye.....	4.82	4.40	3.78	5.22	—	3.62
Length of snout.....	8.56	9.53	8.66	7.83	—	9.13
Width of interorbital space.....	9.10	10.1	9.84	9.57	—	9.86
Postorbital length of head.....	11.3	11.7	11.4	9.57	—	10.9
Least depth of caudal peduncle.....	11.8	12.4	11.8	12.2	—	10.1
Length of caudal peduncle.....	14.8	14.6	15.4	—	—	16.8
Snout to dorsal origin.....	48.0	47.0	44.9	47.8	—	43.1
Snout to adipose origin.....	85.4	84.8	84.6	87.9	—	82.0
Snout to anal origin.....	79.4	80.7	80.0	81.0	—	76.0
Snout to pectoral insertion.....	19.4	20.0	18.3	19.1	—	18.8
Snout to pelvic insertion.....	53.5	54.1	54.0	54.6	—	50.4
Length of longest dorsal ray.....	18.8	23.7	19.6	22.6	—	19.9
Length of longest anal ray.....	14.7	17.5	14.8	17.0	—	16.0
Length of longest pectoral ray.....	19.6	20.8	18.5	19.1	—	19.6
Length of longest pelvic ray.....	17.6	17.8	16.1	17.4	—	18.5
Length of longest upper caudal ray.....	—	26.5	—	23.5	—	22.8
Length of longest lower caudal ray.....	—	—	21.7	24.4	—	21.8
Snout to anus.....	67.6	69.2	68.2	69.6	—	64.8
Anus to anal origin.....	12.0	10.7	10.6	11.3	—	11.2
Dorsal base to adipose origin.....	29.5	29.9	29.0	—	—	29.0
Dorsal fin rays.....	ii, 10	ii, 10	ii, 10	ii, 10	ii, 10	ii, 10
Anal fin rays.....	ii, 7	ii, 7	ii, 7	ii, 7	ii, 7	ii, 7
Pectoral fin rays.....	ii, 12-ii, 12	ii, 15-ii, 15	ii, 15-ii, 15	ii, 16	ii, 16	ii, 15-ii, 15
Pelvic fin rays.....	i, 8-i, 8	i, 8-i, 8	i, 8-i, 8	—	—	i, 8-i, 9
Branched caudal rays.....	17	17	—	—	—	—
Scales in lateral line.....	36	40	41	41	39	41
Scales above lateral line.....	4½	4½	4½	4½	4½	4½
Scales below lateral line.....	3	3½ or 4	3½	3½	3½	3½
Scales around caudal peduncle.....	13	14	13	—	—	13
Scales in front of dorsal fin.....	11	13½	13½	—	—	13
Scales between dorsal and adipose fins.....	12½	14½	14	—	—	14

blackish blotch; dorsal with blackish pigment basally and a blotch distally on anterior rays; caudal fin irregularly barred with black blotches and two black spots basally; peritoneum dusky; a black spot in axis of pelvics.

Named *caucae* in reference to the Río Cauca of Colombia, where it was collected.

*Remarks.*—This new species differs from other members of the genus *Saccodon* as indicated in the key below.

KEY TO THE SPECIES OF SACCODON

- 1a. Pectoral fin rays ii, 15 to ii, 16; scales in lateral line 4 or 4½+39 to 41+3 or 3½.
- 2a. Dorsal rays ii, 10; anal ii, 7; pelvics i, 8; color pattern of elongate dark blotches arranged in three streaks along sides, each row consisting of 5 to 7 elongate blackish blotches; caudal fin with elongate black blotches, and a pair of large spots basally on caudal fin; anal with a

blackish spot.....*Saccodon caucae*, n. sp.

- 2b. Dorsal rays ii, 9; anal ii, 8; pelvics ? ii, 8; color plain, no spots or blotches on sides or on fins.....

*Saccodon wagneri* Kner and Steindachner<sup>5</sup>

- 1b. Pectoral fin rays ii, 12; scales in lateral line 4 or 4½+35 to 37+3; dorsal rays ii, 10; anal ii, 7; pelvics i, 8; branched caudal fin rays 17; 11 scales before dorsal fin; 12½ between bases of dorsal and adipose fins; color of 3 rows of oblong dark blotches along sides; black blotches in caudal fin, and a blackish blotch on dorsal and anal

<sup>5</sup> *Saccodon wagneri* Kner and Steindachner, Abh. Bay. Akad. Wiss. 10: 31, pl. 4, figs. 2, 2a, 1864 (Ecuador).—Günther, Cat. Fishes Brit. Mus. 5: 301. 1864 (Ecuador).—Eigenmann, Mem. Carnegie Mus. 9: 112, pl. 19, figs. 7, 7a. 1922 (western slope of Ecuador).

*Saccodon craniocepalum* Thomillot, Bull. Soc. Philom. Paris 6: 248. 1882 (Río Guayaquil). This species is referred to *wagneri* with some doubt as the description by Thomillot is lacking in detail and appears somewhat contradictory.

fins.....*Saccodon dariensis* (Meek and Hildebrand)<sup>6</sup>

<sup>6</sup> *Parodon dariensis* Meek and Hildebrand, Field Mus. Nat. Hist. Publ. Zool. 10: 84. 1913 (Río Cupe, Cituro, Panamá [Tuyra Basin]).

*Apareiodon dariensis* Meek and Hildebrand, Field Mus. Nat. Hist. Publ. Zool. 10: 271, pl. 17. 1916.—Eigenmann, Ann. Carnegie Mus. 10: 76. 1916 (western slopes of southern Panamá).—Eigenmann, Mem. Carnegie Mus. 9 (1): 111. 1922 (Tuyra Basin).—Breder, Bull. Amer. Mus. Nat. Hist. 57: 114, fig. 5a. 1927 (Río Tuguesa, Panamá).—Hildebrand, Publ. Field Mus. Nat. Hist., zool. ser., 22 (4): 248. 1938 (Río Cupe; Río Chucunnaque; Río Chiatí).

*Apareiodon compressus* Breder, Amer. Mus. Nov., no. 180: 4, figs. 3, 4. 1925 (Río Tuguesa,

Darién, Panamá).—Breder, Bull. Amer. Mus. Nat. Hist. 57: 115, figs. 5b, 6. 1927 (Río Tuguesa).—Hildebrand, Publ. Field Mus. Nat. Hist., zool. ser., 22 (4): 248. 1938 (Chucunnaque Basin).

The senior author has examined the type of *A. compressus*, A.M.N.H. 8408. The left pectoral fin has ii, 12 rays, the right one being broken off near its base; the dorsal is broken, but study shows ii, 10 rays; both pelvics are in good condition, with i, 8 rays each; anal ii, 7. The mouth also is injured. The free upper lip character is clear, but the positions of the teeth are not in a straight line as in *Parodon*. The lower lip is rounded, and the 5-lobed edge found in adults is not developed. I conclude that *A. compressus* is a synonym of *Saccodon dariensis* (Meek and Hildebrand).

ZOOLOGY.—*A new species of Cyclocoelum, a trematode from the catbird.*<sup>1</sup> C. COURSON ZELIFF, Pennsylvania State College. (Communicated by A. WETMORE.)

Four specimens of flukes belonging to the genus *Cyclocoelum* Brandes were collected from a dead catbird found in Adams County, Pa., during 1939 by Assistant Professor Merrill Wood, an ornithologist of the Zoology Department of Pennsylvania State College. They were presented to the author for identification and study. Three of them were in good condition and were stained with Delafield's hemotoxylin, a slight pressure being applied to the specimens between slides. No previous record has been found of a member of the genus *Cyclocoelum* in catbirds, and a study of the worms indicates sufficient anatomical differences to justify regarding them as representing a new species.

#### *Cyclocoelum dumetellae*, n. sp.

*Specific diagnosis*.—Body oblong, sides nearly parallel in middle, body slightly curved to right, narrowed slightly anteriorly and slightly rounded posteriorly, 8.5 mm long by 1.5 mm wide. Cuticle rough and scaly but not spiny. Oral sucker 0.27 mm in diameter, subterminal and rather faintly outlined. Acetabulum lacking. Pharynx 0.22 to 0.27 mm wide by 0.27 to 0.30 mm long. Prepharynx present. Esophagus 0.5 mm wide, short and somewhat sinuous. Intestinal caeca continuous in the posterior portion, typical for the genus. Excretory vesicle between the posterior arc and body wall, with lateral excretory canals. Testes nearly spheri-

cal, 0.52 mm in diameter, the posterior one occasionally slightly flattened anteroposteriorly. Anterior portion of vas deferens observed; vasa efferentia not seen. Cirrus sac 0.07 mm wide by 0.26 mm long, on right side reaching anterior intestinal arc but rarely farther posterior. Genital pore at the level of posterior portion of the pharynx. Ovary 0.26 to 0.30 mm in diameter, between the testes, but to right of and out of line with them. Seminal receptacle unobserved. Mehlis's gland oblong, approximately the size of ovary. Vitellaria extending from slightly posterior of anterior intestinal arc or fork to the posterior border of the posterior intestinal arc, mostly between the caeca and the margins with slight overlapping of the former in some areas; dorsal to caeca. Transverse vitelline ducts between ovary and posterior testis. Ootype and oviduct not observed. Laurer's canal apparently absent. Ova 60 $\mu$  by 120 $\mu$ .

*Host*.—*Dumetella carolinensis* (Linnaeus).

*Location*.—Air sac.

*Locality*.—Adams County, Pa.

*Type specimen*.—U.S.N.M. Helm. Coll. no. 36837; paratype, no. 36838.

*Remarks*.—Khan (1935) gives four groupings of species of the genus based on the relation of the ovary and testes and the intercaecal location of the uterus. One of the three specimens has the posterior testis somewhat oblong. Only one has slight overlapping of the caeca by the uterus. Other slight distortions or deviations might be mentioned that would exclude a speci-

<sup>1</sup> Received April 29, 1943.

men from a system such as that given by Khan. He lists 19 species, six being those described by himself, one of which, *C. nebularium*, has now been allocated to *Hoematotrephus* by Lal (1939). Bhalerao (1935) lists 11 species, one of which is new and seven of which are not listed by the former. Lal (1939) describes no new species, but he suggests that *Receptacoelum* be created for those species with a receptaculum seminis. He considers *Prohyptiasmus* Witenberg to be a synonym of *Cyclocoelum*. Yamaguti (1939) described *C. turusigi* from *Tringa erythropus*, which makes at least six species in sandpipers.

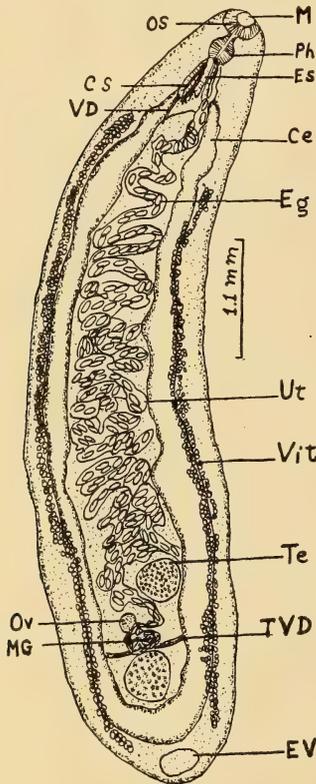


Fig. 1.—*Cyclocoelum dumetellae*, n. sp.: Ventral view. (CS, Cirrus sac; Ce, caecum; Es, esophagus; Eg, egg; EV, excretory vesicle; M, mouth; MG, Mehlis's gland; OS, oral sucker; Ov, ovary; Ph, pharynx; Te, testis; TVD, transverse vitelline duct; Ut, uterus; VD, vas deferens; Vit, vitellaria.)

Observation of the drawings of the species described by Khan (1935) indicates that the curved conditions of his specimens are characteristic of several species. This may be due to contact with the tissues of the host or to a typical habit of muscular contraction. After comparing the characteristics of the specimens with

those of about 30 other species, particularly North American species, considerable variation is noted. The closest similarity is with *C. microcotyleum* (Noble, 1933) and *C. obscurum* (Leidy, 1887). Harrah (1922) gives a more complete description of the latter.

*C. dumetellae* differs from the latter species in a less forward extension of the vitellaria, sinuous esophagus of uniform size, equal testes, and (if constant) in having the anterior testis near the left caecum; also from the former species by the uniform size, the lesser width, presence of an oral sucker, the diagonal relation of the testes, and the position of the ovary on the right side. The comparison with *C. obscurum* is therefore closer than with *C. microcotyleum*. Harrah (1922) has shown that the position of some organs in the body may be inverted in the same species. This condition or a misinterpretation of the surfaces may account for difficulties observed in drawings and descriptions. The species herein described differs from *C. ovopunctatum* Stossich, which is closely related to *C. obscurum*, by the difference in the testis-ovary ratio. It is not clear to the author from the more complete description of Harrah (1922) whether *C. obscurum* (Leidy, 1887) actually occurs in the jewfish and also in birds since most species of the genus have birds as hosts. The former reports it from the western willet (*Catoptrophorus semipalmata inornata*, formerly *Symphemia semipalmata inornata*). It seems likely that some error in labeling may account for the record for the jewfish. An authority whom the author consulted agrees with this view.

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# JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

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No. 9

PALEONTOLOGY.—*Jefferson's contribution to paleontology.*<sup>1</sup> ROLAND W. BROWN, U. S. Geological Survey.

Thomas Jefferson's life spanned the eventful interval of 83 years from 1743 to 1826. This was a restless time when men rebelled against political tyranny and sought freedom of body and mind to investigate nature, engage in legitimate business, and pursue happiness. Although he is known best for his great contribution to the political and humanitarian part of this movement, the many-sided Jefferson also wrote his name imperishably into the early annals of science in the United States.

If, in 1797, we could have peeped into the baggage that accompanied Jefferson from Monticello to Philadelphia, when he was inaugurated as Vice-President in the administration of John Adams, we should probably have been astonished at what we saw. One box contained some large bones and a manuscript describing them. This manuscript was communicated to the American Philosophical Society at Philadelphia on March 10, 1797, and was published in 1799.<sup>2</sup> The first paragraphs introduce and describe these bones and illustrate Jefferson's style:

In a letter of July 3d, I informed our late most worthy president that some bones of a very large animal of the clawed kind had been recently discovered within this state, and promised a communication on the subject as soon as we could recover what were still recoverable of them. It is well known that the substratum of the country beyond the Blue Ridge is a limestone, abounding in large caverns, the earthy floors of which are

<sup>1</sup> Substance of an informal communication to the Geological Society of Washington, April 14, 1943. Published by permission of the Director, U. S. Geological Survey. Received May 24, 1943.

<sup>2</sup> JEFFERSON, THOMAS. *A memoir on the discovery of certain bones of a quadruped of the clawed kind in the western parts of Virginia.* Trans. Amer. Philos. Soc. 4: 246-260. 1799.

highly impregnated with nitre; and that the inhabitants are in the habit of extracting the nitre from them. In digging the floor of one of these caves, belonging to Frederic Cromer in the county of Greenbriar [now in West Virginia], the laborers at the depth of two or three feet, came to some bones, the size and form of which bespoke an animal unknown to them. The nitrous impregnation of the earth together with a small degree of petrification had probably been the means of their preservation. The importance of the discovery was not known to those who made it, yet it excited conversation in the neighborhood, and led persons of vague curiosity to seek and take away the bones. It was fortunate for science that one of its zealous and well informed friends, Colonel John Stewart of that neighborhood, heard of the discovery, and, sensible from their description, that they were of an animal not known, took measures without delay for saving those which still remained. He was kind enough to inform me of the incident, and to forward me the bones from time to time as they were recovered. To these I was enabled accidentally to add some others by the kindness of a Mr. Hopkins of New York, who had visited the cave. These bones are,

1 st. A small fragment of the femur or thigh bone; being in fact only its lower extremity, separated from the main bone at its epiphysis, so as to give us only the two condyles, but these are nearly entire.

2 d. A radius, perfect.

3 d. An ulna, or fore-arm, perfect, except that it is broken in two.

4 th. Three claws, and half a dozen other bones of the foot; but whether of a fore or hinder foot, is not evident.

These bones only enable us to class the animal with the unguiculated quadrupeds; and of these the lion being nearest him in size, we will compare him with that animal . . . I will venture to refer to him by the name of the Great-Claw or *Megalonyx* to which he seems sufficiently entitled by the distinguished size of that member . . .

Then follows a comparison of the respective bones of the lion and *Megalonyx*. Jefferson concludes:

Let us only say then, what we may safely say, that he was *more* than three times as large as the lion: that he stood as preeminently at the head of the column of clawed animals as the mammoth stood at that of the elephant, rhinoceros, and hippopotamus: and that he may have been as formidable an antagonist to the mammoth as the lion to the elephant . . .

The remainder of the paper is devoted to speculations as to whether *Megalonyx* had become extinct. As Louisiana Territory had not yet been purchased and explored, Jefferson said: "Our entire ignorance of the immense country to the West and North-West, and its contents, does not authorize us to say what it does not contain." In support of this suggestion that *Megalonyx* might still be living in the western part of the country he submitted reports that carvings on rocks near the confluence of the Kanawha and Ohio Rivers were said to depict lionlike animals; and he recounted tales of settlers and adventurers who said they had heard the roar of strange beasts at night near their cabins and camps.

Unless it is already clearly understood where described fossil specimens have been placed so that future students may examine them, paleontologists should state explicitly how they have disposed of their material. Jefferson did not neglect this office but concluded his paper in somewhat the legal language of a will:

To return to our Great-Claw: I deposit his bones with the Philosophical Society, as well in evidence of their existence and of their dimensions, as for their safe-keeping; and I shall think it my duty to do the same by such others as I may be fortunate enough to obtain the recovery of hereafter.

These bones are now at the Academy of Natural Sciences of Philadelphia.

Jefferson now had an experience that may come to all paleontologists. It sometimes happens that after a paper has been published the writer discovers that another has anticipated his ideas. Thus, after his paper had been submitted, Jefferson was obliged to add a postscript in which he reports that in the *Monthly Magazine*, September, 1796, London, he had seen an account of animal remains dug up near the LaPlata River in Paraguay. He says:

This skeleton is also of the clawed kind, and having only four teeth on each side above and below, all grinders, is in this account classed in the family of unguiculated quadrupeds destitute of cutting teeth, and receives the new denomination of *Megatherium* . . . The *Megatherium* is not of the cat form, as are the lion, tyger, and panther . . . According to analogy then, it probably was not carnivorous, had not the phosphoric eye, and the leonine roar. But to solve satisfactorily the question of identity, the discovery of foreteeth, or of a jaw showing it had, or had not, such teeth, must be waited for, and hoped with patience. It may be better, in the mean time, to keep up the difference of name.

As this was the only article Jefferson published on fossils he may be classed as a one-paper paleontologist. His interest in paleontology, however, continued unabated, and during his Presidency he had some 300 specimens of mammoth and other bones from the celebrated Pleistocene locality at Big Bone Lick, Boone County, Ky., spread around on the floors of the White House. His generic name *Megalonyx* still stands. He did not propose a specific name for this creature, but this omission was appropriately remedied in 1822 by the French naturalist Desmarest who called it *Megalonyx jeffersoni*. The only assembled skeleton of this species may be seen in the museum of the Ohio State University, Columbus, Ohio. The animal was a ground sloth, of herbivorous habits, and not a lion or lionlike beast as Jefferson thought. *Megatherium* is a genus closely related to *Megalonyx*. Remains of both have been found in Pleistocene deposits, chiefly in caves, at widely scattered localities in North and South America.

Whether Jefferson should be considered an inventor rather than a scientist is a question I shall not attempt to discuss. He was certainly a generous and enthusiastic patron of science and was a potent cause that science was cultivated by other men. He was apparently a member of every literary and scientific society in the country and was in touch with the foremost American scientists of the day—Benjamin Franklin, Joseph Priestly (who had taken up residence in Pennsylvania), Caspar Wistar, etc. He also corresponded with foreign scientists. The first president of the Amer-

ican Philosophical Society was Benjamin Franklin, the second was David Rittenhouse, and the third was Thomas Jefferson.

Jefferson once proposed the establishment of a National Academy of Sciences with headquarters at Washington and branches in every State. This plan, however, did not materialize in his day. It nevertheless casts a revealing light on his mental processes. As everyone knows, he was an individualist who believed in personal initiative and endeavor. He applied this idea in the advocacy of States' rights and against paternalism in the Federal

Government. However, he did not find this attitude inconsistent with the use of Federal money for the advancement of science and the diffusion of knowledge which promoted the welfare of the people.

Of all the sciences, stratigraphic geology seemed least interesting to Jefferson. He said that he "could not see any practical importance in knowing whether the earth was six thousand or six million years old, and the different formations were of no consequence so long as they were not composed of coal, iron, or other useful minerals."

PALEONTOLOGY.—*A revision of the genus Steganocrinus.*<sup>1</sup> EDWIN KIRK,  
U. S. Geological Survey.

Nearly 50 years have passed since the publication of Wachsmuth and Springer's monographic treatment of the North American Crinoidea Camerata. Material collected for some years prior to 1897 and since that time has added considerably to our knowledge of many of the genera and rendered revisions of some of them imperative. Springer had intended to do this work and did so for several genera. Some 30 years ago I pointed out to him that a new genus was represented within the group of species referred to *Steganocrinus*. He agreed that this was so. Doubtless owing to the pressure of more important affairs and ill health, Springer passed *Steganocrinus* by, along with many other projects he had in mind. Several species have erroneously been described under *Steganocrinus*, and one genus has been based on a typical form of the genus. At this time the more obvious synonymies and incorrect citations will be dealt with. The type of *Steganocrinus concinnus* (Shumard) has been found and proves to be much like the original figure of Shumard and quite unlike the forms subsequently referred to it by authors.

Genus *Steganocrinus* Meek and Worthen

*Genotype*.—*Actinocrinus pentagonus* Hall, Meek and Worthen, 1866, p. 195.

*Synonym*.—*Shumardocrinus* Miller and Gurley. (*Genotype*: *Actinocrinus concinnus* Shumard, Miller and Gurley, 1895, p. 40.)

<sup>1</sup> Published by permission of the Director, U. S. Geological Survey. Received May 20, 1943.

Meek and Worthen (1866, p. 195) described the genus *Steganocrinus*, including in it *Actinocrinus pentagonus* Hall, *A. sculptus* Hall, and *A. araneolus* Meek and Worthen. They twice indicate *A. pentagonus* as the typical species, and this genotype has been recognized generally. In a letter to Wachsmuth, dated June 6, 1866, Worthen states: "We have made a genus of *Act. araneolus* which we have named *Steganocrinus*." It has rather generally been assumed that Meek was the responsible author of most of the Meek and Worthen descriptions. In the present instance it appears that Worthen was unaware of Meek's choice of *pentagonus* as type of the genus, although the volume must have been in press at the time the letter was written. Of even more interest for our present purposes, Worthen elsewhere in the same letter writes: "Mr. Meek desires me to ask you if you have a specimen of *Act. sculptus* with any portion of the arms attached; if so he would much like to see it. Perhaps you have only seen it in some other collections, and if so he would like to know whether there is more than one arm to each ray." Further, in a postscript, Worthen writes: "Mr. Meek also wishes to know if you have seen the summit of *Act. sculptus*, and know if it has a proboscis." It is evident that Meek was uncertain at the time whether *A. sculptus* was properly to be placed in *Steganocrinus*.

As restricted, the genus *Steganocrinus* forms a compact, characteristic group of crinoids known at present only in the Burlington limestone and its equivalents of the lower Missis-

sippian. Formerly the genus was considered chiefly to be represented in the lower Burlington, but later collections have shown it to be well represented in the upper Burlington. The theca bears a striking resemblance to *Actinocrinus* in form and ornamentation and can be told with certainty only from the structure of the *post-IAx* brachials. Imperfect specimens, specifically known to be *Actinocrinus*, are often to be found in collections labeled as *Steganocrinus*. All the species described by Miller and Gurley as *Steganocrinus* are referable to *Actinocrinus*. This was inexcusable, as the specimens are in an excellent state of preservation.

The theca of *Steganocrinus* runs a very similar gamut of form to that found in *Actinocrinus*. The earlier species are proportionally low and wide. The later species tend to be more elongate. The tegmen is low and in most species is made up of relatively few fairly large and heavy plates. Typically the dorsal cup is lobate. The lobation in some of the later species is very pronounced. In *Steganocrinus* the *RR* and *IBr<sub>1</sub>* alone are incorporated in the wall of the cup proper. The distal portion of the *IBr<sub>1</sub>* is laterally constricted. Ventrad, as seen where *IAx* is detached, there is a deep groove, the distal face of the plate having practically the appearance of a free brachial. The *IAx* flares outward sharply and is essentially a part of the free brachial series. The *IAx* frequently becomes detached, along with the arms. As noted above, it was on the assumed nonexistence of *IAx* that Miller and Gurley based their genus *Shumardocrinus*. In some of the later species of *Steganocrinus* the *R* becomes proportionally larger, the *IBr<sub>1</sub>* smaller, and the *IAx* greatly reduced.

*IAx* bears a pair of rami modified into what may be styled arm-trunks. They are uniserial, composed of high *Brr*, and bear relatively short, stout, biserial ramules. The drawing of *S. araneolus* (Fig. 4) is taken from Wachsmuth and Springer (1897). It shows the discrete *IAx* as regards the dorsal cup and the character of the arm-trunks. The ventral groove is covered by series of heavy plates. The structure is well shown in Figs. 1 and 2. These figures are copied from Wachsmuth and Springer (1897), where they are identified as *S. sculptus*. They are actually *S. pentagonus*. The ramules are borne on alternate sides of the ramus. Typically each *Br* bears a ramule. Exceptionally a nonramu-

liferous *Br* is interposed. The ramules bear pinules.

*Species referred to the genus.*—

- Steganocrinus araneolus** (Meek and Worthen)  
*Actinocrinus araneolus* Meek and Worthen, 1860, p. 387. "Burlington limestone, Burlington, Iowa." (Lower Burlington.)  
*Steganocrinus araneolus* (Meek and Worthen), 1866, p. 198, pl. 15, figs. 1a, b.  
*Steganocrinus araneolus* Wachsmuth and Springer, 1881, p. 151 (325).  
*Steganocrinus araneolus* Wachsmuth and Springer, 1897, p. 581, pl. 61, figs. 2a, b.

It is possible that *S. araneolus* is the young of *S. pentagonus*. It is suggestive that both at Burlington, Iowa, and near Lake Valley, N. Mex., the specimens of *Steganocrinus* fall into two uniform lots. These are mainly separated by size, for the differences in shape and ornamentation could readily be explained as due to growth. There are no specimens in the collections identified as young *S. pentagonus*.

**Steganocrinus concinnus** (Shumard)

- Actinocrinus concinnus* Shumard, 1855, p. 189, pl. A, fig. 5. "Encrinital limestone, North River, Marion County, Missouri."  
*Steganocrinus concinnus* Wachsmuth and Springer (pars), 1881, p. 151 (325).  
*Shumardocrinus concinnus* Miller and Gurley, 1895, p. 41. (The specimen shown in pl. 2, figs. 7-10, is probably referable to *S. araneolus* (*pentagonus*?).)

Aside from having been made the type of the "new genus" *Shumardocrinus* by Miller and Gurley, this species has been universally misunderstood. Meek and Worthen (1866, p. 200) placed their *Actinocrinus validus* in synonymy with it. Wachsmuth and Springer (1897, p. 582) followed this precedent and furthermore figured as a representative of the species a form widely divergent both from *S. concinnus* and *S. validus*. The form figured by Wachsmuth and Springer is here made a new species.

Wachsmuth and Springer (1897, p. 583) stated that the type of *S. concinnus* was in the "(Worthen) Illinois State collection at Springfield." They must have been referring to the type of *S. validus*. The type of *S. concinnus* is now in the Springer collection in the United States National Museum, having come to it by purchase from Hambach.

The type of *S. concinnus* is a dorsal cup, lacking the *IAxx*. Miller and Gurley's (1895, p. 41) dogmatic assertion that the species "never had

any third radials" is, of course, utter nonsense. It was on this supposed character that the "genus" *Shumardocrinus* was principally based. The cup is in a good state of preservation. Unfortunately, no complete theca referable to the species is known to me, although one specimen from the upper Burlington near Burlington, Iowa, may be conspecific. Such characters as are shown, however, prove that the species is distinct from any described form. The specimen figured by Miller and Gurley (1895, pl. 2, figs. 7-10) could conceivably be a young individual of this species, but this is doubtful. I have not examined the specimen, but the figures as given suggest *S. araneolus* or possibly a young *S. pentagonus* from the lower Burlington.

The cup of *S. concinnus* as preserved has a maximum breadth of 30 mm and a height of but 16 mm. Were the *I*Axx preserved the height would be increased slightly and the breadth considerably increased. It is this low, broad cup that must serve at present as the chief distinguishing feature of the species. The angle of divergence of the sides of the cup is approximately 74°. The surface of the plates is traversed by sharply defined, radiating ridges, such as are common to many species both of *Actinocrinus* and *Steganocrinus*. The specimen mentioned above from Burlington has approximately the same proportions of cup. In this specimen the tegmen is nearly flat and made up of a large number of small plates, none of which is produced into a spinous process nor, indeed, is highly tumid. The type will be illustrated and described at some future time. At present it is sufficient to show that in *S. concinnus* we are dealing with a species with an exceptionally low, broad cup.

*Horizon and locality.*—Shumard's original citation is "Energinal Limestone, on North River, Marion County (Missouri)," collected by Swallow. There seems little doubt, comparing the species with a large series of described and undescribed *Steganocrinus*, that the horizon is upper Burlington.

*Holotype.*—The holotype is in the Springer collection in the United States National Museum, S. 1181.

***Steganocrinus? globosus* Wachsmuth and Springer**

*Steganocrinus globosus* Wachsmuth and Springer, 1897, p. 585, pl. 61, fig. 6. "Ooli-

tic bed of the Kinderhook group; Burlington, Iowa."

There is no way of proving that this species is referable to *Steganocrinus*. The general form of the theca and the incorporation of the radial series in the dorsal cup argue against such an assignment. The radial series, so far as the evidence goes, indicates two discrete arms from each ray. Being unable to give the species a definite generic placement, I think it is better to leave it under *Steganocrinus* with a query.

***Steganocrinus pentagonus* (Hall)**

*Actinocrinus pentagonus* Hall, 1858, p. 577, pl. 10, figs. 6a, b. "Burlington limestone, Burlington, Iowa." (Lower Burlington.)

*Steganocrinus pentagonus* Meek and Worthen, 1866, p. 196.

*Steganocrinus pentagonus* Meek and Worthen, 1868, p. 474, pl. 16, fig. 8.

*Steganocrinus pentagonus* Wachsmuth and Springer, 1881, p. 151 (325).

*Steganocrinus pentagonus* Keyes, 1894, p. 195, pl. 24, fig. 6.

*Steganocrinus pentagonus* Wachsmuth and Springer, 1897, p. 579, pl. 61, figs. 3a-e, 4a, b; also pl. 61, figs. 1e, f, given as *S. sculptus*.

***Steganocrinus validus* (Meek and Worthen)**

*Actinocrinus validus* Meek and Worthen, 1860, p. 384.

*Steganocrinus validus* Miller and Gurley, 1895, p. 42.

*Cited as a synonym of S. concinnus (Shumard).*—

*Actinocrinus concinnus* Meek and Worthen, 1866, p. 200, pl. 15, figs. 9a, b.

*Steganocrinus concinnus* Wachsmuth and Springer, 1897, p. 582.

Over a period of years I have tried to locate the type of this species, but without success. It certainly is not *S. concinnus*, and almost certainly it is a good species. It is to be hoped that the specimen eventually will be found.

***Steganocrinus elongatus*, n. sp.**

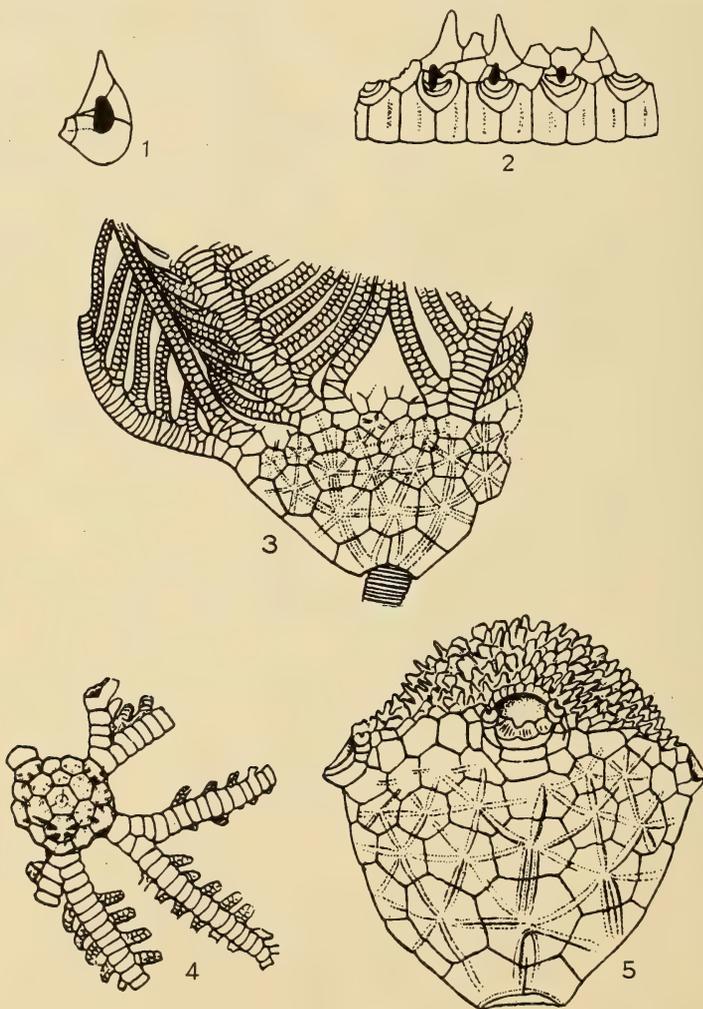
This species is based on the form erroneously ascribed to *S. concinnus* (Shumard) by Wachsmuth and Springer (1897, p. 582, pl. 61, figs. 5a, b). As holotype, I have chosen the specimen figured as 5a. The younger specimen, 5b, will stand as a paratype. The holotype is somewhat crushed and is abnormal as to the radial series of the anterior ray. It is, however, the best specimen known to me, and I have therefore

chosen it as type. The species is rare. In addition to the types there is a specimen larger than the holotype in the Springer collection. Most of the tegmen and a part of the dorsal cup of this specimen are missing. Furthermore, there are a few fragmentary and poorly preserved specimens. It is probable that a few specimens are to be found in other collections.

For *Steganocrinus* the species is a large one, being considerably larger than any described form. There is an undescribed species from the upper Burlington of Hannibal, Mo., that is of comparable size. The theca of the holotype has a height of 41.0 mm and an estimated maxi-

mum diameter at the arm-base, uncrushed, of about 30 mm. The paratype, as is to be expected, is relatively less elongate. The height and diameter are approximately equal.

The general habit of the species varies considerably from any described *Steganocrinus*. The cup is relatively high and not strikingly lobate. The tegmen is low and relatively small. The plates of the cup as shown by Wachsmuth and Springer are smooth. The paratype has moderately strong ridges normal to the faces of the plates. The ridges in most cases do not extend to the center of the plates. From the anal and the *r* and *l ant RR* two ridges carry to the



Figs. 1, 2.—*Steganocrinus pentagonus* (Hall): Cross section and lateral view of portion of arm-trunk.  
Figs. 3, 5.—*Cyrtocrinus sculptus* (Hall): 3, Specimen showing proximal portions of arm-trunks and atrophied rami; 5, a specimen of about maximum size showing incorporation of the bachials in the cup.  
Fig. 4.—*Steganocrinus araneolus* Meek and Worthen: Specimen showing brachial structures.

*BB.* In all other cases there is one short, broad ridge to each face of the plate. In older specimens, as in the holotype, the ridges are present but are poorly shown. They have practically been obliterated by depositions of stereom.

*Relationships.*—The relatively elongate theca of *S. elongatus* sharply differentiates it from any described species of the genus. *S. concinnus* (Shumard), as described above, is notable for its unusually low explanate cup.

*Horizon and locality.*—The species is known only from the upper Burlington. The types are from Burlington, Iowa. One or two rather poorly preserved specimens from Hannibal, Mo., may be referable to the species.

*Types.*—The types are in the Springer collection in the United States National Museum, S. 1182.

### *Cyrtocrinus*, n. gen.

*Synonym.*—*Steganoocrinus* (in part of authors).

*Genotype.*—*Actinoocrinus sculptus* Hall.

#### *Cyrtocrinus sculptus* (Hall), n. comb.

*Actinoocrinus sculptus* Hall, 1858, p. 582, pl. 10, figs. 11a, b. "Burlington limestone, Burlington, Iowa." (Lower Burlington.)

*Steganoocrinus sculptus* Meek and Worthen, 1866, p. 197, text fig. 10 (in part).

*Steganoocrinus sculptus* Wachsmuth and Springer, 1881, p. 151 (325).

*Steganoocrinus sculptus* Keyes, 1894, p. 194, pl. 20, fig. 6 (diagram).

*Steganoocrinus sculptus* Wachsmuth and Springer, 1897, p. 583, pl. 61, figs. 1a-d.

In *Cyrtocrinus* the dorsal cup shows practically no lobation as against the moderate to strongly developed lobation in *Steganoocrinus*. This difference in lobation is a direct expression of the very different character of the radial series in the two genera. The tegmen of *Cyrtocrinus* is high and composed of large numbers of small plates. The tegmen is incompetent, in practically all specimens seen being deformed or missing in whole or part.

In very young specimens of *Cyrtocrinus* the brachial series is incorporated in the cup wall up to and including the *IAx*. In such specimens the more distal brachial structures are clearly shown. One division of the ray is hypertrophied forming a heavy arm-trunk, which bears long, stout, biserial ramules. The other half of the division is atrophied, appearing as a biserial structure similar in appearance and size to the ramules borne by the arm-trunk. With increas-

ing age, the proximal portions of the arm-trunk and its homologue progressively become incorporated in the cup wall as shown in Fig. 5, copied from Wachsmuth and Springer (1897). In such specimens the atrophied ramus can easily be mistaken for a ramule borne by the arm-trunk. Such an interpretation has actually been made in the past.

The arm-trunk itself is uniserial, typically bearing ramules on alternate sides on each second brachial. The *Brr* are low. Occasionally there appear to be two *Brr* between ramuliferous *Brr*, but this is uncertain. The ramules are long, stout, and biserial. They bear pinnules. The base of the ramule is set into the side of the arm-trunk in such a way that it is difficult to tell from which *Br* it really originates. Unfortunately no specimens show the ventral surface of the arm-trunk. However, in specimens where a lateral view is to be had between the ramules, it appears that there is no covering of heavy plates comparable to that found in *Steganoocrinus*.

Meek and Worthen (1866, p. 197, fig. 10) give a crude diagram of a portion of an arm-trunk identified as *S. sculptus* Hall. The structure as shown in this diagram was repeated by Wachsmuth and Springer (1881, pl. 17, fig. 3). Later (1897, pl. 61, figs. 1e, f) a similar structure was illustrated. These figures are here reproduced as line drawings (Figs. 1 and 2). The original of these latter illustrations is in the Springer collection. As a matter of fact, all these figures were based on *S. pentagonus*. The high, stout *Brr*, the heavy, spinous tegmental plates, and the ramules borne on each brachial clearly indicate this. The fragment illustrated when placed side by side with an arm-trunk attached to a specimen of *S. pentagonus* matches perfectly.

The splendid specimen of *C. sculptus* figured by Wachsmuth and Springer (1897, pl. 61, fig. 1a) for the first time showed the true brachial structures of this species. This specimen is diagrammatically copied, in part, as Fig. 3, from Wachsmuth and Springer (1897). As told to me by Mrs. Wachsmuth, this specimen was a late find and was probably prepared and figured without checking the figures made earlier. The diagram given by Keyes (1894, pl. 20, fig. 6) of *S. sculptus* seems actually to have been based on this specimen. The *Brr* are incorrectly

shown, however, ramules being borne by each brachial.

*Relationships.*—*Cyrtocrinus* and *Steganocrinus* show a similar modification of the rami into arm-trunks bearing biserial ramules. This is one of the numerous cases of parallel development constantly to be found among the Crinoidea. In the general habit of the theca, which is of great importance among the Camerata, one suspects a quite diverse origin for the two genera. *Cyrtocrinus* and *Cactocrinus* may well have had a common ancestry, while one would assume a similar relationship between *Actinocrinus* and *Steganocrinus*. The most obvious character that distinguishes *Cyrtocrinus* from *Steganocrinus* is the brachial structure. However, in the general habit of the theca *Cyrtocrinus* differs from *Steganocrinus* more widely, for example, than the successive genera in the *Cactocrinus-Teleiocrinus-Strotocrinus* series.

#### Genus *Actinocrinus* Miller

Miller and Gurley described the following species as *Steganocrinus*: *albersi*, *benedicti*, *blairi*, *griffithi*, *sharonensis*, and *spergenensis*. Bassler and Moodey (1943) have referred all these species, with the exception of *griffithi*, to *Actinocrinus*. In the case of *griffithi*, although listed as *Steganocrinus*, they state: “? = *Actinocrinites scitulus*.” All the species are properly referable to *Actinocrinus*, but most of them fall into synonymy as indicated below. *Actinocrinus sharonensis* and *A. spergenensis* may be valid species. There are a number of species of *Actinocrinus* described from these higher horizons, and only by comparing the types of all the species can the proper standing of the various names be established. Miller and Gurley cite *A. spergenensis* as from the St. Louis. Obviously, this is incorrect. However, the “Probably Burlington age” of Bassler and Moodey goes too far on the other side. The crinoid itself indicates an age of at least Borden or Harrodsburg.

The remaining species described by Miller and Gurley almost certainly fall under two of the commonest and best-known species of the upper Burlington, *Actinocrinus scitulus* Meek and Worthen and *A. multiradiatus* Shumard:

#### *Actinocrinus multiradiatus* Shumard

*Synonymy.*—

*Steganocrinus albersi* Miller and Gurley, 1897, p. 33, pl. 2, figs. 13–16.

*Actinocrinus albersi* (Miller and Gurley), Bassler and Moodey, 1943, p. 267.

*Steganocrinus blairi* Miller and Gurley, 1897, p. 35, pl. 2, figs. 21, 22.

*Actinocrinus biairi* (Miller and Gurley), Bassler and Moodey, 1943, p. 267.

#### *Actinocrinus scitulus* Meek and Worthen

*Synonymy.*—

*Steganocrinus griffithi* Miller and Gurley, 1897, p. 34, pl. 2, figs. 17–20.

*Actinocrinus griffithi* (Miller and Gurley), n. comb., this paper.

*Steganocrinus sharonensis* Miller and Gurley, 1897, p. 32, pl. 2, figs. 10–12.

*Actinocrinus sharonensis* (Miller and Gurley), Bassler and Moodey, 1943, p. 274.

#### *Actinocrinus eximius*, n. name

*Actinocrinus griffithi* Wachsmuth and Springer, 1897, p. 568, pl. 52, fig. 7, May. (Not *Steganocrinus griffithi* Miller and Gurley, 1897, p. 34, pl. 2, figs. 17–20, Jan. 25.)

It is unfortunate that Wachsmuth and Springer's name must be suppressed as a homonym. Dr. Griffith was one of the group of enthusiastic amateurs to whom we owe so much for our knowledge of the Burlington crinoids. The species is rare, but it is a very distinct form. As holotype I have chosen the specimen figured by Wachsmuth and Springer (1897, pl. 52, fig. 7). There is no need to add to the description of Wachsmuth and Springer. Their comment (1897, p. 579) that the “arm structure approaches the genus *Steganocrinus*” may, however, be deleted.

This case and the invalid species noted above are examples of a large number of similar maleficent acts committed by Miller and Gurley. The manuscript of the Camerate Monograph was completed and transmitted for publication in 1894. The fact was well known to all. Miller and Gurley in their Bulletins of the Illinois State Museum described every specimen they could lay their hands on—good, bad, and indifferent. As was well known to their contemporaries, the main purpose was to forestall the work of Wachsmuth and Springer. Springer in his foreword in the first volume of the Monograph puts the case very mildly. Quite apart from ethical considerations, this wholesale description of species has made for a vast amount of confusion. A great many of the new species described are invalid. The drudgery involved in resolving the problems

presented is enormous and is a thankless task at best.

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BOTANY.—*Ten new American Asteraceae*.<sup>1</sup> S. F. BLAKE, Bureau of Plant Industry, Soils, and Agricultural Engineering.

Nine new species, six of which are from continental Mexico and one each from Texas, Baja California, and Colombia, as well as a new variety of *Corethrogyne californica* from California, are described in this paper. The single species from Colombia, *Tuberostylis axillaris*, is of special interest, belonging to a hitherto monotypic genus which seems to be unique among Asteraceae in its choice of habitat (tree trunks or roots of mangroves and perhaps other trees in saline tidal thickets). The occurrence of the two species now known, which are very distinct in characters of foliage and inflorescence, in the same restricted area at Buenaventura, Colombia, and apparently nowhere else, is of some phytogeographic and evolutionary significance.

*Tuberostylis axillaris* Blake, sp. nov.

Herba (?) epiphytica ubique glaberrima; folia ovata petiolata acuminata apice obtusa basi acute cuneata integra margine undulata carnosae 3-nervia evenia; capitula in axillis aggregata sessilia.

Herbaceous?, scandent on tree trunks in

<sup>1</sup> Received May 24, 1943.

tidal thickets; stem (or branch?) simple, terete, light green, pithy, 2 mm thick; leaves opposite; internodes 2.5-4.5 cm long; petioles 1 cm long, sulcate above, connate at base; blades 4.5-6 cm long, 2.2-2.6 cm wide, dull green, sometimes somewhat pustulate, 3-ribbed from base, the lateral veins mostly invisible; heads about 14-flowered, in axillary clusters of about 3-4, sessile, the common peduncle 1-3 mm long, bearing a few small spatulate herbaceous bracts; involucre strongly graduated, many-seriate, 7-9 mm high, the phyllaries appressed, firmly stramineous, 3-vittate, 2- or 4-ribbed, from triangular-ovate (outer) to linear (inner), all narrowed to an obtusish to acutish apex; corollas apparently whitish, cylindrical without distinguishable tube, 4.2 mm long (tube 1 mm, throat 2.5 mm, teeth triangular, obtusish, 0.7 mm long); achenes narrowly oblong, bluntly 3-5-angled or -ribbed, greenish-white, epappose, 2.5-3 mm long, 0.8 mm wide.

COLOMBIA: Vine, scandent up tree trunk in tidal thickets, Buenaventura Bay, Dept. El Valle, 4 May 1939, *E. P. Killip* 35515 (type no. 1772228, U. S. Nat. Herb.).

*Tuberostylis rhizophorae* Steetz, the only species of the genus hitherto known, is at once distinguished by its spatulate-obovate, very ob-

tuse, few-crenate, 1-nerved or weakly triplinnate leaves and terminal panicle. It was described from southern Darien (northwestern Colombia), where it was found by Berthold Seemann on the voyage of the *Herald*, growing on the roots of mangrove (*Rhizophora*), and is still a very rare plant in collections. Specimens are in the U. S. National Herbarium from COLOMBIA: Dept. El Valle: On roots of *Rhizophora* within tide limit, coast of Buenaventura, *Lehmann*; mangrove swamp along Río Dagua, Buenaventura, 7-9 May 1922, *Killip* 5335, 13 April 1939, *Killip* 34958.

The genus is, so far as I know, unique in the family in its choice of habitat (on tree trunks or roots in saline tidal thickets), and the occurrence of its two very distinct species in the same locality is of particular interest. The type sheet bears two stems or branches about a foot long and in old fruit, floriferous in practically all the axils but quite destitute of rootlets.

***Brickellia nutanticeps* Blake, nom. nov.**

*Eupatorium nutans* H. B. K. Nov. Gen. & Sp. 4: 105. 1820.

*Brickellia nutans* Robinson, Mem. Gray Herb. 1: 85. 1917. Not *B. nutans* Robins. & Greenm. 1895.

The name *Brickellia nutans* is not available for this species, having been independently proposed by Robinson & Greenman in 1895 for a supposedly new species now considered by Robinson identical with the slightly earlier published *B. orizabaensis* Klatt. The present provision in the International Rules requiring the rejection of later homonyms was not in force when Robinson's *Monograph of Brickellia* was written.

***Gutierrezia longipappa* Blake, sp. nov.**

Suffruticosa ca. 5 dm alta glutinosa hirtella erecte ramosa foliosa; folia linearia integerrima 3-nervia punctata ca. 5 cm longa 2 mm lata in axillis saepe prolifera; capitula minima 2-flora 1-radiata numerosissima subsessilia in apicibus ramorum et ramulorum arcte conferta; involucri cylindrici 4 mm alti gradati phyllaria straminea apice viridia; flores 2, 1 femineus ligulatus fertilis, 1 hermaphroditus sterilis ovario abortivo, rarissime ambo hermaphroditis; achenium fl. fem. paene glabrum, pappo e paleis 7-8 liberis achenio longioribus sistente; pappus fl. hermaph. e paleis 10 liberis paene 3 mm longis sistens.

Stem shrubby below, with grayish fissured bark, glabrate, about 6 mm thick; branches erect, whitish below, then straw-color, green above, striate-angled, rather sparsely hirtellous, denudate below; leaves alternate, usually with fascicles or short branches in their axils; internodes mostly 5-7 mm long; blades of larger leaves 4.5-6 cm long, 1.8-2.5 mm wide, acutish, callous-pointed, sessile, flat, sparsely hispidulous, densely impressed-punctate, 3-nerved, the midrib prominent beneath, impressed above, the lateral pair much weaker, impressed beneath, impressed or scarcely evident above; individual flower clusters 1.5-2.5 cm wide, flattish or rounded, the whole forming a flattish panicle about 2 dm wide; heads (moistened) 4.5-5 mm long (excluding style-branches), about 1.8 mm thick, compressed, mostly sessile in clusters of 2-5 at tips of short branchlets, a few sometimes solitary and on pedicels 1 mm long; phyllaries few (7), appressed, the outermost linear, obtuse, 1 mm long, thick-herbaceous, the next ovate or oblong, obtuse, thick-herbaceous in middle above and with scarious margin, the inmost (2) oblong, obtuse, 1-nerved, straw-color, scarious with short blunt green tip; receptacle prolonged into a triangular acute or acuminate point about 0.5 mm long; ray yellow, 4.2-4.7 mm long (tube 2-2.5 mm, lamina oval, emarginate or obscurely 3-denticulate, 3-4-nerved, 2.3 mm long); disk corolla yellow, glabrous, 4.2-4.5 mm long (tube 0.8-1.1 mm, throat subcylindric to funnelform, 2.3-2.5 mm, teeth 5, narrowly triangular, recurved, somewhat thickened at tip, 0.7-0.8 mm long); achene oblong or oblong-obovoid, very sparsely erect-pilose, 5-nerved, 1.2 mm long, the pappus of 7-8 free linear oblong 1-seriate obtuse to acute somewhat unequal paleae 1-1.8 mm long; pappus of hermaphrodite flower sub-2-seriate, of 10 subequal linear-oblong acuminate paleae 2.8-3 mm long; style branches of hermaphrodite flower linear, acuminate, hispidulous on back throughout, without stigmatic lines.

TEXAS: 12 miles east of Marfa, Presidio County, 19 Oct. 1937, *V. L. Cory* 26335 (type no. 151924, herb. U. S. Nat. Arboretum); Sanderson, Terrell County, 29 Sept. 1911, *E. O. Wootton* (U. S. Nat. Herb.).

The type specimen was sent by Mr. Cory under the name *Selloa glutinosa* Spreng. (*Gym-*

*nosperma glutinosum* Less.), to which it bears a remarkably close resemblance, although the leaves of that plant are somewhat broader and 3-ribbed; but in *Selloa glutinosa* the heads are about 9-14-flowered, the rays are much smaller, the disk flowers are fertile, the achenes are densely puberulent, and the pappus is wanting. *Gutierrezia longipappa* is distinguished from most species of its genus by its 2-flowered heads, and from all known to me by its subglabrous achenes and very long pappus. Wootton's specimen, mounted with one of *Selloa glutinosa*, agrees closely with the type in essential characters but has a slightly longer ray (lamina elliptic, 3 mm long) and a somewhat shorter pappus (2 mm) in the hermaphrodite flower; the plant is more conspicuously glutinous and the leaves are narrower (1.5 mm) with the lateral pair of veins only obscurely indicated.

***Corethrogyne californica* DC. var. *lyonii***  
Blake, var. nov.

Involucri 5-6-seriati subaequalis vel paullum gradati 1.2-1.8 cm alti phyllaria lineari-oblonga v. paullum oblanceolata maxima ex parte (exteriora omnino) herbacea laxa v. squarrosa.

Stems 12-20 cm long, decumbent or ascending, numerous, densely white-tomentose like the leaves; leaves obovate, 3-4.5 cm long including petiole, 0.8-1.5 cm wide, subentire to crenate-serrate above; peduncles terminal, solitary, 1-headed, green and merely stipitate-glandular, 2-5.5 cm long, bearing 2 or 3 glabrescent bracts; phyllaries 2-2.5 mm wide, often slightly broadened upwardly, densely stipitate-glandular and thinly pubescent, the outer herbaceous throughout, the middle ones with subscariosus margin below, the inmost with chartaceous base and short green tip.

CALIFORNIA: Open slope, Cathedral Peak, southwest corner of sec. 22, T. 11 S., R. 7 E., Merced County, altitude 915 meters (3,000 feet), 4 June 1941, *Gregory S. Lyon* 1572 (type no. 154588, U. S. Nat. Arb.; dupl. herb. Univ. Calif.); Twin Peak, NW $\frac{1}{4}$  sec. 36, T. 11 S., R. 7 E., Merced County, altitude 610 meters (2,000 feet), 12 May 1939, *Lyon* 1310 (herb. U. S. Nat. Arboretum, herb. Univ. California).

Although strikingly different from the common coastal form in its large and loose herbaceous involucre, this plant cannot be considered more than a variety. The two collections

cited come from the Inner South Coast Ranges. Another more ample collection from the same region (*Lyon* 1428), open rocky slope, Laveaga Peak, SW $\frac{1}{4}$  sec. 14, T. 12 S., R. 7 E., San Benito County, alt. 915 meters, 2 June 1940) has a shorter, strongly graduated involucre with the 3-4 outer series of phyllaries herbaceous only above, and must be considered an intermediate nearer to the typical form. The variety is named for the collector, a former student of Prof. H. L. Mason and Prof. Lincoln Constance, who has made extensive collections in the little-known Inner South Coast Ranges of San Benito, Merced, and Fresno Counties, California.

***Archibaccharis peninsularis* Blake, sp. nov.**

Frutex laxis ramis ramosus foliosus; caulis tenuis striatus purpureo-brunneus subglabratus, rami viridescens dense hispiduli; folia ovalia v. obovata obtusa v. acutiuscula apiculata basi cuneata in petiolum folio multiplo brevior anguste decurrentia utroquelatere grosse 1-3-dentata pergamentacea supra laete viridia subtus paulo pallidiora utrinque sparse pilis conicis basi subtuberculatis hispidula margine hispidulo-ciliolata; capitula staminea parva 24-flora numerosa apice ramorum paniculata tenuiter pedicellata folia paullum superantia; involucri hemispherici 3 mm alti ca. 4-seriati gradati phyllaria oblonga v. oblongo-ovata obtusa 1-vittata scarioso-marginata supra ciliata; corollae purpureae, dentibus fauce brevissima multiplo longioribus; achenia compressa 2-nervia erecto-hirsuta; pappus 1-seriatus, setis hispidulis ad apicem incrassatis et barbellatis.

"Low reclining bush with stems 1-1.5 m long"; stem 2.5 mm thick, striate and subangulate by decurrent lines from the leaf-bases; branches few, simple except for a subterminal branch, about 30 cm long or less, greenish, densely cinereous-hispidulous with short several-celled subconic spreading white hairs; leaves alternate; internodes mostly 4-15 mm long; petiole 3-9 mm long, narrowly margined nearly or quite to base, densely hispidulous; blade 2.5-4 cm long, 1.3-2.5 cm wide, plane, coarsely few-toothed mostly above the middle (teeth 1-2 mm high, acute or obtuse, callous-apiculate), feather-veined (lateral veins 3-4 pairs, prominulous on both sides, the secondaries inconspicuous), roughish especially beneath, the hairs denser along costa beneath; panicle

about 17–40-headed, 4–6 cm wide, flattish or somewhat convex, surpassing the leaves by 1–2 cm, pubescent like the stem, the bracts small, lanceolate, the pedicels 2–6 mm long; heads (moistened) 5 mm high, 3.5 mm thick; phyllaries glabrous dorsally, the vitta greenish above; receptacle naked; corollas glabrous except for a few clavellate hairs at base of throat, 3.5 mm long (tube whitish, 1.7 mm, throat campanulate, 0.3 mm, teeth purple, recurving, lanceolate, 1.5 mm long); achenes oblong-obovate, 1 mm long, whitish, erect-hirsute with bidentulate hairs; pappus bristles about 30, slender, white 2.8 mm long; style branches 1 mm long, hispidulous on back above, with obtuse appendages and no evident stigmatic lines.

**BAJA CALIFORNIA:** In shade in small canyon, on rocky talus slopes under oaks, Arroyo Hondo, Sierra Giganta (between La Paz and Loreto), 13 Dec. 1938, *H. S. Gentry* 4120 (type no. 263147, Dudley Herb.; photograph and fragments, herb. U. S. Nat. Arboretum).

This interesting plant, sent me for study by Mrs. Roxanna S. Ferris, is referred to *Archibaccharis* with some doubt, since only the staminate plant is known. In general habit and in the comparatively thin leaves it agrees better with that genus than with *Baccharis*, the only other genus to which it could be referred, and in any case it is quite distinct from any known species of either group. The genus *Archibaccharis* has not previously been reported from Baja California. The species appears to be nearest *Archibaccharis serratifolia* (H.B.K.) Blake, of Mexico proper, a plant with ovate or lance-ovate, sharply acute or acuminate, regularly serrate or serrulate, much more densely pubescent leaves.

***Gnaphalium panniforme* Blake, nom. nov.**

*Gnaphalium pannosum* Gray, Proc. Amer. Acad. 19: 3. 1883. Not *G. pannosum* (DC.) Sch. Bip. Bot. Zeit. 3: 172. 1845.

This Mexican species is apparently still known only from the original collections by Schaffner (no. 227) and Parry & Palmer (no. 420) in the mountains of San Luis Potosí.

***Heliopsis parviceps* Blake, sp. nov.**

Annua tenuissima superne pauciramosa remote foliata, caule bifariam puberulo; folia minuscula ovata acuminata basi late cuneata v. subcordata tenuia serrata triplinervia utrinque

hirsutula; capitula pro genere minima tenuissime pedunculata omnino purpurea, radiis interdum supra brunneoflavescens exceptis; involucri 2-seriati subaequalis ca. 3.5 mm longi phyllaria oblonga v. late ovata; radii 4–5 minimi; achenia radii obovoidea corticata parum tuberculata epapposa, disci oblonga epapposa.

Very slender annual, about 4 dm high, with about 2 elongate branches above, these themselves often with 2 or 3 branches at apex; stem greenish white, about 1.5 mm thick, striatulate; leaves below middle of stem only 2–3 pairs, small (blades 2 cm long, 1.2 cm wide), mostly fallen at flowering time, separated by long internodes; leaves near middle of stem 2–3 pairs, with short internodes (mostly 7–28 mm long), their petioles very slender, 8–15 mm long, flattened above, pilosulous chiefly on margin, their blades ovate, 3–4 cm long, 1.2–1.7 cm wide, green and evenly but not densely antrorse-hirsutulous on both sides with subtuberculate-based hairs; branches when well developed with a long naked internode up to 18 cm long, then bearing 1–2 pairs of rather crowded narrower leaves and 2–3 long-peduncled heads, the peduncles often with a pair of leaves and an undeveloped head above the middle; heads about 11 mm wide (moistened), about 3–10 per stem, solitary and terminal on long and very slender bifariously puberulous peduncles 2.5–8.5 cm long; disk at maturity conical, 6–8 mm high, 5 mm thick; involucre 2-seriate, subequal, 3–3.8 mm high, the phyllaries few (ca. 12), appressed, the outer oblong, obtuse, about 1.5 mm wide, the inner broader, broadly ovate, obtuse, all sparsely puberulous, ciliolate, at first subindurate and pale below, with 3 green vittae and shorter subherbaceous tip, at maturity strongly suffused with purple throughout; rays 4–5, pistillate, fertile, spreading, deep purple on both sides or sometimes dull brownish yellow above, finely papillate on both faces, jointed to the achene and detachable from it, their margins somewhat inflexed for about 0.5 mm above base but the proper tube a mere ring only 0.2 mm long, the lamina suborbicular, thickish, 3.2–3.5 mm long and wide, bluntly 3-toothed, 10–12-nerved (2 of the nerves stronger), hispidulous on the ringlike base and on the nerves dorsally; disk corollas deep purple, glabrous, 3 mm long (tube 0.4 mm, throat 2 mm, not wider than tube for 0.6 mm, then slender-

campanulate, teeth ovate, acute, 0.6 mm long); pales rather thin, 3.6–4.2 mm long, purple above, glabrous, keeled for two-thirds their length or more from base, broadly rounded or subtruncate and bluntly mucronulate; ray achenes broadly obovoid, corticate with a thick papillate and somewhat tuberculate, fleshy, deffergible outer layer, sublenticular, about 3.6 mm long, 2.5 mm wide, rounded on outer face, with a single broad rib on inner face, greenish fuscous, sparsely and obscurely puberulous, with narrow thick margin, this irregularly denticulate or tuberculate and with 2 larger teeth toward apex; disk achenes (immature) oblong, 1 mm long, glabrous, somewhat thickened, truncate, epappose; style branches hispidulous toward apex, with subdeltoid short-cuspidate hispidulous appendages.

MEXICO: Along Cuernavaca-Taxco Road, about 10 miles from Taxco, Guerrero, alt. 1675 meters, 19 Aug. 1935, *L. H. MacDaniels* 128 (type no. 837092, herb. Field Mus.; photograph and fragments, herb. U. S. Nat. Arboretum).

This plant is described as a *Heliopsis* with some hesitation. The ray corollas, set in a concavity at apex of achene, definitely jointed to it, and rather readily detachable, are out of place in the genus and at odds with the definition of the subtribe to which *Heliopsis* belongs. Its closest relationship, nevertheless, seems to be with that genus, and it is referred there for the present. The species is readily distinguished by its tiny purple heads.

***Zexmenia appressipila* Blake, sp. nov.**

Frutex ramosus; caulis tenuis dense strigil-  
 losus; folia lanceolata attenuata falcata basi  
 acute cuneata breviter petiolata triplinervia in-  
 conspicue serrulata firme herbacea utrinque  
 viridia et scabriuscula supra ubique sed non  
 dense strigosa pilis basi lepidotis non tuberculatis  
 et strigillosa subtus ubique non dense strigosa  
 et sessili-glandulosa glandulis albidis; capitula  
 solitaria terminalia pedunculata radiata aurea  
 ca. 5 cm lata; involucri 1.2–1.3 cm alti campanulata  
 ca. 4-seriati phyllaria exteriora strigosa  
 basi ovata indurata pallida appendice  
 longiore herbacea laxa lanceolata, interiora  
 multo breviora ovalia pallida abrupte breviter-  
 que herbaceo-appendiculata, intima exappen-  
 diculata; achenia neque alata neque marginata,

ea disci pappo 1-aristato et squamellato donata.

Slender shrub, opposite-branched, the stem grayish brown, about 3 mm thick, subterete; internodes mostly 3–5.5 cm long; petioles 4–6 mm long, obscurely margined, strigillose and on margin strigose, not ciliate; blades 9–11 cm long, 2.3–2.6 cm wide, usually strongly falcate, obscurely serrulate (teeth about 6–8 pairs, about 0.3 mm high, 4–8 mm apart, blunt, callos), prominulous-reticulate beneath and with a pair of strong lateral veins arising about 1 cm above base of leaf, slightly shining on both sides, deep green above, slightly lighter green beneath; peduncles slender, densely strigillose, 3–4 cm long, shorter than the upper leaves; disk 1.5-(fruit) 1.2 cm high, 1 cm thick; outer phyllaries 12–13 mm long, with pale indurated ovate base 3–4 mm wide, densely strigillose with lepidote-based hairs, and longer, lanceolate, acuminate, loosely spreading, sparsely strigillose tip 2.5–3 mm wide, the next series equal in length, similar but broader with subscarios-margined oval-oblong base and relatively shorter, more abrupt herbaceous tip, the next series much shorter, mostly subscarios with short narrow abrupt herbaceous tip, strigose toward tip, the inmost entirely subscarios, obtuse, obscurely ciliate; rays 9 or more, golden yellow, elliptic-oblong, the tube about 2 mm, the lamina about 2–2.5 cm long, 6 mm wide; disk corollas golden yellow, essentially glabrous, 6.5 mm long (tube 1.5 mm, throat 4 mm, teeth 1 mm); pales narrow, 1-toothed on each side, acuminate, purplish-tipped, minutely hispidulous-ciliate; ray achenes narrowly obovate, 5 mm long, 1.3 mm wide, 3-angled, not winged or margined, finely hispidulous, their pappus of 3 fragile awns (the 2 outer 1.5–1.8 mm, the inner 4 mm long) and about 5 squamellae about 0.5 mm long, these somewhat united with the awns at base; disk achenes nearly linear, blackish, 5–5.5 mm long, 1 mm wide, compressed, 1-ribbed on each face, 4-angled, not winged or margined, sparsely hispidulous, their pappus of a single slender awn 5 mm long and about 5–6 obtuse hispid-ciliate squamellae up to 1 mm long and united at base.

MEXICO: In pineland, Mount Ovando, Chiapas, 14–18 Nov. 1939, *E. Matuda* 3954 (type no. 151925, herb. U. S. Nat. Arboretum).

Distinguished by its comparatively narrow,

long-acuminate, short-petioled leaves, lepidote-strigose and strigillose above and strigose beneath (the hairs not spreading even when the leaves are moistened), its solitary, rather short-peduncled heads with abruptly herbaceous, spreading phyllary tips, and its wingless and, marginless achenes. The species is apparently nearest *Zexmenia aurantiaca* Klatt, which has ovate leaves with non-appressed pubescence. The descriptions of *Z. monocephala* (DC.) Heynh. and *Z. strigosa* (DC.) Sch. Bip. somewhat suggest this plant, but the types of both species, which I examined and photographed in 1925, are entirely different from it.

***Verbesina phyllolepis* Blake, sp. nov.**

Frutex ?; caulis strigillosus anguste alatus; folia lanceolata utroque acuminata sessilia vix auriculata decurrentia supra partem inferiorem integram serrulata supra saturate viridia tactu laevia sparse strigillosa subtus pallidius viridia densius strigillosa penninervia; capitula in apicibus ramorum 1-3 ca. 4 cm lata aurea radiata breviter pendulata; involucri ca. 4-seriati gradati ca. 4 mm alti phyllaria oblonga subindurata pallida, appendice longiore herbacea lineari-elliptica v. subspathulata obtusa apice callosa late patente donata; radii ca. 20 lamina elliptico-oblonga ca. 17 mm longa 4.5 mm lata.

Shrubby ?, sparsely branched above; stems subterete, brownish, striate, rather densely strigillose, winged throughout (only upper part seen) by the decurrent leaf bases, 3 mm thick, the wings in pairs from each petiole-base, herbaceous becoming dry, entire, somewhat veiny, 1-2 mm wide; internodes mostly 7-15 mm long; leaf blades 8-10.5 cm long, 1.5-2.5 cm wide, herbaceous, serrulate above the entire lower third (teeth 4-10 on each side, obtusely callous-tipped, about 1 mm high, 4-12 mm apart), the costa whitish, prominent beneath, rounded, the chief lateral veins 5-7 pairs, curved, prominulous beneath; heads solitary at tip and in the uppermost axils, the peduncles 0.5-2 cm long, winged like the stem; involucre (excluding the appendages) about 4 mm high, puberulous, the herbaceous appendages about 5-7 mm long, 1-1.5 mm wide, spreading or deflexed; rays pistillate; disk corollas numerous, golden, glabrous except for the sparsely pubescent tube, 4.3 mm long (tube 1.1 mm, throat 2.5 mm, teeth ovate, 0.7 mm long); pales yel-

lowish green, pubescent on the narrow keel, acute, 5 mm long, with erect or in youth somewhat inflexed tip; achenes (very immature) obovate, hispidulous above and on the very narrow wings, 2.3 mm long; awns 2, hispidulous, 1.5-1.8 mm long.

MEXICO: In pineland, Mount Ovando, Chiapas, 14-18 Nov. 1939, *E. Matuda* 3953 (type, Herb. Univ. Michigan; photograph and fragments, herb. U. S. Nat. Arboretum).

A member of the section *Verbesinaria*, related to *V. nerifolia* Hemsl. and less closely to *V. liebmannii* Sch. Bip., but distinguished by the conspicuous spreading or reflexed herbaceous appendages of the phyllaries. The leaves are alternate.

***Tridax accedens* Blake, sp. nov.**

Herba ramosa 45 dm alta, basi invisae; caulis patenti-glandulari-pilosus; folia opposita ovata bene petiolata acuta basi subtruncata pauciserrata sparse hirsuto-pilosa; capitula numerosa mediocria discoidea cymoso-paniculata, pedicellis capitulo saepius multiplo longioribus; involucri 1-seriati ca. 3.5 mm alti phyllaria ovali-oblonga apice rotundata subglabra viridescentia margine scariosa; corollae albae; achenia 5-costata dense pilosula; pappus ca. 20-squamellatus, squamellis flor. exteriorum lacerto-fimbriatis ca. 0.4 mm longis, eis flor. interiorum fimbriatis ca. 1 mm longis.

Stem "5 dm high," about 3.5 mm thick, with numerous erectish branches above, green, purplish-tinged, subterete, somewhat sulcate below, rather sparsely spreading-pilose with several-celled hairs 1-1.5 mm long mostly tipped with brownish glands, the branches and pedicels also puberulent with minute several-celled mostly incurved glandless hairs; leaves opposite, much shorter than the internodes; petioles of larger leaves 2.8 cm long, narrowly margined above, pilose with gland-tipped hairs; blades of larger leaves 5 cm long, 4 cm wide, subtruncate at base and then shortly cuneate-decurrent into the petiole, remotely repand-serrate with 5-6 pairs of low bluntish teeth, herbaceous, green on both sides, above sparsely hirsute-pilose with subtuberculate-based hairs, beneath more sparsely hirsute-pilose chiefly along the veins, triplinerved about 4 mm above the base; panicle about 30 cm long, 19 cm wide, nearly naked, its lowest branches subtended by reduced leaves, the remaining bracts

linear-lanceolate or narrowly triangular, 3–10 mm long; pedicels mostly 1–3.5 cm long; heads campanulate, about 22-flowered, about 5 mm high, 7 mm thick (as pressed); phyllaries 5, 1-seriate, all subtending flowers, sometimes with a single small additional sterile outer one, greenish but not at all herbaceous, with narrow whitish scarious margin, usually brownish at apex, 6–8-vittate, obscurely ciliolate above, glabrous on back; receptacle low-conical, the pales readily deciduous; corollas white, densely hirsutulous on tube, sparsely so on some of the nerves and on teeth, 3.5–3.8 mm long (tube 1 mm, throat cylindrical-oblong, about 1.5 mm in outer corollas, 1.8 mm in central flowers, teeth 5, broadly triangular, 1.2 mm long in outer corollas, 0.8 mm in central corollas); pales oblong, rounded, membranous, with greenish center and about equally broad hyaline margin, 3–5-vittate, ciliolate at apex, otherwise glabrous, not strongly conduplicate, 2.8 mm long; achenes of outer flowers obovoid, somewhat compressed, densely and shortly silky-pilose (the hairs spreading when wet), 5-ribbed (1-ribbed on inner face, 2-ribbed on outer, the ribs on outer face blackish, glabrous, and conspicuous), 2 mm long, their pappus persistent, of about 20 lanceolate lacerate-fimbriate squamellae, united at base, about 0.4 mm long; central achenes obpyramidal, with 5 black glabrous ribs, densely short-pilose (the hairs spreading when wet), 1.8 mm long, their pappus of about 20 alternately somewhat unequal oblong obtuse fimbriate squamellae 0.8–1 mm long, united at base in a thick ring; intermediate fruits with intermediate characters.

MEXICO: In llano, Coalcoman, Dist. of Coalcoman, Michoacán, alt. 1,000 meters, 9 Jan. 1939, *G. B. Hinton* 12884 (type no. 1748961, U. S. Nat. Herb.); same locality, 31 Dec. 1938, *Hinton* 12850 (U. S. Nat. Herb.).

*Tridax dubia* Rose, the only close relative of this species, is readily distinguished by its densely pubescent involucre, essentially glabrous or merely puberulent achenes, and short yellow rays.

***Perezia scaposa* Blake, sp. nov.**

Herba perennis scaposa 60 cm alta, caudice crasso longè brunnescenti-piloso; folia rosulata magna oblonga v. oblongo-obovata lyratopinnatifida membranacea infra in costa sparse et decidue pilosa segmento terminali magno

ovato acuto repando-dentato segmentis lateralibus 3–4-jugis multo minoribus deorsum decrescentibus oblongis acutis repando-dentatis, petiolo brevi anguste alato; scapi 3 tenues parce pilosi remote bracteati bracteis herbaceis subulatis erectis paucidentatis 8–10 mm longis paniculam laxam oblongam multicapitatam subaequantem, pedicellis capillaribus minute bracteatis 1–2 cm longis; capitula parva 5–7-flora, in fructu (corollis delapsis) 8–10 mm longa; involucri 6 mm alti valde gradati ca. 5-seriati phyllaria exteriora parva ovata v. oblongo-ovata 1–2.5 mm longa acuta viridescencia ciliolata dorso glabra, media lanceolato-oblonga, intima linearia acuta v. obtusa apiculata; achaenia minute hispidula 4.5 mm longa; pappus stramineus 5 mm longus.

Rootstock about 4 cm long, 1 cm thick, horizontal, bearing fibrous roots; scapes 1–1.5 mm thick at base; leaves all basal, about 7, 15–27 cm long (including the short narrowly winged petiole, this 1.5–5 cm long), 6–12.5 cm wide, dark green, lightly prominulous-reticulate on both sides, essentially glabrous above, beneath with some loose deciduous pilosity along the midrib and veins and sparse appressed hairs on the surface; panicles about 30 cm long, 9–12 cm wide, thinly pilosulous, the branches diverging at an angle of about 30–45°, the bracts of the pedicels lanceolate or subulate, appressed, about 1 mm long; outer phyllaries passing into the bracts at apex of pedicels, 1 mm wide or less, acute and shortly apiculate, the middle ones about 1.5 mm wide, the inmost acute or obtuse, short-apiculate, 1 mm wide, all slightly ciliolate toward apex, glabrous on back; receptacle fimbriate; corolla 2-lipped, 7 mm long, glabrous, the outer lip oval, 3 mm long, 3-dentate, the inner 2-parted; achene fusiform, olive-green, 4–4.8 mm long, very shortly hispidulous with partly subglandular-tipped hairs; pappus soft.

MEXICO: On cliff, Aquila, Dist. Coalcoman, Michoacán, alt. 250 meters, 24 March 1941, *G. B. Hinton* 15838 (type no. 1820864, U. S. Nat. Herb.).

This species is clearly distinct from any of the 5 scapose species described from Mexico and Central America in Bacigalupi's revision<sup>2</sup> of the North American species of the genus. Its closest ally is apparently *P. nudiuscula* Robin-

<sup>2</sup> Contr. Gray Herb., no. 97. 1931.

son, still known only from the original collection from Nayarit (Tepic), which lacks the basal leaves. In *Perezia nudiuscula* the bracts of the scape are much larger (2–4 cm long), the heads 12–20-flowered and decidedly larger (involucre 8–11 mm high), and the pappus bright white.

*Perezia simulata* Blake, sp. nov.

Herba 1 m alta; caulis tenuis puberulus glabratus subflexuosus; folia oblongo-ovata majuscula chartacea acuminata sessilia amplexicaulia repando-denticulata dentibus spinulosis utrinque reticulato-venulosa supra in venis puberula subtus in venis et venulis puberula; capitula mediocria 5-flora in axillis foliorum capitato-congesta; pedicelli breves dense squamosi squamis triangulari-subulatis subpungentibus in phyllaria involucri transeuntibus; involucri anguste obconici valde gradati ca. 11 mm alti phyllaria lineari-lanceolata longe acuminata subpungentia erecta straminea glabra; corollae bilabiatæ; achenia subrostrata dense glandulosa et minute hispida.

Stem very slender, subterete, multistriate, whitish tinged with purple-brown, puberulous with crisped spreading essentially eglandular hairs, becoming for the most part completely glabrate, with some branches above, these shorter than the leaves; leaves 13–15 cm long, about 6.5 cm wide, plane, spinulose-denticulate throughout, feather-veined (lateral veins about 6–8 pairs), strongly amplexicaul with rounded auricles or the smaller upper ones merely sessile, above puberulous with eglandular hairs on the costa and chief veins, otherwise nearly glabrous, beneath densely puberulous or pilosulous with spreading several-celled eglan-

dular hairs on all the veins and veinlets and sparsely on surface, subsessile-glandular on surface; heads in capitate clusters of about 8–11 in axils of stem and branch leaves, the clusters about 2 cm high, 3–4 cm wide (as pressed), the short pedicels (about 5 mm long) completely concealed by the numerous triangular-subulate long-acuminate subpungent stramineous bracts, these minutely ciliate, otherwise glabrous, about 3–5 mm long, passing into the phyllaries; proper involucre slenderly obconic, about 11 mm high, 3 mm thick (moistened), its phyllaries rather few (about 7), linear-lanceolate, long-acuminate into subpungent straight tips, greenish, narrowly pale-margined, stramineous, minutely ciliate, otherwise glabrous, 1.2–1.5 mm wide; corollas "purple," minutely puberulous outside with subcapitate hairs, 11 mm long, the outer lip 4.8 mm long, 3-dentate, 4-nerved, the inner lip divided to base into 2 linear acute lobes 4.8 mm long; achenes slender, subrostrate, densely glandular and minutely hispulous, 6 mm long; pappus white, 9 mm long.

MEXICO: In woods, Coacoman, Dist. of Coacoman, Michoacán, alt. 1000 meters, 15 March 1939, G. B. Hinton 13654 (type no. 1748962, U. S. Nat. Herb.).

Closely similar in habit and most characters to *Perezia dugesii* Gray but with much narrower and more gradually acuminate phyllaries. In none of the specimens of *P. dugesii* examined are the squamose bracts of the pedicels so numerous or so narrow.

*Stephanomeria cinerea* Blake, comb. nov.

*Ptiloria cinerea* Blake, Proc. Biol. Soc. Washington 35: 177. 1922.

ORNITHOLOGY.—A new wood quail of the genus *Dendrortyx*.<sup>1</sup> HERBERT FRIEDMANN, U. S. National Museum.

Recent study of a large series of wood quail has revealed that the form hitherto known as *Dendrortyx macroura griseipectus* Nelson is in reality a composite of two separable subspecific entities. Hellmayr and Conover (Cat. Birds Amer., pt. 1, no. 1: 225–226. 1942) give the range of *griseipectus*

as comprising only "two widely separated localities, Huitzilac, Morelos, and San Sebastián (northwest of Mascota), Jalisco, Mexico," and further state that "although San Sebastián, Jalisco, is widely separated from Huitzilac, Morelos, and the range of *D. m. striatus* in Michoacan would seem to intervene somewhat, the Jalisco specimens are so nearly like *griseipectus* from Morelos and so different from *striatus* that no other

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received July 1, 1943.

way is left than to place them in the same race." I find, on the contrary, that the birds of the two localities are as separable from each other as are the other recognized (and valid) races of the species. The Huitzilac, Morelos, birds, being topotypical *griseipectus*, retain that name, while for the San Sebastián, Jalisco, specimens I propose the name—

***Dendrorhtyx macroura diversus*, n. subsp.**

*Type*.—U. S. N. M. (Biol. Surv. Coll.) 155936, ♂, San Sebastián, Jalisco, Mexico, collected March 28, 1897, by E. W. Nelson and E. A. Goldman.

*Subspecific characters*.—Similar to *D. m. griseipectus* Nelson but differing in having the

lower back, rump, and upper tail coverts more olive-brown and with no or little black barring; in having the flanks and thighs more olive-brown, less barred; and in having the under tail coverts more brownish, less blackish, with less contrast between the dark areas and the whitish tips.

*Range*.—Known only from northwestern Jalisco (Mascota and San Sebastián).

*Measurements*.—4 ♂, including the type—wing 153–161 (156); tail 138–149 (144.5); culmen from the base 20.6–20.8 (20.65); tarsus 50–53 (51.1); middle toe without claw 39.7–40.7 (40.2 mm), 3 ♀—wing 141–151 (146); tail 119–141 (128.7); culmen from base 19.5–20.8 (20.3); tarsus 47–47.5 (47.2); middle toe without claw 38–38.9 (38.3 mm).

ICHTHYOLOGY.—*Two new characinid fishes from South America of the genus Gilbertolus Eigenmann.*<sup>1</sup> LEONARD P. SCHULTZ, U. S. National Museum.

In recent studies of some characinid fishes that I collected in the Maracaibo Basin of Venezuela, it was observed that the forms of *Gilbertolus* inhabiting the Río Atrato and the Río Magdalena of Colombia and the Maracaibo Basin differed from each other so much that it was decided to describe two of them as new subspecies. The form from the Magdalena River was described by Steindachner in 1878.

The members of this genus seem to occur most frequently in the quiet waters of swampy areas and less frequently in the quieter pools of the rivers. They are nowhere abundant, however, and few specimens are preserved in museums.

Genus *Gilbertolus* Eigenmann

*Gilbertella* Eigenmann, Smithsonian Misc. Coll. 45: 147. 1903 (Genotype: *Anacyrtus (Raestes) alatus* Steindachner.)

*Gilbertolus* Eigenmann, in Eigenmann and Ogle, Proc. U. S. Nat. Mus. 33: 3. 1907. (New name to replace *Gilbertella* Eigenmann, preoccupied.)

KEY TO THE SUBSPECIES OF GILBERTOLUS ALATUS

1a. Pores in lateral line 58 or 59; pectoral rays usually i,17; black caudal spot barely extending on base of middle rays of caudal fin

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received April 22, 1943.

- (see table for counts) (Magdalena Basin) . . . . . *G. a. alatus* (Steindachner)<sup>2</sup>
- 1b. Pores in lateral line to base of caudal fin rays 63 to 68; pectoral rays usually i,16; black caudal spot extending on base of caudal fin rays as far as on caudal peduncle (Maracaibo Basin) . . . . . *G. a. maracaiboensis*, n. subsp.
- 1c. Pores in lateral line 69 to 74; pectoral rays usually i,17; black caudal spot not extending on base of caudal fin rays, becoming less distinct in larger specimens (Atrato Basin) . . . . . *G. a. atratoensis*, n. subsp.

***Gilbertolus alatus maracaiboensis*, n. subsp.**

*Holotype*.—U.S.N.M. no. 121386, a female specimen, 120 mm in standard length, collected by Leonard P. Schultz, March 11, 1942, in a caño half a mile west of Sinamaica, Estado de Zulia, Venezuela.

*Paratypes* (all collected by author).—U.S. N.M. no. 121387, 4 specimens, 107 to 126.5 mm, taken along with the holotype and bearing the same data; U.S.N.M. no. 121388, 1 example, 61 mm, February 24, 1942, from the Río Socuy, 3 km above its mouth, Maracaibo Basin; U.S.N.M. no. 121389, 1 specimen, 75 mm, March 2, 1942, from the Río Negro below mouth of Río Yasa, Maracaibo Basin.

*Description*.—This description is based on the holotype and six paratypes. Detailed meas-

<sup>2</sup> *Anacyrtus (Raestes) alatus* Steindachner, Denkschr. Akad. Wiss. Wien 39: 65. 1878 (Río Magdalena).

urements were made on the holotype and a paratype, and these data, expressed in hundredths of the standard length, are recorded below, respectively.

Standard length, in mm, 120 and 107. Length of head 24.3 and 25.0; greatest depth of body 37.5 and 35.5; length of snout 5.42 and 6.08; diameter of orbit 7.66 and 7.94; least width of fleshy interorbital 6.50 and 6.52; postorbital length of head (to most posterior tip of operculum) 11.9 and 12.1; tip of snout to rear edge of maxillary 12.8 and 13.8; distance from base of last anal ray to midbase of caudal fin 10.1 and 9.82; least depth of caudal peduncle 10.1 and 9.82; length of anal fin base 40.6 and 44.0; length of longest anal fin ray 14.6 and 13.6; longest dorsal ray 17.1 and 18.0; longest pectoral (first) 35.4 and 37.6; longest pelvic ray 15.0 and 15.1; length of upper caudal lobe 24.2 and —; and of lower lobe 26.3 and —; tip of snout to dorsal origin 57.9 and 58.2; snout to anal origin 57.5 and 56.6; snout to adipose 87.5 and 86.0; snout to pelvic insertion 44.6 and 44.5; snout to pectoral insertion 26.9 and 28.5; distance between tip of supraoccipital process and dorsal origin 39.7 and 39.3; snout to tip of supraoccipital process 19.0 and 19.6.

The following counts were made, respectively: Dorsal rays ii,9 and ii,9; anal rays iv,40 and iv,45; pectorals i,16–i,16 and i,16–i,16; pelvics i,7–i,7 and i,7–i,6; pores in lateral line to base of caudal fin rays 68 and 65; scales above lateral line to origin of dorsal 14 and 13 and below lateral line to pelvic fin base 13 and 11; scales in a zigzag row around caudal peduncle 21 and 22; scale rows in front of dorsal to tip of supraoccipital process 42 and 41; branched caudal fin rays 17 and 17; gill rakers on first gill arch — and 8 + 1 + 15.

Body compressed, the greatest depth usually through region of anus and contained a little less than 3 times in standard length, head about 4, base of anal fin about  $2\frac{1}{2}$ , both in standard length; eye large, much longer than snout, about 3, interorbital about  $4\frac{1}{2}$ , mouth (snout to rear of maxillary) 2, all in length of head; mouth equal to snout and eye; origin of dorsal an equal distance between midbase of caudal fin rays and front margin of the opercular bone; origin of anal a little in advance of dorsal origin, the latter over the base of the fourth branched anal ray; pelvic insertions a little closer to rear of pectoral bases than to anal

origin; ventral margin sharply keeled from in front of anal fin to between rear bases of pectorals, thence a hard low ridge ending at isthmus; lateral line a little decurved behind head, thence following a straight course to one scale row below midbase of caudal fin; length of caudal peduncle equal to its least depth; palatine bones forming an elevated ridge but edentulous; premaxillaries with a pair of canines at their symphysis, then seven pairs of short sharp-pointed conical teeth laterally; maxillaries with a series of sharp-pointed conical teeth; teeth in both jaws in a single series; dentaries with two pairs of long canines, the outer pair fanglike; two pairs of short conical teeth between the inner pair of canines; dentaries behind outer pair of canines with a series of widely spaced conical teeth; canines on lower jaw fitting into pits in upper jaw; lower lobe of caudal fin longer than upper lobe; caudal fin deeply concave or forked; first rays of all fins longest; the first pectoral rays are exceedingly elongate, reaching past anal origin to a vertical line through dorsal origin; pelvics reaching not quite so far; anal origin a little closer to tip of snout than midcaudal base; pectoral fin lanceolate in shape; dorsal fin rather short, about equal to eye and postorbital length of head; breast is thick and heavy, the width across prepectoral shields about equal to two eye diameters, and it is the widest part of the body; prepectoral shield with a notch; lower angle of preopercular bone with a short flat, spinelike projection posteriorly; the second suborbital does not quite cover two-thirds of the cheek, and the remainder is fleshy; the gill rakers are rather long and slender, numbering 7 or 8 + 1 + 14 or 15.

*Color*.—Silvery on sides, back darker; the black caudal spot extends as much on the basal portion of the caudal fin rays as on caudal peduncle, and is a little larger than pupil; margin of thick lower lip blackish; membranes of fins pigmented, the rays less so; in the two smaller specimens a lateral dark band occurs above lateral line, ending in the black caudal spot; peritoneum silvery.

*Remarks*.—Among other characters this new subspecies differs from the other two forms referred to the genus *Gilbertolus* as indicated in the key. Named *maracaiboensis* in reference to the Maracaibo Basin in which specimens have been collected.

**Gilbertolus alatus atratoensis**, n. subsp.

*Gilbertolus alatus* Eigenmann (not of Steindachner), Mem. Carnegie Mus. 9(1): 164, pl. 26, fig. 1. 1922.

*Holotype*.—U.S.N.M. no. 76976, a specimen 91 mm in standard length, collected by Wilson at Quibdo, Río Atrato, Colombia.

*Paratypes*.—U.S.N.M. no. 120170, 14 specimens, collected along with the holotype and bearing same data.

*Description*.—Detailed measurements were made on the holotype and one of the paratypes. These data, expressed in hundredths of the standard length, are recorded below, respectively.

Standard length, in mm, 91 and 87.4. Length of head 25.9 and 24.7; greatest depth 35.2 and 35.3; length of snout 6.04 and 5.95; diameter of orbit 9.67 and 9.16; least width of fleshy inter-orbital space 6.15 and 6.30, postorbital length of head 12.1 and 11.2; tip of snout to rear of maxillary 13.0 and 13.5; length of caudal peduncle 9.78 and 9.72; least depth of caudal peduncle 9.34 and 9.84; length of base of anal fin 42.4 and 42.6; length of longest ray of anal — and 17.2; longest dorsal ray 18.7 and 18.1; longest pectoral ray 35.3 and 36.4; longest pelvic ray 11.9 and 12.2; length of upper caudal lobe 24.2 and —; lower caudal lobe 28.6 and —; tip of snout to dorsal origin 57.9 and 57.0; snout to anal origin 57.2 and 55.2; snout to adipose origin 87.5 and 87.0; snout to pelvic insertion 47.8 and 45.4; snout to pectoral insertion 29.7 and 28.6; distance from tip of supraoccipital process to dorsal origin 37.4 and 36.7; snout

tip to posterior point of supraoccipital process 20.8 and 20.3.

The following counts were made, respectively: Dorsal rays ii,9 and ii,9; anal rays iv,43 and iv,46; pectoral i,17–i,17 and i,17–i,17; pelvics i,7–i,7 and i,7–i,7; pores in lateral line 72 and 71; scales from dorsal origin to lateral line 13 and 13, and from lateral line to pelvic base 12 and 13; zigzag row of scales around caudal peduncle 21 and 22; number of gill rakers on first gill arch 8 + 1 + 15 and 7 + 1 + 14; number of scale rows from tip of supraoccipital process to dorsal origin — and 41; branched caudal fin rays 17 and 17.

It is unnecessary to describe this subspecies as fully as *maracaiboensis*, as it is very similar in all except the following respects: Dorsal origin equidistant between midcaudal base and rear orbit; the notch in prepectoral shield is much shallower, so that there is hardly any platelike projection at the lower angle; the spiny platelike projection at lower preopercular angle is shorter, so that there is only an indication of a shallow notch above it; the pectorals reach a little past a vertical through dorsal origin.

*Color*.—Caudal spot does not extend out on basis of middle caudal fin rays; otherwise color is the same as in *maracaiboensis*.

*Remarks*.—This new subspecies may be distinguished from other subspecies referred to the genus *Gilbertolus* by means of the key.

Named *atratoensis* in reference to the river system in which it occurs.

TABLE 1.—COUNTS RECORDED ON THE SUBSPECIES OF GIBERTOLUS ALATUS (STEINDACHNER)

Subspecies	Number of fin rays																									
	Anal									Pectoral				Pelvics		Dorsal										
	iv,40	iv,41	iv,42	iv,43	iv,44	iv,45	iv,46	iv,47	iv,48	iv,49	i,15	i,16	i,17	i,18	i,6	i,7	ii,8	ii,9								
<i>atratoensis</i> . . .	—	—	—	2	1	4	2	4	—	1	—	—	18	1	—	10	—	11								
<i>maracaiboensis</i>	1	—	—	—	4	2	—	—	—	—	2	11	1	—	1	8	1	6								
<i>alatus</i> . . . . .	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	1	1	—								
Subspecies	Number of scales																									
	Number of pores in lateral line														Above lateral line			Below lateral line to pelvic base								
	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	12	13	14	15	16	10	11	12	13
<i>atratoensis</i> . . .	—	—	—	—	—	—	—	—	—	—	—	1	5	3	3	2	1	—	1	6	3	1	—	1	4	6
<i>maracaiboensis</i>	—	—	—	—	—	2	1	2	—	1	1	—	—	—	—	—	—	2	1	2	—	—	—	3	1	1
<i>alatus</i> . . . . .	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—

ZOOLOGY.—*Two new ostracods of the genus Entocythere and records of previously described species.*<sup>1</sup> C. CLAYTON HOFF, Quincy College, Quincy, Ill. (Communicated by CLARENCE R. SHOEMAKER.)

At the time of publication of the writer's previous paper (1942) establishing the subfamily Entocytherinae of cytherid ostracods and describing two new species of the genus *Entocythere* epizoic on crayfishes, it seemed apparent that further examination of crayfishes would reveal other undescribed species of the group. At that time the writer had in his possession a few poorly prepared specimens of an undescribed species of the genus *Entocythere*. Upon examination of large numbers of specimens taken in recent collections, this undescribed form has been found in sufficient numbers to merit description. The present paper describes this as a new species, as well as a second new species. The opportunity is taken here to list records of previously described species of *Entocythere* from crayfishes collected in several States of the lower Mississippi Valley.

The bulk of material upon which this study is based was obtained from crayfishes collected by the writer during the spring of 1942 from areas in Illinois, Tennessee, Louisiana, and Arkansas. The crayfishes obtained from Tennessee were collected with the assistance of Prof. C. L. Baker while the writer was working at the Reelfoot Lake Biological Station under a research grant from the Tennessee Academy of Science. The crayfishes from Illinois were identified by the writer, and all the others were identified by Dr. Horton H. Hobbs, Jr., University of Florida. This study was aided by a grant from the American Association for the Advancement of Science through the Illinois State Academy of Science.

For a discussion of the ostracods epizoic on crayfishes and diagnoses of the subfamily Entocytherinae, the genus *Entocythere*, and the subgenera of the latter, the reader is referred to the paper by Hoff (1942).

***Entocythere (Cytherites) riojai*, n. sp.**

Fig. 1

The type material was taken from several crayfishes of the species *Orconectes virilis*

(Hagen) collected from a stream in South Park, Quincy, Adams County, Ill., on April 18, 1942. Holotype (female), allotype, and a number of paratypes, U.S.N.M. 81292. Additional paratypes have been retained provisionally in the writer's collection. The female selected as holotype was taken while in copulation, the male of the pair being the allotype. The paratypes include both gravid and copulating females, since the two kinds differ in several ways. It might appear inadvisable to select as the holotype a copulating, nongravid female rather than a gravid one, but, when the male and female of a copulating pair are selected as the first types, there is little possibility of designating as holotype and allotype individuals of different species.

This new species is named in honor of Dr. Enrique Rioja, an outstanding Mexican taxonomist, who has recently described two new species of the genus *Entocythere* (Rioja, 1940, 1942). Dr. Rioja was the first to discover the presence of two kinds of females in species of the genus *Entocythere*.

*Female.* The shell (Fig. 1, A) of the copulating female is ovate-oblong in general shape, with little irregularity in outline as seen from the side. The anterior end is more narrowly rounded than the posterior, since the greatest height is near the center of the posterior one-half of the shell. The dorsal margin is weakly convex, while the ventral margin presents a shallow concavity at about the anterior one-third. In some individuals this concavity is so poorly developed that the ventral margin is practically straight. Posterior to the concavity the ventral margin is slightly convex. The very fine marginal hairs of the shell are few in number and are evenly spaced along the ventral and end margins of the shell. The anterior one-third of the shell is unmarked and transparent. The posterior two-thirds, the part beginning a short distance posterior to the eye, is usually marked by very fine pits and colored by aggregations of pigment flecks. These flecks are often concentrated in two areas: one near the center of the dorsal margin extending ventrally toward the center of the shell and the other

<sup>1</sup> Received April 20, 1943.

close to the posterior margin of the shell. In a few individuals the flecks have been observed to cover most of the posterior two-thirds of the shell, but, even in this case, there are always concentrations of pigment in the two areas already described. The eye is large in all individuals and is located about one-fifth of the distance from the anterior end of the shell.

Below are given measurements of several shells of copulating females cleared in xylol and mounted in clarite. These measurements are of females found in copulation at the time of capture.

Length	Height	
0.35 mm	0.19 mm	(holotype)
0.34	0.19	(paratype)
0.35	0.19	(paratype)

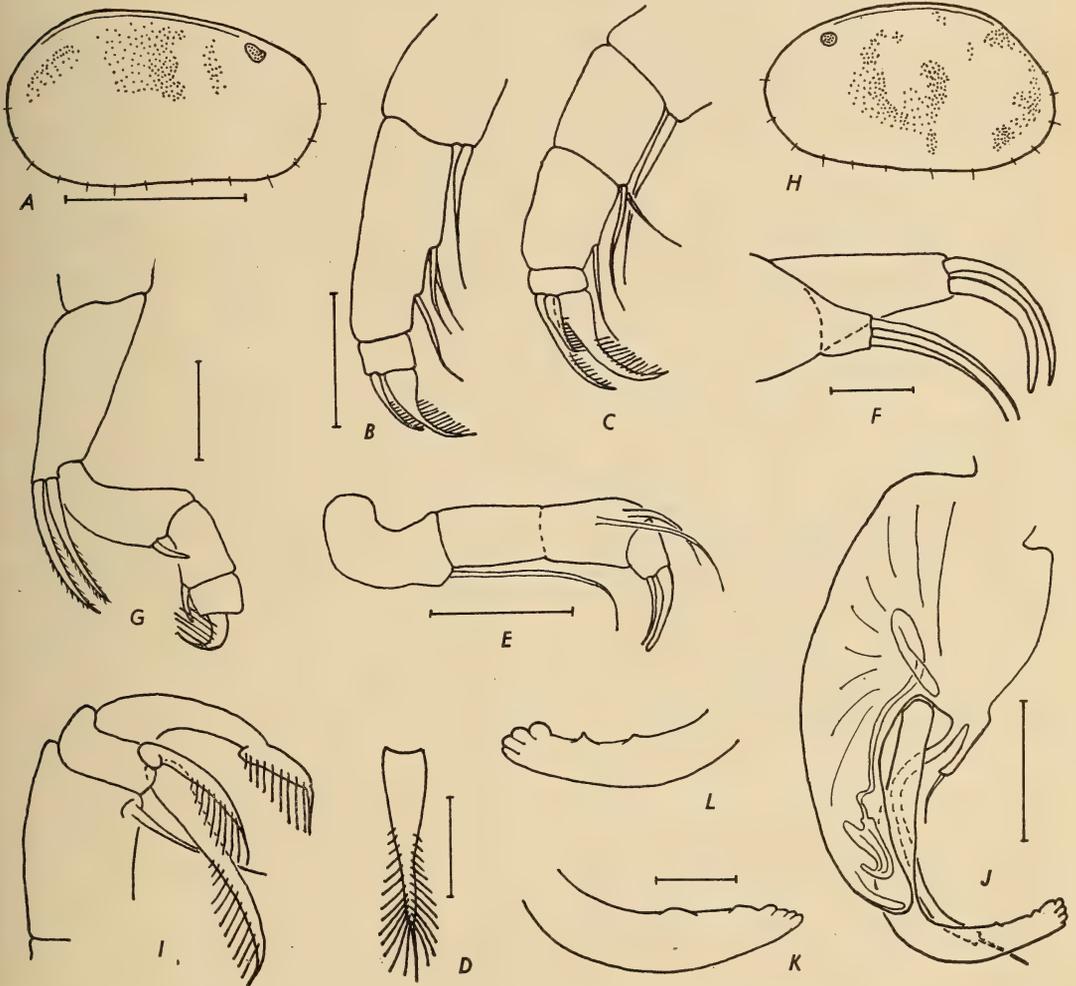


Fig. 1.—*Entocythere riojai*, n. sp.: A, Shell of female holotype as viewed from the right; B, distal part of antenna of copulating female paratype; C, distal part of antenna of gravid female paratype; D, ventral claw of the antenna of a male paratype seen from the flexor side; E, lateral view of the mandibular palp of a gravid female paratype; F, mesial view of the maxillary palp and protopodite of a gravid female paratype; G, lateral view of first leg of gravid female paratype; H, shell of male allotype viewed from the left; I, mesial view of the distal portion of the antenna of a male paratype; J, mesial view of the copulatory organ of the left side of a male paratype; K, the distal end of the "clasping appendage" of the male allotype; L, the distal end of the "clasping appendage" of a male paratype.

All figures were drawn from specimens mounted in clarite. A camera lucida was used. The scale in A equals 0.2 mm and applies also to H. The scale in B equals 0.02 mm and applies as well to C. The scale in D equals 0.01 mm and applies also to I. The scale in E equals 0.025 mm; that of F, 0.01 mm; that of G, 0.025 mm; and that of J, 0.025 mm. The scale in K is equal to 0.01 mm and also applies to L.

Measurements of females from other localities show considerable variation in shell size, with a tendency in many cases for the shells to be somewhat smaller than those of the type collection.

The shell of the gravid female is very similar to that of the copulating type already mentioned, except that the concavity of the ventral margin is much more pronounced and the size of the shell is about 10 percent greater, the length ranging from 0.35 to 0.40 mm or slightly more with the height proportional. Eggs can usually be observed in the gravid type of female but were not seen in copulating females. The eggs range in number from one to four, with two or three the usual number.

With the exception of the antennae, the appendages of the copulating and gravid females are identical in nature. Each antennule is composed of six podomeres. The width of the podomeres decreases in order from proximal to distal. The third podomere is almost square in lateral view, the more distal ones becoming cylindrical. The terminal podomere is the slenderest, having a length between four and five times the central width. The two basal podomeres each appear to bear a single seta; the third two setae; the fourth five somewhat shortened setae, few of which in any individual extend much beyond the level of the tip of the ultimate podomere of the appendage; the penultimate or fifth podomere has no seta; while on the ultimate podomere there are five setae, none of which has a length greater than three times the length of the supporting podomere.

The chief differences between the two kinds of females are to be found in the antennae. Each antenna in the female is composed of four podomeres exclusive of the exopodite or flagellum, which extends to a level with the end of the terminal claws of the appendage. The antepenultimate podomere of the antenna or the first podomere of the endopodite bears on the flexor-distal corner a long, heavy seta, which extends nearly to the level of the origin of the most distal seta of the penultimate podomere. The penultimate podomere of the copulating female (Fig. 1, *B*) is undivided, but in the gravid female (Fig. 1, *C*) a division occurs, so that the antenna appears to be formed of five podomeres, exclusive of the exopodite. In the

copulating female the penultimate podomere has three setae, two forming a pair near the center on the ventral or flexor surface of the appendage and the third a short distance from the distal margin on the flexor surface. The most distal seta of the penultimate podomere has a length somewhat greater than the central width of the podomere, while each seta of the more proximally situated pair has a length about equal to the width of the podomere. In the gravid female the divided penultimate podomere bears a pair of setae on the distal-flexor corner of the basal portion. Another seta is located on the flexor margin of the distal portion about one-third of the distance from the distal end. Each of these three setae is as long as or longer than the basal portion of the podomere. In general, the setae of the antenna are somewhat longer in the gravid than in the copulating female. The ultimate podomere in both kinds of females is small, serving merely as articulation area for the terminal claws. The copulating female has two claws, a large ventral or posterior claw with a row of spinelike teeth passing along both sides and around the distal end as in the male (Fig. 1, *D*), having the appearance from the side, however, of a single row of teeth. These teeth or spines are stout on the distal portion of the claw but become somewhat shortened and weakened near the base. The anterior or dorsal claw is very slender, shorter than the other, and has a few poorly developed spines on the concave surface. The antenna of the gravid female bears three terminal claws, since in addition to the two described for the copulating female there is a third located mesially between the bases of the larger claws. This third claw is small and a little less than one-half the length of the dorsal claw of the antenna. It bears a few weak, short teeth.

The mouth parts are similar in both kinds of females. The mandibles have five to seven, usually six, flattened, spatulalike, multiple-cusped teeth. Two or three small additional teeth may be found in some individuals. The most distal tooth is much wider than the others and has six or seven cusps; the more proximal teeth being progressively smaller and exhibiting fewer cusps. The respiratory plate is reduced to three setae. The palp (Fig. 1, *E*) is composed of four podomeres. The joint between the basal

and the next or antepenultimate podomere of the palp is, however, weakly expressed, while the suture between the antepenultimate and the penultimate podomeres can not be discerned except under optimum conditions. The distal-flexor margin of the basal podomere supports a long, curved seta reaching to the distal end of the ultimate podomere; the antepenultimate podomere has no setae; the penultimate has two setae, a short one near the distal-extensor corner and a somewhat laterally placed longer seta originating from the anterior one-third of the podomere; the ultimate podomere bears terminally a heavy, slightly curved spine at the base of which is inserted a heavy seta nearly equal in length to the length of the spine. The maxilla (Fig. 1, *F*) has an unjointed palp extending far beyond the distal end of the protopodite and ending in two claw-like spines, each falciform, but the ventral one slightly longer and heavier than the other. The two are nearly parallel throughout their length. The base or protopodite ends in two long, stiffened setae, each somewhat longer than the terminal spine of the palp. The respiratory plate usually has 17 setae or rays, although it is very difficult to make an accurate count since the long and slender setae are extremely transparent and can be seen only in preparations made and examined with more than ordinary care. In the case of dissections the respiratory plate is often pulled loose from the protopodite, since the attachment is by a very slender basal stalk. For these reasons the respiratory plate easily may be overlooked.

Each of the three thoracic legs is composed of four podomeres. The first thoracic leg (Fig. 1, *G*) has two plumose setae at the anterior-distal corner of the first podomere. These setae are nearly equal in length, each being almost as long as the next more distal podomere. A single slightly plumose seta is found at the anterior-distal corner of the basal podomere of each leg of the second and third pairs. Each seta has a length not much more than one-half of the length of the antepenultimate podomere. The second podomere of each leg bears a single seta on the anterior margin of each leg a short distance removed from the distal margin. The length of this seta shows considerable variation but in general is not less than one-half of the width of the podomere at the base of the seta

or more than the width of the podomere. The penultimate podomere is distally somewhat widened and meets the ultimate podomere in a poorly marked, probably little movable, joint. The penultimate podomere of each leg bears on the anterior distal corner a seta that has a length approximate to the length of the ultimate podomere. This seta is often so closely appressed to the anterior margin of the distal podomere that it is seen with difficulty. The ultimate podomere of each leg is wider than long. When the terminal claw is flexed the seta of the penultimate podomere contacts the teeth or spines of the terminal claw. Each of the terminal claws bears, on the average, five long teeth.

*Male*.—Shell of the male (Fig. 1, *H*) differing from that of the copulating female only by a ventral margin slightly convex throughout its length and a posterior margin flattened along the dorsal one-half. The measurements of several males mounted in clarite are as follows:

<i>Length</i>	<i>Height</i>	
0.33 mm	0.18 mm	(allotype)
0.34	0.18	(paratype)
0.32	0.18	(paratype)
0.37	0.19	(paratype)

The appendages differ in a few respects from those of the female. The chief difference between individuals of the two sexes is in the antenna, which in the male is modified for clasping the female during copulation. As in the gravid female, the penultimate podomere of the antenna is divided so that the appendage has five apparent podomeres. The setae of the antenna are placed in the same position but are relatively shorter than those of the gravid female. Like the gravid female, there are three end claws (Fig. 1, *I*). These claws are slightly longer than in the gravid female, the ventral claw especially being slenderer and lacking the bulbous basal portion observed in the corresponding claw of the gravid female. The anterior dorsal claw has a length equal to about three-fourths of the length of the longer but slenderer ventral claw. This dorsal claw is heavy throughout its length, is gently curved, and ends distally in a flattened, widened area, which bears a circular row of long teeth or spines that pass around the sides and end, the teeth appearing in side view like the teeth of a comb. The small mesial claw has a length equal

to about one-half of the anterior or dorsal claw. The mouth parts of the male are similar to those of the female. The thoracic legs differ only in the relative lengths of some of the setae, of which those of the antepenultimate podomeres seem usually to be longer in the male than in the female, each having a length greater than the width of the leg at the base of the seta.

The copulatory organ (Fig. 1, *J*) in the male consists of a base and three accessory pieces. The base is proximally widened but abruptly narrowed near the center of the anterior margin at the point of attachment of the accessory pieces. The most dorsal of the three accessory pieces has a short base and a single straight distal seta almost equal in length to the base. The next or center accessory piece is long and slender, being curved at each end but more or less straightened centrally. This accessory piece ends in a seta equal in length to the seta of the first accessory piece. The third or most distal accessory piece (Fig. 1, *K* and *L*) is heavy and falciform. This structure is often called the "clasping appendage." The end of this accessory piece is blunt and distally marked by three or four rounded teeth. The concave margin is toothed with usually two, rarely three, widely separated, almost papilla-form teeth. The "clasping appendage" extends for some distance beyond the base of the copulatory organ.

*Remarks.*—At the present time, it would be difficult to attempt a discussion of the natural relationships of the species in the subgenus *Cytherites* Sars, 1926, especially since the male of *Entocythere* (*Cytherites*) *insignipes* (Sars, 1926), the type of the subgenus *Cytherites*, is unknown. The subgenera of the genus *Entocythere* seem poorly defined, and the entire classification of forms within the genus needs to be reviewed. It is even difficult now to indicate in some of the species a convenient combination of characteristics that might serve as a basis for rapid recognition. Except on the basis of the characteristics of the "clasping appendage," of the male copulatory organ, many of the species of the subgenus may be accurately separated from one another only by careful and detailed study. In the various species of the genus *Entocythere*, there are a few characteristics which, when carefully applied, serve to separate other species from *E. riojai*.

As an aid to future work, a list of the known species of the genus is given here along with an indication of the way in which each may be separated from *E. riojai*.

*Entocythere cambaria* Marshall, 1903, *E. illinoisensis* Hoff, 1942, and *E. claytonhoffi* Rioja, 1942, differ from *E. riojai* by being much greater in shell length, about 0.60 mm, and by having fewer setae in the respiratory plate of the maxilla. These forms have been assigned to the subgenus *Entocythere* Marshall, 1903, as diagnosed by Hoff (1942).

*E. insignipes* (Sars, 1926) differs from *E. riojai* by having seven podomeres and three terminal setae in the antennule, while the latter has six podomeres and five terminal setae. The male copulatory organ of *E. insignipes* is undescribed, the original description of the species being based entirely upon female specimens.

Both *E. heterodonta* Rioja, 1940, and *E. donaldsonensis* Klie, 1931, differ from *E. riojai* by the absence of a seta on the penultimate podomere of each thoracic leg. Neither species has a long, falciform "clasping appendage" with a regular, entire convex surface that could be confused with that structure in *E. riojai*.

*E. columbia* Dobbin, 1941, is easily separated from *E. riojai* by the size, about 0.60 mm in length, and the peculiar shape of the shell. There are also fewer setae in the respiratory plate of the maxilla according to a personal communication from Dr. Dobbin (Evenson). The "clasping appendage" is less curved than in *E. riojai*.

*E. copiosa* Hoff, 1942, may be separated with difficulty from *E. riojai* except by the "clasping appendage," which in the former has the convex margin subdistally divided in contrast to the entire convex surface of that structure in *E. riojai*. Also *E. copiosa* is slightly larger; the setae of the respiratory plate of the maxilla are stronger and more easily seen; and the teeth of the ventral claw of the antenna are usually weaker. These last characteristics are not, however, in every instance entirely dependable for separation of the two species.

*E. humesi*, the second species described as new in this paper, is much larger than *E. riojai* and has four terminal setae on the antennule and only two setae representing the respiratory plate of the mandible. The clasping appendage is not so long or curved as in *E. riojai*.

The problems of intrageneric and inter-

generic relationships in the Entocytherinae and the identification of species are further complicated by the occurrence in some species, as in *E. riojai*, of two kinds of females: the copulating and the gravid. Dr. Rioja in a personal communication to the writer has mentioned the presence of two kinds of females in a species of *Entocythere* from Mexico. Paris (1920) mentions two types of females, "nubile" and "ovigère," in the European species *Sphaeromicola topsenti* Paris, 1916, but does not discuss the two kinds in detail or account for their occurrence. Paris points out the shell differences, especially the increased size and angularity of the shell of the "ovigère" type of female, but mentions no differences in the antennae of the two kinds of females. In *E. riojai* the copulating females have the penultimate podomere of the antenna undivided and the antenna ending in two claws, while the gravid females have a divided penultimate podomere and three antennary claws.

An exact explanation of the occurrence of the two types of females can not be given at this time. In observations made on about 75 adult individuals, the majority of them females, it was noticed that all the females found in copulation were characterized by an undivided penultimate podomere in the antenna and two end claws. These have been designated as copulating females. None were observed in a gravid condition. On the other hand, practically all the larger females with the divided penultimate podomere and three end claws on the antenna were found to be carrying large, well-formed eggs. The females of this type never were observed in copulation.

On first noticing the two kinds of females, the writer supposed that he had discovered a case of parthenogenesis, since this phenomenon would explain the occurrence of copulation in the one kind of female and not in the other. Parthenogenetic development is known in many fresh-water ostracods, being common in species of the family Cypridae, but a morphological difference as exhibited here between females of the two kinds apparently is unreported. Observation does not substantiate the hypothesis that there is one type of female producing eggs requiring fertilization before development and another kind producing eggs developing without fertilization, since, if the hypothesis held, eggs should be observed in at

least a few of the smaller females. Such eggs have not been found. The only adequate explanation for the two kinds of females seems to be that a molt occurs between the time of copulation and the time of development of the eggs within the ovary. At the time of this molt there appear the three claws and the divided penultimate podomere of the antenna as characteristic of the larger, gravid female. Whether this explanation is the correct one can be determined only by observation of the development of females in culture. Unfortunately, methods of culturing the epizoic ostracods are as yet undeveloped.

*Ecology.*—The lack of host specificity in the relationship between *E. riojai* and different species of crayfishes supports the writer's (1942) former observations. Three different species of crayfish are reported as being hosts to *E. riojai* in the six collections. These crayfish species are given in the paragraph on distribution.

In the six collections made of *E. riojai*, the species was found associated twice with *E. copiosa* and four times with *E. illinoisensis*. By this association is meant the finding of ostracods from the crayfishes of one collection and not from the same crayfish, since all the crayfishes of a collection are examined together as a single lot. *E. riojai* was found alone in two collections, but the absence of other forms from these two collections may be the result of small samples.

A review of the habitats, from which the material was secured, reveals the interesting fact that *E. riojai* has been found only on crayfishes from small streams where there is considerable current and never from the quiet waters of lakes or the larger, more slowly flowing streams. Large numbers of collections from different areas may make possible some interesting ecological deductions with reference to this and other species of *Entocythere*.

*Distribution.*—In addition to the type locality, where the species is very abundant, *E. riojai* has been found in collections as follows: a few individuals from *Orconectes virilis* (Hagen), Salt Fork at Homer Park, near Homer, Champaign County, Ill., on May 23, 1940; a few individuals from *Orconectes propinquus* (Girard) from Stony Creek, Oakwood, Vermilion County, Ill., September 19, 1940; a few individuals from *Orconectes propinquus*

(Girard) taken from the stream in Crystal Lake Park, Urbana, Champaign County, Ill., October 2, 1940; a number of individuals taken from *Orconectes longimanus* (Faxon) in a stream near Casa, Perry County, Ark., June 17, 1942; several individuals from *Orconectes meeki* (Faxon) from a stream near Crossroads, Pulaski County, Ark., on June 17, 1942.

**Entocythere (Cytherites)**  
**humesi, n. sp.**

Fig. 2

The type material was secured from a single slightly atypical male crayfish of the species *Cambarus bartonii robustus* Girard collected by Dr. Arthur G. Humes from a stream near Boston, Erie County, N. Y., on May 17, 1942. Holotype (female), allotype, and one paratype (female), U.S.N.M. 81293. Four paratypes, one male, one female, and two immature individuals, have been retained in the collection of the writer. This species is named in honor of the collector, Dr. Arthur G. Humes.

*Female*.—Shell from the side (Fig. 2, A) subreniform, with the posterior end higher and more broadly rounded than the anterior. The ventral margin of the shell has a shallow concavity deepest just behind the anterior one-third of the shell, while the posterior one-half of the ventral margin is weakly convex. The anterior end of the shell is narrowly rounded. The anterior margin meets the dorsal margin without interruption except for a slight indentation just ventral to the junction of the two margins. The dorsal margin is strongly arched with the highest point or apex located between the center and the posterior one-third of the margin. From the apex the dorsal margin slopes in an even arc both anteriorly and posteriorly. The posterior margin is dorsally somewhat flattened but ventrally rounded, meeting the ventral margin without angulation. In juvenile individuals a distinct protuberance or angulation is located at the posterior-ventral corner of the shell. The eye is well developed, is easily observed through the transparent valves, and is located near the anterior one-fifth of the shell. The valves appear asetaceous and show no important shell sculpturing. Poorly developed, scattered areas of pigment occur, however, on the dorsal one-half of each valve posterior to the eye. A more complete description of the shell is at present impossible be-

cause the material available for study is limited. Some indication of the shell size is shown by the following measurements of a gravid female paratype: length of shell, 0.50 mm; height at level of ventral concavity, 0.24 mm; greatest height, 0.29 mm.

With respect to the cephalic appendages, each antennule is composed of six podomeres. The first or basal podomere is heavy; the second has a length little less than twice the width; the third has a length about one and one-half times the width; the fourth or antepenultimate podomere is about twice as long as wide; the penultimate about as long as the antepenultimate but much slenderer; the ultimate is six to seven times as long as wide, with a length approximate to that of the next more proximal podomere. The basal podomere appears to bear a single seta on the ventral-distal corner, while the distal seta of the second podomere is somewhat mesial in position. The third podomere supports two setae. The antepenultimate podomere has four distal setae, one on the flexor margin and one on the extensor margin, with the other two mesial in position. These setae are long, some of them reaching slightly beyond the base of the terminal setae of the appendage. The fifth or penultimate podomere does not bear setae, but four terminal setae are located on the ultimate podomere of the antennule. The antennae closely resemble the antennae of several other species of the subgenus *Cytherites* Sars, 1926, each being composed of four podomeres, exclusive of the exopodite, and ending in two claws (Fig. 2, B). The penultimate podomere is undivided. The anterior or dorsal terminal claw is weak, with the teeth so poorly developed that they are seen only with great difficulty. The ventral claw is the larger, is proximally bulbous, and has a comblike row of long teeth along the distal two-thirds of the claw. The penultimate podomere of the antenna has a length nearly equal to three times the average width of the podomere and bears three setae on the flexor or ventral margin. One of these is removed a short distance from the distal end of the podomere, and the other two form a pair slightly anterior to the center. Each has a length almost equal to the width of the podomere at the base of the seta. The seta of the flexor-distal corner of the antepenultimate podomere has a heavy basal por-

tion and does not reach the level of the origin of the most distal seta of the penultimate podomere. The antepenultimate or second podomere of the antenna (the basal podomere of the endopodite) has a distal width approximate to the length of the ventral margin. The flagellum or exopodite reaches to the level of the terminal claws of the endopodite. The protopodite of the mandible bears six spade-like or spatulaform teeth, the mesial two usually being longer than the others and having a single cusp, while the more laterally placed teeth are multicusped, the outside one having six well-developed denticles or cusps. In some instances a small but rudimentary additional tooth may be found mesial to the others, thus making seven teeth in all. A short distance proximal to the teeth the protopodite bears a short, heavy seta on the convex or anterior surface. This seta is directed toward the distal end of the protopodite. The respiratory plate is represented by two setae: one more than one-third as long as the mandibular palp, the other about one-fourth the length of the palp.

In some individuals one of these setae appears to be directed mesially, usually closely appressed to the protopodite, while the shorter of the two setae often stands erect. These setae are fleshy in appearance, the bases being widened, and they appear to originate from a small papilla. The mandibular palp (Fig. 2, C) of four podomeres extends distally beyond the protopodite. In this palp the juncture of the basal and second podomere is not well marked but can be located by noticing the origin of the seta at the distal-flexor corner of the basal podomere. This seta reaches the level of the ultimate podomere of the palp. The straight basal two-thirds of the seta is often directed parallel to the flexor margin of the palp, while the distal one-third is evenly curved. The probably inarticulate juncture of the antepenultimate or second and the penultimate or third podomere is too weak to be easily observed. On the anterior face, slightly removed from the distal end of the penultimate podomere, is a gently curved seta extending almost to the tip of the terminal spine of the ultimate

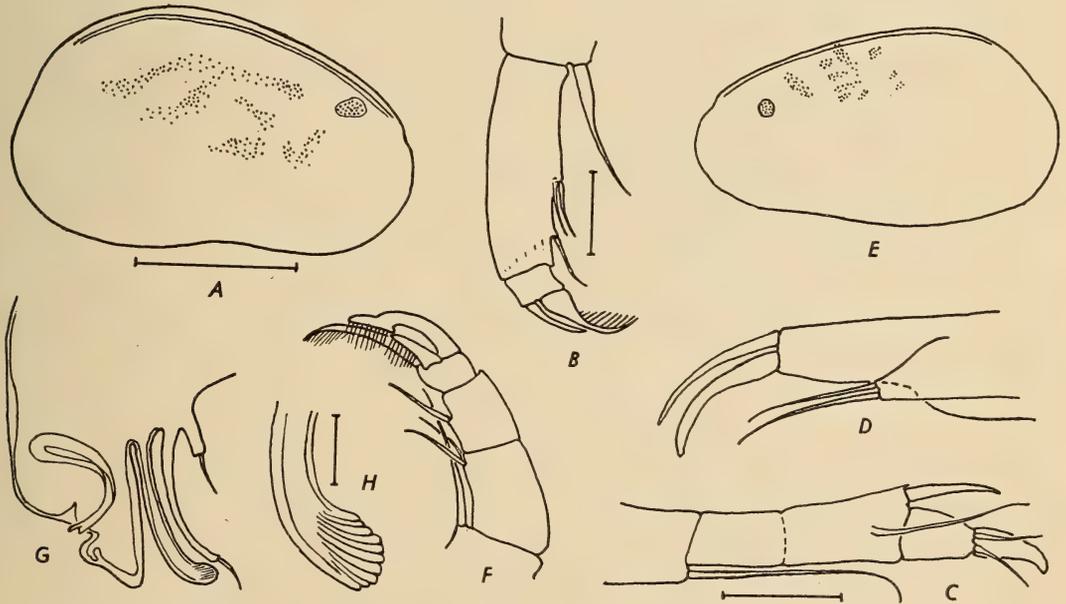


Fig. 2.—*Entocythere humesi*, n. sp.: A, Shell of a female paratype as seen from the right side; B, mesial view of the distal end of the endopodite of the antenna of a female paratype; C, anterior view of the mandibular palp of the holotype; D, mesial view of the masticatory process and the maxillary palp of a female paratype; E, shell of male allotype viewed from the left side; F, mesial view of the endopodite of the antenna of male allotype; G, lateral view of the distal end of the copulatory organ of male allotype; H, end of "clasping appendage" of male allotype.

All figures were drawn with the aid of a camera lucida from specimens mounted in clarite. The scale for A equals 0.2 mm and applies also to E. The scale for B equals 0.025 mm and applies as well to F and G. The scale for C equals 0.02 mm and may be applied to D. The scale for H is equal to 0.01 mm.

podomere, while at the extensor-distal corner of the same podomere is a sharply pointed, spinelike seta whose tip extends slightly beyond the distal end of the ultimate podomere. The terminal podomere is distally narrowed and has a flexor margin whose length is slightly greater than the basal width of the podomere. In addition to the heavy terminal spine, which is curved near the tip, the ultimate podomere bears two fine setae originating beneath the base of the spine. The spine has a length somewhat greater than the length of the extensor margin of the ultimate podomere, while each seta is somewhat shorter. In Fig. 2, *C*, the terminal podomere of the mandibular palp is shown slightly rotated to expose the two terminal setae, which are difficult to distinguish as separate setae when observed in lateral or mesial view. The maxilla (Fig. 2, *D*) includes a single masticatory process, an unsegmented palp, and a respiratory plate bearing 16 rays or setae. The unsegmented palp ends in a heavy but gently curved spine along the convex side of which runs a second similarly curved but slenderer spine, slightly shorter than the first. The single masticatory process terminates distally in two long setae, each curved gently near the tip and reaching some distance beyond the base of the terminal spine of the palp.

The three pairs of thoracic legs are similar, as each consists of four podomeres and terminates in a sickle-shaped claw displaying on the concave surface five teeth in addition to the one that is a continuation of the basal portion of the claw. The center teeth are considerably longer than the others. The legs differ chiefly in the presence of two setae at the anterior-distal corner of the basal podomere of the legs of the first pair but only a single seta in this position in the legs of the second and third pairs. The penultimate podomere of each leg has a single heavy, short seta on the distal anterior corner. The antepenultimate podomere supports a single seta on the anterior margin somewhat removed from the distal end of the podomere.

*Male*.—The shell of the male (Fig. 2, *E*) is similar in general shape to that of the female except that the concavity of the anterior portion of the ventral margin seems to be more weakly developed and may be so nearly wanting that the ventral margin appears practically straight. Redescription with an indication of

the limits of variability of shell size and shape will be advisable when additional material can be secured for study. Two males mounted in clarite have shell measurements as follows: length, 0.45 mm; height behind eye at level of weak sinuation of ventral margin, 0.19 mm; and maximum height at the level of the apex of the dorsal margin, 0.24 mm.

The appendages of the male resemble those of the female. The podomeres of the antennules are not so wide, however, making them appear slightly slenderer in general aspect. The number and position of the setae are identical in the antennules of the two sexes. The antennae of the male (Fig. 2, *F*) present the characteristics associated with that sex. As is common among males of species of *Entocythere*, the penultimate podomere of the present species is so divided that each antenna appears to be composed of five podomeres. Two setae stand at the flexor-distal corner of the basal portion of the penultimate podomere, while a third seta is located on the ventral margin slightly anterior to the center of the distal portion. The antenna of the male terminates in three claws. The ventral claw is long and has very poorly developed teeth along only the terminal one-third of the concave surface. These teeth are much weaker than usual in males of species of this genus. The extreme tip of the ventral claw is bent ventrad. The dorsal or anterior claw is shorter and heavier than the first claw described and bears long teeth arranged comblike along the distally flattened margin. The third claw is mesial in position, being interposed in position between the bases of the other two claws. This third claw has a length equal to about two-fifths of the length of the ventral claw and just reaches the proximal limit of the flattened area of the dorsal claw. The teeth of the mesial claw are much better developed than the teeth of the ventral claw. Perhaps as a sexual difference, the seta of the basal podomere of the endopodite of the antenna reaches to the center of the ultimate podomere of the endopodite, being much longer than the corresponding seta in the female. With respect to the mouth parts, the limited material available makes impossible accurate checking of all details pertaining to the mandible of the male. There seems, however, to be close agreement in structure of the mandible in the two sexes. It was clearly seen that the

distal end of the ultimate podomere of the mandibular palp of the male bears a long, heavy, gently curved spine close to the base of which originate two slender, short setae. The maxilla of the male allotype appears to have a respiratory plate bearing 17 rays or setae. The setae of the respiratory plate could not be counted accurately on the male paratype available. The slight variation of the allotype from the 16-rayed condition observed in the female holotype is no more than can be expected as an individual difference. No essential differences were noticed between the thoracic legs of the female and the male.

The copulatory organ (Fig. 2, *G*) differs distinctly from that of other known *Entocythere* species. The base of this structure terminates in a well-chitinized, truncate lobe. The base supports three accessory pieces, of which the dorsal is fleshy in appearance and consists of a short base and a long, slender terminal spine. The second or middle accessory piece has a much longer base directed distally and anteriorly, extending just beyond the end of the base of the copulatory organ. The second accessory piece is terminated by a slender, curved spine approximate in length to the spine of the first accessory piece. The third accessory piece or "clasping appendage" (Fig. 2, *H*) is sickle-

shaped or falciform, curved more distally than proximally, and formed of a highly chitinized bar, distally widened and fan-shaped, marked terminally by longitudinal corrugations or grooves. This "clasping appendage" reaches almost to a level with the end of the spine of the second accessory piece.

*Remarks.*—*Entocythere humesi* may be separated from other species of the genus *Entocythere* by no single characteristic except the shape of the "clasping appendage" of the male copulatory organ. A combination of characteristics will serve, however, in the case of the female, for separation of *E. humesi* from other described species. This is the only species that has a combination in the female of four terminal setae on the antennule, an undivided penultimate podomere in the antenna, and two respiratory setae representing the respiratory plate of the mandible.

*Distribution.*—Known only from the type locality.

#### *Entocythere copiosa* Hoff, 1942

In 1942, the present writer reported *E. copiosa* as abundant from a number of different species of crayfishes collected from several localities in Illinois. The present study reveals the occurrence of this species in many collec-

TABLE 1.—COLLECTIONS OF THE EPIZOIC OSTRACOD ENTOCYHERE COPIOSA

Date	Crayfish host	Habitat	Location
14-VI-1942	<i>Procambarus clarkii</i> (Girard)	Roadside ditch	Near Port Allen, West Baton Rouge Parish, La.
14-VI-1942	<i>P. blandingii acutus</i> (Girard)	Roadside ditch	Near White Castle, Iberville Parish, La.
15-VI-1942	<i>P. clarkii</i> (Girard)	Roadside ditch	Near Alexandria, Rapides Parish, La.
15-VI-1942	<i>P. hinei</i> (Ortmann)	Roadside ditch	Near Livonia, Pointe Coupee Parish, La.
15-VI-1942	<i>P. clarkii</i> (Girard)	Roadside ditch	Near Westover, West Baton Rouge Parish, La.
15-VI-1942	<i>P. blandingii acutus</i> (Girard)	Roadside ditch	Near Dry Prong, Grant Parish, La.
16-VI-1942	<i>P. blandingii acutus</i> (Girard)	Roadside ditch	Near Dry Prong, Grant Parish, La.
17-VI-1942	<i>Orconectes clypeata</i> (Hay)	Stream	Ivesville, Pulaski County, Ark.
17-VI-1942	<i>Orconectes meeki</i> (Faxon) <sup>1</sup>	Stream	Ivesville, Pulaski County, Ark.
17-VI-1942	<i>P. blandingii acutus</i> (Girard)	Stream	Ivesville, Pulaski County, Ark.
25-VI-1942	<i>P. clarkii</i> (Girard)	Bayou	Walnut Log, Obion County, Tenn.
26-VI-1942	<i>P. clarkii</i> (Girard)	Bayou	Walnut Log, Obion County, Tenn.
13-VII-1942	<i>P. clarkii</i> (Girard)	Bayou	Walnut Log, Obion County, Tenn.
20-VII-1942	<i>P. clarkii</i> (Girard)	Lake	Lake Center, Obion County, Tenn.
25-VII-1942	<i>Cambarus d. diogenes</i> (Girard)	Stream	South of Walnut Log, Obion County, Tenn.
25-VII-1942	<i>Orconectes i. immunitis</i> (Hagen)	Stream	South of Walnut Log, Obion County, Tenn.
25-VII-1942	<i>O. i. immunitis</i> (Hagen)	Small stream	South of Walnut Log, Obion County, Tenn.
25-VII-1942	<i>O. i. immunitis</i> (Hagen)	Pool in stream bed	Near east side of Reelfoot Lake, Obion County, Tenn.
25-VII-1942	<i>Procambarus clarkii</i> (Girard)	Small stream	Near east side of Reelfoot Lake, Obion County, Tenn.

<sup>1</sup> Males of *O. meeki* in this collection reported as slightly atypical.

tions from widely separated areas in Louisiana, Arkansas, and Tennessee. Data relative to these collections are given here in tabular form.

The data in the table show an apparent lack of habitat selection in the instance of this species, since the form is found in roadside ditches, pools, lakes, and various types of streams. This lack of habitat preference is in direct contrast to the condition mentioned with reference to *E. riojai*.

#### *Entocythere illinoisensis* Hoff, 1942

Besides the Illinois localities for *E. illinoisensis* given in the writer's paper of 1942, this rather infrequent species is now known from two localities in Arkansas. Near Casa, Perry County, Ark., a collection of 11 individuals of *Orconectes longimanus* (Faxon) produced several ostracods of the species *E. illinoisensis* in association with several specimens of *E. riojai*. The collection was made from a swiftly flowing stream on June 17, 1942. A second collection of *E. illinoisensis* was made on the same date from a small stream near Ivesville, Pulaski County, Ark. Two individuals, one male and one female, of this species were obtained from a collection of the crayfishes *Orconectes meeki* (Faxon) (males slightly atypical) and *Cambarus blandingii acutus* (Girard). Also in this collection were large numbers of *Entocythere copiosa*.

Like *E. riojai*, the present species favors stream habitats and in most cases has been collected from streams where there is considerable current. This is shown not only by the present records but also by the several previous records (Hoff, 1942).

In the collection from near Ivesville, Ark., the female agrees in detail with type specimens, but the male is somewhat atypical, since the pronounced knob or projection on the convex side of the "clasping appendage" of the male copulatory organ is greatly reduced. The "clasping appendage" is otherwise not abnormal, resembling in detail typical individuals of *E. illinoisensis*. The modified "clasping appendage" of this atypical male to some small degree resembles that of *E. cambaria* Marshall 1903, but other body structures are certainly not those of *E. cambaria*. For the

present, until more material can be procured, this specimen will be assigned to *E. illinoisensis*. Upon the acquisition of additional material, it will be possible to show either that this one individual is abnormal or that a new species or subspecies is represented.

#### SUMMARY

1. Two species of the genus *Entocythere*, *E. riojai* from Illinois and Arkansas and *E. humesi* from New York, are described as new.
2. Locality records extending the geographical ranges of *E. copiosa* and *E. illinoisensis* are given.
3. *E. riojai* and *E. illinoisensis* have been found to occur only on crayfishes from small streams where there is considerable current. *E. copiosa* apparently does not show any habitat preference.

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## Obituaries

WILLIAM ALBERT HOFFMAN, head of the department of parasitology in the School of Tropical Medicine, San Juan, Puerto Rico, died on April 4, 1943. Born in Jersey City, N. J., April 18, 1894, he obtained his B.S. degree at Cornell University (1917) and his Sc.D. at Johns Hopkins University in 1924. After teaching entomology and zoology at Iowa State College from 1917 to 1918, he was associated with the U. S. Department of Agriculture until 1920, and then served a year as assistant entomologist to the State of New York. While at Johns Hopkins (1921-24) he was assistant in medical entomology and, upon graduation, was sent by the Rockefeller Foundation to Haiti as medical entomologist in a survey of that republic. In 1926 he joined the newly founded School of Tropical Medicine and was delegated to organize its department of parasitology, with which he was closely identified until his death.

While in Haiti, Professor Hoffman was particularly interested in the anophelines of the region. In Puerto Rico he clarified and defined the epidemiology, distribution, and biology of schistosomiasis as found there. Some of his investigations on the biology of schistosomes were carried out in close collaboration with Dr. Ernest C. Faust. Among the important findings relating to this parasite were the experimental proof of the snail species that serves locally as the intermediate host, improvement of concentration methods in searching for ova in the feces, refinement of experimental means of inoculation of animals with cercariae, and, in collaboration with Dr. W. H. Taliaferro, development of a highly promising skin test. He also contributed to our knowledge of filariasis and *Fasciola hepatica* and to the biology of several parasites of domestic animals.

Hoffman's main interest, however, was in the field of taxonomic entomology. As an outstanding authority on the Ceratopogonidae he was widely consulted on problems of identification; he described several new species of *Culicoides* and, with the late Dr. Francis M. Root, published a review of the North American species of that genus. His listed publications number about 60, including important sections in Wolcott's *Entomologie d'Haiti* and Gay's *Aspects of disease and host resistance*. He belonged to several scientific societies.

Professor Hoffman will be remembered by a wide circle of admirers and friends not only for his scientific accomplishments but also for his rare ability to inspire enthusiasm in all who worked near him; for his unstinted generosity toward those who needed a helping hand; for his devotion to the art of music; and for the humble simplicity and almost ascetic austerity of his life.

RICHARD FAY JACKSON, senior chemist, National Bureau of Standards, died at his home in Chevy Chase, Md., on June 1, 1943. He was born in Dorchester, Mass. on January 2, 1881. He attended the Boston Latin School and Harvard University, receiving the degree of A.B. (magna cum laude) from the latter in 1903 and the Ph.D. degree in 1917 from the same institution. Upon the completion of his undergraduate work at Harvard, Dr. Jackson served as research assistant at Massachusetts Institute of Technology from 1905 to 1907. He entered the Government service on October 1, 1907, as laboratory assistant in the Polarimetry Section, National Bureau of Standards.

An enthusiastic and painstaking worker in the field of sugar chemistry, Dr. Jackson directed his researches into the investigations of problems dealing with the physical properties of the sugars and to the development of new and improved methods of their preparation, purification, and estimation. He made extensive studies of the sugars, sucrose, dextrose, and levulose, and his many articles on their physical and chemical properties received international recognition. In recognition of his contributions on levulose, the Washington Section of the American Chemical Society awarded him the Hillebrand prize in 1925, Dr. Jackson being the first recipient of this honor. His phase-rule studies of the system lead acetate, lead oxide, and water and the system dextrose, levulose, and water have been accepted as authoritative. His studies on the preparation and hydrolysis of inulin led to his discovery of three new crystalline difructose anhydrides among the products of hydrolysis.

Dr. Jackson was an untiring worker in the affairs of the Association of Official Agricultural Chemists, serving for many years as associate referee on reducing-sugar methods and for the past several years as general referee on sugar

and sugar products. He was a member of the International Commission for Uniform Methods of Sugar Analysis and contributed generously of its efforts.

Dr. Jackson was a member of the American Chemical Society, the Washington Academy of Sciences, the American Institute of Chemists (fellow), and the Chemists Club of New York.

CARL F. SNYDER

WILLIAM ALBERT SETCHELL, algologist, plant geographer, and chairman of the Department of Botany of the University of California for nearly 40 years, died in Berkeley, Calif., on April 5, 1943. He was born in Norwich, Conn., on April 15, 1864. As an undergraduate at Yale University, his boyhood interest in biology and especially cryptogamic botany was stimulated primarily by D. C. Eaton. After matriculation young Setchell was enabled to continue his work in botany, under W. G. Farlow, at Harvard, where he was awarded the doctorate in 1890. He returned to Yale as an assistant but was soon attracted to Berkeley.

The series of papers on the marine algae of the Pacific coast of North America by Setchell and N. L. Gardner contain probably his best known writings. Although a fully competent taxonomist, he never regarded classification as a final goal but was always more deeply interested in the "dynamic aspects" of biology—a point of view that he vigorously encouraged in his students. From this study of the algae of North America, he was led to investigate the marine flora of other Pacific areas. An association with the Carnegie Institution of Washington permitted Professor and Mrs. Setchell to make a series of trips to the Pacific islands, Australia, New Zealand, eastern Asia, and South Africa. These travels were designed primarily to facilitate investigation of the nature of reef-formation but they also aroused or augmented his interest in ethnobotany, insular endemism, trans-oceanic migration, and the classical problems of plant distribution from a possible "antarctic" center.

Geobotany—which he defined as a synthesis of the distributional, ecological, and genetic or historical phases of the study of taxonomic

entities and associational groupings—attracted nearly as much of his attention as did taxonomic study of cryptogamic plants. He liked to emphasize the importance of occasional chance dissemination of germules by normal agencies and was loathe to accept the promiscuous shifting of poles and continents or the rise and fall of land bridges to explain distributional patterns.

From a study of temperature effects on the development of algae and marine flowering plants, he became interested in the temperature thresholds in the life cycle of flowering land plants. He devoted particular attention to certain of the hypogeous fungi and to the morphology of the Balanophoraceae. He was the instigator of the important genetic investigations on *Nicotiana* extended by R. E. Clausen and T. H. Goodspeed and their students. His published scientific contributions, dating from 1883 to 1943, embrace about 150 titles.

Professor Setchell was a member of the National Academy of Sciences, the Washington Academy of Sciences, and of the American Philosophical Society; a fellow of the American Academy of Arts and Sciences, the American Geographical Society, the Torrey Botanical Club, and the California Academy of Sciences; a sustaining member of the California Botanical Society; and a member of the Linnaean Society of London, as well as of many other scientific organizations, both in this country and abroad.

His students remember him as a stimulating if unorthodox teacher. His wealth of experience and observation and the diversity of his interests, combined with a keen critical judgment, enabled him to digress interestingly in any direction. He took a particularly warm interest in the education and personal life of many young students, the informal and populous "Order of Nieces and Nephews," whose members are to be found all over the world. Despite the number and excellence of his written contributions to science, it may well be that his influence on their careers and lives will outweigh all his other accomplishments.

LINCOLN CONSTANCE



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No. 10

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# JOURNAL

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ETHNOLOGY.—*The last passenger pigeon hunts of the Cornplanter Senecas.*<sup>1</sup>  
WILLIAM N. FENTON, Bureau of American Ethnology, and MERLE H. DEARDORFF, Warren, Pa.

*"Perhaps again one will say, 'Now once again they are nesting'."*

Among the few descendants of the famous old chief still living on the Cornplanter Grant in Warren County, Pa. (Deardorff, 1941), Willie Gordon, inveterate trapper and renowned bear hunter, and Lydia Bucktooth, his neighbor, remember going after squabs to the beechwood groves south of Sheffield where the passenger pigeons (*Ectopistes migratorius*) were last reported to be nesting. Others—Windsor Pierce and Ezra Jacobs—remember hearing the oldsters tell about these expeditions, but they were too young to go along. At Coldspring, above the State Line, is the conservative community of the Allegheny Band of Seneca: Alice White remembers that when she was a little girl her parents joined a party of families that made an expedition to the pigeon roosts at some place below Warren; and Chauncey Johnny John, although born at Cattaraugus Reservation, N. Y., and not so old as some others, had been on several such hunts when quite young. Evidently, among the Seneca such trips to the pigeon roosts were a regular event in the annual round of getting a living.

That this custom comes down from earlier days with every likelihood that it is pre-Columbian is indicated by the narratives of early travelers. Since the passenger pigeon was one of the most abundant birds, if not the most abundant in North America, it is not unreasonable to assume that the Indians had long depended upon its annual

return to the nesting grounds, where they procured the squabs in great numbers to supplement their diet; in fact, at this season of the year it seems to have constituted the principal part of the food supply.

#### EARLY REFERENCES

##### *Netting*

The Relations of 1656–57 of the first Jesuit mission to the Onondaga remark how the pigeons gather in the spring at the salt springs adjacent to Onondaga Lake in such numbers that they are taken in nets . . . "that sometimes as many as seven hundred are caught in the course of one morning." (Jesuit Relations, vol. 43, p. 153; see also Le Mercier's Relation of the previous year.) In the Cayuga country, where the game was so plentiful that 1,000 deer were killed in a single season, Father Raffeix (1671), reporting on the Mission of St. Joseph at *Goioguen* [Cayuga], says: "Fish—salmon, as well as eels and other kinds—are as plenty here as at Onnontagué [Onondaga]. Four leagues [12 miles] from here I saw by the side of a river, within a very limited space, eight or ten extremely fine salt springs. Many snares are set there for catching pigeons, from seven to eight hundred being often taken at once." (J. R., vol. 56, p. 49.)

Further evidence that the Onondaga netted passenger pigeons at the famous salt springs is found in Pehr Kalm's monograph (1759), which contains the following description of the activity:

I have also observed that the pigeons have a special fondness for the kind of soil which is

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received June 8, 1943.

much mixed with common salt; this soil serves them as food, as a spice to blend with the food, or for its medical properties, I do not know which. At the salt springs of Onondago [*sic*], . . . where the soil is so strongly mixed with salt that the ground during a severe drought becomes entirely covered with it and as white as frost, making it impossible for plants to grow, I noticed with astonishment, in the month of August, 1750, how covetous the pigeons were of this kind of soil. The savages in Onondago had built their huts on the sides of this salt field, and here they had erected sloping nets with a cord attachment leading to the huts where they were sitting; when the pigeons arrived in swarms to eat of this salty soil, the savages pulled the cords, inclosing them in the net, and thus at once secured the entire flock. At certain times, when they come in such numbers that the ground could hardly be seen for them, the savages found it more advisable to use a gun, as by a single discharge of bird-shot they could sometimes kill as many as 50 or more; and this proved a splendid source of food supply. (Kalm, 1912, p. 415. See also "A Bibliography of Peter Kalm's Writings on America," in Kalm, 1937, p. 774.)

Although it would appear from these accounts, and one other by Pierre Boucher which follows, that the Iroquois from early times had used nets for taking pigeons, whether their use was learned from the white men remains an open question. Pierre Boucher, in his "true and genuine description of New France" in the seventeenth century, says: "There are birds of another kind called wild pigeons. . . . There are prodigious numbers of them . . . they are to be found everywhere in this country. The Iroquois take them in nets as they fly, sometimes by 300 or 400 at a time."<sup>2</sup>

The two accounts by Boucher and Kalm sound rather as if the Indians originated the idea of netting pigeons, but Mitchell points out that the English colonists of Massachusetts took them in nets about 1660 and had done so for some time previously, according to John Josselyn.

Eye-witness accounts of the Seneca netting and snaring pigeons are scarce, if not lacking, in the literature. Morgan, who worked mainly with Seneca informants at Tonawanda *circa* 1850, says: "Nets of bark

and twine were . . . spread for pigeons and quails." And he describes a simple bird snare, formerly much used against blue jays that came for corn, which might have been used on single pigeons with great effect. (Morgan, 1901, vol. 2, p. 24.)

The Cayuga evidently set nets for pigeons on high places. The nets are said to have been made of twine from swamp milkweed fiber, basswood, or slippery-elm bast. The net (*gada'qu'dakwa'*) was spread between two upright sticks, and the netter sat back at some distance holding one end, waiting for a high wind to blow the pigeons into it, when he would pull the net. The folk-tale of "the foolish nephew," in which this information occurs, does not disclose how the netted pigeons were killed, but they were tied in bunches to take home. When the hero and his uncle reached home they plucked the feathers, spitted the birds on sticks, roasted them beside the fire, and dried them for later use.<sup>3</sup>

In later times professional pigeoners set out similar nets without any tripping device on high bluffs along Lake Ontario. That this practice was probably in use among the Cayugas of the region is indicated by their folk-lore and by the authorities already cited.

#### *Raiding Nests for Squabs*

Historical accounts of Seneca pigeon hunts sustain the statements of informants that when the squabs were ready to leave the nest the nesting-trees were felled and the fattened squabs were taken by hand and killed and gutted for smoking and drying before packing them home.

The Gilbert Narrative of the sufferings of a Pennsylvania family during their captivity among the Senecas, 1780-83, tells how Benjamin Gilbert, Jr., was adopted into the family of a Seneca chief who settled on Buffalo Creek; and, being considered the "King's" successor, Benjamin was entirely freed from restraint and permitted to go fishing and hunting with his Indian contemporaries. In the spring of 1781—

<sup>2</sup> MONTIZAMBERT, EDWARD LOUIS, *Canada in the seventeenth century. Being a translation of a true and genuine description of New France, by Pierre Boucher*. Paris, 1664, p. 43. Montreal, 1883, in Mitchell, 1935, p. 119.

<sup>3</sup> COOK, ELIAS (Cayuga), "Grand River Reserve (Canada) (1918)," in F. W. Waugh, *Iroquois folk-lore* (MS.), Notebook 5, p. 40 ff. National Museum of Canada.

the whole Family moved about six Miles up Lake Erie [near Big Tree] where they staid about two Months to gather their annual Store of Maple Sugar, of which they made a considerable Quantity.

As soon as the Season of this Business was over, they returned to their old Settlement [on Buffalo Creek], where they had not continued long, before an Indian came with an Account that an astonishing Number of young Pigeons might be procured at a certain Place, by falling Trees that were filled with Nests of young, and the Distance was computed to be about fifty Miles: This Information delighted the several Tribes; they speedily joined together, young and old, from different Parts, and with great Assiduity pursued their Expedition, and took Abundance of the young ones, which they dried in the Sun and with Smoke, and filled several Bags which they had taken with them for this Purpose. Benjamin Gilbert was permitted to accompany them on this Excursion, which must have been a curious one for whole Tribes to be engaged in. On this Rarity they lived with extravagance for some Time, faring sumptuously every Day. (Severance, 1904, pp. 115-116.)

It was probably the same hunt that Horatio Jones and his Indian foster parents attended. They had gone down from Niagara and Buffalo Creek to the Allegheny River to visit Cornplanter, his mother's brother, when a runner came in shouting, "*Yu-ak-oo-was, yu-ak-oo-was!*" [*jäh'gowa'-son'on*] ("Pigeons, pigeons!") ["Big breads," or passenger pigeons.] He said the birds had roosted in a wood on the Genesee River, about two days' journey above Canadea village.

All was now bustle and confusion, and every person in the village who could bear the fatigue of travel at once set out for the Genesee. On their arrival at the place designated by the runner, Jones beheld a sight that he never forgot. The pigeons, in numbers too great to estimate, had made their temporary homes in a thick forest. Each tree and branch bore nests on every available spot. The birds had exhausted every species of nesting material in the vicinity, including the small twigs of the trees, and the ground was as bare as though swept with a broom. The eggs were hatching and thousands of squabs filled the nests. Every morning the parent birds rose from the roosts, the noise of their wings sounding like continuous rolls of distant thunder, as flock after flock soared away to obtain food. A little before noon they began to return to feed their young; then arose a deafening chorus of shrill cries as the awkward younglings stood up in the nests with wide open mouths. . . . Soon after noon the old birds departed again to return about sunset,

when they came in such dense flocks as to darken the woods. All night long the sound of breaking branches caused by overloading the roosts, and the whirring and fluttering of falling birds trying to regain their foothold, disturbed the usual silence of the forest.

As the annual nesting of the pigeons was a matter of great importance to the Indians, who depended largely [?] on the supply of food thus obtained, runners carried the news to every part of the Seneca country, and the inhabitants singly and in bands, came from as far east as Seneca Lake and as far north as Lake Ontario. Within a few days several hundred men, women, and children gathered in the locality of the pigeon woods. . . .

For their temporary accommodation the people erected . . . huts constructed by setting up two crotched stakes on top of which a pole was laid. Other poles were placed against the ridge, three or four on each side, with the lower ends resting on the ground. One or two poles were then tied across the others parallel with the ridge-pole and to these were fastened long over-lapping sheets of bark forming tent-shaped huts with one open end that was closed at night by curtains of skins and blankets. This form of cabin was easily erected in a short time, and afforded a fair shelter to the occupants during the brief period of their stay.

The Indians cut down the roosting-trees to secure the birds, and each day thousands of squabs were killed. Fires were made in front of the cabins and bunches of the dressed birds were suspended on poles sustained by crotched sticks, to dry in the heat and the smoke. When properly cured they were packed in bags or baskets for transportation to the home towns. It was a festival season . . . and even the meanest dog in camp had his fill of pigeon meat. (Harris, 1903, pp. 449-450.)

No one missed the annual fun at the pigeon roosts if he could possibly get there. That year "forty warriors on their way from Niagara southward, halted . . . for a few days to enjoy the sport and obtain a supply of cured birds for food on their journey" (*ibid.*, p. 450); and there were a dozen or more white captives in the encampment. Marriages were evidently sometimes contracted at the pigeon roosts, for it was at one of these rendezvous near the shores of Seneca Lake, where the Indians assembled annually for days and weeks together, that Sarah Whitmore in 1782, at the time of her proposed marriage to a Mohawk chief, met Horatio Jones, who succeeded his Indian rival. "The young birds were fat and juicy and were devoured in large numbers; while the squaws smoked great quantities of them

for future use. Consequently, with the Indians, the 'Pigeon Roost' was synonymous of a feast and dance, and especially of a council." (Gunn, 1903, p. 517.)

Moreover, on occasion the serious business of a council was set aside so that the people could go after squabs. In May of 1791, while Col. Thomas Proctor was at Buffalo Creek holding councils with the Iroquois, seeking to get some of them to accompany him to the tribes on the Wabash River, the Senecas invited him to watch them gather pigeons:

May 6. Red Jacket and Captain O'Beel came to see me, when the former acquainted me with the reason why no council would be held this day, to wit: That it was their pigeon time, in which the Great Spirit had blessed them with an abundance; and that such was his goodness to the Indians that he never failed sending them season after season, and although it might seem a small matter to me, the Indians will never lose sight of those blessings. This is, therefore, the reason why our men, women, and children, are gone from their towns, but on tomorrow our headmen will return and your business again shall be taken up. 'Tis a matter worthy of observation, that at some convenient distance from every one of the Indian settlements, the pigeons hatch their young in this season of the year, and the trees, which they commonly light on, are low and of the bushy kind, and they are found in such great abundance, that exceeding a hundred nests, a pair of pigeons in each are common to be found in a single tree, so that I have seen in one house, belonging to one family, several large baskets full of dead squabs; these they commonly take when they are just prepared to leave the nests, and as fat as possible for them to be made; when after they are plucked and cleansed a little, they are preserved by smoke and laid by for use. (Proctor, 1896, p. 497.)

#### *Feasts and Festivals*

Pigeon time evidently coincided with one of the periodic festivals when the Iroquois invariably returned thanks for an abundant flight of pigeons. Pigeon time came soon after the maple harvest; and it is noteworthy in the modern Seneca Maple Festival, as it is still celebrated toward the end of March at Tonawanda, that Pigeon Dance regularly leads off the social dances (Fenton, 1941).

Likewise, Proctor himself found the Senecas in a festival mood. On the third of May, several days before he witnessed the pigeon hunt, Proctor went out to the Onon-

daga settlement, three miles east of Buffalo, to honor an invitation to dine with the principal chief of the Onondaga. He remarks how well the women were dressed in silken stroud and ornamented with many silver trappings, and says that the feast "principally consisted of young pigeons, some boiled, some stewed, and the mode of dishing them was, that a hank of six were tied with a deer's sinew around their necks, their bills pointing outwards; they were plucked but of pen feathers [*sic*] [pinfeathers (Ketchum)] there plenty remained; the inside was taken out, but it appeared from the soup made of them, that water had not touched them before. The repast being the best I had seen for a long time, I ate of it very heartily, and the entertainment was given with the appearance of much hospitality." (Proctor, 1896, p. 497.)

The Iroquois apparently considered their own feasts and religious exercises of equal importance with Proctor's business, and between such delays and those caused by the British commandants, Proctor lost an equal amount of time. Cornplanter assembled the chiefs on May 7 to allot planting grounds to tribes and families who had put themselves under the protection of the Six Nations; and the great dance which was performed the next afternoon was presumably the Planting Festival or Seed Dance, which, it appears from Proctor's journal, was then of four days' duration, ending in a general community drunk.

Moreover, the Seneca religiously remember their obligation to the Creator for the things which he annually sends them in abundance by returning thanks in season, and they also pray that this condition shall continue always. In the old days they did not trust to chance to conserve the supply of plants and animals on which they subsisted, but they took some regular precautions to insure their perpetuation. To this day, when they take medicinal plants, tobacco is offered at the first plant of the desired species, which is then left to grow to seed for ensuing years. Deer were not taken at certain seasons; and the Seneca say that they did not molest pigeon hatcheries until the squabs were ready to leave the nests, while the older birds

were allowed to go free. What is more, the Senecas ascribed human qualities to the pigeons, which alone of all the birds nested in communities. It was customary when they took their young to levy among the hunters a collection of gifts such as silver brooches, wampum, and articles of apparel as an offering to propitiate the pigeons. These gifts were borne by a priest to the wood's edge beside the pigeon colony, where he set them down and kindled a small fire. On the embers of this fire he sprinkled sacred tobacco (*Nicotiana rustica* L.), and it is believed that the words of his invocation were carried aloft on the smoke to the Creator and to the spirit-forces of the pigeons, who were ordained to sustain the people living on the earth. His voice alone carried the entreaties of all the people, returning thanks that the pigeons had once more nested near their settlement and making this offering in exchange for the squabs they were about to take; and they prayed that this privilege should continue always. As late as 1896 aged Senecas living at Cattaraugus remembered this custom, which was unknown to our informants, but which is fully illustrated by a series of myths collected by Hewitt that we shall return to later.<sup>4</sup>

#### Conservation

Religious-minded individuals among the Seneca could feel satisfied that the pigeons, having smelled the tobacco and thinking they had been thanked, would remain well disposed; but there were undoubtedly more practical individuals, like the savages (Onondagas, Oneidas, and Mohawks) who came under Peter Kalm's observation, who

made sure the annual pigeon-flock increase was not endangered by pre-season hunting. Kalm says:

While these birds are hatching their young or while the latter are not yet able to fly, the savages or Indians in North America are in the habit of never shooting or killing them, nor of allowing others to do so, pretending that it would be a great pity on their young, which would in that case have to starve to death. Some of the Frenchmen [presumably those Kalm met in 1749 enroute from the Hudson River to Montreal, when immense flocks of pigeons were encountered] told me that they had set out with the intention of shooting some of them at that season of the year, but that the savages had at first with kindness endeavored to dissuade them from such purpose, and later added threats to their entreaties when the latter were of no avail. (Kalm, 1912, p. 412.)

#### Archery

Of the ancient Iroquoians, at least the Huron (J.R., vol. 10, p. 143), Seneca, and Cayuga pursued the adult pigeons in the woods and shot them with bow and arrows. In a Cayuga folk-tale, "The Mischievous Uncle and the Boy Wizard," the hero twice shoots a single arrow through a row of pigeons sitting on the same limb, getting a great string of birds both times (Waugh, MS.). The Senecas formerly used bows and arrows to shoot pigeons on the wing, and the great nestings were sometimes the occasion of intertribal archery contests, according to "Antler," an anonymous author who witnessed these trials during the first third of the last century when the Six Nations, as in Proctor's day, were still in possession of Buffalo Creek. Detailed information on how the Iroquois tempered hickory and ashen bows with hot oil, on how bow strings were made, and on the use of blunt-headed arrows in taking birds and small game lends credence to this record. Although in retrospect the immensity of the nesting may be exaggerated, nevertheless the pigeon grounds must have been extensive to cover the townships mentioned and to provide hunting for the several bands of Senecas concentrated there. "Antler" writes:

During my boyhood days I lived in close proximity to a tribe of Indians of whom I took my first lessons in the use of the bow, and subsequently became much attached to that kind of sport. Partridges, wild pigeons, squirrels and numerous small fry fell victims to my aim. . . .

<sup>4</sup> In 1870 Esquire Johnson, then in his nineties, in an interview with Mrs. Ashur Wright, which Parker, 1923, p. 424, has published, mentioned a tobacco-smoke offering "to propitiate the pigeons when they took their young, the offering of payment to the old ones,—a brass kettle or other little dish full of *ot-go-ah* [wampum], brooches, and various other things which the man who raised the smoke would deposit on the ground before he put the tobacco on the fire, and he says that he left the kettle there when they left home [?], considering it a real payment to the pigeons. . . ." The prayer is said to have been the same as one related elsewhere by Oliver Silverheels, which is lost. (A. C. Parker, p. c.)

The bows which the Indians used in early days (say fifty or sixty years ago) were made of white ash or hickory, worked out of seasoned timber and washed over at different times with hot oil. They became impervious to water and retained the natural strength and suppleness. However plenty hickory and ash trees may be, there are comparatively few which are of the quality which is required to make a good bow. The strings were made of a single strand of raw hide evenly cut and slightly twisted and made perfectly round by rolling, being about the size of common fence wire and apparently about as hard. Blunt-headed arrows were used for killing birds and small game, and were invariably used among the wild pigeon roosts and nesting grounds.

Among the happiest recollections of these latter days are those that carry me back to boyhood sport among the wild pigeons. Reader, have you ever visited the nesting grounds of wild pigeons? . . . one of the wonders in natural history. The first and most extensive nesting grounds that I visited was in the western part of the State of New York as early as 1823. The nesting began in Cattaraugus County, near the Allegheny River, reaching north to the town of Collins, Erie County, covering a section of country about 30 miles in length and supposed to average 6 miles in width, including a part of all the following towns: South Valley, Coldspring, Napoli, New Albion, Dayton and Towanda [?], most of which have been organized and settled long since the date mentioned. Here was an area estimated at 180 square miles, covered with a thick growth of timber, every tree bearing from one to 50 nests, according to size of top. . . . I enjoyed the satisfaction of rambling through this enormous hatchery. . . . I was a youngster at the time . . . [this was the biggest nesting he recollected]. . . . None but large and extensive forests, with an overabundance of beech mast, could support such a vast body of pigeons during the time of building, hatching and feeding which lasts 6 or 7 weeks, more or less. The building begins about the first of April, or before. . . . The nest consists of a bunch of dry twigs and sticks which seem to be slightly thrown together, yet . . . so strongly and ingeniously connected with the branches that winds and storms cannot dislodge them.

. . . It was seldom that more than one young pigeon was raised on a single nest, but occasionally two were found. During the time of building and hatching, the mast on the hatching grounds would be mostly consumed, consequently the old birds were compelled to forage for long distances to collect food while feeding their young; and . . . [each pair is able to return to its own nest], which is the counterpart of thousands. . . .

Perhaps there is nothing that will draw out a whole tribe of Indians, old and young, like a pigeon hatchery. The flesh of the young wild pigeons is fat and juicy and fine flavored, and doubtless a young pigeon is the sweetest and

daintiest morsel that ever tickled an Indian's palate. Here were gathered at different points most of the natives, old and young, from three or four tribes of Indians. Here the best archers from the Buffalo, Cattaraugus, and Alleghany reservations had met for a trial of skill. I am not well posted in the scores of modern times, but it was then and there that I saw greater feats of archery than I ever witnessed before or since.

It seems that the Seneca nation of Indians have wholly or nearly abandoned the use of the bow, save among the small boys.—ANTLER. *Piney Falls, Jan. 13th.* ("Antler," 1880, p. 14.)

#### CORNPLANTER PIGEON HUNTS

Taken together with the previous historical records, the following narrative accounts of pigeon hunts that live in the memory of old Cornplanter residents assume some importance for local history in western New York and Pennsylvania. It is, however, the wider implication of the facts contained in these narratives that will interest students of Iroquois ethnology, since they demonstrate a continuity of custom coming down from early times to the recent past that broadens our understanding of the economy of these woodland tribes. These accounts, too, illustrate some Indian attitudes toward conservation, revealing a set of values at odds with the "pioneer spirit" of our forebears.

#### *Scouting the Pigeon Nestings*

"Early in March or April," said Willie Gordon whose Indian name is *gak'ji'*, "dishful," "we would see the *jäh'gowá*, 'big bread' (passenger pigeon) flying north in flocks so large that their numbers darkened the sky and their wings sounded as thunder. They came as a plague of locusts and devoured every sprouting plant. They would nest in patches of beechwood timber where they flocked to eat the beechnuts."

Informants agree with authorities that the passenger pigeons could be seen going over in March at the end of the sugar season, before the snow was off the ground (Todd, 1940, p. 267).

Under date of April 15, 1822, Joseph El-kinton, first teacher at the Friends' Indian School at Tunesassa (Quaker Bridge, N. Y.), noted in his diary that no pupils showed up for school that day. He supposed they had gone with their parents to hunt pigeons.

School reopened on May 7. It appears that thereafter school was regularly closed for the sugar-making and pigeon season.

People knew that in about two weeks from the time they nested the eggs would hatch, and so the word went about. Lydia Bucktooth, whom Marsh Pierce—"a very bossy man"—used to call *niga'negagi'sa'a*, "little soup," said that there was no particular organization to the hunt at Cornplanter—"one man said to another, 'Let's go,' and he said the same to somebody else; and so everyone went who could possibly go because the pigeon hunt was a good time—just like a fair or picnic."

In the old days decisions regarding movements of the band rested with the chiefs, and group economic activities that involved abandoning the village in large numbers usually followed a decision of the council. And so when the pigeons flew over in March scouts were sent out to follow them to the nesting grounds. These scouts stayed perhaps a month, as it took the pigeons a while to build sketchy nests; two weeks to hatch the young; and then a period for the young to grow. At this point the scouts returned to the chiefs with sample squabs. Estimates were made as to the time when the squabs would be ripe; and then the whole community started. The object was to take the squabs when they were at their best: at the point just before they were ready to leave the nest.<sup>5</sup>

On matters of formality Cornplanter Senecas bow to their neighbors upriver in York State, where the conservative long-house people of Coldspring keep up the old ways. And in the matter of scouting the pigeon roosts Chauncey Johnny John did not fail us with details. He said: "In spring when the pigeons flew over on their way to *hadinonhgwaa'ee'*, their roosts (pigeon nesting grounds) [literally, their habitat], the chiefs would send out scouts to follow them and find out where they alighted. Pigeons

<sup>5</sup> According to Todd (p. 269), the incubation period was two weeks, and the young were ready to leave the nest in another two weeks. "They became very fat and weighed almost as much as the old birds." Cf. Forbush, 1936, pp. 39-46. It is remarkable how well the testimony of these old Senecas stands up in comparison with the facts as established by ornithologists.

made nests in all kinds of trees: the nests were just a few sticks laid together—worse than a crow's nest; they laid one or two eggs.<sup>6</sup> When the nest had been made and the eggs laid and hatched, the scouts would bring back a few samples of the newly hatched squabs to the chiefs, telling them where the pigeons nested. The chiefs would examine the squabs and say, 'two weeks' or 'three weeks'—meaning it would be that long until the squabs were ready to take. During this time the old pigeons would fly away every day to get food. There were so many of them that they soon used up the food about the nesting place; so they would fly off to the fields and particularly to the beechwoods in all directions. Later, when the buckwheat and other seeds sprouted, they would raid the fields."

Windsor Pierce remembers being stationed at the buckwheat fields with a shotgun to shoo away the pigeons, and Willie Gordon said, "As soon as it was discovered where they were nesting, the scouts would pass this way (through Cornplanter) saying, '*Onenh gyon' ai' jäh'gowa dyodionhgwaa'ee'*' (Now they say once again the big-bread [passenger pigeon] is nesting there). People would know immediately when and where to go, because *dyodionhgwaa'ee'*, 'where they are nesting,' or *ganonh'gwaae'*, 'the pigeon nestings,' was back of Sheffield [in Forest County]."

#### *Migration to the Pigeon Grounds*

The ancient "pigeon country" for these Seneca was for the most part comprised of the following northern counties of western Pennsylvania: Warren, McKean and Potter, Elk, Cameron, Forest, and northern Jefferson. These were also the old hunting grounds of the Seneca. The watersheds of Tionesta Creek and the Clarion River were familiar to these Indians as favorite deer and bear hunting grounds, and the pigeon nesting mentioned in these accounts were on the high plateaus toward their many

<sup>6</sup> This is correct, according to some authorities, although competent ornithologists are inclined to regard one egg per female pigeon as the normal yield per nesting, and the second egg may represent use of the same nest by a second female. (A. Wetmore, p.c.)

heads. The hunt which Willie Gordon describes took place on the site of what is now called Ox-Bow Hunting Camp, south of Byromtown in Forest County, near the heads of Blue Jay and Spring Creek. Now much of the land where pigeons used to nest is cleared for farms or is growing up again in the huge half-million acre timber-farm called Allegheny National Forest. In this region the beech once flourished, and there was a plentiful supply of food for the birds.

Willie Gordon says: "People would come here from Cattaraugus and Coldspring by wagon, and we would go off beyond Sheffield to get the squabs. Families traveled in box-wagons driving teams of oxen or horses, if they had them; and the wagons were heaped high with axes, guns, cooking utensils, and children and with barrels or bark casks for packing the squabs. Some of the families from Cattaraugus [Reservation] would stop overnight 'where the bridge [bank?] is steep' (*dwas'gwanezot*) south of Leon, N. Y. They reached *dyo'neganoo*, 'Coldspring,' the second night, and the combined parties came down the river road to Cornplanter. If they continued from here by wagon, the shortest way leads up the south fork of Hodge Run, 'where the trail comes down' (*djai'nhdon'*), and one climbs up on Quaker Hill and goes down again to Glade, where they crossed over."

Alice White of Coldspring recalls that her family passed "between the rocks" (*degas'-deogen'*) on Quaker Hill, where—according to the Gordons—travelers used to seek shelter returning from Warren.

"When it was time to leave Coldspring," says Chauncey Johnny John, "everybody packed up and went as he could. Some had wagons; most hadn't; so they went down the river in boats or rafts to what they then called Glade (just north of Warren Boro limits). Here they left their boats with people to watch them, and took off for the pigeon country."

#### *Routes to the Pigeon Country*

Two main routes led from Cornplanter to this "pigeon country." One went via Kinzua Creek to Dunkle's Corner and Ludlow, where one could take the train to Sheffield. This was the route most commonly

used by the walkers. Those who came down from Cornplanter on rafts, or over the hill by wagon, went up Dutchman Run through Clarendon to Sheffield, where the two routes merged at least as far as Barnes.

Willie Gordon outlined two different ways that he followed when he went to the pigeon country:

(A) From his home at Cornplanter he crossed the Allegheny and walked to Kinzua, "fish on spear" (*genzo'aa'*), and followed up Kinzua Creek to Dunkle's Corner, thence to Ludlow; from Ludlow he took the Pennsylvania train to Sheffield; on foot from Sheffield to Barnes; then to Brookston, where the big tannery was, and they turned off south west for Watson Farm and on through to Pigeon (which is the name of the post office, but the railroad station is Frosts), and Byromtown. Here they went a mile and a half south into the woods to the site of the present Ox-bow Hunting Camp. Formerly an old Scot named Cunningham lived there. He was a miser, Willie says, and he lived there in a log house and raised some potatoes which he sold to the Indians.

(B) From his home at Cornplanter, like the majority of people from higher up the river at Coldspring, he boated down to Glade and walked in. Ascending Dutchman Run, he went to Stoneham where he camped the first night out. From Stoneham he went to Sheffield; and so on by the same route as A.

Willie was able accurately to retrace his footsteps, remembering such landmarks as the Brookston tannery and old man Cunningham, the miser, who is also recalled by Mrs. Maggie Frost (74), a native at Pigeon or Frosts, whose recollections of the pigeon nestings checked at every point with Willie's. Lydia Bucktooth had no recollection of the route, but she remembered very well what took place when they reached the camp. Informants agree that they always went to the same place to camp.

Many Coldspring people hunted the same grounds with the Cornplanters; but it appears that others customarily camped several miles away on Blue Jay (*di'di'geh*). Chauncey Johnny John says his party came down the river to Glade (*dedye'hätha'*)

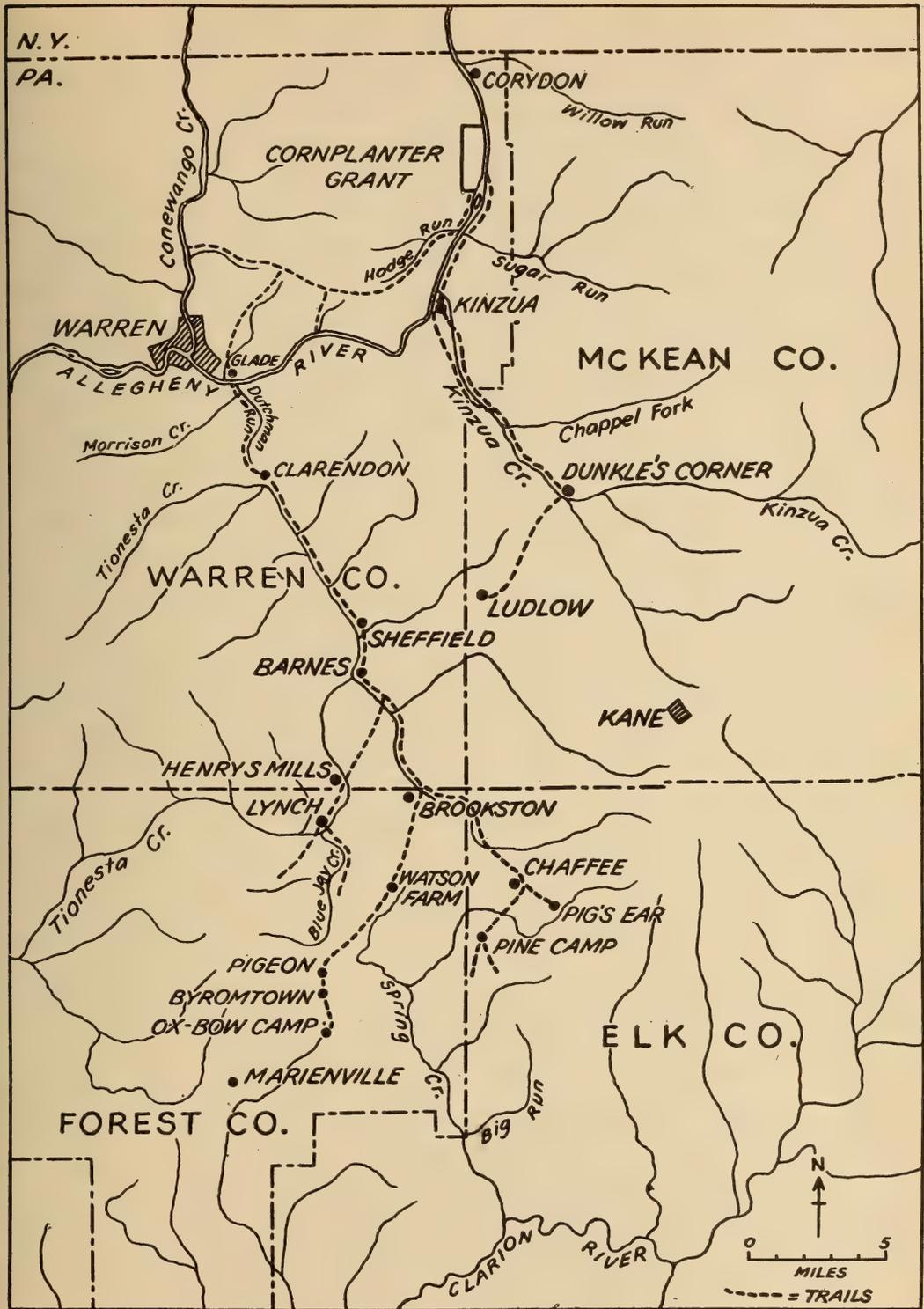


FIG. 1.—Routes to the Cornplanters' pigeon country in northwestern Pennsylvania.

"where they turned off," where the roads to Kinzua and Kane fork. In retracing his steps Chauncey directed us from Clarendon, to Sheffield, to Barnes. There were no Indian names for places enroute because the Indians had never settled there. At Barnes an improved road now turns off to the right, following Tionesta Creek down to Blue Jay and Lynch. It helps Chauncey's story to know that he declined to take this road; and it has since been developed that it was not in existence at the time he passed that way to hunt pigeons. In the old days they turned off farther along, on what is still a dirt road. Chauncey remembered that two or three families of deaf and dumb people lived on the corner of this old road to Henrys Mills, and later we found that the descendants of these people (also deaf and dumb) still live there. From Henrys Mills Chauncey's party had gone down to Lynch, where Blue Jay enters the Tionesta Creek. Near the head of Blue Jay is Pigeon. According to Chauncey, the whole region from Watsonstown and Pigeon downhill to Lynch was occupied by pigeon nestings. The Indians camped on Blue Jay flats because, as Chauncey said, "the water was good." He thinks there were not so many nests on top of the hills as there were on the slopes. His locations check with all the stories as to where pigeons nested in these parts.

There were doubtless other routes that were followed to the pigeon nestings, depending on where they had been reported for that year. The trail down the Tionesta from Barnes to Blue Jay followed lower ground than did the route via Watson Farm and Brookston. The road from Lynch to Pigeon was usually muddy. These considerations no doubt also influenced the hunters, the drier trails being preferred in wet seasons.

Another big pigeon nesting ground, according to the whites, was at Pine Camp in Elk County, which could be reached by following the road from Barnes through Brookston to Chaffee and on into the woods about Pig's Ear.

#### *Organization of the Hunt*

To say that the Seneca pigeon-hunting expeditions were formally organized affairs

would be an overstatement, for they do not assume the formal aspects of the Buffalo hunts of the Plains Indians. Yet, individualistic as the Senecas are, one can observe in their behavior together a tendency to repeat year after year certain traditional ways of behaving, which become set forms observable as definite cultural patterns. People got to the pigeon nestings any way they could, as we have seen: Some boated down the river and walked in, others went in wagons, and still others went via Kinzua and Ludlow and took the train to Sheffield, walking the rest of the way. Most just went. Nevertheless, once they got together at the camping grounds, an organization came into being.

The hunting party from each locality was sometimes in charge of a leader or headman whom the families had appointed for the duration of the hunt. He was selected for qualities of character and leadership: he must be a speaker (*haiwano'ta'*), one who knows how to address an assembly, and he must be a sober man to whom the people look up. His duties were to order the line of march, arranging the camp each night on the road by assigning camping sites to the families of his band. Every morning, according to Alice White, before they broke camp the leader would preach to the people: First he returned thanks to our Maker for all living things on earth and upward toward the sky-world, and then he asked for good luck on the day's journey. Then he urged the people to keep order. Again at night when they had retired he would preach to the camp, exhorting the adults to avoid recrimination and sin and urging the children to behave. Thus the Indians camped along the way; they were in no hurry to get there.

This tendency of the Iroquois peoples whenever they are gathered in a group inevitably to select a speaker, who always behaves in this traditional way that is expected of him, is what is meant by "observable cultural patterns." In this sense the hunts were organized affairs.

The following incident related by Lydia Bucktooth of Cornplanter as to what prompted her family to join the hunters at the nesting grounds on one occasion illus-

trates their spontaneity. Lydia first went with her parents when she was 6 or 7. Her mother had been sick (she died when she was 52), and her father said when word came that the pigeons were nesting, "Come on, you might as well go along and see this once before you die." Although she was sick, she went anyway. They canoed down to Glade; then they traveled over the hills—there was no road—taking a shortcut to a place back of Sheffield, to the "place where the pigeons were nesting" (*djoditnonhgwa'iee*). (Lydia said that this term, which literally means "the place of their habitation or residence," hence "roost," means the whole pigeon-roost or nesting grounds.)

*The Camp: Lean-tos*

When they arrived at the nesting grounds lots of people were there, both white and red. Lydia's family made a camp for themselves which she described in some detail. It was a lean-to, closed on three sides and open only in front. It rested on posts, with hemlock boughs laid on for a roof. She did not say whether the posts were crotched to support a ridge pole on which the rafters were presumably laid. The fire was built out in front. As far back under the side as possible a pile of hemlock boughs several feet thick was laid as a bed, on which they slept. (Lydia does not say whether they slept with heads, sides, or feet toward the fire, but the last seems to have been the usual orientation.) They stayed several weeks; and sleeping under the lean-to on a hemlock bed did her mother so much good that "it cured her of consumption."

Indians who came every year to the vicinity of Bells Run near Ceres, N. Y., to hunt in the spring and to make splint baskets, "would build wigwams of hemlock bark, which were too low for them to stand up in, but which afforded them a comparatively comfortable place to sleep, into which they could crawl in time of storm. They built their fires close to the opening, and slept with their feet to it . . . [on] . . . hemlock boughs, . . . rolled up in blankets . . ." (Mann and King, 1896, p. 144). As early as 1805 John Lyman had encountered, in May, a party of 30 Senecas from Allegany

Reservation encamped upon the abandoned site of a town near the mouth of Trout Run, 7 miles below Coudersport, Pa. This was during the pigeon nesting season (French, 1919, p. 23).

People returned year after year to the same camping sites. If there was any pre-emption of hunting grounds, in the sense that the Senecas of Tonawanda used to blaze witness trees to mark off a sector of the sugar grove which a given family had preempted for that year, it was rather of camp sites than of pigeon trees. This is, of course, only natural, as the trees were cut down to get the pigeons. Since, however, families returned year after year to the same sites, the younger men had to go farther down to new sites as they came along. On arriving they built themselves lean-tos in the manner already described (C. J. John). As the season advanced, the pigeons moved gradually farther north. It appears that only the young men and those older men who were themselves professional pigeon-catchers or who were employed by white professionals followed them as they moved out of range of the original band camp site.

When a large party under the guidance of a headman or leader arrived where the pigeons had been reported nesting, the leader instructed his party how to conduct themselves at the nesting ground. The hunting camp, as Willie Gordon remembers it, was a clearing enclosed by open-face shanties or lean-tos that were covered with a deep thatch of hemlock boughs. He said that a steep roof with lots of boughs would turn a heavy rain. In these shelters individuals bedded down for the night on hemlock boughs or bracken ferns, which gave off a stimulating aroma.

Informants agree that there were two camps. All the Cornplanter people lived together in one—"on one side of the fire," as the Iroquois say; and some of the Coldspring and Cattaraugus people occupied the opposite side. Thus the camp was divided in two by locality as well as by religion, for the Cornplanter people were then Christians; but the Coldspring and Cattaraugus campers were followers of Handsome Lake, the prophet, and were therefore so-called

"pagans." Between the two camps a platform of stones was built for the use of the "speaker" who roused the camp at day-break.

Someone was appointed to go to each shelter early every morning to inquire whether everyone was well. The runner for the chief or "speaker," as is customary in Iroquois society, then came back and reported to the "speaker," who stood up on the stone platform and returned thanks to the Creator for keeping all well during the night and asked for good luck during the day's hunt. "He returned thanks for every thing all the way from the ground up to the sky." The same people officiated for both camps.

"I can remember," Willie Gordon related "how the 'speaker' used to arise before daylight and preach every morning while we were at the pigeon camp. He returned thanks that everyone was well and asked for protection and good luck during the day of hunting, and then he chanted our thanks to our Maker with the prayer they call *ganon'yonk*." This is the regular Seneca prayer of thanksgiving for all things from the earth upward to heaven that the Creator ordained for man's sustenance and improvement. "This chant always reminded me of the baying of a hound, because the speaker would begin each article with—*Da'onen di'oya'ko* ('And so now then another thing')—and continue on a high note to the end of that subject, when his voice would fall. Then, having finished the whole prayer, he would charge the people to be honest: he would say the worst thing for a man to do is to drink. 'Be careful not to use liquor or to sin while on this hunt!' Then he would tell the old people to stay in camp and watch the little children so that they did not stray into the woods and get lost."

#### *Hunting Techniques*

As soon as they had eaten, they all went out, both camps working together during the day. There was no particular organization to the hunt; everybody was for himself. Individual families worked for themselves, and there was no such thing as sharing the

kill. The Indians were interested only in the squabs, and to get them the men cut down the beech and hickory trees about 6 inches in diameter, according to Willie Gordon, so that the women and children could raid the nests. When a tree fell, the men, women, and children scuttled about picking up the squabs out of the bushes. They were killed by knocking them on the head with a stick, by pinching the heads at the temples between thumb and forefinger, or by wringing their necks.<sup>7</sup>

The squabs were at once cropped and gutted, and a little salt was put on them. Willie Gordon emphasized the need of cleaning the squabs immediately: "We would open them and take out the 'innards' and crop, for the meat smells badly if the crop is left." However, the squabs were not plucked of feathers then or later. They were carried back home with the feathers on. The weather was usually cold enough so they would keep; but, to repeat, the crops had to be taken out at once or the meat would spoil.

Many of the squabs were eaten at the camp; but large quantities were packed for transportation to the homes. In later years there were increasing numbers of white buyers who took, sometimes, the whole catch.

The hunters lived principally on squabs that they had caught. These were boiled, after the women had picked them clean of feathers; but those to be taken home were salted and roasted until dry before the fire, or boiled and smoked in strips as fish. Here our informant illustrated with his hands how the meat was cut into strips. Others do not recall that pigeons were smoked. Perhaps this reflects only a failing interest in

<sup>7</sup> Biting the head just back of the eyes was the approved method of killing the catch among professional netters both in Ontario and Pennsylvania. (Mitchell, 1935, p. 124; French, 1919, pp. 82, 102.) However, it is possible that this trait was adapted from Indians. The western Eskimos bite the necks of auklets when netting them (Dr. Henry B. Collins, Jr., *conversation*), and this seems to be a widespread trait among the Eskimo as far east as Greenland. How much farther it extends is uncertain. French (opp. p. 152) illustrates pincers that were invented and patented by James V. Bennett to reduce such "cruelty at the wholesalé butcheries to a minimum."—W. N. F.

preserving them in quantity. The hunters grew fat on squabs and squab grease spread on potatoes, which they bought from Cunningham, the white man.

Each family strove to fill as many as possible of the barrels they had brought, and when they returned to settlements such as Coldspring and Cattaraugus the families who had not gone on the hunt begged to buy squabs of those who had made the trip to the pigeon roosts. Willie Gordon said: "A long time ago the Senecas salted the squabs like pork in casks of elm bark which they made, or in big stone crocks which they had obtained in trade.<sup>8</sup> Each family worked for itself. Leaders of the hunt got nothing extra for their efforts."

An extract from the personal correspondence of Jesse Cornplanter of Tonawanda Reservation, N. Y., summarizes and confirms the statements of other informants. Although Jesse is too young to have gone out from Cattaraugus to hunt squabs, his statement is an interesting example of how such knowledge persists among the Iroquois long after a custom is dead.

I will tell you this much about this matter. My mother [deceased] had the good fortune to be born early enough to have gone with this hunt for squabs in her childhood, but she recalled clearly what they did. She said that they had some scouts that they sent out before the pigeons starts to nest or hatch their young; these scouts had to report back to the village, and then when the time came, they all would start out in wagons with empty barrels. They would travel all day and then would camp for the night. They used to go to some place around Kinzua, Pa., in the big hardwood forest. They had one Head Man who had full charge when en-route, [and] they would all gather every morning for a speech of thanks and ask for blessing and luck in their venture. When they arrived at the spot, which seems to have been in the hills or young mountains of the Alleghenies, it would be all of beeches. The limbs would be just covered with the nests of these pigeons, (she said it looks like a crows nest—just a few sticks), and there would be three or four squabs [others say two] in each nest. Then they would cut the trees down and as the tree falls, then the children and women did gather the squabs, and they would gut it and then salt it and put it in layers in the barrels. She never saw them smoked as your version says . . .

<sup>8</sup> Salting for winter use is a trait that was acquired early from the white settlers (Mitchell, 1935, p. 107).

In the evenings each camp had its own doings. The Cornplanters were at this time pretty much Christian; so they sang hymns, prayed, and listened to preaching. The preacher at that time was John Jacobs Esquire, and he was always called Esquire to distinguish him: it was as much part of his name as the rest. Over in the Coldspring camp, where the Handsome Lake followers were quartered, they would sing and dance and have preaching according to their own custom. Willie Gordon never went to see it, as—he says—he was at that time "full of religion" (Christianity); and he stayed away. Lydia Bucktooth was too small, and Chauncey Johnny John, who would know, remembers no ceremonies attached to the hunt, and said there was no connection between hunting pigeons and the Pigeon Dance, that he had ever heard of. "It is just another animal dance with nonsense words." Willie said even John Jacobs Esquire could not see any harm in what was done in the morning—the thanksgiving to all the spirit-forces; but in the evening the two camps did not mix.

This activity continued for two or three weeks, often longer. "After the squabs got so big that they would fly when the trees were felled, we would leave that place and go somewhere else," said Willie Gordon. As the pigeon nests were destroyed they would move ahead and build others. The younger people would follow the pigeons for a long time, runners going on ahead and reporting back to the chiefs, as we shall see below. The pigeons roosted all over that country. The forest was mostly beech, but Willie pointed out stands of "pigeon cherry" (*Prunus pennsylvanica* L.f.) (*ganondjo'gwane'*) from which the Senecas took pitch for burns. It is notable that some of the finest stands of cherry anywhere are yet in this forest. Unlike Chauncey Johnny John, Willie and Lydia say the pigeons nested mostly on the plateau and they had no recollection of finding them in the Blue Jay and Spring Creek Valleys at all.

#### THE PIGEON IN SENECA FOLKLORE

Several legends involving the passenger pigeon were formerly current among the Senecas. Our informants neither knew how

their ancestors acquired the technique of hunting pigeons nor did they connect this activity with the beginnings of the Pigeon Dance, of whose origin they are ignorant. Moreover, the few published myths have been overlooked by historians among ornithologists, who are more or less unfamiliar with the literature of American Indian folklore. Mitchell (p. 17), after considerable search, found only three stories—two Huron and one Neutral; and thought it strange that such legends should be so scarce, and somewhat unnatural that this amazingly spectacular creature was not more closely linked with the folklore of the Indians, who were ordinarily acute naturalists. But, as we shall see, these birds were more than a source of provender. Among the Seneca, at least, folk-tales furnish answers to our questions concerning the introduction of hunting, the origin of the pigeon songs and dance, the nature of the invocation at the ceremony for propitiating the pigeons, and the sacred character of albino or white pigeons.

#### *Taboo on Taking Albino Pigeons*

The white or albino pigeon, like the "white crow," was considered sacred because "he was the headman" or "chief of the pigeons." "Never disturb him, and never cut down a tree in which a white pigeon has nested," said Chauncey Johnny John. Ascription of supernatural power to white animals pervades Seneca mythology: witness the magic white beaver, the white otter, the white dog sacrifice, etc. It is well known that albino bison were considered sacred among the Plains Indians. None of our informants recalls seeing such a white passenger pigeon. For further information we turn back a generation to the Cattaraugus informants of Curtin and Hewitt.

#### *Pigeon Hunting in Mythology*

A tendency for a folk to project their daily activities into ancient times is a constant characteristic of mythology. As the myths themselves sometimes survive the projected activity, they become a source of information on the former culture of the folk. This is precisely the case with pigeon hunting. A Seneca myth purporting to be the

origin of the porcupine people, a clan not present among the Seneca, refers to an ancient time when the Iroquoians were apparently a single nation of hunters and gatherers. As they became numerous, the game became so scarce that it was necessary for the tribe to divide. This decision was made in public assembly, which guaranteed to each band of maternal kindred (*ohwachira*) its own hunting territory. Subsequently, internecine warfare arose out of attempts to punish trespassers. Now, the porcupine people of this myth are said to be the descendants of one Wendat (Huron) woman, the matron of one of these separated bands. In this account of the yearly cycle of their economy, one sees projected the fundamental patterns around which later Seneca economy was organized as recently as the pigeon hunts we have described.

The porcupine people knew where to gather nuts, berries, and small fruits, and they also knew just where the wild pigeons had their roosts.

They noted the whereabouts of these places, and when the season was fully come their leaders and chiefs would call to their people in a loud voice: "Come! Let us go to feed ourselves abundantly where the wild pigeons have now prepared their roosts for the purpose of breeding." At this time the wild pigeons were so numerous that many flocks stretched over large tracts of territory darkening the light of the sun and making with their wings a loud rushing sound resembling that of an approaching tornado. Giving heed to the call of their leaders, the people would make the necessary preparations to go to the roosts of the wild pigeon. Having reached the designated place, the people quickly put up temporary camps and then went out at once to kill the squabs, which they brought to their lodges to broil and eat with boiled corn bread and corn soup. All were delighted with the bounty of nature—the gift of the Master of Life.

Having thus spent part of the summer killing wild pigeons, after the birds had departed, a leader among the people would say: "Oh! friends, cousins and kindred, the deer people have now gone in this direction and are now fat and in good condition to be killed for food and for their skins. Let us decamp now and go the place where they may be found. Up and let us be going. Let us lose no time in delay." So, leaving the grounds of the pigeon roosts early in autumn, they would journey to the land where the deer were accustomed to feed and raise their young. (Curtin and Hewitt, 1918, pp. 654-656.)

*White Pigeon, Chief of the Pigeons*

Seneca story-tellers depicted the white pigeon as chief of the pigeons who live as people in colonies and hold councils. The decision of the council of birds is revealed to an old man in a vision while on a solitary hunt. The pigeons offer their young for the support of man and decree rules for conducting the hunt. This supports the contention of Coldspring informants that a master of the hunt governed the conduct enroute to the pigeon grounds. The pigeons entered into a contract with mankind: in return for their young they expected an offering and invocation with tobacco smoke. Violations led to misfortunes among the hunters.

This is the story of the White Pigeon, the chief of the pigeons (after Curtin and Hewitt, 1918, pp. 694-696):

*[White pigeon chief of colonies]*

It is said that among the wild pigeons the white ones are the chiefs of their communities. According to tradition, a white pigeon once flew into the forest lodge of a noted man, the Wild Cat. The visitor did not appear ill at ease but stood in the lodge wherever it seemed good to him, and then without remark he flew away.

The old man, Wild Cat, somewhat amazed by this quiet conduct of his visitor, related the incident to his neighbors, saying that this visit portended . . . something out of the ordinary. . . . But an entire year passed and nothing unusual happened to old Wild Cat. . . .

*[Council of birds: Pigeons ordained for man]*

But at about the same season the next year the same White Pigeon again visited the old man's lodge. At this visit the old man believed that the White Pigeon was a man . . . , so he conversed with him. . . . White Pigeon informed the old man . . . that all the various tribes of birds had held council . . . [and]\*. . . had decided that the wild pigeons should furnish a tribute to mankind, because their Maker had selected the wild pigeons for this important duty . . . other birds had only very little to give . . . because . . . [they lived] dispersed here and there, and . . . could be obtained only with difficulty, while the others had nothing to offer toward the support of mankind.

*[Taking squabs]*

So, being the only tribe of birds which built their nests and reared their young in a single community, it was resolved by the various tribes of birds that the pigeons should spare some of their young men for food. White Pigeon continued by saying that he had come purposely to notify old man Wild Cat of this . . . decision, and

tell him *the young pigeons* were to be taken in proper season, and the manner in which this must be done.

*[Master of hunt: Places "pole across path"]*

He said: "In the season of the roost, when the young pigeons have attained a suitable size for eating, the people should select a suitable person as superintendent or *master of the hunt*, and he should give the essential directions to the people for . . . [preparing] . . . for the hunt before starting for the hunting grounds where the pigeons have their roosts in the forest."

On such a hunting expedition the entire community was engaged, and so it was not unusual to have a very large crowd of people moving along a common path at this time. However, to secure order and obedience certain rules for the march must be observed by all. . . . When the party halted to rest, to eat, or to camp, for the night, the leader would place a rod, suitably painted, across the path, and no one was permitted to pass over it or to go around it for the purpose of continuing the journey regardless of the rest of the party. It was held that should one break this injunction some misfortune would inevitably befall the party. When the party was ready to proceed the leader would take up the rod and then the journey would be resumed.

*[Offering to pigeons]*

Upon nearing the roosting place of the pigeons it was customary to make a collection of gifts from the people, consisting of various articles of ornament and trinkets of all kinds, for an offering to the pigeons. These . . . gifts were placed in a bark bowl and this was borne . . . into the forest to some swampy place where the tall weeds were plentiful, and these gifts were spread out on a piece of elm bark while native tobacco was burned and an invocation . . . was made to the pigeons and their Maker.

Tradition reports that for the first hunting expedition the people . . . did not observe the rules of the master of the hunt, . . . some went around the painted rod . . . others withheld presents . . . and many accidents happened to them: some broke their legs, others their arms, some fell sick, and some died. . . .

Killing both young and old pigeons at any season is by implication proscribed.

*The Song of the Pigeons*

The white pigeon as chief and elder of the Pigeon Tribe discloses their songs and dance to a pure man who has a vision at the nesting grounds in another tale which Hewitt obtained in 1896 from Joshua Buck (Onondaga) (BAE MS. No. 2883) of Grand River, Canada; and published with the Curtin col-

lection (pp. 663–666). The original text is in Onondaga, Buck's native tongue. He called the story *Djo'hä Hodiënna'*, "The Song of the Pigeons."

[Families had separate camps]

These birds had formed a nesting place. . . . Having received knowledge . . . a great number of men, women, and children, starting from their villages, went to the place where the pigeons formed their roosts . . . arrived . . . they at once began to build their temporary camps according to their *ohwachiras* [maternal families] and clans and kindred.

[Puberty vision quest]

. . . A man who had just reached . . . puberty and had no evil habits went with this crowd of people. . . . He was a very good person . . . they began to travel from place to place through the roost to kill such pigeons as they needed. At this time the upright young man heard the tumult arising from the cries of pigeons (conversing) together and he also saw the pigeons in vast numbers wheeling in circles.

Suddenly . . . greatly surprised to see flying among the pigeons one white in color . . . As he watched . . . the white pigeon left the others and alighted . . . nearby. At once the pigeon began to speak, saying: "Understand that we have selected you to tell your people what . . . we desire . . . most . . . You must tell your chief that we do not like to have so many among you in this place who do not remember Him who has created us. [Our Maker.] There are many who think only evil things to please themselves. We wish that they who have evil thoughts should put away evil desires, and we believe that whoever does not do so will suffer some grave misfortune.

[Thanksgiving morning and night]

"We further wish you and your people to join us in daily returning thanksgiving when each morning and evening shall return to us. We think this profitable. . . . You see us when the morning comes making a great tumult, and you hear us all talking while we circle around the place in which we have our roost. The reason for this behavior is . . . we are offering thanksgivings to Him who has created our bodies. In the evening this takes place again . . . and you see us then circling around our roosting place, and you hear the accompanying sound and confusion of voices. Now, understand, we are going through the ceremony of the dance, and we are singing. This signifies that we are happy; we are full of joy.

"We have no protest to make against your coming to this place to obtain the young whose bodies resemble ours. Indeed, you wish that these [offspring] shall become a source of satisfaction [subsistence]. . . . we have only the kindest of feelings toward you in this pursuit of your desires. You must know, too, that Our Maker has

ordained that this our flesh shall be for the welfare and contentment of human beings dwelling on the earth.

[Pigeon dance and tobacco offering]

"You must understand further that I, at whom you are looking—I who am speaking to you, am indeed the oldest person among my people, and it is on account of my great age that they have chosen me to come to you and tell you our wishes and to teach you our songs. You, too, are able to sing them. It is essential that you should enjoy yourselves; that you shall dance in order to do this; and that all your people who are here shall take part. In dancing you shall make circuits around the places where you have kindled your fires. When you have finished the singing and dancing you shall go with your chief to make an offering of tobacco at the very border of our encampment [roost], where you two shall stand to perform this ceremony. When you have kindled a fire you shall cast native tobacco on it, and while thus occupied you must pray our Creator to permit you and your people to pass the period of your stay here in health and prosperity. At that time, your chief, too, shall cast something on the fire—things of which you make daily use, and these objects shall become the token or message of the people. Furthermore, we together, you and my people, must unite in performing this ceremony, and we must also be of one accord when we make this prayer and request of the Creator of our bodies. Now it is for you to return to your people and tell them fully what I have said to you. This is what I have to say."

Then the upright young man replied to his pigeon friend: "Your proposition is agreeable to me, and I will fulfill my duty . . . by telling my people all that you have said to me."

[Youth learns songs]

Without speaking further the white pigeon . . . flew away. The young man, while watching it fly off, saw a large number of pigeons moving in a circle as they flew along; and he heard the birds sing, making a very loud song, a tumult of voices. He listened very attentively and for a long time and finally learned the songs which the pigeons were singing so loudly. Then he returned to his lodge and his own fireside.

[Youth relates vision to clan chief who carries out contract with the supernaturals]

At once he related in every detail all the white pigeon had said to him. A messenger was sent for the chief of his clan, and when he arrived the upright young man again repeated all that the white pigeon had said to him concerning the duties of the people who were there to hunt squabs. When the chief had heard . . . he at once said: "Let us at once do as the white pigeon has proposed. Let someone be detailed to make a collection of offerings, and then we shall proceed with the re-

mainder of the ceremony." Certain headmen were detailed to make the collection of offerings. Going from lodge to lodge, they collected various articles presented to them as offerings in the ceremony. Some gave wristlets, some bracelets, some necklaces, while others contributed articles of dress, moccasins, and tobacco of the native variety. When they had visited all the lodges they returned to the lodge of the upright young man, where he and their chief awaited them.

[*Offering to pigeons*]

After they had properly arranged the offerings the chief said: "Let us start now; we will go toward the place which borders on the pigeon roost or nesting place." Then they two started, the chief and the upright young man. When they reached the border of the pigeon roost they kindled there a very small fire, and the young man made an offering of native tobacco by casting it into the fire, at the same time asking the Creator for health and welfare and contentment for all the people while they were at that place. His prayer was long and earnest, and when he ceased his invocation the chief stepped forward to begin his prayer. Bringing all the articles which had been offered and standing before the fire, he said in prayer: "Thou who hast created our bodies, here lie all those things by which we support our message (by which we support its head), all the words of our prayer. We offer these to Thee. Accept them as a testimony of our faith." Then he laid all the objects which he had brought near the fire. Thereupon the two men returned to the lodge of the upright young man.

[*People called to repent, and to learn new dance*]

When there they went at once from lodge to lodge to call a council of the people. As soon as the people had come together and had seated themselves according to their families and clans the chief arose and addressed them. He urged them to repent of their evil deeds . . . and to offer . . . thanksgivings to their Creator in the morning and also in the evening. . . . When he had finished his address on the need of observing faithfully the things which had been taught them by the Pigeon people, he said: "Now let us severally give thanksgivings to the Creator of our bodies, and moreover we will dance to the songs of the Pigeon people. Every person should take part in this ceremony."

[*Two leaders lead whirling column of pigeon dancers*]

Thereupon the upright young man and the chief took their stations at the head of the line of dancers. When all were in line and ready the young man began to sing the songs of the pigeons, and all danced following their leaders. In dancing they made a circuit of the lodges, moving slowly to the rhythm of the songs as they turned from the right toward the left. When the young man had sung all the songs the young man had reached the point of departure.

[*Explanatory elements: Counter-clockwise movement of social dances*]

Then the chief, addressing the people, said: "We have now, indeed, performed this ceremony as it has been taught to us by the people of the pigeons; and when we shall depart from this place we must take back with us this ceremony, which will be of great benefit to us. We have learned these songs here from a superior people, and so we must cherish this ceremony. We have learned, too, that in dancing we must always make the circuit of the fires in one direction: namely, from the right to the left. The reason for this is that you use your right hands either to seize or to release whatever you wish, so it is necessary that the right side at all times be on the outside of the circle of dancers, and that the part of the body in which lies our life shall at all times be on the inside of the line of dancers. Let us now make ready to start for our homes." With loud shouts of approval and of exuberance or joy the dancers returned to their lodges to make preparations to depart for their homes.

RELATIONS WITH WHITE PIGEONERS:  
NETTING

Our informants emphatically stated that Seneca Indians never took the old pigeons, which they deemed inferior as food, for their own account; and that they never knew Indians to shoot into the trees with shotguns to slaughter the roosting old pigeons wholesale as did the whites; but many Indians did work for the numerous white pigeoners who used these practices as well as nets. Chauncey Johnny John remembers big nets that covered the whole tree and recalls that some Indians did as the white people and set up nets on posts, into which the pigeons flew and fell down. That, however, was when Indians were selling to the white people. This is interesting in view of Morgan's statement already cited and the evidence of Cayuga folklore. The Rochester Museum has two pigeon nets and a stool-pigeon stool which came from the neighborhood of Irving, adjacent to Cattaraugus Indian Reservation (Seneca). They are indubitably quite old (A. C. Parker, p.c.), but there is no assurance that they were made and used by Indians.

The U. S. National Museum has a passenger pigeon trapping outfit consisting of net, releaser pole, and pigeon baskets for transporting live pigeons that was used by white commercial trappers. It was contributed by Courtenay Brandreth, of Ossin-

ing, N. Y., through Dr. A. K. Fisher (Division of Ethnology, *Acc. No.* 100939: A. Wetmore, Assistant Secretary, p.c.). According to Mr. Brandreth, the equipment belonged to Tot Acker, of Sing Sing, N. Y.

The net was used in southeastern New York by white people, and I think the technique they used came from Europe. . . . The nets were laid flat on the ground a few feet apart. The spaces between them were baited [with salt or corn], and the nets were sprung inward. A live pigeon was tied to the hover and it was raised up and down to simulate a bird lighting. Also, live birds had their eyelids sewn together and were thrown into the air and pulled down with a string for the same effect. I think you will find needles and thread still in the decoy basket. (Courtenay Brandreth, p.c. 11/24/1942.)

Such devices were widely employed by professional trappers, or catchers, as they were usually called. Willie Gordon described how, when working with professionals, the Indians would clear all leaves from a piece of ground; bait it with salted corn; and put up a very large net, either suspended from trees or tied down to saplings. The hired Indians hid in the bushes until the ground was covered with feeding old birds to pull the "trigger" and release the net, which would envelop the pigeons. This description is not unlike that of Peter Kalm's observations of hunting practice among the Onondaga, and it seems unlikely that the Seneca had not tried netting birds at an earlier time.

White men were usually present among the Indians to buy all the squabs that were for sale. Lydia Bucktooth's family went just for a good time, with the idea of selling all the squabs they caught to white buyers. Lydia said that if there was any way to bring the squabs home people would do it, of course; but many had all they could do to get home themselves with their axes, kettles, and camping paraphernalia. She thinks not many squabs were brought back from the hunt. Alice White, whose people went in an ox-cart, says that her father brought back barrels filled with squabs, most of which were at once given away to the old people who had not been able to go on the hunt. Many Indians, no doubt, did as Willie Gordon who says he carried home as many

dressed squabs as he could pack into ash-splint carrying baskets suspended from a burden strap or tump line, passing across the chest and shoulders, or forehead, to the back. A carrying basket filled with dressed squabs was a pretty heavy load.

Indians hunted side by side with professional pigeon hunters for many years. Competition gradually sharpened. The pigeons were disappearing, and large timber acreage was destroyed. As the railroads entered the pigeon country—which was also the timber country—public opinion was stirred against the waste of both. The year 1868 is said to have seen the last great nesting on New York soil, at Bells Run, near Ceres in Allegany County. According to Fred R. Eaton, of Olean, the whole Cattaraugus band of Senecas moved to the nesting grounds and remained for two weeks to take pigeons. White professionals attended, of course, and their method of stretching and baiting nets is well described; but it does not appear that the Indians used this technique.

"They also invaded the roosts and knocked the squabs from the nests, felling trees so as to shake down hundreds together. In preparing them for shipment their crops were torn out to prevent the breast meat from souring, they were packed in barrels and hurried to the city. Pigeons continued to nest in this locality until 1872." (Eaton, 1910, p. 383; Mann and King, 1896, p. 99.) This business of shipping pigeons was apparently engaged in by both Indians and whites; and thus the Indian techniques were commercialized when squabs were taken for the market.

There were large nestings after this in some years, at least in northwestern Pennsylvania. The flight of 1878 was unusually heavy, accounted for by the professionals—who followed the pigeons wherever they were, east or west—by guessing that the Wisconsin-Michigan flights were following the eastern route that year. Some idea of the extent of the traffic, the movements of the pigeons and the shift of attention from dead to live birds as the weather grew warm may be had from the extracts from *The Warren Mail* for 1878, presented in the Appendix hereto.

The advent of railroads in the pigeon

country—which was also the timber country of northwestern Pennsylvania—brought the eastern markets for both birds and lumber closer and made both more valuable. Public opinion, impressed by the failure of the pigeon flights to materialize annually in such large numbers as formerly, forced legislative protection for the birds on their nesting grounds, in Pennsylvania; and local land owners no longer looked with indifference on the destruction of their trees. It does not appear that much attention was paid to the provisions of the laws made to protect the pigeons themselves. So long as the hunters let the trees alone, there was little interference with them.

Willie Gordon tells how on one occasion officers from the sheriff's office came on horseback to stop the Indians from felling trees. "They said, 'If you Indians cut down any more trees we will arrest you.' Now, old Jesse Logan, Frank Logan's grandfather, who was among us objected. He reminded them of the white people's treaty with Cornplanter which reserved for the Indians of his band the right to hunt, fish, take pigeons, and fell timber wherever they may be in 22 counties of New York and Pennsylvania. One of the party, Jonathan Pierce, returned here to Cornplanter for the treaty papers, but he did not arrive back at the pigeon camp until late the following day, since it was a day's walk each way to the camp in Forest County some way south of Sheffield [see above]. When the officers were shown the papers, they said that if the Indians would leave the big trees so that the timber would be spared and just cut down the smaller ones, this would satisfy them. And so we did this."

Willie says further: "At that time there was a great crowd of Indians, and whites who had come on horseback and in wagons to buy the squabs which we had caught. They were always right there to fill them with squabs. There were traders and merchants, for then the only white settler in that region was a man named Cunningham of whom we bought potatoes that he raised in a small clearing beside his log cabin in which he was continually troubled by marauding bears who came in the night and clawed on the door."

*Willie Gordon's Narrative of His  
First Pigeon Scout*

Now, as I have said, when the squabs got so big that they would fly every time the men felled the trees in which they perched, we would have to quit that place and move our camp to another nesting grove. On the occasion of this story, white horsemen had reported a place where the pigeons had gone in great flocks. So then our leaders called a council there to decide among ourselves whether to return home next morning or to continue hunting. The council appointed two scouts: my uncle, the late Charlie Gordon, and Alfred Halftown, to go see if they could locate the reported pigeon roost and to report back to the council. Now I was just a small boy at that time and I wanted to tag along with Uncle Charlie, but he did not want the bother of having me with him for fear that I might get lost in the big woods. But I went anyway. Moreover, I had a double-barrel muzzle-loader shotgun that I carried and a powder horn and various sizes of shot. And so I followed.

We had gone some distance when we commenced to hear a rumbling noise—*mmmmmmmm!*: like that. We went on, trying to determine which way the noise came. We were in the big timber—no path, no trail—way back of Sheffield. Then we saw fresh tracks which we thought were the tracks of a panther, *he<sup>n</sup>iis*. In front of us we could see the passenger pigeons at work on the beech-nuts on the ground. When they would fly they would all fly at once, making this great humming noise—*mmmmmmmm!* We crossed a little brook where the shores were completely white with feathers of the birds that had bathed there. Here a tree was uprooted and in the upturned earth we could see for certain the tracks of a big panther. We were afraid of that. Now the older ones wanted my gun. Up to that time they had considered me and my double-barrel gun a nuisance—something to stop and wait for. Now at that time I had two shots in there; I had loaded it that morning with fine birdshot.

One of the men took my gun and shot it off and then reloaded it with buckshot, and I had nothing. But we walked on and at last we came to the place where the pigeons had nested. Here we cut down a little tree intending to take some squabs back to camp, as we had been instructed to find the nests and bring some squabs to let the people see their condition. Then the council would decide whether to remove to that place or to return home.

When we were ready to start back each of us had a different idea as to which direction our camp lay. Finally, after much discussion, we decided to take one way, and we walked on and on through the woods, becoming very hungry and thirsty. It was growing late when we saw smoke far off and we decided to go see what it might be, for we thought it might possibly be our own camp. When we at last reached the place where the smoke arose, we discovered that some white people had been camping there. There were

hemlock-bough shanties, and outside a fire was still smouldering. We went inside one shanty and found provisions: there was canned milk—this was the first time I ever saw milk in cans; there was coffee and sugar. So now then we sat down and prepared a meal and so then we ate. After we had had enough, we returned thanks and packed up everything there was left over and carried it with us; and we followed the white men's trail, which at its end came down to the muddy road where it was rutted by the wagons of many pigeon traders driving toward our camp. So at the end of this road that so many people had traveled we found the Indian camp. When we reached camp it was getting dark and the people had gathered to discuss what had become of us. They were afraid that we were lost.

If I ever again hear that there is to be a pigeon hunt I will try and go there. It is the best fun you ever saw. When we get back people will not know us—we will be fat from eating squabs and drinking pigeon-oil. You ought to see how fat those squabs are!

#### DISAPPEARANCE

Nevertheless none of the old Senecas ever again expect to see the *jáh'gowa* fly north in the spring. Several Cornplanter people told us that they had heard the old folks say those birds tried to cross the ocean and that they had all perished in a storm by drowning, starvation, or exhaustion. However, this is "old hat," as every ornithologist knows. So the "big breads" live now only in the memories of a few old people like Willie Gordon and Lydia Bucktooth. But the young people of Coldspring Longhouse continue to dance the Pigeon Dance, still a favorite social dance among all the Iroquois; and at Tonawanda it is an integral part of the spring Maple Thanksgiving Festival.

Of the numerous reasons advanced by ornithologists to explain the disappearance of the passenger pigeon, adequately treated by Mitchell in her monograph of this species, only those theories entertained by Indians concern us here. The Indians believed that their practice of taking squabs when they were ready to leave the nests was a measure of conservation. By long observation they knew that there were plenty of birds until white competition and attention to the adult birds, shot and persecuted relentlessly with nets and traps, gradually reduced the number and size of the annual nestings, until they disappeared entirely.

The notion that the passenger pigeon was present in great numbers one year and completely gone the next has been proved a popular fallacy. As early as 1660 they had already begun to disappear from the New England coast; and in the Iroquois country of New York and western Pennsylvania, and in Ontario, their disappearance was noticeable by 1850. In 1848 there is record of shipment from Cattaraugus County, in western New York, alone of over 80 tons of the birds. Four years later occurred the last great nesting at Ashford, between the Allegheny and Cattaraugus Senecas. Practically all the squabs, together with a greater portion of the old birds, were captured (Mer-shon, 1907, p. 122). After the great nestings at Ceres in 1868-72, there is still record of occasionally very heavy flights in northwestern Pennsylvania for the next decade or so. According to Todd, the last attempted nesting of any size in northwestern Pennsylvania was observed in Potter County in 1886. After that only a few birds appeared at Sheffield, the locus of the Cornplanter Seneca hunts, which pretty well dates them. The last passenger pigeon seen in Warren County by one who was competent to identify it was reported by Ralph B. Simpson on the Allegheny near Warren, in company with a flock of mourning doves, May 20, 1893.

No single cause serves to explain the disappearance of the passenger pigeon. Mitchell thinks the immediate cause was the upset of its equilibrium of life in terms of its optimum population density—which was certainly high—to which the increasing disturbance of its nesting contributed. All authorities seem agreed that the culprits in this process were the market hunters who destroyed the annual crop of squabs by raiding the nests and substantially reduced the size of the adult flocks by netting and shooting. Clearing the land was detrimental of course; but as the forests have survived the pigeons, this alone will not account for their extinction. Diseases introduced along with domestic poultry may have taken some toll; but their effect could be only inconsiderable as compared with that of man's destruction of the species. The market hunters

found a ready explanation for what happened in a legend that persists, as we have seen, as a tradition among the Senecas: The theory that a cyclonic disturbance on the sea drowned the birds in great numbers. Kalm advanced it in 1740 (1759), and the story has been cropping up in one form or another ever since.

It is certain, therefore, that the passenger pigeon's disappearance can not be attributed to natural enemies, or to the Indian. Forbush, who gave this problem some thought, pointed out that for the years that pigeons were most abundant its natural enemies were most numerous; and that its extinction is coincident with the disappearance of bears, panthers, wolves, lynxes, and birds of prey. Forbush says:

The aborigines never could have reduced appreciably the number of the species. Wherever the great roosts were established, Indians always gathered in large numbers. This, according to their traditions, had been the custom among them from time immemorial. They always had slaughtered these birds, *young and old*, in great quantities; but there was no market among the Indians, and the only way in which they could preserve the meat for future use was by drying or smoking the breasts. They cured large quantities in this way. Also, they were accustomed to kill great quantities of the squabs in order to try out the fat, which was used as butter is used by the whites. (Forbush, 1936, p. 41; cf. 1927, vol. 2, p. 59. Italics added.)

At least two authorities have argued that all that is required to bring about the extinction of a species is to kill off a large proportion of its offspring each year before they reach maturity. Nature cuts off the rest. (Forbush, 1936, p. 44; Townsend, 1932, p. 382.) The Indian practice of taking only the young birds and leaving the breeding stock which they considered a measure of conservation became a means of extinction when employed by professional pigeoners.

Dr. Alexander Wetmore, who has read this manuscript, offers another explanation: "As one matter of biological import there is little question in my mind that but one egg was the normal complement in the set of this species. Occasionally two eggs were found, but where this occurred it is my opinion that the second egg came from a female other than the rightful owner of the

nest. It is not unusual for birds of this type to lay an occasional random egg in this way. The fact that the birds normally reared only one young per season is enough to account for their disappearance under the heavy persecution to which they were subjected by commercial trappers and hunters, since no species can stand such a toll with a rate of reproduction that requires at least two years to reproduce the original pair (A. Wetmore, p.c., 11/9/1942)."

In any event, the commercial hunter was the principal factor in the extinction of this species.

#### HISTORICAL CONSIDERATIONS

##### *Value as Food to the Seneca Indians*

The question naturally arises as to how important was the passenger pigeon as food in the diet of the Seneca Indians. We have already seen that the neighboring Cayuga and Onondaga netted pigeons at salt licks and on bluffs, and we have presented a number of early and modern records of huge nestings that were attended by whole bands of Senecas and segments of the aforementioned tribes. Presumably for several weeks between maple harvest and planting season, when the pigeons nested, the Seneca settlements were more or less evacuated while the population concentrated at the nesting grounds to take squabs and smoke them for transportation home. Great quantities were consumed on the grounds; all informants testify how fat they became. During this period, and for some weeks thereafter, squabs constituted the bulk of their diet. In fact, one wonders whether the Indians must not have become as fed up with eating pigeon and drinking pigeon broth as did the pioneers of Canada (Mitchell, pp. 106-107). However, with the Indians, their ceremonies at hunting suggest that the pigeons very often came in time to relieve starvation. At this season the Iroquois were often reduced to eating their seed corn. In good years there were squabs aplenty to keep the Senecas, and all the Iroquois for that matter, through the planting season—particularly if one can accept as typical such nestings as the one observed by John Lyman, an early settler. He says it extended 100 miles along

the Upper Allegheny in late May and early June of 1805, and again in 1810 (French, 1919, pp. 23-25).

#### *Prehistoric Evidence*

Before the white man settled in America, ancestors of the Iroquoian peoples took passenger pigeons and presumably ate them. Bones of adult birds are common among the bird remains from refuse heaps of precontact village sites in the Iroquoian area. It seems reasonable to assume that these early peoples preferred the squabs to adult birds, as did their descendants. Moreover, since the bones in young birds are not completely ossified until the fledglings leave the nest, and remembering that it was the practice to take the squabs just before they left the nests, it follows that if, as we suspect, prehistoric Iroquoians took great quantities of squabs and ate them on the grounds, squab bones—if they survived at all—would not be represented in the village site remains. This fact may account for the dearth of reports on this species for New York State Iroquois sites. (However, absence of data may also reflect careless archeological technique. Pigeon bones are small.)

In the refuse heaps of two prehistoric sites within the historic area of the Neutral tribe (Niagara Peninsula), reported by Wintemberg on identifications by A. Wetmore (U. S. National Museum), passenger pigeon bones are dominant among the bird remains at Uren, while at Lawson village site the passenger pigeon is the third ranking bird (in their diet) after turkey and ruffed grouse. But the numbers of mammal bones were by far in the majority.<sup>9</sup>

At Roebuck, a prehistoric Mohawk-Onondaga site in the St. Lawrence Valley, again mammal bones were most abundant, and bird bones were not numerous. Of 13 species of birds reported, the passenger pigeon was sixth in order of frequency (Win-

temberg, 1936, p. 14). While these figures are suggestive, they remain inconclusive without comparable statistics from prehistoric Seneca sites in western New York.

#### *Comparative Notes*

From the fragmentary archeological evidence we turn to some comparisons of passenger pigeon hunting among other historic eastern woodland tribes whose territories were traversed by these migratory creatures. To know that neighboring tribes followed the annual pigeon nestings, observed similar customs and utilized hunting techniques identical with those of the Senecas would strengthen the case for the aboriginality of the Seneca activity. The Seneca material assumes proper perspective in such a comparison; and, other things being equal, what we have been able to establish for Seneca passenger pigeon hunting illuminates references to other tribes, broadening our view of the relation of man to his natural environment in eastern America.

Passenger pigeons nested in eastern Massachusetts and were relatively abundant throughout New England until nesting began within fifty years of white settlement. The early nestings at Essex, near the coast, were only 30 miles from the white settlements; Wood (1629-34) describes a nesting colony that filled a great pinery, "from whence the Indians fetch whole loades of them" (Wood, 1865, *in* Forbush, 1927, vol. 2, p. 59). Wood does not say that Indians trapped adult birds. The inference is that they took the squabs from the nests. *Wuskówhan* is given by Roger Williams (1643) as the Algonquian word for "pigeon"; of which Cotton Mather writes, "Or Indians call these *Pigeons*, by a name that signifies *Wanderers*" (Schorger, 1938, p. 474). Mather's statements are probably of Natick origin. They are a tribute to the keenness of Indian observation on the habits of birds, but they contain no information regarding the Indians in relation to the pigeons other than the apparent fact that Mather met them, too, at a salt marsh. Williams, however, observes: "In the 'Pigeon Countrie' [which Trumbull assigns to the northern part of Nipmuck territory, now Worcester, Mass.; then occupied by a

<sup>9</sup> Wintemberg, 1928, p. 5; 1939, p. 9. In the Lawson prehistoric village site in Middlesex County, Ontario, of 11,000 animal bones, the majority (10,000) were of mammals; second in rank were 186 bird bones, "in order of their abundance: wild turkey, ruffed grouse, Passenger Pigeon, Canada goose . . ."

Acknowledgement is made to Dr. Alexander Wetmore, who made the identifications, for the opportunity to discuss these matters with him.

little band called 'furthestmost Neepnet men,' next neighbors to the Showatucks] . . . these Fowls breed abundantly, and by reason of their delicate Food (especially in Strawberrie time when they pick up whole fields of the old grounds of the *Natives*, they are a delicate fowle, and because of their abundance, and the facility of killing them, they are and may be plentifully fed on." (Williams, 1866, p. 116.)

As in New England, the passenger pigeon receded from the coast of New York and New Jersey with the Indians. It may be inferred from the following accounts that the coastal Algonquians, the aborigines of New Netherland, once took these birds in much the same manner as the Iroquois. In "Description of New Netherlands, 1671," it is said by Montanus that fowls, turkeys, geese, ducks, pigeons and other feather game are also easily obtained. "The pigeons fly in such flocks that the Indians designedly remove to their breeding places, where the *young* birds *pushed* by hundreds from their nests, serve for food during a long month for the whole family" (Montanus, p. 123).

We do not find accounts of the early Delaware hunting them, but it is reported that their annual custom of burning the woods in hunting deer "kept the woods clean, so that pigeons readily got acorns, which then not being devour'd by hogs, were plenty almost everywhere." (Samuel Smith, 1890, p. 511.) However, for the eighteenth century David Zeisberger, writing of the Delaware of whom many had accompanied him from eastern Pennsylvania to the present site of New Philadelphia, Ohio, in the years 1779 and 1780, says:

The wild pigeon is of an ash-gray color, the male being distinguished by a red breast. In some years in fall, or even in spring, they flock together in such numbers that the air is darkened by their flight. Three years ago (i.e. 1776 or 1777) they appeared in such great numbers that the ground under their roosting place was covered with their dung above a foot high, during one night. The Indians went out, killed them with sticks and came home loaded. At such a time the noise the pigeons make is such that it is difficult for people near them to hear or understand each other. They do not always gather in such numbers in one place, often scattering over the great forests. (Zeisberger, 1910, p. 66.)

He is speaking here of pigeon hunting on the fall return-flight, when the pigeons nested for only *one night*; and these must have been old birds that his tame Indians *knocked* out of their nests. These Indians had guns. It is curious that Zeisberger, who lived for three years in the pigeon-nesting country near Tionesta, Pa., says very little about pigeons during this period.

The process of taking squabs and melting down the fat for domestic purposes as a substitute for butter and lard is reported as a general practice among Indians and many whites: tribes are not specified (Wilson, 1812, vol. 5, p. 107). In Virginia the early settlers took pigeons in winter. John Lawson (1709) speaks of prodigious flocks of pigeons during 1701-1702; and of the Indians of Carolina he writes: "You may find several Indian towns of not above seventeen houses, that have more than one hundred gallons of pigeon's oil or fat; they using it with pulse or bread as we do butter, . . . the Indians take a light and go among them in the night and bring away some thousands, killing them with long poles, as they roost in the trees" (Lawson, 1860, pp. 78-79).

This seems to be the only specific reference for the Southeast, and one can not estimate to how many tribes it applies. Westward in Tennessee we lack eye-witness accounts of the Chickasaws taking pigeons; but within 50 miles of Memphis, Lusher's map of 1835 specifies "Pigeon Roost Creek" which Myer says was also the name of the short-cut trail or "Pigeon Roost Road," leading between the home of the Chickasaws in northern Mississippi and the Chickasaw Bluffs. Here there were vast roosts in heavily timbered bottoms, which must have been famous far and wide, as they are remembered in place names. Myer thinks they were known to the Chickasaw and were the probable reason for the trail (Myer, 1928, pp. 817-819).

To the north in the Great Lakes area, the Siouan-speaking Winnebago of Wisconsin poked pigeons out of their nests with long poles after the manner of Lawson's Indians of Carolina. They considered pigeons their "chief" birds, and hunts were undertaken in season when the chief decided to give a

feast. They were prepared by broiling or steeping and had a delicious taste. Large quantities were taken after storms when many died of exposure (Radin, 1923, pp. 112-113).

It is among the Potawatomi of Michigan, however, that we find the closest approximation to Seneca pigeon hunting. In Chief Simon Pokagon's classic portrayal of the Michigan nestings, which Forbush has called the best description of the nesting of these birds, the Potawatomi techniques are those of the Seneca. He says: "A pigeon nesting was always a source of revenue to our people. Whole tribes would wigwam in the brooding place. They seldom killed the old birds, but made great preparation to secure their young, out of which the squaws made squab butter and smoked and dried them by thousands for future use. Yet, under our manner of securing them, they continued to increase."<sup>10</sup>

The Ottawa ate pigeons (Kinietz, 1940, p. 240), but we find no details as to their methods of hunting them.

#### SUMMARY AND CONCLUSIONS

Once more we have seen the reminiscences of a few old Senecas, bolstered by historical fact, grow into a study of monographic proportion. As usual, Seneca tradition clarifies some points on which history is silent, while recorded history serves to date the disappearance of one more activity that old Senecas recall as being formerly part of their yearly economic cycle. In the case of pigeon hunting most of our materials come from members of the Cornplanter Band of Senecas in northwestern Pennsylvania. These people have been generally disregarded by ethnologists because they have been so long acculturated to white ways, but the authors of this paper have long suspected that the Cornplanter people could still yield information on material culture of hunting, with which they are still preoccupied. In the present study of the last passenger pigeon hunts of the Cornplanters, Willie Gordon and others have contributed to the increase of the literature on this ex-

tingent species. During the last years of their annual migration to the pigeon roosts around Sheffield and Byromtown, in Warren and Forest Counties, Pa., the Cornplanter people came into contact with the professional white pigeoners at the climax of their activities in the late 1870's. After this, the birds for the most part disappeared under the relentless persecution of the professional netter.

While it is apparent that from early times the Iroquois—notably the Onondaga and Cayuga—set nets for pigeons, both stationary nets on high places and trip nets at salt licks, nest-raiding seems to have been the predominant hunting technique among the Iroquois. This was certainly true of the Seneca, who seem to have used no nets except when they hired out to white pigeoners, as was true of the Indians of Massachusetts, New Netherland, Carolina, Wisconsin and Michigan. In aboriginal times squabs were generally considered more palatable than adult birds, and the pigeon roostings offered such abundant store of provender—both meat and oil—for the taking, that netting and archery, mainly effective with adult birds, were of secondary importance. There was no market for the adult birds, then, as trade was undeveloped. Nor does there seem to have been any sport in Indian life akin to trap-shooting.

The Iroquois regarded the annual return of the passenger pigeon as one of the blessings ordained by the Master of Life. The sudden arrival of great flocks of birds to nest in the neighboring forests not only relieved the economic strain at a period when they were sometimes reduced to eating their seed corn, but also justified their faith in the bounties of nature. For this great blessing they were duly thankful, and they prayed that this condition might continue always. They allowed the birds to nest and to hatch their young; and the nests were not disturbed until the young were ready to leave. They believed that the practice of taking squabs at their prime and of allowing the adult birds to go free to reproduce the species was a measure of conservation, which was probably true under the circumstances. Our Seneca informants were shocked at the way professional pigeoners violated nature

<sup>10</sup> Chief Simon Pokagon, from *The Chautauquan* 22 (20). Nov. 1895; in Mershon, 1907, p. 54.

by indiscriminate slaughter of old and young birds alike and by the relentless pursuit of the flocks from place to place.

The Iroquois ascribed human traits to the animal and plant world. It is small wonder that the folklore of these people observes that the passenger pigeons were the one bird that congregated in communal settlements like Indian villages, and that folk-tales ascribe to the pigeon colonies a humanlike society. An albino pigeon as chief fulfills the role of the sacred white animal, a common belief among woodland Indians. In a mythological encounter, the culture hero, a pure youth, meets the sacred white pigeon during a vision and enters into a compact with him. Rules are established governing the conduct of the hunt and the taking of squabs. These data cover such details as the *master of the hunt* who as in later times orders the migration, keeps the crowd together, places a "pole across the path at night"; keeps separate the camps for maternal kindred. Even the construction of lean-tos is covered. Continuing the pattern for Iroquois origin legends, the myth provides the rationale for ceremonies attending the hunts of later years: the camp caller, morning and evening thanksgiving, a ceremony for propitiating the pigeons with an offering of trinkets and sacred tobacco which—as always in Iroquois ceremonialism—is the intermediary between man and the spirit-world. Moreover, we find here an origin legend for the Pigeon Dance of later Iroquois ceremony; and its tenuous connection with the Maple Thanksgiving Festival is strengthened by the fact that pigeon hunting followed soon after the sugaring and lasted well into planting time. The youth relates his vision to the clan chiefs who carry out his contract; they call a council of the people to learn the new dance. Two dance leaders precede the whirling column, and an explanatory element about the counter-clockwise movement of social dancers represents the projection of a modern usage into ancient times.

Whether Indians or whites originated the pigeon-netting techniques is a question that can not be resolved entirely. The "nettings" at the Syracuse salt licks and westward into the Cayuga country may not have been the

same as the techniques of the professional netters. On the contrary, the complicated set-nets of the white pigeonier, with their weights, releasing poles, stool pigeons, decoy baskets, etc., seem to have emanated from southern Europe. They were used in New England as early as 1660.

We have shown that the Indian method involved knocking the young out of the nests with long poles or cutting down the trees to get at them. We must accept the Seneca testimony that they used European devices when assisting white pigeoniers, for the Iroquois knew other types of traps, and it was not beyond their abilities to devise adequate bird-trapping devices had they so desired, or had they any interest in taking the adult birds. There is a possibility that there was some trade latterly in splint decoy baskets of the type Indians sometimes make, but the specimens examined do not appear to have been made by any of the Indian tribes of the northeast.

Willie Gordon's narrative of his first pigeon hunt, from which this study sprang, is a tale of the late period of acculturation, of course. It represents the best of the last shreds of Cornplanter Seneca ethnology, which can be made to serve a useful purpose in reconstruction.

We have said something of the disappearance of the passenger pigeon, principally because the last nestings in Pennsylvania were in the area under study and to show that the stock explanation given by the Indians, and by many whites, is only a bit of recurrent folklore. The Seneca by themselves could not and would not have depleted this species.

Finally, it may be said that the passenger pigeon had a definite place in the hunting economy of the Iroquoian tribes from very early times. This is indicated by the evidence of archeology in the area. Although the accounts of pigeon hunting among the other northeastern tribes from New England south to the Carolinas are fragmentary, we believe that the material we have collected for the Senecas is probably fairly typical of other tribes throughout the range of the passenger pigeon. At least, the evidence in the way of comparative distribution, fragmentary as it is, does not reveal

much cultural diversity in hunting this species, from tribe to tribe. Perhaps this is obvious: there were limitations to ways of killing squabs.

#### APPENDIX

The discovery of oil in territory near and in the pigeon country in the 1860's was naturally attended by very rapid extension of railroads all through this area. The increased slaughter of wild pigeons, especially by professionals who came from all over the country attracted by the market facilities provided by the better transportation, was attended by a decline in the size and number of pigeon flights. By the Acts of May 1, 1873, and of May 1, 1876, Pennsylvania attempted to protect the birds, using the theory that disturbance of adults on their "roostings" was the cause of the trouble. This was not effective; so the Act of June 10, 1881, extended protection specifically to the squabs, banning the taking of any birds, young or old, with gun, net, or trap within a mile of the nesting grounds. A heavy license fee of \$50 was to be collected by each county in which the trapper worked.

During this period *The Warren Mail*, a weekly paper in the largest town near the pigeon grounds, was edited by an honest, high-minded gentleman greatly interested in law enforcement. His paper makes only casual mention of pigeons before 1878. The flight of that year was heavy, attended by large numbers of professionals from everywhere who paid no attention to the laws—and by a rising of the editor's dander on account of this. For us the result is an unusually good account of what went on in the pigeon woods. We extract from the *Mail's* weekly reports enough to give some idea of the extent and character of these activities.

*Mar. 18, 1878:* "Pigeons were seen flying over town last Thursday morning [i.e., Mar. 7]. Too high for shooting."

*Mar. 19, 1878:* "Pigeons are feeding and flying around Warren and the shot-gun squad are wide awake."

*Mar. 25, 1878:* "The pigeons have been flying in large flocks in this section for several days. They are reported as nesting in the wild woods of Forest County, beyond Sheffield. Numerous pigeon catchers are at Sheffield, Kane, Tidioute, Tionesta and all along the line. Last week nearly

100 barrels of dead birds were shipped from Sheffield. At this rate the pigeons will soon be exterminated."

*Same issue:* Quotes from the *Tionesta [Forest County] Republican* to the effect that "Sheffield is the shipping point for large quantities of pigeons. A small army of men are trapping them at their roosting and feeding places in Forest Co. It is alleged that large numbers have been shot near their roosting places, which act is contrary to law. In 3 days last week about 50,000 pigeons were shipped."

*Same issue:* Again quoting the *Tionesta Republican*: "The pigeon trappers are not doing very big business here, we believe, owing to the difficulty they experience in keeping spectators and hunters at a sufficient distance from their base of operations as not to scare the birds. The gang up about Balltown [up the Tionesta Creek, below Blue Jay mouth], however, are scooping them in at a great rate. They took 80 dozen in 2 days. They ship them to Sheffield for New York where, we hear, they sell for \$3 per dozen."

*April 4, 1878:* "The pigeons shipped to N. Y. from Warren and Forest Counties are sold at \$2.00 a dozen."

*April 23, 1878:* "Up to last Saturday [the 20th] 291,741 pigeons had been shipped from Sheffield. Probably nearly as many have gone from Tionesta while some 40,000 have been shipped from Tidioute. Over half a million birds have been caught, for which probably \$75,000 were received. Who says this 'neck of the woods' is not productive?"

*April 30, 1878:* "Mr. Gemmill [the freight agent at Sheffield] informs us that the total number of birds shipped from Sheffield up to April 27 is 353,846. Lately, the price of dead birds is low and 14,600 live ones were shipped during the last week. Counting 50,000 from Tionesta and 40,000 from Tidioute, which is no doubt below the actual figure, we have 443,846. Some have been shipped from Kane and other points while many have been carried away by shootists. It is probably safe to say that 500,000 birds, dead or alive, have been taken in this section."

*May 14, 1878:* "The number of pigeons, dead and alive, shipped from Sheffield up to and including Monday, May 13, is 505,516! So says Mr. Gemmill, the freight agent, who has the exact number. They are still nesting in the woods of Forest County. The pigeon men say the Michigan birds have come to this 'neck of the woods'."

*May 28, 1878:* Quoting the *Tionesta Republican*: "Davy Hilands shipped 500 pigeons to N. Y. this morning—the first that have been shipped from this station for some time. The trappers are now operating near Brookston and also about Kane and altogether the pigeons get no rest at all."

*June 11, 1878:* "Pigeons are still being shipped from Sheffield. Up to last Monday over 700,000 pigeons have been shipped and 200,000 from Kane Mr. Gemmill tells us that there are over 2,000

dozen pigeons in coops awaiting shipment. They are now nesting up Kinzua Creek on Chapel Fork."

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BOTANY.—*New grasses from South America*.<sup>1</sup> AGNES CHASE, United States National Herbarium.

Among recent collections of South American grasses received by the U. S. National Herbarium are three undescribed species, one each from Colombia, Uruguay, and Curaçao, one of the Dutch West Indies. Although this island is popularly regarded as one of the Antilles, biologically it belongs with Venezuela.

*Stipa rosengurttii* Chase, sp. nov.

Perennis, caespitosa; culmi erecti, subfiliformes, 25–85 cm alti; folia basi crebra, vaginis inferioribus dense imbricatis; ligula circa 1 mm longa; laminae involutae, filiformes, 6–12 cm longae, interdum longiores, erectae, hispiduloscabrae vel scaberulae; panícula 4–6 cm longa, ramis erectis, paucifloris; spiculae brevipedicellatae; glumae 3-nerves, acuminatae, marginibus hyalinis; gluma prima 6–7 mm longa, gluma secunda 5–5.5 mm longa; lemma convolutum, 3.3–3.4 mm longum, 1–1.2 mm latum, anguste obovatum, fuscum, tuberculatum, coronatum, infra coronam constrictum, dorso pubescens, callo brevi, longe barbato, pilis lemme 2–3-plo brevioribus; arista 1.8–2 cm longa, bigeniculata.

A caespitose perennial; culms erect, subfiliform, 25 to 85 cm tall with 2 or 3 nodes above the base, the nodes ascending-pilose or in age glabrescent; leaves crowded at the base, the lower sheaths overlapping and forming a swollen base, the lowermost relatively broad and loose, appressed pilose at the very base between the strong nerves, the middle and upper sheaths glabrous or scaberulous; ligule firm, about 1 mm long; blades involute, filiform, 6 to 12 cm long in the type specimen (to 25 cm in *Rosengurtt* B 216), erect or nearly so, hispidulous-scabrous to scaberulous; panicle long-exserted, 4 to 6 cm long in the type specimen (to 12 cm in *Rosengurtt* B 216), the few short branches erect, few-flowered, the axis and branches angled, scabrous; spikelets on erect sparsely hispidulous pedicels 1.5 to 3 mm long; glumes firm-membranaceous with hyaline margins, acuminate, 3-nerved, the first 6 to 7 mm long, the second 5 to 5.5 mm long, the delicate apex

of both readily breaking off; lemma convolute, 3.3 to 3.4 mm long, 1 to 1.2 mm wide, the callus very short with a dense ring of stiff, white hairs from one third to half as long as the lemma, the body of the lemma narrowly obovate, brown, finely tuberculate throughout, with a line of pubescence on the back extending nearly to the summit, the summit of the lemma smooth, cylindric forming a whitish crown stiffly ciliate to erose, the lemma constricted below the crown; awn 1.8 to 2 cm long, twice geniculate.

Type in the U. S. National Herbarium, no. 1819591, collected in a moist meadow, Monzón-Heber, Estación Juan Jackson, Province of Soriano, Uruguay, December 3, 1942, by Gallinal, Aragone, Bergalli, Campal, and Rosengurtt, PE-5120.

This species, with its dense tufts of filiform blades, narrow panicle, and plump tuberculate lemmas resembles *Piptochaetium*. It belongs in the section *Stephanostipa* Speg. of *Stipa*.

It is a pleasure to name this species for Dr. Bernardo Rosengurtt, a keen student of the grasses of his country, whose collections in the past few years have more than doubled the number of specimens of Uruguay grasses in the U. S. National Herbarium.

The only other collection known is a taller, overmature specimen, *Rosengurtt* B 216, from Río Negro and Arroyo [?] Palleros, Province of Cerro Largo, Uruguay, January, 1936.

*Paspalum curassavicum* Chase, sp. nov.

Perenne, dense caespitosum; glabrum, stoloniferum, stolonibus elongatis arcuatis, circa 50 cm longis; culmi erecti, foliosi, 30–40 cm alti, ramosi; vaginae arctae, imbricatae; ligula ciliata, 0.5 mm longa; laminae planae, 4–12 cm longae, 2.5–4 mm latae; racemi 2, conjugati, erecti, 3–3.5 cm longi; rhachis 0.7 mm lata; spiculae solitariae, 2.2–2.4 mm longae, 1.1 mm latae, ovato-ellipticae; gluma secunda et lemma sterile aequalia, 3-nervia; fructus 2 mm longus.

An erect densely caespitose glabrous perennial, with a hard knotted base and brittle arching stolons 50 cm or more long, with erect leafy branches from knotted bases, the stolons compressed or sulcate; culms rather rigid, leafy,

<sup>1</sup> Received June 26, 1943.

30 to 40 cm tall, only one flowering to 8 to 15 sterile culms, all branching at the middle nodes, the branches erect or nearly so, sometimes in small fascicles; sheaths close, overlapping, the lower two or three with reduced blades from rudimentary to 5 mm long; ligule a ring of hairs 0.5 mm long; blades rather firm, flat, 4 to 12 cm long, 2.5 to 4 mm wide, rather sharp-pointed, sometimes with a few hairs at base; racemes 2, included at base, erect, 3 to 3.5 cm long; rachis 0.7 mm wide; spikelets not imbricate, 2.2 to 2.4 mm. long, 1.1 mm wide, ovate-elliptic, pale; second glume and sterile lemma equal, minutely pointed beyond the fruit, 3-nerved (the midnerve occasionally suppressed); fruit 2 mm long, the tip of the palea enclosed.

Type in U. S. National Herbarium, no. 1762213, collected under tall opuntias, west of Hato, near north coast of Curaçao, February 27, 1940, by Agnes Chase (no. 12282). Duplicate type in the Herbario Nacional de Venezuela, Ministerio de Agricultura y Cría, Caracas.

Known only from the type collection, from soil of disintegrated coral and shells. Only a small colony of overmature plants found. It is possible that in a favorable season inflorescences may be more plentiful. The species belongs in the *Disticha* group, related to *Paspalum vaginatum* Swartz and *P. distichum* L. It differs from both in its cespitose erect habit and arching stolons, in the ciliate ligule, and in the smaller spikelets.

***Paspalum reclinatum* Chase, sp. nov.**

Annun, glabrum; culmi decumbentes, ramosi, 50–65 cm longi, compressi vel sulcati; vaginae laxae, subcompressae, glabrae vel marginibus obscure pubescentibus; ligula circa 0.2 mm longa; laminae planae, flaccidae, patentes, 3–9 cm longae, 4–8 mm latae; racemi 8–13, maturitate patens vel reflexi, 1–2.5 cm longi;

rhachis 0.7–1 mm lata, apice spiculam gerens; spiculae solitariae, vix imbricatae, 2.5–2.7 mm longae, 1–1.1 mm latae, lanceolato-ellipticae, glabrae; gluma secunda et lemma sterile aequalia, tenuia, 3-nervia, fructum superantia; fructus pallidus, laevis.

A decumbent, straggling, annual, glabrous as a whole; culms rooting at the lower nodes, 50 to 65 cm long, bearing a few flowering branches nearly as long as the primary culm; culm compressed or grooved; sheaths rather loose, subcompressed, glabrous or very obscurely pubescent along the margin; ligule about 0.2 mm long; blades flat, thin, spreading, 3 to 9 cm long, 4 to 8 mm wide, rounded at base, abruptly acuminate, glabrous or very obscurely puberulent back of the ligule, the margin scaberulous; racemes 8 to 13, at maturity spreading or reflexed on a flattened axis, 6 to 7 cm long, the racemes 1 to 2.5 cm long; rachis 0.7 to 1 mm wide, minutely pubescent at the base and with a spikelet at the apex; spikelets solitary, approximate but not imbricate, pale to faintly yellowish, 2.5 to 2.7 mm long, 1 to 1.1 mm wide, lanceolate-elliptic, glabrous; glume and sterile lemma loose, very thin, 3-nerved, slightly exceeding the fruit; fruit about 2.2 mm long, pale, smooth and shining.

Type in the U. S. National Herbarium, no. 1795921, collected in Colombia, Dept. Cauca; Cordillera Occidental: Cerro de Munchique, Hoya del Río Tambite, 2,000–2,500 meters altitude, July 16, 1939, by E. Pérez Arbeláez and J. Cuatrecasas (no. 6211).

This species belongs in the *Dissecta* group, and resembles *Paspalum prostratum* Scribn. & Merr. It differs from that in being glabrous as a whole, in the narrower rachis with a spikelet at the apex, and in the slightly larger spikelets, with the loose glume and lemma exceeding the fruit.

ZOOLOGY.—A new genus of Virginia millipeds related to *Scytonotus* and a new species from Florida.<sup>1</sup> H. F. LOOMIS, Coconut Grove, Fla.

In the summer of 1937, while enroute to Florida, I collected a number of immature specimens of a milliped in leaf litter near Panorama, on the Sky Line Drive, Va. The specimens were recognized as an undescribed species of the order Merocheta, but continued search in the time available yielded no mature animals and only a few more young ones. The locality was revisited in 1938 with similar results, and farther south, in Tennessee near the Virginia line, additional young were collected. Since then several entomologist friends of mine have unsuccessfully attempted to find specimens in the region.

The oldest individuals thus far collected have 18 segments, with the gonopods of the males represented by low, rounded mounds, although in other respects the animals might pass as fully grown. In dorsal sculpture and form of the pore-bearing callus of the lateral keels they appear more closely related to *Scytonotus* than to any other American genus, although the keels project farther from the body. However, this does not preclude inclusion in the Sphaerotrachopidae, to which *Scytonotus* belongs, and it is expected that mature animals may have 19 segments, as does that genus.

Since there is no other American milliped bearing close resemblance to the new Virginia form, illustrated in Fig. 1, its presentation as a new genus is hazarded although based on juvenal material. With the extensive collecting that has been done in the region about Washington it is somewhat unusual that this milliped remained hidden so long. Its name has been chosen in recognition of this and because of its somewhat shaggy appearance. In order that description and illustration of important features of mature specimens may be made, it is hoped that naturalists visiting the Blue Ridge region will be stimulated to collect full-grown individuals of this interesting addition to the fauna adjacent to Washington.

The second milliped treated here belongs to the established xystodesmid genus *Eurymerodesmus* Broelemann, most males of which have two elevated lobes of varying length and shape, according to the species, projecting from the margin of the orifice through which the gonopods are thrust. The new member of this genus, discovered in north Florida, is by far the smallest species in it and shows less coloration.

Types deposited in the Museum of Comparative Zoology, Cambridge, Mass.; paratypes are in the U. S. National Museum, Washington, D. C.

*Lasiolathus*, n. gen.

*Type*.—*Lasiolathus virginicus*, n. sp.

*Diagnosis*.—Differing from *Scytonotus* in the smaller size, broader body, more convex and tuberculate dorsum with longer setae, serrate margins of the segments, and the greater production outward of the lateral carinae.

*Description*.—Body small, relatively broad and probably composed of 19 segments at maturity; dorsum evenly convex and densely beset with tiny, sharply conic, setiferous tubercles arranged in a semblance of transverse rows.

Head large, exceeding the first segment in width but not so wide as segment 2; vertex densely pubescent and with a pronounced median furrow; antennae moderately long, subclavate, increasing in thickness to joint 6.

First segment subelliptic in shape; front margin bordered by numerous setiferous teeth or tubercles projecting upward and forward; seta-bearing tubercles of the surface scattered instead of seriate as are those of the other segments.

Second, third, and fourth segments with lateral carinae produced forward, those of the ensuing segments projecting outward, and only on the two segments preceding the last are the carinae posteriorly produced; dorsal tubercles in five or six transverse rows, in addition to which both the dorsal and ventral surfaces are finely granular; outer and posterior margins of the segments with projecting tubercles similar to those of the dorsal surface; pores each open-

<sup>1</sup> Received June 10, 1943.

ing from a quite large and almost smooth swelling near the posterior corner of segments 5, 7, 9, 10, 12, 13, 15, 16, and, at maturity, possibly from segment 17 also; metazonites sharply raised high above the prozonites, which have the surface finely reticulated; metazonites with finely fimbriate supplementary posterior margin.

Last segment with surface minutely granular and setiferous but lacking tubercles as found on the other segments; apex with four long setae.

Anterior and posterior sternum of each segment broad, separated by a transverse depression; each with a longitudinal median furrow deepest at its anterior end.

*Lasiolathus virginicus*, n. sp.

Fig. 1

Numerous specimens with 17 and 18 segments, an 18-segmented male being the type, collected at Panorama, Sky Line Drive, Va., July 13, 1937, and June 21, 1938; three specimens with 16 or 17 segments collected at Jonesboro, Tenn., June 25, 1938, by E. M. and H. F. Loomis.

*Description.*—Living color very light pink, probably darker at maturity.

Body stout, about five times longer than wide; actual length 9 to 10 mm, width 1.8 to 2 mm; dorsum strongly convex.

Head with vertex very convex and with a deep median sulcus, the surface minutely granular and densely beset with short, erect hairs; frontal area less granular and with fewer hairs; clypeal area smooth, shining and with a still smaller number of hairs; in front of the antennal socket and extending obliquely outward from it there is a pronounced swelling of the surface; lateral margin in front of the socket emarginate; antennae rather short and thick, joints 3 and 6 subequal, exceeding the others in length but joint 6 thickest of all.

First segment much narrower than the head; broadly and evenly rounded in front and with about 22 to 24 small, conical tubercles projecting upward and forward from the margin, each with a seta at the apex; perhaps 80 more similar tubercles are crowded together on the surface but these are inclined toward the rear.

Second segment considerably wider than the head; lateral carinae produced forward, those of segments 3 and 4 decreasingly so and all others

with the carinae projecting directly outward; outer margin of the carinae with five or six projecting tubercles, the first of which is formed by a continuation of the slightly thickened anterior margin of the carina and lacks an apical

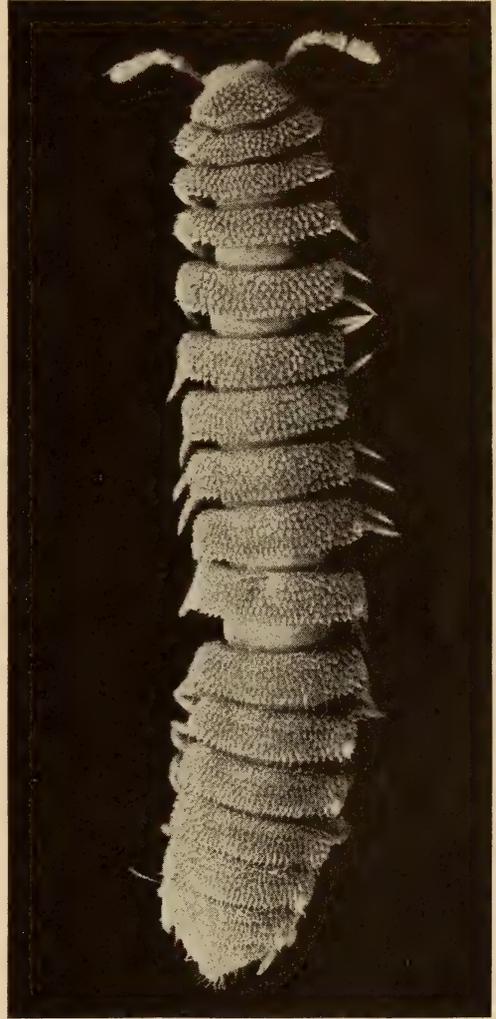


Fig. 1.—*Lasiolathus virginicus*, n. sp.: 18-segmented male.  $\times 12$ .

seta; on pore-bearing carinae several of the marginal tubercles are replaced by the large pore callus at the posterior corner; posterior margin of segments with 20 to 24 projecting setiferous tubercles; dorsum of segments 2 to 4 with setiferous tubercles in five irregular rows, those of the ensuing segments in six rows except

that on the last segment no tubercles are present and the setae are scattered and reduced in number; surface of the tubercles, the intervals between them, and the ventral surfaces, including the sterna, finely granular; anterior corners of the lateral carinae rounded in outline, the posterior corners also rounded and not produced backward except on the penultimate and antepenultimate segments where small angles are developed.

Last segment with a short, slightly deflexed apex.

**Eurymerodesmus minimus, n. sp.**

Fig. 2

One mature male (type) and three immature specimens collected at Marianna, Fla., October 27, 1941, by E. M. Loomis.

*Diagnosis.*—This is by far the smallest member of the genus as it is known today; the dilute color may be diagnostic, although in older specimens it may become more intensified; the gonopods differ from those of other members of the genus.

*Description.*—Length 15 mm, width 2 mm.

Color of living animal translucent white with a light pinkish tinge, which was lost soon after preservation in alcohol.

Head with a shallow but definite groove on the vertex; labrum with a forwardly projecting fringe of 24 to 30 setae; behind the labral fringe is a clypeal series of about 20 stout setae, and still farther back, near the junction of the clypeus with the front, 2 to 4 erect setae cross the median surface, and a group of about 5 setae occurs on each side near the labral margin; the clypeal-frontal setae longer than those of the two anterior series; antennae with joints 2 to 5 subequal in length, somewhat exceeded by joint 6; longitudinal ridge under the mandibular stipe of uniform height, end-

ing simply instead of in an incurved process as in males identified as *E. mundus* Chamberlin from between Duncanville and Cedar Hill, Dallas County, Tex.

Segments of the usual form but with the lateral margins somewhat more thickened than in *mundus*.

Male with the ventral surface of the legs, and the sterna, somewhat hairy, but not to the great extent found in *mundus*; sterna of pregenital legs 3 to 7 lacking special processes; claws of male legs lacking a bulbous process at the base as in *mundus*, a character not previously mentioned for that species.



Fig. 2.—*Eurymerodesmus minimus*, n. sp.: Gonopod, lobe of sternum, and base of eighth leg; lateral view.

Margin of the opening around the gonopods raised on each side at its outer posterior limits into a broad triangular lobe, the base of which is on a line extending obliquely outward and backward, the process raised only about to the height of the base of the first joint of the eighth legs; posterior or inner face of the process with a few erect setae; process on one side of the body widely separated from the opposite one, the surface between the processes descending from the sternum of the eighth legs toward the inside of the body with its edge very much lower than the margin elsewhere.

Gonopod as shown in lateral view in Fig. 2.



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# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES

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*A scientific recreation—the extent and accuracy of our measurable concepts.*<sup>1</sup> HARVEY L. CURTIS, National Bureau of Standards.

Before giving consideration to the subject I have chosen for this evening's address, I wish to assure members of the Washington Academy of Sciences that I am not unmindful of the fact that this nation is in the midst of a war which demands all our intellectual acumen as well as our physical stamina. It would seem fitting that the address of the retiring president should deal with some of the problems that are concerned with the war effort. However, any scientific topic connected with the war could not be adequately treated because of restrictions imposed by military necessity. That would limit a discourse involving the war effort to an emotional subject that would either stimulate our egotism by praising our accomplishments or would raise our morale by appealing to our sense of responsibility as leaders in science. I am convinced that no pronouncements of mine would appreciably influence your morale. Concerning egotism, I prefer to make no comments. I have, therefore, chosen a subject that has no relation to this war. My purpose is to furnish a little recreation to those who are scientifically minded.

The description of the universe in which we live is facilitated by our ability to evaluate numerically many of our concepts concerning it. Thus a length can be expressed numerically in feet, a mass in kilograms, a time in hours, and other quantities in terms of appropriate units. The concepts that can be expressed by reference to a single unit are the simplest of those which are recognized by human beings. Other concepts, such as heat, light, and sound, require for

their evaluation two or more numbers, each associated with its own unit, and the relationship between these numbers may be expressed by means of a mathematical equation of some complexity. Still other concepts such as odors, emotions, and physical pain can not yet be numerically evaluated. This address will be concerned only with the simplest concepts, so that any quantity to be discussed can be completely evaluated by a single number when associated with a specific unit.

The accuracy with which a given object or quantity may be measured can be expressed numerically. Thus the equatorial diameter of the earth, a distance of more than  $12\frac{1}{2}$  million meters, has now been measured with an accuracy of about 1 part in 300,000. The uncertainty in the value of the diameter is, in this case, solely the result of errors in the experimental determination, since both the standard meter and the equatorial diameter are definite to a much higher degree of accuracy. However, if our standard of length were a wooden meter stick, which might change in length from day to day by a part in a thousand, then the accuracy of determining the equatorial diameter would be limited by the definiteness of the standard and might be 5,000 or 10,000 meters instead of the experimental error of 50 meters. It is the aim of all standardizing laboratories so to maintain their fundamental standards that the accuracy of any measurement involving them will depend either on the experimental method used in making the measurement or on the indefiniteness of the object or quantity to be measured, and not on the definiteness of the standard.

The accuracy that can be attained in measuring a quantity depends on its magnitude. A very large or a very small distance,

<sup>1</sup> Address of the Retiring President of the Washington Academy of Sciences delivered at the 317th meeting of the Academy, February 18, 1943. Received March 15, 1943.

or mass, or time, or any other quantity can not be measured with as much accuracy as one of intermediate value. It is of interest to trace the accuracy of measurement in a few of our concepts throughout their entire range.

Another interesting feature of our simple concepts is the extent of their range. The evaluation of the range of any concept requires that the largest and smallest object or quantity of this concept be measured in terms of the same unit. Then the extent of the concept may be taken as the ratio of the value for the largest known object or quantity to the value of the smallest. The measurements must be in terms of the same unit, but the extent of any concept is independent of the unit used in making the measurements.

Our evening recreation will therefore consist in considering the accuracy of measurement of various physical quantities throughout their entire range and in giving an estimate of the extent of the range of the same quantities. For each of the physical quantities considered there have been selected a number of familiar objects, which range in size from the smallest to the largest for that quantity. For each physical quantity there has been prepared a chart showing the relationship between the size of an object and the accuracy with which it can be measured. A comparison of the charts will show interesting similarities and differences between the quantities.

The three basic quantities in our system of physical measurements are length, mass, and time. Each can be measured over a wide range. Also, the accuracy with which measurements can be made in every part of the range of each is known. Hence, they have certain features in common. A logarithmic plot of accuracy of measurements vs. range will be made using the same relative scale for each, so that comparison can be made of the three curves.

The plot of length or distance shown in Fig. 1 has for its basic ordinate the meter and for its other ordinates multiples or sub-multiples of the meter. The abscissas are the accuracy of measurement. The scale of distance extends both below and above the unit line, each step representing a factor of

1,000. The scale of accuracy, the abscissa, which has for its unit line one part in one, extends in the positive direction only; each step representing a factor of 10.

The distances indicated on the chart and the accuracy with which they can be measured will now be considered in detail. The object corresponding to the unit ordinate line is the standard meter bar. Two meter bars can be compared with an accuracy of a part in 10 million, or perhaps under very favorable conditions to a part in 30 million. One can appreciate the attainable accuracy by noting that the error in comparing two meter bars is about one-twentieth of the diameter of a fiber of spider silk.

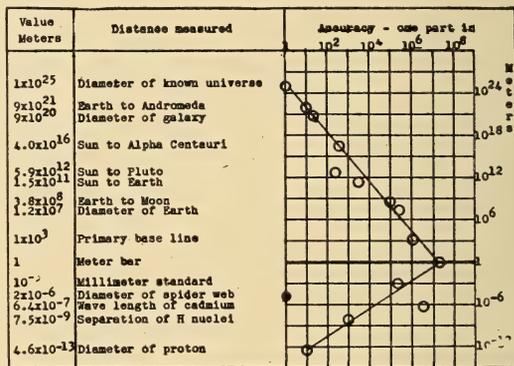


FIG. 1.—The accuracy of measurements of length.

The base line used in primary triangulation, usually a kilometer, can be measured with an accuracy of a millimeter, or a part in a million. The diameter of the earth, about 12 million meters, is known with an accuracy of only a part in 300,000. The larger distances are all astronomical. The accuracy decreases as the distance increases. The values for the accuracy both in this chart and those to follow were, for the most part, either obtained from published data or have been supplied by men experienced in the different fields. In only a few cases is the author's judgment involved.

The greatest distance that can be measured is the diameter of the known universe. The distance to the farthest observed nebula is considered to be of the order of 500 million light years. Assuming this to be the radius of our known universe, the diameter is  $10^{25}$  meters. The 200-inch telescope is expected to double this.

For distances less than a meter, which are plotted below the unit line, the accuracy decreases rapidly as the measured distance becomes smaller. For millimeter standards the accuracy has dropped to a part in a few hundred thousand. The distance between the nuclei of a hydrogen molecule is known only to a part in a thousand, while the diameter of a proton, the smallest known object, is known only to 10 per cent.

Exceptions to the uniform decrease in accuracy with decrease in size are the wave lengths of light. The universally accepted standard is the wave length of the red cadmium line. While less than a millionth of a meter in length, this wave length is known with an accuracy of a few parts in 10 million. This accuracy in measurement can be attained because nature places hundreds of thousands of the waves end to end with such fidelity that it is only necessary to measure from the first to the last and count the number of intervening waves.

I have included the diameter of a spider web (a fiber of spider silk) as it is about the smallest distance with which everyone is familiar. However, spider webs vary greatly in diameter, so that one can not assign a definite value to the accuracy of their measurement; hence a dot is placed on the unit line of accuracy at the approximate distance.

This chart shows that, at the present time, length measurements can be made with the greatest accuracy for distances of about 1 meter. This region has not materially changed for several hundred years. Recently interference methods permit the comparison of two end standards which are a decimeter long with about the same accuracy as can be obtained in comparing two line standards which are a meter in length. Thus, while the meter has not been displaced as the length that can be most accurately measured, it is conceivable that it may be when electron microscopes or X-ray interferometers are applied to the measurement of length.

The extent of our concept of length, which is obtained by dividing the largest known length by the smallest, is  $2 \times 10^{37}$ . As pointed out when extent was defined, this is not dependent on the unit used in

measuring distance. It is a ratio of two like quantities and is therefore dimensionless.

The accuracy with which masses of various magnitudes can be measured is shown in Fig. 2. The coordinates have the same relative values as the preceding chart, each step in the vertical direction representing a factor of 1,000 and each step in the horizontal direction representing a factor of 10. The unit ordinate is 1 kilogram.

Two kilogram standards can be compared with an accuracy a little less than one part in a billion. However, two tons can be com-

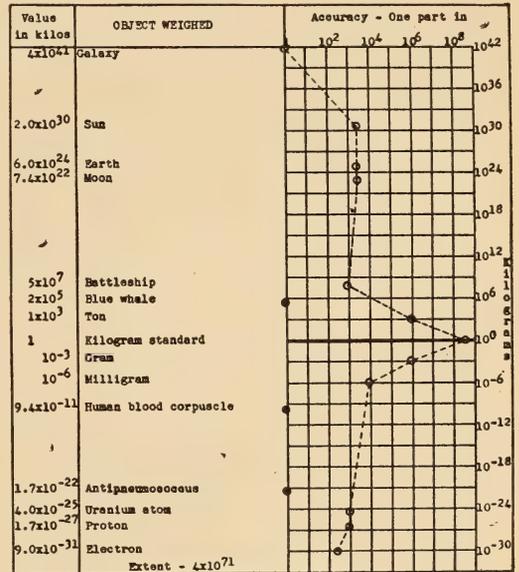


FIG. 2.—The accuracy of measurements of man.

pared only to a part in a million, while a battleship can be weighed only to a part in a thousand. The blue whale has been introduced, as members of this species are probably the largest animals that ever inhabited the earth. Since the accuracy of weighing is not available, the weight is indicated by a dot on the unit line of accuracy. A battleship is one of the largest of the terrestrial objects that are ordinarily weighed. The accuracy with which the mass of nearby astronomical objects, such as the moon, earth, and sun, can be determined is largely dependent on the accuracy with which the universal constant of gravitation can be measured. Hence, all have been given the same accuracy. Our galaxy is the largest

mass considered, being about that of a hundred billion suns. One might include the mass of the known universe, that is probably a hundred billion times that of our galaxy. However, the value is so uncertain that the accuracy scale would have to be extended to negative values of the exponents before it could be represented.

When values less than a kilogram are considered, the accuracy decreases rapidly with decreasing weight. Two living objects may interest the biologists. An antipneumococcus germ or virus is among the smallest of living things. It would require  $10^{27}$  of them to weigh as much as a whale. The human blood corpuscle is, on the multiplication scale, about midway between the extremes of living things. The weighing of the very small objects: viz., atoms, protons, and electrons, requires an entirely different technique than employed for ordinary objects. The electron is the object having the smallest mass known. Its value has been determined with an accuracy greater than 1 per cent.

The extent of the measurement of mass is  $4 \times 10^{71}$ .

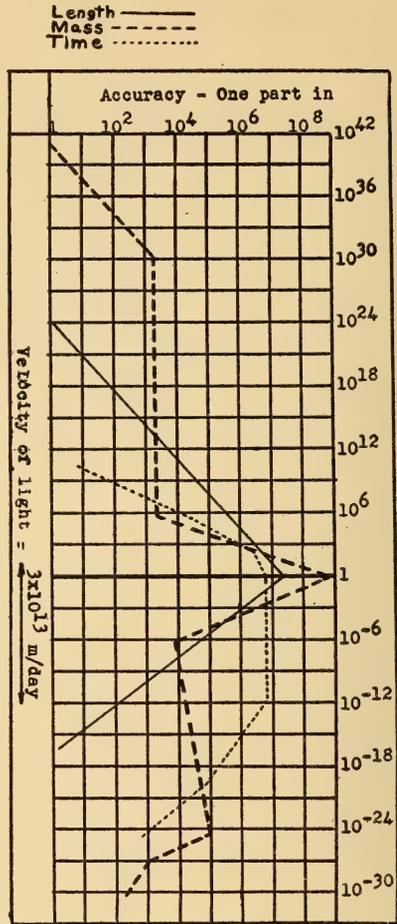


FIG. 4.—Comparison of the accuracy of measurements of length, mass, and time.

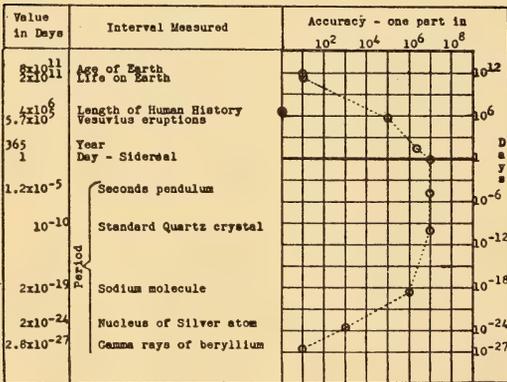


FIG. 3.—The accuracy of measurements of time.

The accuracy with which time intervals can be measured is shown in Fig. 3. The unit ordinate is the day. This is universally used as the standard of time, the second being merely a convenient submultiple of the day. The accuracy of measuring a single day is about a part in 10 million. A single year can be measured to about a part in 3 million. For the next interval I selected the

time between the two great eruptions of Vesuvius, the first on August 24, 79 A.D., and the second on December 16, 1631. If we consider the changes in calendar that took place, an error of a day or two in establishing these dates is quite probable. The length of human history is too indefinite to warrant more than a dot on the line of unit accuracy. It is now established that the first solid crust still remaining on the earth solidified about 2 billion years, or  $8 \times 10^{11}$  days, ago. This, then, is the age of the earth, and it is the oldest point on our time curve that can be definitely established. Life has existed for about one-fourth of that time. There is an uncertainty of at least 10 per cent in both these times.

When times less than a day are considered, the period of the seconds pendulum

and that of a standard quartz crystal can each be determined with the same accuracy as the day itself. The period of the sodium molecule is known with great accuracy, and even that of the nucleus of the silver atom is comparatively well known. The shortest vibration that can be ascribed to a known source is the gamma radiation from beryllium, which is known with an accuracy of about 10 per cent.

The extent of the measurement of time is  $3 \times 10^{38}$ .

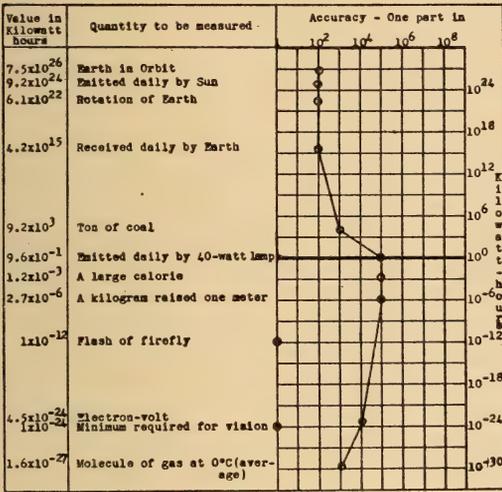


FIG. 5.—The accuracy of measurements of energy.

It is interesting to compare the accuracy curves of the three fundamental quantities of our system of measurements. The curves of the three preceding charts are, therefore, brought together in Fig. 4. An application of these curves is the selection of a suitable base line for measuring the velocity of light. This velocity is about  $3 \times 10^{10}$  m/day. If the length of the base line is from 10 to 100 meters, the time to be measured is between  $6 \times 10^{-11}$  and  $6 \times 10^{-12}$  days. Both this length and this time can be measured with an accuracy of about a part in a million. If a longer base line is chosen the length can not be measured with this accuracy, while if a shorter base line is chosen the accuracy of the time measurement will be decreased.

In each realm of science charts similar to those here presented can be prepared. Outside the fundamental quantities the physical quantity of widest interest is energy. Un-

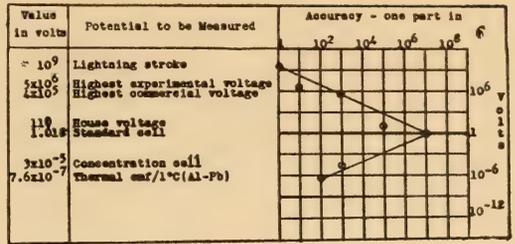


FIG. 6.—The accuracy of measurements of electrical potential.

fortunately, there is no one unit of energy that is regularly used in all fields where measurements of energy are made. I have chosen to take the kilowatt-hour as the basic unit in preparing the chart in Fig. 5. Nearly every adult has some feeling for this unit because it appears on all electric bills. It may be given some semblance of reality by noting that the electrical energy converted to radiant energy in 24 hours by a 40-watt lamp is approximately a kilowatt-hour.

The accuracy with which energy measurements can be made is much less than in the case of the basic quantities of our measurement system. In no case is an accuracy greater than a part in a hundred thousand obtainable, and that accuracy holds for the range from unity to  $10^{-6}$  kilowatt-hours. The energy of a ton of coal can be measured to 0.1 percent, but all astronomical energy only to 1 percent. On the other hand, molecular and electronic energy can be measured with reasonable accuracy.

It is expected that a retiring president shall make some mention of the field of science to which he has given special attention. In order that I may not disappoint you I will extend our recreations to include

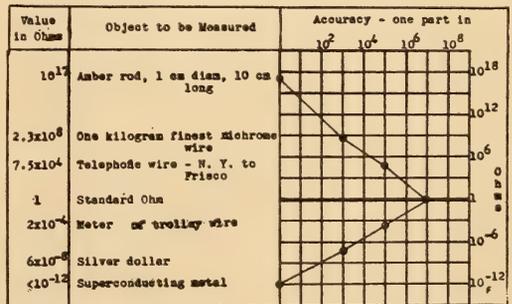


FIG. 7.—The accuracy of measurements of electrical resistance.

some of the electrical units. The first of these to be considered is electric potential, which is shown in Fig. 6.

The scale is the same as previously used. The unit ordinate is the volt, which is represented by the electromotive force of a standard cell that can be measured with an accuracy of a part in ten million. The upper limit is the potential of a lightning stroke, and the lower limit is the thermal electromotive force between similar metals.

The second electrical unit to be considered is electrical resistance, represented in Fig. 7.

The unit ordinate is the ohm, which can be measured with an accuracy of 1 part in 10 million, the same as for electrical potential. The values range from  $10^{17}$  ohms for the resistance of an amber rod to about  $10^{-8}$  for a silver dollar, although a wire of a superconducting metal has a resistance less than  $10^{-12}$  ohm, the limit of measurement. An interesting feature of electrical resistance is the possibility of bringing before you objects representing nearly the extremes of the values that are normally measured.

The chart for electrical capacitance is shown in Fig. 8 to illustrate the small extent of some units. The most precise measurements of capacitance can be made on an air capacitor having a capacitance of about 0.1 microfarad. This is equal to the capacitance between two plates, each 4 meters in diameter and 1 mm apart. The capacitance between the earth and the Kennelly-Heavyside layer is only 40,000 microfarads. The capacitance between a ball 2 mm in diameter and the walls of a large room in the center of which the ball is placed is  $10^{-7}$  microfarad.

The chart in Fig. 9 has been prepared to show the extent of each of the quantities which have been considered. The scale is a multiplication scale, with each numbered division being a factor of  $10^{10}$ , or 10 billion. The enormous difference in the extent of the different quantities is apparent.

It would be interesting to extend this study to measurements outside the physical field. As an example, consider the measurement of intelligence. There can be little question that the accuracy that can be attained in determining the I.Q. of an in-

dividual in the normal range of intelligence is much greater than for a genius or for a moron. Other examples will doubtless occur to workers in the biological and sociological fields.

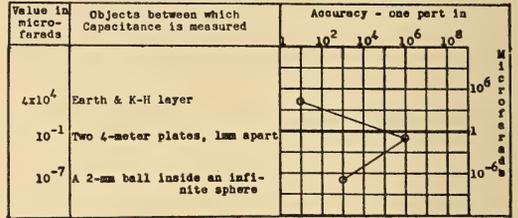


FIG. 8.—The accuracy of measurements of electrical capacitance.

The charts that have been given apply only to measurements as they can be made at the present time. Had a scientist of the last generation prepared such charts, the accuracy of measurement would, for almost every quantity, have been appreciably less throughout the entire range. Also, for many of the quantities the extent would have been much less than can now be claimed. It is to be expected that future scientists will improve the accuracy of measurement and extend the range. It is intriguing to contemplate a chart with a series of curves showing, for the beginning of each century for which data are available, the accuracy and extent of the measurement of such fundamental quantities as length, mass, and time. For those to whom this type of recreation has an appeal, there is ample room.

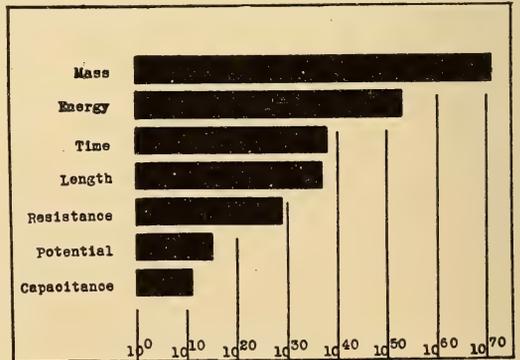


FIG. 9.—The extent of measurements of seven physical quantities.

HISTORY OF SCIENCE.—*The genealogical tree of modern science.*<sup>1</sup> PAUL R. HEYL, National Bureau of Standards.

Science may be defined as an ordered and correlated body of knowledge, as distinguished from a group of uncoordinated facts. Any branch of knowledge which has reached this ordered stage of development may be called a science, though in common usage this term is often understood as referring to what are called the natural sciences—astronomy, physics, chemistry, geology, and biology. There are, however, other branches of knowledge equally entitled to rank as sciences under this definition, such as mathematics, logic, linguistics, economics, ethics, and that which its devotees like to call “the science of sciences”—philosophy. In fact, in the Middle Ages theology was called “the Queen of the Sciences.” Viewed from this aspect, the term “science” may be regarded as covering almost the whole range of human thinking; and as it is obviously impossible to cover such an extent of territory in a limited time, we shall confine ourselves to a more restricted field.

The first thing necessary is to get a good perspective of the subject, to see where and when the earliest scientific records are to be found, how scientific centers arose in other places, while the activity of the earlier ones faded away, and to which of these early centers modern science is most indebted for its heritage.

The oldest civilizations are those of China, India, Egypt, and Babylonia. It is not always possible to assign definite dates to the earliest events mentioned in the ancient records of these countries, as these records sometimes disagree among themselves by hundreds of years. All that modern historical scholarship feels safe in saying is that recorded history in China and India dates from somewhere in the third millennium B.C., and in Egypt and Babylonia perhaps a thousand years earlier.

In all these countries (except India) the earliest scientific records are in the field of

astronomy. This is but natural, as a practical acquaintance with the rudiments of astronomy is indispensable to primitive people. The sun is their clock; the moon affords a measure of periods of time too long to be counted conveniently in days; and eclipses of the sun and moon must have inspired terror from earliest times.

The astronomy of these early days contained a large element of astrology; nevertheless, a considerable amount of astronomical knowledge was accumulated. In connection with this a parallel development of mathematics was unavoidable. The beginnings of the other sciences came later.

China, for geographical reasons, was long isolated from the western world. Even the silk trade did not become important until near the beginning of the Christian Era, and this involved no cultural relations between China and Europe. The silk was sent from depot to depot, serving the Indian and Persian empires, and changed hands many times along the route. The first Europeans to reach Peking were the Polos, in the latter part of the thirteenth century. Marco Polo records in the account of his travels only one item that may be regarded as of a scientific nature. He says in one place:

“It is a fact that all over the country of Cathay there is a kind of black stones existing in beds in the mountains which they dig out and burn like firewood. If you supply the fire with them at night, and see that they are well kindled, you will find them still alight in the morning; and they make such capital fuel that no other is used throughout the country. It is true that they have plenty of wood also, but they do not burn it, because these stones burn better and cost less.”

But Marco Polo's account of the manners and customs of the Chinese was not taken seriously by his contemporaries. He was popularly known as “Marco Millions,” and his book was regarded as a collection of travelers' tales. It was centuries before his account of his travels received the attention it deserved.

<sup>1</sup> Address delivered at the 1216th meeting of the Philosophical Society of Washington, March 27, 1943. Received May 15, 1943.

The Chinese annals contain lists of comets dating back ostensibly to about 2300 B.C. The early parts of this record are rather confused, but modern astronomers have checked the later parts and found them intelligible and trustworthy as far back as 611 B.C. The Chinese seem to have been early acquainted with the length of the solar year, as the first Jesuit missionaries, who arrived in China in the seventeenth century, found that it was an immemorial custom among the Chinese to divide a circle into  $365\frac{1}{4}^{\circ}$ . The Chinese seem also, at an early period, to have used astronomical instruments with graduated circles by which measurements of right ascension and declination could be made. Some of these instruments, constructed about 1280 A.D., were still to be seen at Peking in 1881. They show that the Chinese anticipated by at least three centuries some of Tycho Brahe's most important inventions, and one of their sages is credited with having measured with considerable accuracy the obliquity of the ecliptic.

The inventions of gunpowder, of printing, and of the magnetic compass are also ascribed to the Chinese. The art of printing from movable blocks was undoubtedly known in China in the early centuries of the Christian Era. It is possible that the claim of antiquity for the invention of gunpowder is also well founded, as explosives were a natural development from the incendiaries used in warfare by all the nations of antiquity. There is some doubt, however, as to the antiquity of the Chinese knowledge of the compass, as their first documentary record of this device is not earlier than the sixteenth century.

But even granting the early invention of all these things, the western world received none of them from China. The beginning of cultural intercourse between Europe and the Far East dates from the arrival of Jesuit missionaries in China in the seventeenth century, and by that time western science had developed to such a degree that China had nothing of value to offer.

The ancient records of India are silent on scientific matters, but it is reasonable to assume that astronomy (or astrology) was

not nonexistent there in early times. Indirect evidence of this is found in the growth of Hindu mathematics. About 600 A.D. Hindu algebra and geometry had reached a remarkable stage of development, and to some unknown Hindu sage the western world is indebted for two inventions of the first rank in practical importance—the symbol for zero and the principle of position in numeration. These devices were taken up by the Arabs and later transmitted by them to Europe, whence we speak of the “Arabic” numerals.

In ancient Egypt astronomy was to a certain extent the handmaid of religion. The stars were observed that they might be duly worshiped. These observations, however, were not without their usual practical aspect. For example, the heliacal rising, or first appearance at dawn of the bright star Sirius, heralded the beginning of the rise of the Nile, so important in Egyptian agriculture.

The ancient Egyptian mind excelled in practical engineering rather than in theoretical science. In geometry, the Egyptians laid emphasis on making constructions and determining areas. This was probably a consequence of the necessity of determining boundaries anew after the recession of the annual Nile flood. The Greeks (perhaps rather contemptuously) called the Egyptian geometers “rope-stretchers,” rather than philosophers, and there is some evidence that this opinion was not unjustified.

There is in the British Museum an Egyptian papyrus, written by one Ahmes some time before 1700 B.C. It is entitled “Directions for Obtaining the Knowledge of All Dark Things.” It shows that the Egyptians of that day cared but little for mathematical theory. It contains practical rules for determining areas, with no theoretical proof. These rules give more or less inaccurate results. For instance, the area of an isosceles triangle whose sides measure 10 ruths and the base 4 ruths is given as 20 square ruths, or half the product of the base by one side. Occasionally, however, the results are rather close. The area of a circle is found by subtracting from the diameter one-ninth of its length and squaring the remainder. This is

equivalent to a value of  $\pi$  equaling 3.1604, a very fair approximation.

There is evidence, however, that the ancient Egyptians carried out their engineering work with a high degree of perfection and no little ingenuity. The precise orientation of the Pyramids shows the care with which they observed the heavenly bodies, and in heavy construction they accomplished work which has called forth the admiration of modern engineers.

The quarrying, transporting, and erecting of the many obelisks still standing in Egypt illustrate this engineering skill. It is sometimes said, rather superficially, that the Egyptians had unlimited man power; but a little reflection will show that something more than this was required.

and written records of later periods give us some hints of the methods used.

The Egyptians knew the use of rollers, of the inclined plane, and of the lever. Single pulleys for changing the direction of a rope were used, but pulley blocks and screw jacks were not known. What modern engineer would undertake to move and erect one of these great stones without the aid of these two important mechanical powers?

Two kinds of stone were used by the Egyptians—granite and limestone. The obelisks were cut from quarries in upper Egypt, over 300 miles from the Mediterranean coast, and transported by water down the Nile to the place where they were to be erected. In one of these quarries there was found a broken saw in a cut in the rock.

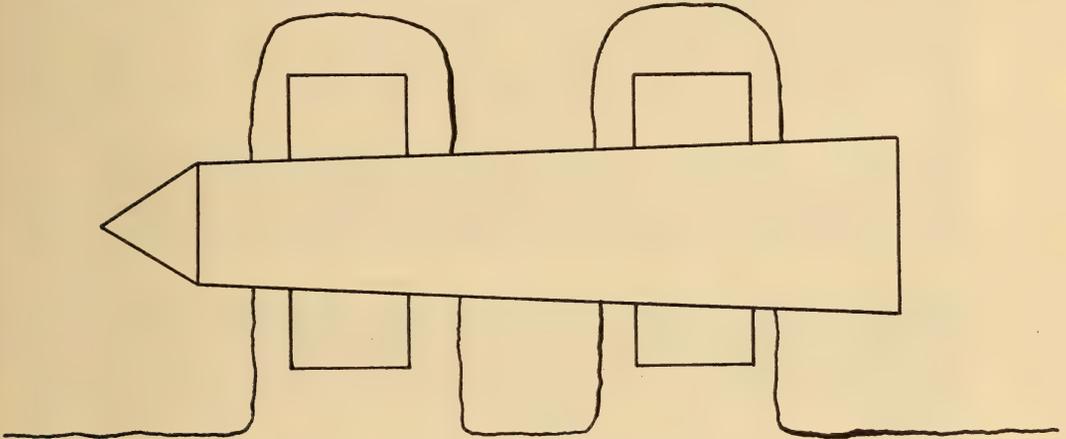


Fig. 1.—Egyptian method of loading an obelisk.

An obelisk 150 feet high, with an average cross section of 100 square feet, will weigh about 1,000 tons. Allowing 2 feet per man, not more than 150 men could stand around one of these great stones as it lay on the ground; and the lifting of such a stone by unaided man power would require each man to lift about 7 tons.

Our knowledge of how the Egyptians accomplished their feats of engineering comes from three sources. The rainless climate of Egypt has preserved for us in their original perfection numerous drawings on the walls of ancient temples and tombs, depicting the daily life of the common people. Remnants of unfinished work are found here and there;

This saw was a large two-man saw, of copper or bronze. It had no teeth, but fragments of emery were found lying about it. Mines of emery have been known from remote antiquity in the islands of the eastern Mediterranean. It is obvious that the cutting of the stone was accomplished by feeding the saw with emery and water. It is not an uncommon practice today to cut stone by use of belts of wire rope, driven by a steam engine and fed with sand and water.

The loading of the stone on a boat was a problem requiring considerable ingenuity. A stone weighing 1,000 tons, if it got away from those handling it and fell only 6 inches,

would break the bottom out of any boat. Pliny, in his *Natural history*, tells how this loading was done.

Pliny visited Egypt a thousand years after the obelisk period, but he apparently found a living tradition that he preserved for us; and when I tell you what it was, you will remember it for a thousand years, if you live that long.

The lower surface of the stone was probably not more than a foot or so above the water level. Two large flat boats were then loaded down with stone, pushed under the obelisk—and the stone unloaded!

The obelisk was then floated down the river to the desired locality, and the loading process reversed. Near one of the obelisks at Luxor there is still to be seen the trace of

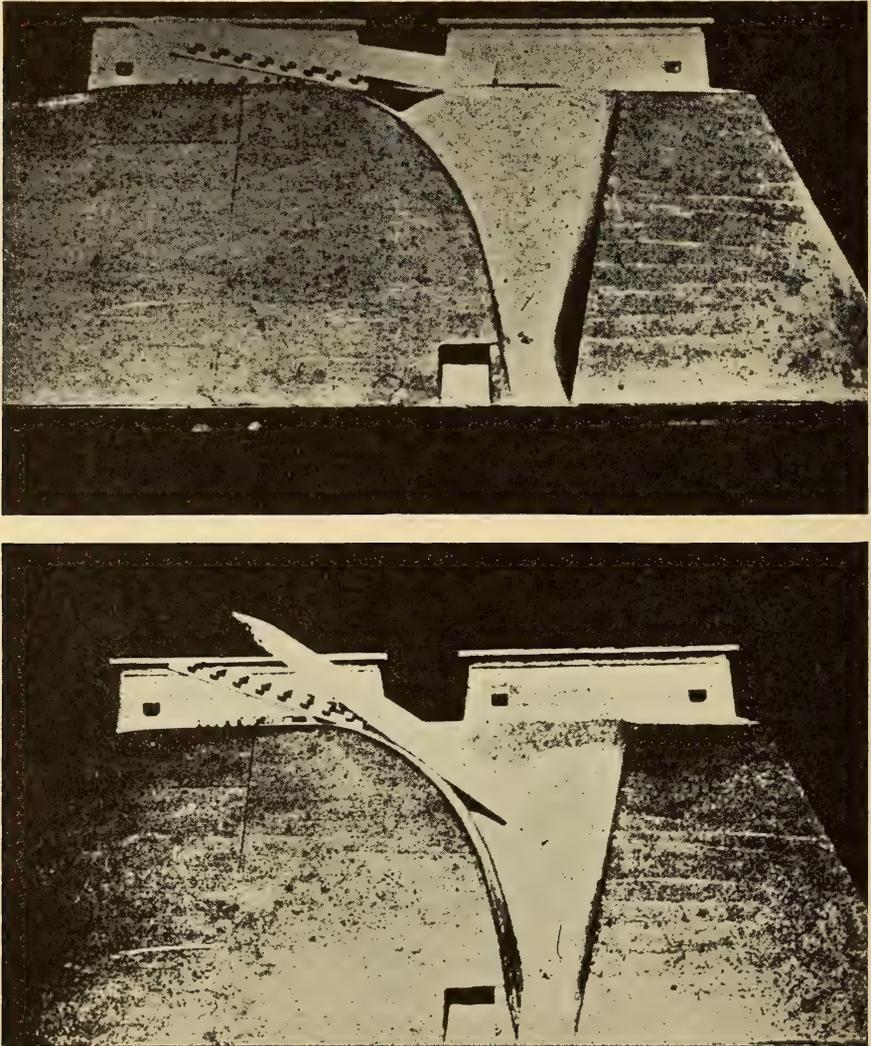


Fig. 2.—Egyptian method of erecting an obelisk.

The method employed is illustrated in Fig. 1. The obelisk was brought down to the river bank and laid parallel to the river. Two canals were dug under it, so that it was supported at the middle and at the ends.

the canal by which it was floated in from the river at the time it was erected.

The erection of an obelisk was a task that required still more ingenuity than loading it on a boat. A thousand tons of stone in an

elongated form is not only heavy, but brittle. Unless carefully supported there is danger of its breaking by its own weight. Fig. 2 shows how the erection of an obelisk was carried out.

The first thing was to prepare the stone base. Around this were built up walls of Nile mud, which were tamped down and allowed to dry thoroughly. One of these walls was extended into a long inclined plane. The empty space between the walls was then filled with dry sand from the desert.

The obelisk, supported on a long wooden frame, was then pushed up the incline on rollers, bottom first. On reaching the top its bottom end tilted downward and rested on the sand. An opening was then made at the bottom of the wall and the sand removed, a bucketful at a time. The sand ran down as in a gigantic hourglass, and the obelisk finally came to rest on its base in an upright position.

In chemistry, the Egyptians were probably no farther advanced than other peoples of antiquity. The arts of tanning and dyeing and the production of brass and bronze were widely practiced in ancient times. But by an accident of history the Egyptians contributed something to the science of chemistry that no other nation had an opportunity to do—they gave it its name.

The fertile land of Egypt is a streak of black Nile mud, 5 to 15 miles wide, across the yellow sand of the desert. In the ancient Egyptian tongue the country was called "Khem," or "Khmi," meaning "black earth." When the Mohammedan Arabs came into Egypt in the seventh century A.D., they were interested in the simple chemical arts they found there. They combined an Arabic prefix with the native name of the land, and coined the word "al-Khemi," meaning "the Egyptian art." Not until the middle of the sixteenth century did this word lose its Arabic prefix, and the alchemist become a chemist.

In the early records of Babylonia we find much of importance in the field of astronomy, especially well preserved for us on clay tablets. The principal constellations, as we know them, including the signs of the

zodiac, originated in Babylonia. The period called the Saros, of 18 years and 11 days, in which eclipses of the sun and moon repeat themselves very nearly, was discovered in Chaldea at an unknown epoch. By means of this cycle the Babylonian sages were able to predict eclipses. The first "Nautical Almanac" was published annually on clay tablets, now in the British Museum. These tablets contain times of new moon, of heliacal risings and settings, of conjunctions and oppositions of the planets, and predictions of eclipses. One of these old tablets contains an interesting astronomical report:

"To the king, my lord, thy faithful servant, Mar-Istar:

"On the first day, as the new moon's day of the month Thammuz declined, the moon was again visible over the planet Mercury, as I had already predicted to my master, the king. I erred not."

It is from the Babylonians that we have derived our division of the circle into 360°, as they had a calendar of 12 lunar months, which is still preserved by their modern kinsmen, the Mohammedan Arabs.

It was from the Babylonians that the Greeks obtained their first scientific stimulus. The genius of the Greek mind lay not so much in invention as in development and perfection. The great Greek teacher Plato (429-348 B.C.) recognized this when he said: "Whatever we Greeks receive, we improve and perfect." This was well illustrated in the genesis of Greek science.

Greek science did not originate in the mainland of Greece but in the Greek colonies in the Ionian islands in the eastern Mediterranean. It was 200 years before this movement reached the mother country.

About 650 B.C. certain Babylonian sages found their way to the shore of the Mediterranean, where they came in contact with Greek colonists. A school was founded on the island of Cos, which soon became a new center of learning. Among the Ionian philosophers we find the names of many famous scientific pioneers, not only in astronomy and mathematics but also in physics and medicine.

Thales of Miletus was one of the earliest

philosophers of this school. His name is traditionally associated with the prediction of a solar eclipse and with the electrical properties of amber. Pythagoras of Samos was a pupil of Thales, and his name suggests a well-known geometrical theorem. He later migrated to the Greek colonies in Magna Grecia (Sicily and southern Italy), where a new scientific center grew up that later furnished teachers to the mother country.

In the Ionian island of Samothrace, at some time prior to 400 B.C., there was discovered the magnetic toy known as the Samothracian rings. Aristarchus of Samos, about 250 B.C., was the first to suggest a heliocentric theory of the solar system. Hippocrates of Cos, about 450 B.C., is still known as the "Father of Modern Medicine," and framed copies of the Hippocratic oath, which was administered to all candidates for the profession in his day, are now to be seen hanging in physicians' offices.

Certain of these Ionians are known to have visited Egypt, and undoubtedly they profited to some extent by what they learned there, but the greater part of the credit for the origin of Greek science is undoubtedly due to Babylonia.

The rise of Athens and the ensuing Golden Age of Greece (480-338 B.C.) brought in another new center of learning. Here we have the names of Plato and his pupil Aristotle.

With the fall of Athens and the rise of Alexander the Great, a new center of scientific learning grew up at Alexandria. This city was founded by Alexander in 332 B.C., and its first ruler, Ptolemy Soter (not to be confused with the astronomer Ptolemy), offered opportunities to Greek scholars to continue their studies under his auspices. He built for their accommodation the museum where, maintained by royal bounty, they resided, studied, and taught. He laid the foundations of the great Alexandrian library and originated the search for copies of all written works, which resulted in the formation of a collection such as the world has seldom seen. The successors of Ptolemy Soter carried on his original plan vigorously, and one of them, Euergetes (247-222 B.C.), compelled all travelers who arrived in Alex-

andria to leave a copy of any literary work that they possessed.

The Alexandrian school, though located on Egyptian soil, was essentially Greek in its personnel and habits of thought. About 80 B.C. Egypt came under Roman domination. After this time the character of the school gradually suffered a change. The earlier scholars had devoted themselves to science and literature, while in later times their main interest was in what we would now call philosophy. Yet while it lasted (until the fifth century A.D.) the school of Alexandria included some great names: Euclid (about 300 B.C.); Apollonius of Perga (200 B.C.), the author of a treatise on conic sections; Eratosthenes (230 B.C.), who made the first measurement of the circumference of the earth; and Hipparchus (160-125 B.C.), who found the epicyclical theory of the heavens, later known as the Ptolemaic system, from its most famous expositor, Claudius Ptolemaeus.

The culture of Rome was largely borrowed from the Greeks. The Romans excelled in their own right in law and administration and developed considerable ability in the building of roads and aqueducts, but manual labor of any kind was held to be degrading. Seneca (3 B.C.-65 A.D.) said:

In my own time there have been inventions of this sort, transparent windows, tubes for diffusing warmth equally through all parts of a building, short-hand which has been carried to such a perfection that a writer can keep pace with the most rapid speaker. But the inventing of such things is drudgery for the lowest slaves; philosophy lies deeper. It is not her office to teach men how to use their hands. The object of her lessons is to form the soul. In them there is nothing of instruments for the necessary use of artisans.

With such a stigma resting upon it, no great development of science could have been expected under Roman auspices. The fall of Rome (476 A.D.) made matters worse, for the barbarians who overwhelmed Rome had no traditions of culture; and in addition to this indifference to science there developed in Europe a positive hostility to it in an unexpected quarter.

In the early centuries of the Christian Era there existed a widespread belief that the Last Judgment was close at hand and might be expected to occur within any one's lifetime. In consequence, time was precious and should be devoted to saving souls rather than to the study of natural phenomena that were so soon to pass away. Eusebius, bishop of Caesarea in Palestine (260-340 A.D.), speaking of scientific investigators, said: "It is not through ignorance of the things admired by them, but through contempt of their useless labor that we think little of these matters, turning our souls to better things." His successor, Basil, declared: "It is a matter of no interest to us whether the earth is a sphere or a cylinder or a disk, or concave in the center like a fan."

As the years passed and the last day did not occur, the prophets revised their calculations and finally announced that the great event would happen in the year 1000. This prediction received wide belief and was a factor in prolonging for centuries in Europe the idea that the study of nature was a waste of time. When the year 1000 finally arrived this belief was as strong as ever. Many European peasants thought it useless to till their fields, and in consequence much suffering occurred.

This feeling that scientific study was a waste of precious time undoubtedly had much to do with the almost total eclipse of science in Europe during the Middle Ages. However, during this period scientific knowledge was kept alive in the East by the Arabs.

Arabia, at the time when Mohammed came upon the scene (about 613 A.D.), was in a state of political chaos. Part of it was under Persian influence; the rest of the population either lived in towns, each of which had its own government, or else belonged to various wandering tribes maintaining the traditions of family and tribal rule and fighting continual battles with one another. Mohammed's success in welding together this apparently unpromising material into a united and conquering nation is one of the wonders of history. At his death in 632 he left Arabia practically unified. His succes-

sors conquered the whole of northern Africa and crossed the strait of Gibraltar into Spain, where they remained an important element of the population until the time of Columbus. The post-Mohammedan Arabs encouraged learning, exalted the supremacy of reasoning, founded schools from Bagdad to Granada, and did everything possible to apply scientific knowledge to the purposes of every day life, so much so that the Crusaders were astonished at the magnificence and splendor of the civilization with which they were confronted. Arabic scholars made translations from the Greek writers and added contributions of their own. The extent of the scientific knowledge of the Arabs is illustrated by the following words, all of Arabic origin, which still preserve their original signification—nadir, zenith, alchemy, alkali, algebra, cipher, carat, elixir. The esteem in which the Arabs held scientific study at a time when Europe regarded it as worthless is illustrated by a burst of enthusiasm from one of their own writers (850 A.D.), who said: "In the Last Day, may Allah have mercy on the soul of Al-Razi, for he was the first of mankind to draw up a table of specific gravities."

It is impossible to regard this change in the group psychology of the Arabs in post-Mohammedan times without feeling that there must have been something dormant in their heredity that responded in its own way to the general stimulus given by Mohammed. It is unthinkable that Mohammed could have brought about the same result with any of the tribes of central Africa. In this connection we think at once of the intellectual achievements of that other ancient branch of the Semitic race—the Babylonians. Scientific learning seems to have been indigenous to the soil of ancient Arabia.

It is true that there is another side to this story. Besides those Arabs who kept the lamp of learning burning, there were others, religious fanatics, such as the Caliph Omar, who ordered the destruction of the remnants of the great Alexandrian library on the ground that if the books agreed with the Koran they were useless, and if they did not they were pernicious, and should be de-

stroyed. Fortunately, Arabs of his type seem to have been an insignificant minority.

To return to Europe, after the critical year 1000 had passed the people seem to have gradually lost faith in the prophets of doom, and interest in scientific investigation began to reappear here and there. In the latter part of the twelfth century the magnetic compass came into use, and in the thirteenth century we have Roger Bacon, a scientific pioneer.

The revival of interest in science in Europe was a part of the general renewal of interest in learning. The Renaissance period was not, as it is sometimes represented, a sudden break with medievalism and a birth of the modern world. It extended over a period of a century or more. A number of conditions favorable to the rapid development of learning happened to coincide, and as a result man's outlook on himself and nature in general became profoundly modified.

One of these conditions resulted from the capture of Constantinople by the Turks in 1453. With the fall of the Byzantine Empire many learned Greeks fled into Italy, bringing with them manuscripts of Greek literature and (what was more important) the ability

to read them. A revival of interest in the culture of the ancients ensued, especially in Italy, which became the chief center of the Renaissance.

The invention of printing at about this time made it possible to obtain many copies of books at a comparatively trifling cost, and the voyages of Columbus produced new ideas and prepared men's minds to accept the more human and naturalistic view of the universe which had been current among the Greeks, in place of the mystical aspect which it wore to the medieval schoolmen and ecclesiastics.

It will be seen from this brief sketch of the genealogical tree of European science that its roots are to be found in the ancient civilizations of Babylonia, Egypt, and India, in the order of importance as named. It is probably safe to say that Babylonia contributed more than Egypt and India together. The contributions of these ancient civilizations converged, partly for geographical reasons, on Greece, where they fell on fertile soil. From the Greeks this heritage of knowledge passed to the Romans, and later, on the decline of Greece and Rome, it passed to the Arabs, who were its custodians until the revival of learning in Europe.

ETHNOLOGY.—*Hokan discovered in South America.*<sup>1</sup> JOHN P. HARRINGTON.  
(Communicated by WILLIAM N. FENTON.)

The purpose of this paper is to show the Hokan affinity of Quechua, "lengua general," that is, general language, of the Inca Empire, formerly, and still at the present day, spoken in large parts of what are now the countries of Peru, Ecuador, and Bolivia, in South America, and much heard at the present moment even on the streets of Cuzco, Quito, and Potosí. Hitherto the affinity of Hokan has been carried only to the Subtiaba language of the Pacific watershed of Central America.<sup>2</sup> The present discovery carries Hokan a step farther, and for the first time unites the two continents of North and South America linguistically. I

wish to express deep indebtedness and gratitude to Dr. Luis E. Valcárcel and to Prof. J. M. B. Farfán, the latter having gone farther than any other person in a bold analysis of Quechua linguistic forms.

Following Sapir's discernment that similarity of meaning should have precedence over similarity of sound as a guide in the assembling of forms for comparison, Farfán and the present writer, with entirely different backgrounds, have analyzed Quechua forms, with the result of becoming entirely convinced that these are made up of agglutinated elements, stereotyped and worn into a peculiarly nonperspicuous condition. Bases and their endings, and even bibases in origin, have become phonetically improved and evaluated for statement and for labeling of entity. But in origin Quechua forms

<sup>1</sup> Received August 28, 1943.

<sup>2</sup> SAPIR, E., *The Hokan affinity of Subtiaba in Nicaragua*. Amer. Anthropol. 27: 402-435, 491-527. 1925.

were conglomerations, like those of other Hokan languages, consisting of bases and affixes amalgamated together, and are still thus composed, and could be advantageously pried apart, if we only had some good means of doing so with certainty. Quechua doubtless contains bases of first and of second position and many affixes. The Quechua language has changed through countless generations since the time when it was more nearly related to Hokan, many of those which were perhaps in early times principal forms having gone out of use. Yet the main Hokan traits of affinity still remain, in sounds, in structure, in vocabulary. The assumption of the present status has been attended with ablautings of vowels and with changings of consonants. Component sounds in various settings have developed differently; yet in spite of this phonetic shifts can be worked out, some of them not too good, and being not too good they are the more convincing for showing genetic affinity. Hokanity pervades the entire make-up of Quechua.

We simply do not possess a good approach to the analysis of Quechua. The dialects of Quechua are not sufficiently differentiated for furnishing such an approach. And there is no extraneous language closely enough related to Quechua to render synchronic findings in it well worth while. Early recordings in Quechua itself throw light on only a few forms.

*The name of the Quechua language.*—The native name of the Quechua language in Quechua itself is runasimi, which means literally a person's mouth, but the second member is extended by metaphor to signify language, so that the whole means native's language, coinciding exactly with the current Spanish term: *lengua general*. The language is called Quechua in Spanish, but not so in Quechua speech itself. The geographical term *qheswa*, mountain valley, was also used as a place name and from this usage became applied to an inhabitant or collectivity of inhabitants of a place. The term *qheswa* was in use meaning inhabitant of the province of Cuzco, and from this use it was only a step to the taking of the term into Spanish in the form Quechua and as the name of the language in its entirety.

*Loan words of Quechua origin in Spanish.*  
—No better appreciation of the prominent position of the Quechua language with regard to influence on Spanish can be gained than from an examination of some of the words common in Spanish which have come into it from Quechua. A large bilingual population has for generations helped along this borrowing. Well-known Spanish words which have found their way into Spanish from Quechua are: *Andes* (from *anti*, mountain-region); *campa*, *Campa* (from *kampa*, cove); *chaco*, *Chaco* (from *teaku*, hunt); *chacra* (from *teaxra*, cultivated field); *charqui* (from *tearki*, jerky); *cóndor* (from *kuntur*, condor); *Cuzco* (from *Qotcgo*, name of the Inca capital); *guacamayo* (from *wakamayu*, macaw); *guano* (from *wanu*, manure); *pampa* (from *pampa*, plain); *papa* (from *papa*, potato); *pita* (from *pita*, string); *puma* (from *puma*, mountain lion); *puna* (from *puna*, elevated plain); *quina* (said to be from *kina*, Peruvian bark); *quipo* (from *qhipu*, knot).

*The three approaches to the analysis of Quechua.*—(1) The main approach will always have to be internal analysis within the Quechua language itself, by comparison of forms with related ones and with forms not related. It was by internal analysis and with a guiding background knowledge of some of the Hokan languages of North America that realization of the Hokan nature of Quechua first dawned upon me. Starting with *wi-qe*, tear, which reminded me vividly of *Pomo yu-xa*, tear, lit. eye-water, i.e., eye's moisture, I obtained old Quechua elements for eye and for water: *wi-*, eye; *-qe*, water. It was easy to see that Quechua *nyawi*, eye, also occurring in *nyawpa*, in front of, must have replaced an older and once dominant *wi-*, eye. Three forms are to be found of the old word for water: *-qe*, as in *wi-qe*, tear; *qo-*, for instance in *qo-tea*, lake; and *qa*, seasonal stream. *Sun-kha*, beard, was sensed to be literally mouth-hair, the first syllable a form of *simi*, mouth, the second syllable evidently to be identified with *qa-*, skin, pelt. To adduce the very rare great similarity between Quechua and a Hokan language far north, I formed *wa-si-lya-y*, my little house, and compared it with *Chimariko a-wa-lla-i*, my little house.

Comparison within Quechua itself sometimes shows what is the meaningful part of a word. For instance, it becomes apparent that haly- signifies earth, upon comparison of (h)aly-p(‘)a, earth; haly-pi, to dig; haly-ma, to dirty. Sometimes one is at a loss to know which forms to select for comparison. Thus pa-na, sister, and pa-ya, old woman, may belong together.

2. It is rare indeed that early spellings of Quechua are helpfully divergent from the present-day ones. Examples of useful early spellings are rinkri, ear, now ordinarily rinri; -kta, objective, not standardly -ta.

3. Sometimes a dialect of Quechua, divergent in its retention of a form, offers material for comparison which the standard language does not offer. Thus phy-yu, cloud, is shown by the Cajamarca dialect of Quechua pu-kuta, cloud, to have its first syllable carry the meaning of cloud. Notably the Chinchay dialect of Quechua, a vocabulary of which first was published in the second edition of Torres Rubio’s *Arte de la lengua Quechua*, Lima, 1700, is removed from the standard Quechua as regards forms and vocabulary.

Comparison of Quechua with the Hokan languages is more restricted by lack of sure analysis in Quechua than by any other factor.

*Metaphorical extension of definition.*—When for instance nyaw-sa, blind, lit. not having eyes, is found to have had its meaning extended by metaphor to sightless, we contemplate what has been called a metaphorical extension of meaning. Metaphorical means, literally, carrying beyond.

*Ranking of elements negligible as regards comparison.*—It is found again and again upon comparing extraneous Hokan forms with Quechua that the compared elements override the weight which they have assumed in a given language, with the result that a theme or base has sometimes to be compared with an affix, or vice versa.

*Abbreviations.*—The name of the language from which taken is placed before a compared form. If the name of the language is short, or if the name occurs rarely, it is written out in full. And in general description, language names are not abbreviated. For instance, Yana, the name of a Hokan

language of California, is so short that it would be unnecessary to abbreviate it. The few language names which it is advantageous to shorten as labels of provenience preceding cited forms are:

Chim.....	Chimariko
Choct.....	Choctaw
Q.....	Quechua
Sal.....	Salinan
Subt.....	Subtiaba

PHONETICS

In bird’s-eye view, the Hokan languages show a contrastive distinguishing of six vowels, for the most part, which vowels can be written by the familiar symbols: a o u e i ə. Some of the Hokan languages furthermore distinguish short and long vowels, but Quechua does not.

In far perspective as regards consonants, what may be called the principal characteristic of the Hokan languages is that while many of them, as for instance Yana, have only one articulatory series produced by the back of the tongue and again only one produced by the front of the tongue, Quechua, for instance, has two back-of-the-tongue series, which could be spoken of as the q and the k series, and Salinan is noted for possessing two front-of-the-tongue series, which could be spoken of as the ʈ and the t series. No Hokan language has been found which has both the two rear and the two front series.

It is a general feature of the phonetics of the Hokan languages to have developed, in addition to unaspirated clusives, which would naturally be written with the unaspirated values of Spanish t and p for instance, also a clicked variety of clusives, and again a strongly aspirated variety of clusives, thereby greatly increasing the number of distinctive consonant sounds.

The Hokan system of consonants, without listing in separate lines the doubling of rear or of front series, yet taking into cognizance the widespread triple appearance of clusives as unaspirated, clicked and aspirated, would be somewhat as follows:

’	h											
k	k’	kh	x									
y												
t	t’	th	c	tc	tc’	tch	s	ts	ts’	tsh	r	n
p	p’	ph	w	m								

*Comparison of sounds.*—Widespread studies have shown that consonant sounds when syllabo-initial and again when syllabofinal diverge in development, and that languages long apart, as for instance Quechua and Yana, have been preceded by scores of generations of linguistic change of which there is no record, of which change we do well to puzzle out the results without ever being able to learn the details of development. Both vowel and consonant appearances in Quechua are shockingly diverse. Rit'i, snow, appears in the Ancachs dialect of Quechua as raku, snow. Even articulatory series of consonants are not adhered to in development. Thus urqo, mountain; hirka, mountain top. Appearance of a word with two of the three forms of clusive can be illustrated by: qoso, husband; qhari, man in prime; Cajamarca Q tayka, heel; Q t'ayku, heel.

## VOWELS:

*a, o, u—a*

Q qaqa, rock; Pomo kabe, stone; Sal (t)exa', stone; Q -qo, water; Yana xana, water; Pomo -xa, water; Q phuyu, cloud; Sal pa'i', cloud.

*u, a—o*

Q pu-, to sleep; Chim po-, to sleep; Subt -apo, to sleep; Q mukiy, to be suffocated; Sal (i)mo'kLop, to be drowned (pl.); Q muqo, knee; Pomo mōko, knee; Q matcay, cave; Pomo mo, cave. It should be noticed in this connection that Spanish o regularly appears as u in Spanish loan words into Quechua. Thus Spanish cotón, shirt; Q kutun, shirt.

*u, w—u*

Q phu-, to blow; Pomo pu-, to blow; Q wi-, eye; Q uy-a, face; Pomo ui, eye.

*a, i—e*

Q amu, mute; Yana 'ému, to stop crying; Chinchay Q teatea, old woman; Sal tc'ene'', old woman; Q waman, falcon; Chim wemer, eagle; Q silyu, unguis; Sal icele'', unguis.

*i, u—i*

Q silya, gravel; Subt si'nu, stone; Q nyiy, niy, to say; Pomo ni, to say; Q tuta, night; Chim diwe-, night.

## CONSONANTS:

*' , q, y—'*

Q iwa, plant, tree; Subt i'ci, tree; Q qalyu, for \*'alyu, tongue; Chim -pen, tongue; Q yawar, blood; Sal a'kat, blood.

*h—h*

h is non-occurrent in any of the Hokan languages except in interjection or song padder, or as a secondary development.

*q, qh, k, w—q, k*

Q khipuy, to tie; Pomo qo, to tie; Q qowi, cuy; Sal kol', hare; Q orqo, male; Q qosa, husband; Q qhari, man in prime; Pomo kawi, boy; Q kun-ka, neck, throat, voice; Chim -ki, neck; Q yawar, blood; Sal a'kat, blood.

*k—k'*

Q kuru, worm; Sal ek'ot, snake, worm, grub.

*q', qh—x*

Q saq'aqa, bone of dead; Sal axa'k, bone; Q qho-, nose; Chim -xu, nose.

*t, r, n—t, d, n*

Q tayta, father; Sal te'le'', father; Q inti, sun; Pomo da, sun; Sal na, sun. Within Quechua itself one finds Q pirutu, piruru, bone-flute; Q tchataku, ragamuffin, tchanaku, rag.

*t, tc—tx*

Q tulyu, bone; Chim -txun, bone; Q tawna, walking-stick; Sal itxau, cane; Q tea(n)ka, leg; Chim -txan, leg.

*tc'—tc*

Q tc'ini, small; Chim tcite, child.

*tc—tcx*

Q teuta, to drag; Chim-texa-, to pull.

*s, r—s*

Q sonqo, heart; Chim -santce, heart; Q simi, mouth; Pomo si-, with the mouth; Q rin(k)ri, for \*sinkri, ear; Shasta isak, ear; Q yawar, blood; Chantal awas, blood.

*tc—ts*

Q tciwtci, fledgeling; Pomo tsita, bird.

*ly, y—l, n*

Q qalyu, tongue; Chim -pen, tongue; Sal epa'l, tongue; Q ilyay, to shine; Yana -'lai-, to warm; Sal lo'L, to get burnt; Q muyu, circle; Chim nolle, round; Q nyoqa, noqa, I; Chim nōut, I.

*y—y*

Q ay-a, corpse; Yana ya, person; Q yu-, to think; Pomo -yi-, referring to thinking.

*p—p, b*

Q ispiwi, lamp; Chim pī'a, n, fat; Q para, rain; Yana ba-ri-, to rain; Q pupu, navel; Chim -napu, navel.

*w—w*

Q wira, n, fat; Pomo wi-m, n, fat; Q wanu, manure; Chim -wax, excrement; Sal p'xat', excrement, intestines; Q wixsa, belly; Pomo wōxa, belly.

*p—m, b*

Q patca, the earth; Pomo ma, earth; Chinchay Q paqa, head, chief; Chim me-, with the head; Pomo ba-, with the head.

*Accent.*—Each Hokan language has its own accentuation. In Quechua the accent has settled on the penult, but is kept distinctive on the ultima in words in -teá, dubitative. The Chinchay dialect of Quechua has inherited more of the ultima accentuation than has the standard Quechua.

#### MORPHOLOGY

Morphology, as the term is applied to language, is the study of denotatory form, Greek morphêe being the equivalent of Latin forma, both signifying form. Morphology amounts in actuality to the analysis of words, the word consisting of a denotatory theme, or of extended theme known as base, or of a pair of these, without or with affix or affixes. A general term for the denotatory element of language is morphom. Identity of usages and parallelism of the words for ant and fear convince me with Brugmann that foorma and morphêe are the same word, while Sanskrit shows that it is the Greek which has become metathetical, the Latin and Greek originating background having been \*thormáa.

The Hokan languages have two parts of speech: actional and substantival. The actional is split into four etymal classes: verb, adverb, conjunction, and interjection; the substantival is split into three etymal classes: noun, adjective, and pronoun. The actional is the main part of speech, the substantival being subsidiary, or adverbial, to it.

Almost every linguistic form is what could be termed in Latin: versiformis, changing in form.

A widespread Hokan trait is the infrequent occurrence of a completely duplicated word, which could bear such Latin terminology as reduplicatio tanta. Such duplication occurs in Quechua, where there is a tendency in the vernacular writing of the language to place a hyphen between the two duplicate members: sira-sira, scorpion.

A thorough study of compounding in several of the Hokan languages, including Quechua, has arrived at the conclusion that all compounds are double only, consisting of an antebase and a postbase, each of which may not, or may, in itself be a compound, the two together constituting a bibase. Furthermore, in all these languages it is illuminating that the modificatory precedes the modified, the postbase constituting the main weight of the compound and carrying the conjugation or declension, or whatever is the inflection of the bibase as regards sentence. When the postbase is a verb and the antebase is a noun or adjective, the noun or adjective is adverbial to the verb. Although vernacular orthography may employ the custom of writing antebase and postbase as separate words, or of writing affix as a separate word, as is largely in vogue in the vernacular writing of Quechua, cobasing and affixing are the actual status and writing as a single word is preferable; an affix is never etymable and in this an affix differs from the usual theme or base. Every compound in Quechua is a doublet. Thus the well known Quechua compound inkawasi, palace, lit. emperor-house, is a bibase, each of its members consisting of a theme enlarged by addition of a little-understood postfix, but if either, or both, of the members were in itself a compound, the entirety would still be a bibase, and this is a characteristic not only of Quechua, but of every Hokan language that I have looked into. Postbasal or the like is often a short-cut term for postbasal noun, to which term postbasal adjective is to be contrasted.

Languages far apart sometimes co-inherit minor traits. One should notice a widespread peculiar feature of Hokan compounding which consists of an -n- of un-

known origin thrust between the two bases of certain bibases, while other bibases do not have or permit of this. Thus Q *uma-nulyu*, skull, lit. head-bone; but Q *uma-qara*, scalp, lit. head-skin; Chim *himi-nalla*, moon, lit. night-sun; Chim *himi-samdu*, devil

In Quechua very rarely a postbase is on the verge of becoming a versal postfix. Thus *-ruma*, person, which frequently occurs merely with the force of a gentilicous postfix. Or the meaning of one of the bases of a bibase may have become obscure, as in Q *kaw-lyama*, llama divinity, the first base of which has lost assertion of a meaning which it must once have had.

Again, where one might expect to find co-basing in Quechua, the antebase may be represented by the postpositioned form of a noun or adjective. Thus Q *wasi-q punku*, house door, lit. house's door, instead of *wasipunku*, house door.

It is a widespread trait of the Hokan languages, including Quechua, to vary the form of certain much-used postfixes with the result of producing a better fitting together. Doublet forms arise, one postvocalic, and the other postconsonantal. The shortest way of indicating such two forms is to let *v* stand for vowel, *c* for consonant. Thus in Subtiaba a certain postfix has the doublet forms: *v-yū*, *c-ū*. If a postfix does not have doublet forms, even a harsh coming together of consonants has to occur. Thus Q *takeq-kuna*, singers. Whenever a morphon manifests itself in two forms, these forms are known as doublets, and each has a separate background and usage; just as pre-Latin \**dvis-* appears both as *dis-* and *bis-*.

Another feature common to many Hokan languages and shared by Quechua is that now and then a base without change functions in two or more etymal classes. Thus Q *tealywa*, to fish, fish. Or the functioning may be in two etymal subclasses. Thus Q *nyawpa*, locational adv., in front of, temporal adv., long ago. In Quechua in rare instances a noun can even occur as a postposition.

*Hyphenization to indicate analysis.*—Navarro Tomás has a system which employs seven different "signos analíticos" for

indication of pried apart constituent elements of a word. Common usage employs instead of this system, advantageous when one gets used to it, merely the hyphen for indication of such analysis.

*Listing of affixes.*—The Hokan languages on the whole run largely to the postfixation of affixes. Yana for instance has no prefixes at all, and Quechua recognizes only eight. It is practical to list affixes separately according to whether prefixed or postfixed, under each of the speech classes to which the affix can be added, and in three lists as regards whether the affix is sentential, versal, or paradigmatical.

#### ACTIONAL

The main part of speech is the actional, presented before the other part of speech, which is the substantival, because this presentation conforms with psychology. Dinner should be presented before dessert, verb before extraneity, all of which is merely expletive to the verb.

#### VERB

The Quechua verb is thoroughly Hokan in its complications, having only one mode (I include the imperative, hortatory, and prohibitive in this mode), no gender, singular and duoplural number, progressive, integral and static aspect, four tenses, including near and remote past, and a passive voice built by coupling the static participle with the verb to be. An example of this last formation is Q *rikusqa kany*, I am seen, formed from Q *riku-sqa*, seen.

#### *Verb Affixes*

##### *Verb Sentential*

Q *-taq*, interrogative; Pomo *da*, interrogative.

##### *Verb Versal*

###### *Prefix*

Q *as-*, slightly (compare Q *as*, numeric pronoun, a little); Sal *as*, child, son; Subt *ax*, a little.

###### *Postfixes*

Q *-ku*, reflexive; Yana *-gu-*, self.  
 Q *-lya*, petitive; Chim *-la*, diminutive.  
 Q *-pu*, applicative; Yana *-t'p'au*, own.  
 Q *-ri*, future; Yana *nī*, *ni*, to go; Pomo *ne-*, to go.  
 Q *-teá*, dubitative; Chim *-dialhin*, dubitative.

Q -tci, causative; Yana -dju, causative; Choct -tci, causative.

*Verb Paradigmatical*

Q -i, imperative; Yana -'i', imperative with third person object; Subt -la, -l, imperative.

Q -n, present; Chim -n, -ni, -in, incompleted action, present; Pomo -n, present.

Q -na, future static participle, purposive, instrumentative; Sal na-, purposive; Choct na, instrumentative.

Q -q, -qe, present participle; Pomo -k, agentive.

Q -sqa, static participle; Chim -ak, completed action; Sal -k, static participle.

Q -y, infinitive; Yana -'i, infinitive; Sal i-, versusverbal nominal.

*List of Verbs*

Q hanlyay, to yawn; Chim -xaca-, to yawn.

Q hap'iy, to take; Choct habe-na, to receive.

Q kaniy, to bite; Q kiru, tooth; Yana -gal, to bite; Pomo g'a-, with the teeth.

Q kay, to be; Pomo ke-m, to be.

Q kirpay, to cover; Choct ialipa, to cover.

Q kutcuy, to cut; Choct katce-li, to cut.

Q mi-, to eat; Chim ma, ama, to eat; Sal ama, to eat.

Q mukiy, to be suffocated; Sal \*(i)mo'kLop, to drown (plural).

Q munay, to love, to want; Chim mi'ina, to like, to love; Pomo mara, to like.

Q nyiy, niy, to say; Pomo ni, to say.

Q onqoy, to get sick; Q umphu, sickly; Q unay, to delay; Subt -ndi'yu, to be sick.

Q pakiy, to break tr; Sal (k)a'p'axtenop, to smash, to shatter.

Hunancayo Q paly-puy, to fall; Yana midja-, to be heavy; Choct il-beca, heavy.

Q pampa-tcay, to even, to forgive; Yana -p'al-, to be flat; Pomo pai, a flat.

Q punyuy, to sleep; Chim po-, to sleep; Subt -apo, to sleep.

Q putututuy, to stink; Chim -potpot, to boil; Sal (k)o'poṭoṭ'na, to boil.

Q -puy, to swim; Yana p'u-, to swim.

Q phatay, to burst tr.; Choct mita-i, to burst intr.

Q -phay, to wash, in u-phay, to wash the face; Chim -pok-, to wash.

Q phukuy, to blow; Yana p'ô-, to blow; Pomo pu-cul-, to blow.

Q -qoy, to sleep; Subt -gu', to sleep.

Q raqray, to split intr.; Q raxra, a crack; Pomo dak, to split.

Q rikuy, to see; Yana da-, to see.

Q riy, to go; Yana ni, ni, to go; Pomo ne-, to go.

Q ru-, to burn intr.; Q nina, fire; Choct lua, burnt.

Q ruray, to do, to make; Sal ti', to do; Subt -da, to make.

Q saqtay, to pound up; saq-ma, a blow with the fist; Pomo sax, to strike; Choct isso, to strike.

Q takiy, to sing; Chim tak-, to sing.

Q tiyay, to sit, to stay; Q tuhu (archaic), chair; Subt -ta'u, to sit.

Q t'aq-lya, a slap; Yana -t!at'a-, to pat, to slap; Pomo t'ap, to slap.

Q t'i-piy, to pull up by the roots, to pull out (a hair); Choct ti'afi, to pull out or up.

Q tçuray, to put; Q teurkuy, to load; Choct tala-li, to put.

Q te'aqtcy, to water; Q te'aran, moist; Q teapuy, to dip; Choct teabbi, to dip.

Q urmay, to fall; Q ura, beneath; Q urupi, below; Yana -di-, -dî-, down.

Q wanyuy, to die; Subt -nyu-, to die.

Q waqay, to cry; Chim wō-, to cry; Yana -wa-, -wā-, to cry; Sal xāta, to cry.

Q yuypay, to count; Pomo mi-yi, to count.

ADVERB

*Statemental Adverb*

*Negative*

Q manan, no, not; Chim -nan, negative.

Q -tcu, negative; Chim xu-, not; Yana k'u-, not; Pomo kui, not; Sal ko-, not.

SUBSTANTIVAL

NOUN

*Noun Affixes*

*Noun Versal*

*Postfixes*

Q -tea, nominal, diminutive nominal; Yana -ts!i, collective diminutive nominal.

Q -na, nominal; Yana -na, -la, nominal.

Q -r, nominal; Chim -r, nominal.

Q -lya, nominal, diminutive nominal; Chim -la, diminutive nominal.

*Noun Paradigmatical*

*Postfixes*

Q -kuna, duoplural; Chim -kule, duoplural, in qā'-kule, ye.

Q -wan, instrumental, comitative; Chim -mdi, -mdu, instrumental; Choct -iba, instrumental.

*List of Nouns*

PLANT

PLANT PARTS

Q i-wa, plant, tree; Choct iti, tree; Subt i'ei, tree.

Q maly-ki, tree; Q mily-m(w)a, wool; Q maly-qo, fledgling already having fuzz; Q maly-ta, whelp, young mammal; Choct bafëlli, brushy.

Q qisqa, thorn; Q khisa, nettle; Q khisa-kuru, fuzzy caterpillar; Sal xa'ke, spine.

ANIMAL

ANIMAL PARTS

Corporeal

Q ay-a, corpse; Q ay-lya, meat; Q ay-tea, meat; Q ay-lyu, kinsperson; Yana ya, person.

Q han-k'u, sinew; Q han-k'a-tcakiy, to limp; Yana ba'ma, sinew.

Q yawar, blood; Chinchay Q yaar, blood; Q yawi-ru, soldier; Chontal awas, blood.

Q wi-ra, n, fat, lava; Q wira-p'uku, lantern; Q wira-qotca, god, God, Mr., lit. lava-lake; Pomo wi-m, n, fat.

Q saq'aqa, bone of dead; Sal axa'k, bone.

Q tulyu, bone; Chim -txun, bone.

Q tcuxtca, bodyhair; Sal ecax, feathers, whiskers.

Q qa-ra, skin, pelt; Q sun-kha, beard; Pomo he-le, hair.

Q aka, excrement; Q aka-yoq kelyay, rusty iron, lit. iron having excrement; Q t-axya, ball-excrement (e.g. of llama); Chim -wax, excrement; Yana wakli-, to defecate.

Head

Chinchay Q pe-qa, head, chief; Chim me-, with the head; Pomo ba-, with the head.

Q yu-yay, to think; Q yu-kay, to deceive; Q yu-pay, to count; Q yu-yay-kuy, to imagine; Q yu-yay-sapa, discreet; Pomo ba-yi, to teach; Pomo mi-yi, to count.

Q ma-t'i, forehead; Chim -mo-sni, forehead.

Q rin(k)-ri, for \*sink-ri, ear; Shasta isak, ear; Atsugewi asmak, ear.

Q wi-, eye, in wi-qe, lacrima; Q uy-a, face; Shasta oy, eye; Pomo ui, eye; Sal u-, face.

Q wi-qe, lacrima, lit. eye-water; Pomo yu-xa, lacrima.

Q qho-nya, nose mucus; Q qho-rqoy, to snore; Chim -xu, nose.

Q simi, mouth; Q sin-si, to show the teeth; Q sun-kha, beard, lit. mouth hair; Q san-qa, roof of the mouth (with -qa compare wasi-qata, house roof); Pomo si-, with the mouth.

Q qalyu, for \*alyu, tongue (from qalyu has come into Spanish Callao, name of the principal port of Peru); Chim -pen, tongue; Sal epa'l, tongue.

Q kiru, tooth; Q ki-pi, worn-down dentition; Q kaniy, to bite; Yana -gal, to bite.

Q kun-ka, neck, throat, voice; Q kunay, advice; Chim -ki, neck.

Q wax-ra, horn; Chim -wee, horn; Yana weyu, horn.

External Trunk

Q qhasqo, chest; Chim usi, chest; Sal iëo'', chest.

Q teutcu, female breast; Chim ci-ra, female breast; Yana to'ik'i, female breast.

Q wixsa, belly; Pomo wōxa, belly.

Q pupu, navel; Chim -napu, navel; Sal xapi'-cucwe't, navel.

Q wasa, dorsum; Subt giitea, behind.

Viscera

Q sonqo, heart (also used with congruent noun having illative postposition, e.g. a friend to dogs, lit. heart into dogs); Chim -santce, heart.

Q kuku-pi, liver; Ancachs Q kukus, liver; Subt gi'ko, liver.

Q hayaqen, gall; Sal t-e'rk, animal's gall.

Q uspun, guts; Chim -pxa, guts; Sal p'xat', excrement, intestines.

Privates

Q wa-, buttocks, anus, in wa-ra, pants; Q wanu, manure; Chim -wi, anus.

Q tcupa, tail; Q teutcupay, to drag behind; Q teuta, to drag; Chim -texa-, to pull.

Pectoral

Q ma-ki, hand, arm; Q ma-te'in, upper arm, upper leg; Chim -tran-pu, arm; Chim imu, to hold; Yana mō-, to reach, to hold; Pomo mi-, ma-, with the hand; Pomo ma, to hold; Sal me'n, hand; Sal t'o'puk, arm, wing; Subt nyau', hand; Subt paxpuu, arm.

Anal

Q mexlyay, lap; Sal ma'pok, thigh.

Q tca(n)ka, leg; Q teaki, foot; Chim -txan, leg.

Q muqo, knee; Q maki-muqo, wrist, lit. hand-knee; Chim hitxani-maxa, knee, lit. leg-knee; Pomo mōko, knee.

*Pectoral and Anal*

Q silyu, unguis; Q sily-q'uy, to scratch with the nails; Sal icele'', unguis.

ANIMALS

*Low Forms*

Q kuru, worm; Q khisakuru, fuzzy caterpillar, lit. nettleworm; Chim xawin, caterpillar; Sal ek'ot, snake, worm, grub; Sub unyu', worm.

*Insects*

Q usa, headlouse; utha, chicken-louse; Q isa, louse species; Q uru, spider; Q uru-si, spider; Pomo atcī, louse.

Q tchilyiku, cricket; Sal te'e'l', cricket.

Q pilypintu, a small butterfly species; At-sugewi palala, butterfly; Washoe palolo, butterfly; Pomo lilawa, butterfly.

Q t'oxto, bee; Chim xōwu, yellowjacket.

*Fishes*

Q tcalywa, to fish, fish; Q tcalytcaly, to wriggle in the water as a fish does when swimming; Q tcalypu, to submerge intr.; Pomo ca, fish; Sal swan, fish; Tonkawa esva-la-n, fish.

*Amphibians*

Q q'ayra, frog species; Chim qātus, frog; Subt kosta-lu', frog.

*Birds*

Q tciwtci, fledgling (compare also Q teutei, thrush); Chim tira, bird; Pomo tsita, bird; Sal ca'xwe, bird. Q tciwtci is the general term for fledgling, with which is to be contrasted Q malyqo, fuzzy fledgling.

Recuay Q watas, crow; Chim wa'la, wa'da, crow.

Q waman, falcon; Chim wemer, eagle.

*Mammals*

Q huk'u-tca, mouse, lit. inner cornerlet, from Q huk'i, inner corner; Pomo -uk, corner.

Q qowi, cuy (*Cavia aperea*) (this animal is called in Spanish cuy alias conejillo de Indias, the former having been taken over from Quechua into Spanish); Q kututu, male jack-rabbit; Sal kol', hare.

Cajamarca Q teitei, bat; Sal te'e'mtcem, bat.

AGE-SEX

Q qhari, man in prime; Q qosa, husband; Q orqo, male; Pomo kawi, boy.

Q warmi, woman in prime; Q watca, woman (vulgar expression); Q warma, young; Q wararay, to chatter; Pomo xatai, woman.

Q teina, female; Q teiteu, pregnant; Chim -sa, woman.

Q wawa, child; Q wawasimi, childhood dialect; Q makipwawa, finger, lit. handlet; Yana -'alā-, child.

Q te'ini, small; Q hute'uy, small; Q teuri, father's son; Chim teitei, child; Choct uci, child; Subt tei'tei, small.

Chinchay Q tcatca, old woman; Sal tce-, old; Choct teikki, old.

STATUS

Q masi, companion; Esselen -i'wis, friend.

KINSHIP

Q tayta, father; Q Tayta-tca, God; Sal te'le'', father.

Q mama, mother; Q ma-rq'a, to carry in arms; Sal apai'', mother.

Q qosa, husband (already given above).

PHENOMENA

Q aqo, sand; Q te-'aqo, white clay; Chim ama-yāqa, sand, lit. earth sand.

Q katci, salt; Pomo keē, salt.

Q matcay, cave, Q matcu-la, grandfather, ancestor; Yana mu-, hole; Pomo mo, hole, cave.

Q nyan, trail; Choct hina, road.

Q pampa, n, plain, adj, flat. (that pampa means primarily flat land is shown by pampatciy, to forgive, lit. to even); Q paxra, bald, lit. smooth; Q pax-ta, perhaps; Pomo pai, a flat.

Q para, rain; Q parqo, to irrigate; Yana barī-, to rain.

Q pa-tca, the earth (that the primary meaning is the earth is shown by Q patca-phuyu, fog, lit. earth-cloud); Q patcax, 100; Pomo ma, earth; Subt umba, earth.

Q phosoqo, foam; Pomo phus, foam.

Q phuyu, cloud; Cajamarca Q phukuta, cloud; Sal pa'-'i', cloud.

Q qaqa, rock; Chim qā'a, stone; Yana k'ai-na, stone; Sal (t)exa', stone.

Q qasa, cold weather; Q qhasay-ukhu, in winter; Chinchay Q qaca, cold weather; Chim xatsa, cold; Yana hātslit'-, cold; Choct ho-teukwa, cold.

Q qa, seasonal stream; Q qo-, water; Q -qe, water in wi-qe, lacrima, lit. eye-water; Chim -xa, water; Yana xa-na, water; Sal (t)ca', water.

Q rumi, stone; Q ruru, fruit pit, seed, eyeball; Q runtū, egg; Q ranra, gravel; Pomo ta, sand.

Q silya, gravel; Subt si'-nu, stone.

Q tuta, night; Chim diwe-, night; Subt m-i-durū, night.

Q tciraw, dry season; Chim atexumni, dry.

Q tchisi, to become night; Q tchilyu, black; Q tehi-maxlyu, night-snow; Q te'isi, last night; Q te'extei, gray; Chim tcēlē-i, black.

Q witca, up; Q wayra, wind, aloft; Q wayq'o, valley; Q waylya, meadow; Chim wiemu, up; Chim waida, upstream, east; Yana -wasa-, above.

Q yaku, water; Pomo g'oki, to drink.

ASTRONOMICAL

Q inti, sun; Q inka, emperor (one title of the emperor was inti-p tcuri, son of the sun); Q intu, to conquer; Q ilyay, to shine; Q lyilyi, heat-eruption; Chim alla, sun; Pomo da, sun; Sal na, sun.

Q paxsa, moon; Washoe d-i-be, luminary; Subt bii', day.

ABSTRACT

Q muyu, circle; Q muyuy, to circulate; Chim nolle, round.

Q sinri, line; Q siq'e, line; Q siray, to sew; Q sirk'a, vein; Q siru, net; Pomo ca-, with end or point.

Q su-ti, name; Sal a'se, name.

COLORS

Q puntcaw, day, daylight; Q paqar, morning; Washoe pi-, white.

MATERIAL CULTURE

Fire

Q k'antca, fire; Q q'ontca, hearth; Q k'an, heat; Q q'oniyi, hot; Q q'ilyimsa, charcoal; Q kanay, to burn; Q qhono, also qhanoy, to light (ceremonial fire at festival); Q kanka, a roast; Chim kōwa, coals.

Q q'osny, smoke; Chim qe, smoke.

Q nina, fire; Q inti, sun; Q ilyay, to shine; Yana -'lai-, to warm; Sal lo'L, to get burnt.

House

Q wa-si, house; Chinchay Q wa-hi, house;

Chim a-wa, house; Chim w-issa, door, lit. house's trail.

ADJECTIVE

*Adjective Affixes*

Adjective affixes are partly the same as noun affixes.

*List of Adjectives*

Q alyi, alyin, good; Choct a'li, true, good.

Q amu, mute; Yana 'ému-, to stop crying.

Q hatun, large; Pomo m-atō, large.

Q hun-t'a, full; Q hun-t'a-q, punctual; Q hunu, a million; Yana ba'nī-, to be full; Sal ep'enāteL, to fill (plural subject).

Q nyuxnyu, sweet and soft; Q nyunyu, female breast; Q lyulyu, tender shoot of a plant, tender meat; Chim lo'or-en, soft.

Q lyusk's, slippery; Chim -klu-, to slip; Yana -lili-, to be smooth; Pomo les, to smear.

Q mosoq, new; Subt ma'ca, raw.

Q poqes, adj, fat; Yana p'ui-, to be fat; Pomo puī, greasy; Sal upi-nit, fat.

Q q'enqo, twisted; Chim p'qēlē'-in, crooked; Sal (Sitjar) upk'i'na, to twist.

Q q'urqo, bitter; Yana k'lai-, to be bitter.

Q tchaki, dry; Q tchaka, hoarse; Chim atexumni, dry.

PRONOUN

*Personal Pronoun*

Q nyo-qa, no-qa, I; Chim nō-ut, I.

Q -y, my; Chim -i, my; Sal e-, my.

Q qan, you; Sal k-, you (employed in the imperative only).

Q pay, he; Sal pa, that.

*Demonstrative Pronoun*

Q kay, this; Chim qe, this.

Q teay, that (by you); Pomo te-, that; Subt ta-, that. Q teay is the only demonstrative which is also used as a verb prefix meaning that already referred to.

*Interrogative Pronoun*

Q ima, what?; Sal ma-s, someone; Subt ma'-na, what?

Q pi, who? Yana apbi-, who?

*Numeric*

Q as, a little. (Q as-, slightly, as a verb prefix, has already been presented above.) Subt ax, a little.

*Numerals*

- Q -puni, self; Chim p'un, 1.  
 Q iskay, 2; Chim xoku, 2.  
 Q kinsa, earlier kimsa, 3; Chim xodai, 3.  
 Q tawa, 4; Hokan (as reconstructed by Sapir) \*axwa, 4.

*Consonant Prefixes*

Several consonant prefixes, isolated in Quechua with great difficulty, have been found, and are here presented together, since they have bearing together on connection with Salinan, one of the Hokan languages noted for development of such consonants.

Cajamarca Q qewa, plant; Q iwa, plant; Sal k-, intransitive, less commonly transitive, rarely indicative of plural subject. The presence of initial q can also be interpreted as in place of initial ' , unwritten in the present paper.

Q p-ilyu, crown; Q ilya-y, to shine; Q m-alya, earth prepared for sowing; Q halyma-y, to bank earth around a plant; Sal p-, transitive, less commonly intransitive, rarely indicative of singular subject.

Q saqe-y, to leave; Q haqe-y, to leave; Sal se-, substantive.

Q t-awa, 4; Hokan (as reconstructed by Sapir) \*axwa, 4; (but compare Yana daumi-, 4); Q t-axyá, ball-excrement; Q aka, excre-

ment; Q te-'aqo, white clay; Q aqo, sand; Sal t-, nominal.

## WORD ORDER

Word order has in each one of the Hokan languages an established precedent. Initial and final positions in the sentence are the most emphatic. In Quechua the standard word order is ovs, in which o stands for objective, v for verb, s for subjective. The interrogative postfix -taq, which has been given above, is the only postfix of sentential stratum presented in this paper, and imparts interrogation to a word or to an entire sentence, a modulation which could also be executed by voice alone. Chimariko has two standard word orders: svo and sov.

## RÉSUMÉ

Experience in the evaluating of Quechua words for comparison has been like that of the geologist who explores waterway cobbles. The interior of the cobbles has to be looked into and anchored before provenience is certain. As Quechua words become in the future better analyzed, their connection with Hokan forms will become more certain and standardized.

ZOOLOGY.—*Another Mexican snake of the genus Pliocercus.*<sup>1</sup> HOBART M. SMITH, University of Rochester. (Communicated by HERBERT FRIEDMANN.)

Through the courtesy of the authorities of the Museum of Vertebrate Zoology, of the University of California, and particularly of Thomas Rodgers, I have had the privilege of examining and describing an interesting specimen of *Pliocercus elapoides*, which not only extends the known range of the genus northward about 300 miles from central Veracruz to central Tamaulipas and into another faunal area, but also represents a race distinct from any known previously.

*Pliocercus elapoides celatus*, n. subsp.

*Holotype*.—Mus. Vert. Zool. 24689, collected by Meldon Embury at Ciudad Victoria, Tamaulipas, Mexico, on June 31, 1937.

*Diagnosis*.—Like *P. e. elapoides*, but outer black rings of each triad on body greatly re-

duced, shorter than yellow rings, sometimes absent; ventrals perhaps fewer (126 in a male as compared with 128 to 131); black rings on body perhaps more numerous (12 as compared with 9 or 10) in males. Like *P. e. schmidti*, except snout uniformly black (except at lip); nuchal black collar not involving labials or parietals and covering 8 instead of 5 scale lengths on nape; and the primary black rings longer, involving 3 or 4 ventrals and  $4\frac{1}{2}$  or 5 dorsal scale lengths.

*Description of holotype*.—Head scales normal; portion of rostral visible from above about as long as median suture between internasals and about two-thirds the greatest length of internasals; latter two-thirds as long as broad, a little more than half as long as prefrontals; frontal pentagonal, the anterior edge forming a slight convexity, sides markedly convergent, posterior edges meeting at an acute angle;

<sup>1</sup> Received September 15, 1943.

frontal longer (4 mm) than its distance from tip of snout (3.3 mm) and posterior median edge of parietals (3 mm); nasal completely divided, posterior section a little larger and higher than anterior; loreal about as large as anterior section of nasal, a little longer than high; a large upper and a very small lower preocular; latter separating third labial from orbit, former widely separated from frontal; 2 postoculars, lower two-thirds size of upper; temporals 1-1-2, the anterior longest; 8-8 supralabials, the last 2 subequal in size and larger than others; 9-9 infralabials, 5 in contact with anterior chinshields, 2 with posterior, the anterior in contact medially with its mate, 6th largest; chinshields equally elongate, anterior slightly the broader; posterior chinshields in contact for about half their length; 2 small scales between chinshields and 1st ventral.

Dorsal scales smooth, pitless, in 17-17-17 rows; ventrals 126; tail tip missing; anal divided; snout-vent length 230 mm; male.

Black head cap extending posteriorly to tip of frontal and anterior tips of parietals, uniform on snout except near lip, extending laterally to about the middle of the first 5 infralabials; edge of entire upper lip light; a light collar following this, presumably yellow in life; a black nape collar involving tips of ventrals, occupying 8 scale lengths dorsally, and involving extreme posterior tips of parietals, the posterior parts of the tertiary temporals, but not the labials. Eleven other, similar dark bands on body, all complete, involving 3 or 4 scale lengths ventrally and  $4\frac{1}{2}$  or 5 dorsally, separated from each other by areas about equal to or a little greater than their length. A narrow light ring bordering each black ring, occupying little more than one-half of 1 scale length. Between the yellow rings are red bands in which most of the dorsal scales are black-tipped; this black spotting is usually, but not invariably, more concentrated next to the yellow bands, thus forming the effect of secondary black rings; these secondary rings are indistinct, however, narrower than the yellow rings, and sometimes not evident. On the tail the pattern is much the same, except that the

secondary black rings are more distinct. In no place do the secondary black rings extend onto the ventral surface. The belly and subcaudal surfaces are unpigmented except for the primary black rings; the chin and lower labial regions are also immaculate. The red rings are evident ventrally, however.

*Remarks.*—This specimen is markedly different from *e. elapoides*, the nearest race geographically, particularly in the reduction of the secondary black rings (see diagnosis). It resembles *e. schmidti* more than any other race, but in addition to being geographically distant has narrower primary black rings and a mottled snout; *e. schmidti* and *e. celatus* may be considered either as parallelisms or as slightly differentiated forms of a more primitive and more widely distributed stock. The latter alternative appears the more attractive, for although *e. elapoides* is centrally situated between the other two races, its pattern is relatively highly specialized and is subject to frequent bizarre variation. *P. e. laticollaris* is another slightly differentiated form similar to *e. schmidti* and *e. celatus*, but having incomplete black rings and more numerous infralabials.

With the addition of the present race to the list of known forms, it is of considerable interest to observe that every biotic province on the Atlantic coast of Mexico is now represented by its distinctive race of *P. elapoides*. While the details of the distribution of the four Atlantic races in Mexico are not known, a strong correlation with the four corresponding provinces is indicated, although a certain amount of discrepancy in exact boundary lines of races and provinces is to be expected. Although the east coast subspecies of *P. elapoides* are now perhaps completely outlined, at least with no further additions to be anticipated, the races of the Pacific coastal regions are very poorly known. That two or three races remain to be discovered and defined in that region is highly probable. Whereas eight species and subspecies of *Pliocercus* are now known from Mexico, about 11 are to be expected, and, of course, more may occur.

PALEONTOLOGY.—*Identification of Actinocrinus chloris Hall.*<sup>1</sup> EDWIN KIRK,  
U. S. Geological Survey.

Wachsmuth and Springer (1881, p. 146 (320), and 1897, p. 571) cite McChesney's species *Actinocrinus tenuisculptus* and place *A. chloris* Hall in synonymy with it. This precedent has generally been followed by authors. It turns out that the two species are quite distinct and indeed referable to different genera. My attention was called to this case of mistaken identity while checking over some of McChesney's species. It was obvious that the specimen figured by McChesney, if accurately drawn, could not be the species figured by Wachsmuth and Springer (1897, pl. 55, figs. 4a, b). Fortunately, I found in the U. S. National Museum a sulphur cast of the holotype of *A. tenuisculptus* made by Whitfield, which agrees with McChesney's illustration. The type itself was destroyed in the Chicago Fire. I had long known the beautiful little species identified by Wachsmuth and Springer as *A. tenuisculptus*. The identity of the "*A. tenuisculptus*" of Wachsmuth and Springer (1897) was established by the fortunate discovery of the cotypes of *A. chloris* Hall in the portion of the White collection acquired by Springer from the University of Michigan. The species has never been figured, and its identity has never been recognized. It proves to be the form erroneously identified by Wachsmuth and Springer as *A. tenuisculptus*. The following citations will correct the synonymy:

***Actinocrinus chloris* Hall**

*Actinocrinus chloris* Hall, 1861a, p. 3; 1861b, p. 275. "Burlington limestone, Burlington, Iowa. Collection of C. A. White." (Lower Burlington.)  
= *Actinocrinus tenuisculptus* Wachsmuth and Springer (not McChesney), 1897, p. 571, pl. 55, figs. 4a, b.—Moore and Laudon, 1943, pl. 10, fig. 11.

The cotypes of *Actinocrinus chloris* Hall are two specimens in the Springer collection in the U. S. National Museum numbered S 1142. One is an imperfect dorsal cup. The other is a some-

what crushed theca. There can be no question as to their identity, thanks mainly to the distinctive character of the species.

Many of the crinoids described by Hall, Meek and Worthen, and others in the early days are based on badly preserved specimens, and a minimum amount of time was spent preparing them. There was such intense rivalry in describing new species that a name was attached to almost any specimen found, however imperfect. When figured the specimen took on a more passable aspect, owing to the kind ministrations of the draftsman. Wachsmuth was the first to be sedulous in collecting good crinoids and spent days in preparing them.

***Cactocrinus tenuisculptus* (McChesney),  
n. comb.**

*Actinocrinus tenuisculptus* McChesney, 1860, p. 15, pl. diagram p. 17 ("Burlington division of the Carboniferous limestone series, Columbia, Missouri"); 1865, pl. 5, figs. 1a, b; 1868, p. 11, pl. diagram p. 12, pl. 5, figs. 1a, b.  
Not *Actinocrinus tenuisculptus* (= *Actinocrinus chloris* Hall) Wachsmuth and Springer, 1897, p. 571, pl. 55, figs. 4a, b.—Moore and Laudon, 1943, pl. 10, fig. 11.

This species is referred to *Cactocrinus*. With equal propriety it could be referred to *Teleocrinus*. In a species such as this the decision as to generic assignment must be arbitrary. It is placed in *Cactocrinus* because it more nearly resembles some species referred to that genus than any species referred to *Teleocrinus*.

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<sup>1</sup> Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received July 9, 1943.

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## PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

### GEOLOGICAL SOCIETY

#### 601ST MEETING

The 601st meeting was held at the Cosmos Club, January 14, 1942, President C. S. Ross presiding.

*Informal communications*—J. B. MERTIE, JR., spoke on nomograms of formulae on optical properties of minerals.

*Program*—W. T. PECORA and S. W. HOBBS: *Geology of the Nickel silicate deposit near Riddle, Oregon.*

W. G. PIERCE: *Heart Mountain and South Fork thrusts, Wyoming.* The Heart Mountain thrust sheet of northeastern Wyoming is traceable from Clark Fork Valley southward beyond the South Fork of Shoshone River. If it continues still farther southward into the northwestern part of the Wind River Basin, as appears possible, its linear extent is more than 90 miles.

The South Fork thrust is beneath, and is older than, the Heart Mountain thrust. A troughlike fold of the South Fork thrust sheet, which appears to have been downfolded after the thrusting, lies in the valley of the South Fork of the Shoshone River. The rocks in the trough have been folded into a syncline, and a recumbent anticline presumably formed during the emplacement of the thrust. Northeastward from the South Fork of the Shoshone, the thrust extends as a low-angle fault into the Shoshone Reservoir, where it is thought that the inclination and trend change abruptly, and that the fault thence continues to the northwest up Rattlesnake Valley as a high-angle shear fault.

The Heart Mountain thrust probably was not shoved eastward for a distance of many miles by a pressure applied at the western edge of the thrust. The active compressional force

that produced the thrust may have been directed westward as an underthrust.

It seems doubtful if the western source of the Heart Mountain thrust extends down into the crystalline basement, for throughout its known east-west extent of 35 miles there are no rocks older than the Ordovician Bighorn dolomite in the thrust sheet. Likewise the South Fork thrust probably does not extend below the Sundance formation of Jurassic age, for, although this formation commonly floors the thrust, there are no older rocks anywhere in the thrust.

The emplacement of the South Fork thrust followed the deposition of early Wasatch strata. The emplacement of the Heart Mountain thrust followed the deposition of later Wasatch strata, and after partial erosion of the thrust sheet the "early basic breccia" of the region were deposited.

Vertebrate fossils indicate that the Heart Mountain thrust was emplaced near the close of the lower Eocene. The South Fork thrust was formed some time earlier in the Eocene. (*Author's abstract.*)

F. E. MATTHES: *Glacial events of the historic period.* Fairly complete records exist of the major advances and recessions that the glaciers in the European Alps have experienced during historic times. These records show that toward the end of the sixteenth century climatic conditions grew more severe than they had been during the Middle Ages, and the glaciers gained considerably in length and volume. Alpine villages that had prospered for centuries were overwhelmed by advancing glaciers, or rendered uninhabitable by torrents of melt water; and such catastrophes occurred repeatedly during the first half of the seventeenth century. Other periods of marked glacier expansion were chronicled in 1680, 1719, 1743, and 1770. The last notable glacier advances took place in 1820

and 1850. All these advances were of about the same magnitude, but most of them fell short of the limits reached by those of the early 1600's. Since 1855 recession has been dominant, and since 1920 it has proceeded at an accelerated rate.

From comparative studies of the moraines in the Alps it is clear that the historic glacier advances have been by far the greatest that have occurred since the Pleistocene ice age. The moraines in Norway and Iceland tell a similar story. These facts, taken together with the abundant evidence that is now at hand that great warmth prevailed during the middle part of postglacial time, warrant the view, it is believed, that the historic period had been, in effect, a period of moderate reglaciation—a "little ice age," as a clever journalist has called it.

#### 602D MEETING

The 602d meeting was held at the Cosmos Club, January 28, 1942, President C. S. Ross presiding.

*Informal communications*—H. D. MISER spoke on the Red River Dam near Denison, Tex.

*Program*—E. B. ECKEL: *Geology of the New Idria District, California.*

EUGENE CALLAGHAN: *Some features of tin, tungsten, and antimony deposits of Bolivia.*

ROBERT E. ALLEN: *The oil outlook in this war.*

#### 603D MEETING

The 603d meeting was held at the Cosmos Club, February 11, 1942, President C. S. Ross presiding.

*Program*—W. C. ALDEN: *Cirques, hanging valleys, and high-level benches of Glacier National Park.*

WALTER H. BUCHER: *Method proposed to introduce a concept of "limits of error" into the stratigraphic timing of tectonic movements.*

#### 604TH MEETING

The 604th meeting was held at the Cosmos Club, February 25, 1942, President C. S. Ross presiding.

*Informal communications*—EARL INGERSON spoke on measurements of linear elements in the field.

*Program*—J. B. MERTIE, JR., and R. R. COATS: *Tin deposits of Seward Peninsula, Alaska.*

R. N. JAHNS: *Sheet structure in granites; its*

*origin and use as a measure of glacial erosion in New England.* Sheet structure in New England granites consists of lenticular, flat to gently curved exfoliation shells that tend toward parallelism with the exposed rock surface. In general they become progressively thicker, flatter, and more regular with increasing depth, and they have been observed at and near the bottoms of the deepest quarries. Sheeting is completely independent of all primary structures in the rock and commonly transects contacts between the granite and xenoliths, roof pendants, the country rock itself, and minor postgranite intrusive bodies. Evaluation of the possible causes of sheet structure in the light of present available data indicates that the release, through removal of superincumbent load, of a primary confining pressure to which the rock has become adjusted is chiefly responsible for the large-scale exfoliation phenomena involved. Insolation, the progressive hydration and formation of chemical alteration products in certain susceptible minerals, and the mechanical action of fire, frost, and vegetation are possible minor contributory causes.

With very few exceptions the sheet structure on the granite hills of northeastern Massachusetts and adjacent parts of New Hampshire, where detailed studies have been made, is preglacial in origin. Its attitude with respect to present topography therefore facilitates certain comparisons with preglacial topography, and thus permits minimum estimates of the thickness of material removed by glacial ice from specific localities. Cross sections that show the critical relations have been constructed for several typical hills.

The minimum depth of glacial erosion can also be estimated by a second, less direct method. Not only do the granite sheets or shells thicken with depth, but statistical data demonstrate a fair degree of quantitative consistency in this relation. The sizes of large granite boulders—and therefore of the respective sheets from which they were torn by the ice—thus furnish an additional clue to their original depth beneath the pre-glacial surface. Results of studies by the above methods suggest the removal of a blanket of rock and preglacial regolith at least 10 to 15 feet thick by glacial abrasion and plucking from the stoss, or north slopes of most hills, and of a somewhat greater thickness from their east slopes, summits and west slopes. Severe plucking and quarrying of jointed rock

appears to have been responsible for strongly concentrated erosion on the lee, or south and southeast slopes of many hills to maximum demonstrable depths in excess of 100 feet.

CHESTER R. LONGWELL: *Some structural features in southern Nevada.*

#### 605TH MEETING

The 605th meeting was held at the Cosmos Club, March 11, 1942, President C. S. Ross presiding.

*Program.*—R. L. NICHOLS: *Flying bars in Boston Harbor.*

R. P. FISCHER: *The vanadium deposits of Colorado and Utah.* Deposits of carnotite and vanadium-bearing sandstone are widely distributed in western Colorado and eastern Utah and have been the principal domestic source of vanadium, uranium, and radium. At present these deposits are being intensively mined for vanadium. Most of the deposits are in the Morrison formation, but there are some in the Entrada sandstone and the Shinarump conglomerate.

Recent X-ray studies by Sterling Hendricks of the Department of Agriculture indicate that the principal vanadium mineral, heretofore considered to be roscoelite, belongs to the hydrous mica group of clay minerals. This mineral impregnates the sandstone, coating sand grains and partly or completely filling interstitial spaces between the grains. Shale pebbles and finely divided "mud" material in the ore-bearing sandstone are rich in absorbed vanadium. Carnotite and other vanadium minerals are found in some of the fossil plant material associated with the ore. The vanadium-bearing hydrous mica is in part rather uniformly disseminated through the sandstone and in part concentrated along bedding planes or in thin zones that cut across bedding. Because these zones form curved or undulant planes, they are called "rolls" by the miners. Where the sandstone was strongly mineralized, as along the favorable bedding planes or along the rolls, the grains of quartz sand have been partly dissolved, resulting in a small decrease in volume of the mineralized sandstone and causing minor "slumping," which is evident where the rolls cut across the bedding at a moderate angle.

Ore bodies are irregularly tabular masses which lie essentially parallel to the sandstone beds, but the ore does not follow the beds in de-

tail. The trend of elongate bodies is indicated by the orientation of the rolls within the ore, and this trend also suggests the probable alignment of any adjacent bodies.

No satisfactory explanation can yet be offered for the origin of these deposits. The ore bodies appear not to have been localized by such geologic structure as fractures or folds, but within limited areas they are restricted to certain stratigraphic zones.

LOUIS McCABE: *Application of a new petrographical method to the study of coal.*

#### 606TH MEETING

The 606th meeting was held at the Cosmos Club, March 25, 1942, President C. S. Ross presiding.

*Program.*—W. C. ALDEN: *Some aspects of the geology of Glacier National Park.*

P. D. TRASK: *Some ideas on the origin of northern California manganese deposits.*

N. W. BASS: *Relationship of crude oil to stratigraphy.*

#### 607TH MEETING

The 607th meeting was held at the Cosmos Club, April 8, 1942, President C. S. Ross presiding.

*Informal communications.*—H. D. MISER spoke on the use of a common geophysical instrument for afternoon field parties.

*Program.*—J. PEOPLES: *Some features of the chromite of the Stillwater Complex, Montana.*

R. E. STEVENS: *Composition of some chromites of the Western Hemisphere.*

T. A. HENDRICKS: *A cold spring manganese deposit in North Dakota.*

#### 608TH MEETING

The 608th meeting was held at the Cosmos Club, April 22, 1942, President C. S. Ross presiding.

*Informal communications.*—H. C. SPICER demonstrated an A. C. microchemical heater.

J. S. WILLIAMS presented lantern slides of an Alaskan glacier surface.

*Program.*—W. M. CADY: *Quicksilver deposits of Sleitmut, Georgetown District, southwestern Alaska.*

G. A. COOPER: *Silicified fossils and their significance.*

D. F. HEWETT: *The Morro da Mina mine, Brazil.*

## 609TH MEETING

The 609th meeting was held at the Cosmos Club, November 11, 1942, President C. S. Ross presiding.

*Program.*—R. W. IMLAY: *Jurassic formations of the Gulf region.*

CHARLES MILTON and JACK MURATA: *The occurrence of Weinschenkite in Virginia.*

L. G. HENBEST: *Sandstone dikes near Salida, Colorado.*

## 610TH MEETING

The 610th meeting was held at the Cosmos Club, November 25, 1942, President C. S. Ross presiding. President Ross announced the death of Dr. HERMAN STABLER, of the U. S. Geological Survey.

*Program.*—MICHAEL FLEISCHER and W. E. RICHMOND: *Mineralogy of the manganese oxides.*

W. S. TWENHOFEL: *A molybdenite deposit in the Glacier Bay area, southeastern Alaska.*

JOHN W. FREY: *Oil in the mind.*

## 611TH MEETING

The 611th meeting was held at the Cosmos Club, December 9, 1942, Vice-President CURRIER presiding.

C. S. Ross presented his presidential address, *Clays and soils in relation to geologic processes*, published in this JOURNAL 33 (8): 225-235. 1943.

## 50TH ANNUAL MEETING

The 50th annual meeting was held at the Cosmos Club after the adjournment of the 611th regular meeting, Vice-President CURRIER presiding. The annual reports of the Secretaries, Treasurer, and Auditing Committee were read and approved.

The results of balloting for officers for the ensuing year were as follows: *President:* HERBERT INSLEY; *Vice-Presidents:* W. H. BRADLEY and GEORGE TUNELL; *Treasurer:* K. J. MURATA; *Secretaries:* J. J. FAHEY and K. E. LOHMAN; *Members at large of the Council:* R. S. CANNON, L. W. CURRIER, M. D. FOSTER, E. N. GODDARD, and E. F. OSBORN; *Nominee as Vice-President of the Washington Academy of Sciences representing the Geological Society:* C. S. ROSS.

MEMORIAL TO MISS OLIVE C. POSTLEY, READ BEFORE THE GEOLOGICAL SOCIETY OF WASHINGTON BY H. D. MISER, MARCH 26, 1941.

OLIVE C. POSTLEY, a member of this Society

for the past 20 years, died at Emergency Hospital in Washington on January 14, 1941. She was born in Washington, the daughter of Dr. Charles E. and Clara M. Postley. She acquired her professional training at George Washington University, where her major subject was geology. Early in life she joined the staff of the Geological Survey as a clerk and devoted herself to varied and responsible duties in that organization. In 1926 she qualified under the Civil Service as junior geologist, and in 1931 was advanced to assistant geologist. She served most efficiently as assistant to the chief geologist for a period of almost 30 years—during the administrations of David White, W. C. Mendenhall, T. W. Stanton, and G. F. Loughlin. Her capacity for accomplishment merited and received continued recognition and advancement.

Miss Postley, besides serving as the chief geologist's assistant, handled personally a great volume of direct and written inquiries to the Survey about the oil, gas, and coal resources and the geology of the United States. She made occasional field studies, chiefly under David White's guidance, in Pennsylvania, West Virginia, and Virginia, and through wide travel elsewhere in the United States acquired much personal knowledge of the geology of the country. Her knowledge of oil and gas is indicated in her publications, which include several papers on the oil and gas geology of the United States, and maps showing the oil and gas fields in Louisiana and Kansas. The Kansas map is unique in that it shows the geologic ages of the producing formations in the fields. It is the first oil and gas map of this type that the Geological Survey has issued. The Survey's recently published oil and gas map of the United States bears Miss Postley's name as a joint author.

In recognition of her work in petroleum geology she was elected in 1926 to membership in the American Association of Petroleum Geologists.

As an individual Miss Postley was vivid and eager, absorbed in the adventure of life, and alert to all that it had to offer. She was instantly responsive to friendliness; her generosity, unselfish and untiring devotion to others, and intense loyalty were among her outstanding characteristics. Her energy and enthusiasm outran her strength and continued to the end—perhaps hastened that end. Thus a great void is left in her personal circle, and the Society has lost an energetic member.

## Obituaries

MARY JANE RATHBUN, an original member of the Academy, died at her home in Washington, D. C., on April 4, 1943, in her eighty-third year. She was born in Buffalo, N. Y., on June 11, 1860. What she knew of zoology she learned largely through her own efforts and powers of observation. Educated in the public schools of Buffalo, where she was graduated from the Central High School in 1880, she majored in English and received a gold medal for excellence in that subject. To her thorough knowledge of the English language she attributed a great deal of her success in later life. This mastery of English is reflected throughout her extensive correspondence with zoologists in this country and abroad and in her many published works.

The first time she ever beheld the ocean was in 1881, when she accompanied her brother Richard, later the director of the U. S. National Museum, to Woods Hole. She often remarked that it truly opened up to her a whole new world, and from that time on she devoted herself largely to studies of marine life.

Her first employment was wholly on a voluntary basis with the old U. S. Fish Commission, with which she spent the summers at Woods Hole from 1881 to 1884, when she was appointed to a clerkship with a very modest stipend. As Spencer F. Baird in those days was both Secretary of the Smithsonian Institution and the head of the Fish Commission, which he founded, it was but a step from one organization to the other. In 1886 Miss Rathbun was appointed copyist in the division of marine invertebrates of the National Museum, where her duties as record-keeper and cataloger brought her into intimate contact with the veritable flood of marine life which descended upon the Museum as the result of the intensive investigations of fisheries and aquatic resources of the United States in which the Commission was pioneering at that time. The beautifully written specimen labels and catalogue entries in her clear, flowing Spencerian hand have never been equaled for clarity and legibility, and today they form the backbone of the records of the division of marine invertebrates. She was one of the first to use that early block-letter type-writing machine known as the Caligraph. The

station data and accession lists of the once famous and still valuable Gloucester Fisheries Donations which she ran off on that machine are still in use.

Very early in her career Miss Rathbun became interested in the decapod Crustacea, and almost without exception they form the subject matter of her 158 published works. The first of these was a study dealing with the genus *Panopeus*, published jointly with Dr. James E. Benedict, her superior officer in the division of marine invertebrates at the time. The last was a monograph of the oxystomatous and allied crabs of America, published by the U. S. National Museum.

Included in her bibliography are a number of truly monumental accounts of marine and fresh-water crabs. The Paris Museum published her treatise on the fresh-water crabs as *Descriptions de nouvelles espèces de crabes d'eau douce appartenant aux collections du Muséum d'Histoire Naturelle de Paris*, Bull. Mus. Hist. Nat. [Paris], no. 2, 1897. The U. S. National Museum issued her four monographic bulletins dealing with marine crabs as follows: *The grapsoid crabs of America*, Bulletin 97, 1918; *The spider crabs of America*, Bulletin 129, 1925; *The cancroid crabs of America*, Bulletin 152, 1930; and *The oxystomatous and allied crabs of America*, Bulletin 166, 1937. Two other notable papers dealt with fossil crabs. The first, on *The fossil stalk-eyed Crustacea of the Pacific slope of North America*, was published as U. S. National Museum Bulletin 138, 1926; and the second was issued as Special Paper No. 2 of the Geological Society of America, entitled *Fossil Crustacea of the Atlantic and Gulf Coastal Plain*, 1935.

In 1916 she received an honorary M.A. from the University of Pittsburgh, and in 1917 her doctorate from the George Washington University.

In 1914 Miss Rathbun relinquished her salary and title as assistant curator in charge of the marine invertebrate collections, in order that the money so saved might be devoted to the hire of an assistant to ease the burden of routine falling to that much understaffed division. She continued her research work, however, as associate in zoology, and in the 25 years that followed before her retirement from

full-time active work in the Museum some 80-odd of her total 158 papers were completed. Such personal sacrifice and devotion to science, and to the institution which gave her her opportunity of pursuing the studies to which she had dedicated her life, are seldom encountered in this world.

During her lifetime Miss Rathbun gave the Museum her extensive carcinological library and at her death bequeathed the Smithsonian Institution \$10,000 to further the work on decapod Crustacea in which she never lost interest and in which many another student became interested because of her works and personal encouragement.

WALDO L. SCHMITT.

With the death of CHARLES SCHUCHERT of Yale on November 20, 1942, geology lost one of its most eminent and most devoted students. Professor Schuchert was born on July 3, 1858, in Cincinnati, Ohio, where he lived for about one-third of his long life. He was educated in the public schools there but never had the advantages of a university education. Like several other noted geologists from Cincinnati, Schuchert became interested in the geology and fossils for which that region is noted. His leisure and spare time from his trade of cabinet making were spent in collecting and studying these fossils. The Schuchert collection of brachiopods attracted the attention of Prof. James Hall, of Albany, N. Y., who invited Schuchert, then 30 years old, to become his assistant. In Albany Schuchert came under the influence of J. M. Clarke and C. E. Beecher, and under these incomparable mentors his education in paleontology was completed.

After leaving the influence of the great Albany school, Schuchert started his practice of paleontology and geology with the Minnesota Geological Survey. Then he became assistant to C. E. Beecher at Yale for one year. From Yale he went to the U. S. Geological Survey for a short term and in 1894 became assistant curator of paleontology at the U. S. National Museum. There he served for ten years, leaving in 1904 to become professor of historical geology and curator of geology of Peabody Museum at Yale on the death of C. E. Beecher. In these capacities he served until 1923, when he relinquished the curatorship at the Museum. In 1926 he became pro-

fessor emeritus and retained this title until his death in 1942.

At Yale Schuchert taught many graduate students and carried on numerous researches in paleontology and historical geology. His most important contributions to the latter are contained in his writings on paleogeography and paleoclimatology which he, more than anyone else, has made into a fascinating story. In paleontology Schuchert made contributions to our knowledge of many groups of fossils. His first love among the invertebrates was the brachiopods, and he devoted much time and considerable money to accumulating the fine Schuchert collection of brachiopods now at Yale. In stratigraphy he made contributions to our knowledge of the Devonian and Silurian periods, but in later years his interest turned to the Permian period. He died a few weeks before the appearance of the second volume of his ambitious *Historical Geology of North America*.

Schuchert served geology and Yale with single-minded devotion. As he once expressed it to the writer, he "married the science" and gave his whole life and much of his wealth to the welfare of his abstract mate. Having no immediate family with its drain on his time and pocketbook, Schuchert devoted himself to research, writing, and collecting. His salary and revenue from books were largely spent on geology and the field work of many deserving graduate students. His writings include more than 200 titles covering stratigraphy, paleontology, historical geology texts, and biographical sketches and memoirs.

Professor Schuchert was very generous and encouraging to the young men. In his later years his mellow philosophy and kindly interest strengthened and comforted many struggling students. Schuchert will long be revered for these qualities as well as for his devotion to geology, a devotion that helped him surmount the difficulties of early poverty and lack of training and led him to the foremost professorship of historical geology.

Professor Schuchert received many honors: the Hayden and Thompson Gold Medals of the National Academy and the Penrose Medal of the Geological Society of America. He received an LL.D. degree from New York University (1914) and the honorary Sc.D. from Yale (1930) and Harvard (1935).

G. A. COOPER.



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No. 12

# JOURNAL

OF THE

# WASHINGTON ACADEMY OF SCIENCES



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# JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

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ENTOMOLOGY.—*Insect taxonomy and principles of speciation.*<sup>1</sup> J. MANSON  
VALENTINE, Bureau of Entomology and Plant Quarantine.

Probably no taxonomic science has been built upon so many conflicting systems and standards as has entomology. There are three apparent reasons for this heterogeneity—the tremendous scope of the science, its long history, and the diversity of approach of its many contributors. Furthermore, during the past few decades it seems to have suffered an era of isolation during which it attained a high degree of specialization and artificiality. The effort to standardize in terms of simple “generic” and “specific” characters, usable in keys, has resulted in great confusion and has considerably obscured the evolutionary picture. Nature, deeply subtle, can not reveal itself fully when examined piecemeal, each part dissected from the whole; and a collection of organisms so classified is therefore apt to reflect merely an arbitrary system in the mind of the worker, and to contribute little toward a comprehension of evolutionary phenomena.

Some of the early naturalists, such as Thomas Say and John L. LeConte, unhampered by conventionalities that have arisen since their time, seem to have had almost an intuitive approach to problems of speciation. Knowingly or not, they worked as if impressed by the more or less qualitative characteristics distinguishing reproductively insulated populations—the true test of specific integrity. They used their judgment and rarely did they commit a serious error. Contrast their relatively sound work with that of turn-of-the-century nomenclators, whose deductive, conventional taxonomy often led to such extremes as the attachment of multitudes of specific names to individual variations and anoma-

lies, worn and bleached specimens, vague geographic races, stages of maturity, and, not infrequently, to the sexes of the same species.

Of recent years, systematic workers have begun to treat insects more as complex, living organisms. They have found it better science to study a relatively few species exhaustively than a large number of miscellaneous species superficially. There has thus accumulated enough evidence in entomology alone to place the species principle on a firm basis of fact, and some hope now dawns that the naming and arranging of insects will reflect the biological forces under which they have evolved. This practice, continued, will tend to produce a simple, flexible taxonomy—one that may eventually bring a gratifying degree of order to a subject now in considerable chaos.

In simplest terms, the species may be defined as a unit population of genetically similar though sometimes outwardly variable organisms that will interbreed freely in their natural habitat. No barrier due to internal factors operates to prevent normal individuals from reproducing. In other words, the species is a clan whose members are compatible psychologically, physiologically, and morphologically. When closely related species of this ideal type are not isolated by spatial or temporal limitations, they are *insulated* from one another as a result of the operation of internal specific systems (“mechanisms”), which may be classified as follows:

1. *Anatomical insulation.* The lock-and-key-like, sclerotized genitalic structures of both sexes, often extremely complex and usually characteristic of the species, tend to restrict successful insemination to within the species.

<sup>1</sup> Received September 25, 1943.

2. *Physiological insulation.* Egg-sperm specificity, i.e., incompatibility between the sexual products of two species as exhibited in resistance to cross fertilization, in abnormality of development, in disturbances of fertility of offspring, etc.

3. *Ethological (behavioristic) insulation.* Specific selectivity, i.e., reluctance under natural conditions to engage in interspecific mating. This may be extended to include ostracism and isolationism of hybrids and anomalies.

The first is hypothetical but doubtless operates to a greater or lesser extent in insects; the second is a possibility that lacks experimental proof in insects; the third, however, is a demonstrable fact not only in insects but in other groups of animals as well. Related species of migratory ducks, for example, traveling in mixed company during the mating period, preserve perfectly their specific integrity in spite of occasional crossing, whereas the same species will hybridize much more freely in confinement. A similar phenomenon occurs in ungulate, carnivorous, and primate mammals. Indeed, it may be said of all closely related and associated species that a most important segregating factor, and perhaps often the *chief* one, is preferential selectivity. This amounts to habitual or instinctive reluctance on the part of an individual to accept for a mate any other individual, presumably of another species, presenting sexual stimuli other than those to which the first has been conditioned. That this specific conditioning can be artificially overcome, at least in the higher vertebrates, has been adequately demonstrated, and there is little reason to doubt that, in like manner, ethological (social) interspecific avoidances between related and associated species of insects will also tend to dissolve as a result of selective confinement under laboratory conditions.

From a general survey over the whole compass of speciation, beginning with minor, local variants and culminating with very distinctive aberrant species (many monobasic genera), it is at once obvious that the gradient is not a simple, gradual one but is beset with numerous plateaus and peaks that represent categories into which various kinds of "species" may be roughly

classified. Further analysis reveals a rather distinct split of the entire picture into two curves, which are more or less superimposed at their bases. The object of the present paper is to compare these two major categories in their purest form in an effort to detect a possible fundamental, causal difference that might justify a clear-cut taxonomic interpretation.

In groups of plastic organisms exhibiting an abundance of valid species, it is a common phenomenon to find the most similar forms (perhaps those of most recent origin) living in closest ecological proximity. This is well illustrated in the Coleoptera, where species closest of kin very often live in intimate association, providing evidence that environmental segregation in these cases may be virtually ruled out as a functional isolating mechanism. Very similar and apparently congenetic species of Carabidae, for example, commonly share the same micro-habitats, nor is there any reason to believe that in most instances their respective breeding seasons do not at least overlap. Two and even three species of cave beetles (*Pseudanophthalmus*), showing extremely close affinity yet representing unquestionably distinct forms, repeatedly have been taken running together in the same cave or cave system in which they are localized. To cite another example, out of an almost inexhaustible field, certain species of archaic, flightless weevils (*Proterhinus*) in the Hawaiian Islands are proximate not only in kinship but in habits as well, being found together on identical host plants. Very closely related but discrete species not infrequently occur in pairs and occupy the same macro- and micro-ranges. Familiar examples among the carabids are *Calosoma scrutator* (F.) and *C. willcoxi* LeC., *Scarites subterraneus* F. and *S. substriatus* Hald., and *Galerita janus* F. and *G. bicolor* Drury.

Such species automatically receive the acid test of integrity since, in the natural state, they habitually refuse to cross with their related associates although there is no apparent lack of opportunity. The separating factor appears to be essentially an internal one—a specific "awareness" or recognition of kind. Furthermore, the phenomenon is suggestive of an intrapopulation

origin of an important class of species which may owe their existence, in large measure, to self-restricting conditionings, sexual and social, within the morphological (mutational?) range of the population. Indeed, it can be maintained that speciation of this type is fundamentally psychophysiological. At least, when once it is started there is no reason to suppose that it can not be sustained by autoselectivity over and above any help from anatomical incompatibilities that may have arisen during the course of speciation. Although the first-stage products are not always easy to distinguish taxonomically, careful study usually reveals separating characters that are multiple and localized rather than generalized, constant rather than fluctuating, and qualitative rather than quantitative. Oftener than not, drastic changes in male genitalia, of a higher order than the usual variations in this plastic structure, give the clue to such specific dichotomy.

Unfortunately, there is a current tendency on the part of biologists to treat genitalic barriers merely as another "isolating mechanism" on a par with environmental segregation. Perhaps it would be well to bear in mind that these distinctive anatomic features are, after all, part of the speciation phenomenon itself. It is confusing, if not illogical, to accept the results of a biological process as their own initial cause. To clarify the problem one must proceed further with the analysis. Although the genitalic dissimilarities that tend to insulate related forms may contribute to the "purification" of a species, they should, in the writer's opinion, be viewed also as part of the consequences of a far more intrinsic and complex biogenic process with roots deep in the behavioristic psychology and sexual interactions of organisms. Perhaps it is not too extreme a view to hold that true speciation, a phenomenon not encountered in the intricate divergences of parthenogenetic forms, or in the plastic instability of asexually reproducing lower organisms, is essentially correlated with sex. More completely, it is the liberation of discrete morphological momenta, which are to some extent sustained and directed by the attractions, aversions, and compatibilities of organisms, but

on which these psychophysiological momenta or conditionings are to the same degree dependent.

In antithetic contrast to associative speciation is dissociative raiation, the products of which are customarily (but very possibly inaccurately) termed "subspecies." Typical raiation, as has often been pointed out, is the effect on a species of an external factor—environmental segregation. This operates principally to circumscribe specialized adaptive salients and to establish genetic strains much as would selection. The segregating agency, always circumstantial, is usually secular (geographical, ecological, or temporal), though occasionally it is biological, as in the case of parthenogenetic forms whose various lines become isolated by virtue of their inability to cross. The ideal picture of raiation is one in which autoselectivity is notably absent, the local populations, or races, hybridizing freely where ranges overlap. They differ from true species in that they tend to exhibit distinguishing characters that are relatively superficial, generalized, quantitative and fluctuating. Even when, in extreme raiation, the changes taking place may pervade the entire facies to such an extent as to appear of qualitative value, they may usually be interpreted as alterations in degree rather than in kind, since no new character is ordinarily involved. Assuming, as seems permissible from the available evidence in Coleoptera, that totally different factors enter into the origin of associative species and dissociative races, it is not unreasonable to suppose that the observable differences between the two categories reflect on the one hand the relatively internal nature of the speciating "drives" in contrast to the relatively external mechanism of raiation on the other.

The two processes, though dissimilar in principle, are not, however, mutually exclusive, and long-continued isolation of sister colonies might conceivably result in potential speciocentrism demonstrable as refusal to cross when the opportunity arrives. It is true that in cases of discontinuous geographical raiation, and of raiation due to abrupt adaptation to environmental differences, populations sometimes exhibit such conspicuous departure from ancestral type

as to render their specific or racial status a matter of considerable question. The taxonomic problems that thus arise are admittedly often very difficult; but in the writer's experience indecision is due oftener to an inadequate knowledge of the species in its entirety than to the unavailability of valid evidence.

In the Caraboidea, geographically discontinuous or "spotty" distribution of a species is the exception rather than the rule, discounting, of course, the clearly obligatory type of segregation such as that imposed by insular, mountain-top, and cave life. Nor does the condition involving obligatory segregation necessarily correlate with increased taxonomic confusion. In cavernicolous faunas, for instance, it is surprising how trivial are the observable differences between colonies of widely ranging species of cave beetles (*Pseudanophthalmus*) isolated in individual caves over a subterranean system scores or even hundreds of miles in extent—a phenomenon in distinct contrast to the unmistakable, nonoverlapping distinctions between related species in the same cave. It is more than likely that most of these populations have had an extremely long history of isolation; yet a recent survey of the genus has shown that there are remarkably few forms that can not immediately be assigned either specific or racial rank.

Products of mountain-top isolation often exhibit similar conservatism. The following is a typical example: *Steniridia aeneicollis* (Beutenmüller) and *S. tricarinata* Casey are very closely related "species" of an ancient stock of cychrine carabids endemic to the Appalachian region south of glaciation. These two forms are at present restricted to the forests above an altitude of about 4,000 feet, respectively, in the Black and Pisgah-Balsam-Smoky Mountain Ranges of North Carolina and Tennessee. In their consistent and distinct differences, and in their inability or unwillingness to traverse the extensive surrounding valleys, they stand out as conspicuous isolation products in an otherwise itinerant group containing five clear-cut species whose comparatively wide ranges broadly overlap. At least two of these species ascend the mountains sufficiently

high to live in association with the two summit-dwelling relicts. If we consider the latter as a single species, the characters that separate all six are trenchant and multiple, involving drastic genitalic and tarsal modifications; whereas the relicts differ one from the other only quantitatively, in minor changes of contour, development of the interstitial costae, and suppression of sclerotization in the transfer apparatus of the male copulatory organ. They represent a distinctly lower order of mutual divergence than do their associated relatives of higher rank, despite the probability that these extreme orophilic forms have had the long-time "advantage" of complete isolation from each other.

Insular races often seem to be stabilized by a similar evolutionary inertia. An experiment performed by the writer illustrates this rather clearly. A tiger beetle, *Cicindela vitiensis* Blanchard, inhabiting the larger Fiji Islands, is both abundant and ubiquitous throughout its range. Each large island and each of a variety of overlapping ecological frames furnishes its distinctive race or subrace. For many years *vitiensis* has been considered the only tiger beetle in Fiji. Not long ago, however, the writer discovered a local, mountain-dwelling colony of another cicindelid living in intimate association with *vitiensis* but apparently not hybridizing with it. The new form exhibits qualitative specializations of characters present in *vitiensis* that establish without doubt its status as a distinct species as well as its probable origin from *vitiensis*. Interspecific copulation tests under laboratory conditions gave the following results: With equal numbers of each sex of both species present, out of 38 matings observed, only 3 were interspecific. The latter were abortive, recognition apparently causing premature separation. Psychological insulation of this order coupled with probable physiological and morphological barriers could easily account for the genetic preservation of the species, while the fact that specific selectivity in mating was not found to be absolute merely confirms the closeness of the relationship. These data contrast strikingly with those resulting from a similar experiment in which two geographic races of *vitiensis*, differing

quantitatively chiefly in respect to color pattern, were brought together—the *Viti-levu* race (*vitiensis* s. str.) used in the above tests, and another (*v. imperfecta* Horn) inhabiting the island of Taveuni 100 miles distant. Out of 121 matings observed in cages containing equal numbers of both sexes of the two races, 59, or almost exactly half, were interracial.

It may well be that raiation under certain circumstances, such as at the extremes of extensive, divergent clines, can proceed to the point of potential insulation tantamount to speciation. Indeed, there is some evidence to this effect; yet the basic concept of speciation through biogenic discontinuity is not invalidated thereby. Fulfillment of the species standard would still depend, in the last analysis, upon the natural association of diverging groups and the spontaneous building up of an internal block between them. All the indications are that, if there is a potential split, interracial aversions must actuate the final disunity and determine its permanence. One would therefore expect speciation by raiation to be, at most, atypical, since isolation, the one factor most responsible for raiation, precludes association, the one condition essential to a true test of speciation. For example, the most distinctive races of caraboids, and consequently those most likely to establish species, occupy relatively restricted ranges, to which they are often secured by adaptive and sedentary instinct, or confined by actual physical barriers. Although negative, evidence arising from this relationship militates strongly against a total explanation of speciation in terms of raiation. On the other hand, gradual eradication of ecological and geographic obstacles over considerable geologic time, followed by colonization of available areas, could and probably has played an important part in the union of isolated races; but there seems to be no more evidence that races thus thrown together will take a specific stand than there is that they will cross. Field data from various sources, including vertebrate as well as invertebrate groups, have shown both to be possibilities. Probably significant, however, is the relative scarcity of observed instances of insulation between merging races in con-

trast to the abundance of cases illustrative of closely related and associated species exhibiting little or no indication of raiation, past or present. It is therefore difficult to escape the conclusion that intolerance of the unfamiliar, regardless of mode of origin or apparent tangibility of the departure, is a more fundamental factor in true speciation than isolation, which does not necessarily contribute to the establishment of distinctions appreciable to the organism.

Radical speciation apparently resulting from ancient and complete isolation may, in some cases, be interpreted as the survival of the more specialized of two or more congenetic and possibly competing species. It does not seem necessary, however, to assume extinction of the more conservative, ancestral forms to account for drastically distinct endemics, since it is well known that species confined to small areas, particularly to small islands, often fail to meet the usual specific standards of consistency established by free-ranging continental forms. Their variability, or "fluidity," may be a direct result of a sedentary life, or it may be due to the entrapment of genetic strains, or to both, but whatever the origin such a plastic potential must function as the ideal set-up for divergent speciation of the true associative type involving not only the new products but the more conservative progenitors as well. In the Carabidae, at least, endemic faunas of circumscribed ranges are largely made up either of obvious races or of compact groups of many species. The much rarer instances of single species occupying isolated ranges usually fall into the category of geologically antique, aberrant residua of one-time flourishing evolutionary tangents.

In summary, the results of an analysis of the species problem as presented by studies in various groups of the Caraboidea indicate that speciation may be defined as relatively complete morphogenic (mutational?) departure sanctioned and channeled by psychophysiological conditioning; and that raiation, a process involving environmental closeting, is the establishment of genetic lines, adaptive or fortuitous, that are essentially superficial and devoid of internal, insulating organization. The two do

not appear mutually dependent, nor are they mutually exclusive. Whether raiation attains the species level depends upon the synchronous introduction of antipathetic responses between two or more merging races formerly spatially remote, an event that certainly is possible but, supported as it is by very few factual data, is probably atypical. Whether or not the species level is maintained depends largely upon the degree of fixation of an internal "awareness" whose sporadic involution in related associates may cause occasional anastomoses in the dichotomous tree of normally repellent, discrete evolution. Endless shifting circumstances, such as bring about sequestration, changing habits and locale, introduction of new faunistic elements, adoption of the parthenogenetic method of reproduction, etc., may mask the history of a species, its origin, deployment, and restriction, but so indelible is the nucleus of specific character that the relatively minor alterations due to change of life seldom, if ever, succeed in eradicating the stamp beyond recognition. All things considered, it is probably not too extreme a view to hold that sexual reproduction, together with at least initial association of divergent elements, is a *sine qua non* of the actual process of true speciation.

From the foregoing, two fundamental evolutionary principles suggest themselves: (1) True species may not be essentially dependent upon isolation for their origin; (2) secular isolation, though correlated with

differentiation, may not by itself be a primary speciating factor. Speciation often appears to be the spontaneous introduction of new, self-insulating units within a parent-species population; it is the end product of self-augmenting, biogenic momenta involving the organism in its entirety. Typical raiation, on the other hand, is the effect on the species of group segregation, a factor imposed from without and operating disinterestedly in much the same manner as natural selection. To evaluate the mixed products of these two processes is the chief concern of taxonomy, a science whose complexity increases with the plasticity, youth, and colonizing drive of the group under consideration.

The scope of entomological taxonomy is so vast that the experimental approach to all its problems is out of the question. However, if good judgment based on carefully studied models takes the place of indiscriminate key-character hunting, great strides can be expected toward a system that will reflect evolution. A supposed new species should in every instance be subjected to a critical analysis, both as to the nature of its distinctions and as to the spatial relationships existing between it and its nearest allies. If these criteria were universally applied, systematics would gain immeasurably in significance, for it would then portray evolution in such a manner as to bring out not merely degrees of differences but *kinds* of differences as well.

GEOLOGY.—*The paleontology and stratigraphy of the upper Martinsburg formation of Massanutten Mountain, Virginia.*<sup>1</sup> MARK H. SECRIST and WILLIAM R. EVITT, The Johns Hopkins University. (Communicated by E. W. BERRY.)

During the course of field work on Silurian stratigraphy, Dr. Charles K. Swartz found what at first was thought to be a new species of the gastropod *Lophospira* in the upper part of the Ordovician Martinsburg formation in the Massanutten Mountain region of Virginia. In order to determine the significance of this fossil, Dr. Swartz approached the senior author, who has been engaged for some years in a study of the general problems concerning the stratigraphy and fauna of the Martinsburg, assisted,

since the summer of 1941, by the junior author. As a result of this inquiry, a study was made not only of the section in which Dr. Swartz found the gastropod in question but also of another section somewhat farther south. The material collected has yielded ten new species of gastropods, pelecypods, and brachiopods. It has become evident that both the fauna and the lithology of the upper Martinsburg in these eastern sections indicate conditions different from those represented by the upper Martinsburg farther to the west and south.

<sup>1</sup> Received July 12, 1943.

Studies of intermediate regions are not sufficiently advanced to allow correlations between eastern and western areas to be included in this paper. We shall limit ourselves to a description of the new species and a statement of the evidence and conditions as they exist in the field and shall make definite correlations only between the two sections investigated in Massanutten Mountain.

*Location and extent.*—The area covered in this report lies in the Massanutten Mountain region of the Appalachian Valley Province of Virginia. This mountain is a large monadnock that projects from the floor of the Shenandoah Valley and extends about 50 miles in a northeast-southwest direction. The mountain itself is double, composed of two roughly parallel ridges, which are the limbs of a synclinal fold in the Paleozoic rocks, the more resistant formations of which have withstood to a greater degree the processes of erosion that have leveled the less resistant early Paleozoic limestones to form the broad, flat floor of the valley. The mountain divides this valley into a western part and an eastern part, which are occupied, respectively, by the North and South Forks of the Shenandoah River. New Market Gap, in Shenandoah and Page Counties, is the only large gap that cuts across the mountain, though several smaller gaps offer passage for unimproved country roads.

The outcrops studied occur in two localities: (1) along the road near the northern end of Passage Creek Valley in Warren County, extending for a distance of 710 feet (road distance) northward from the contact with the overlying Massanutten sandstone; and (2) about 40 miles to the south, along the Catharine Furnace Road on the north side of Cub Run in Page County, extending eastward 1,350 feet (road distance) from the contact with the Massanutten sandstone. Passage Creek drains the minor valley between the two ridges of Massanutten Mountain, having its headwaters north of New Market Gap. It flows northeastward and empties into the North Fork of the Shenandoah River east of Waterlick, just beyond the northern end of the mountain. Cub Run is a small stream flowing northward and

eastward into the South Fork of the Shenandoah River a few miles south of Newport in Page County.

*Underlying formation.*—The Martinsburg formation, where observed in the Massanutten region, is underlain conformably by the Chambersburg limestone. In this section of Virginia we have recognized four lithologic divisions of the latter: (1) comparatively massive, impure limestone with several thin beds of bentonite near the base; (2) nodular, thin-bedded, argillaceous limestone; (3) a zone of blue limestone in beds 12 to 18 inches thick separated by thin beds of shale; followed gradationally by (4) the upper part of the formation, which, in the unweathered state, consists of compact, medium-bedded, impure limestone with numerous clay partings causing it to weather into thin sheetlike layers. The transition from this last zone into buff-weathering, preponderantly argillaceous lower Martinsburg is relatively abrupt. Zones (1) and (4) are well exposed at Cub Run, though at Passage Creek the entire Chambersburg formation is concealed. However, a complete section of the formation is exposed along Tumbling Run on the Lee Highway 2 miles southwest of Strasburg and about 5 miles west of Passage Creek.

*Overlying formation.*—The contact of the Martinsburg and the overlying Massanutten sandstone was not observed, but the concealed interval in which it occurs at both places amounts to only a few feet. The Massanutten formation is a massively bedded, white to gray sandstone and quartzite, conspicuously cross-bedded and very resistant, causing it to form prominent cliffs whose talus slopes invariably conceal the contact with the underlying Martinsburg. At Cub Run conglomerate beds with pebbles an inch or more in diameter are common. At Passage Creek the average grain size is much smaller. The contrast in the lithology of the two formations is everywhere a striking feature.

*Regional and structural relationships.*—A broad picture of the Martinsburg in the entire Massanutten Mountain area indicates that the upper part has experienced very little change, though the middle and lower portions have suffered both structural and

lithologic modification in the northern, northeastern, and western parts of the region. In the Cub Run section, on the contrary, very little alteration or deformation is evidenced.

An accurate determination of the thickness of the Martinsburg in the Massanutten region is impractical (see Butts, 1933, p. 21). Our measurements of sections farther west and south at Monterey Mountain, Catawba Mountain, Narrows, and McCalls Gap, for example, give thicknesses ranging from 1,400 to 2,200 feet. As a result of general field observations, we think the apparently much greater thickness in the Massanutten Mountain region is due to structural readjustments within the formation as visibly expressed by folding, faulting, and lithologic deformation.

*Lithologic description of the Martinsburg formation.*—In the Massanutten area, the Martinsburg formation is not exposed sufficiently for continuous investigation. At Passage Creek outcrops suitable for stratigraphic and faunal studies are restricted to the upper part of the formation. The lower part, where exposed, shows the results of structural and lithologic deformation. At Cub Run exposures are continuous from the massive Massanutten sandstone through the arenaceous upper Martinsburg and well down into the argillaceous middle portion, below which they are intermittent and of irregular extent into the underlying Chambersburg limestone. The following description is based largely upon the Cub Run section:

The gradation from the argillaceous limestone of the upper Chambersburg into the calcareous shale of the lower Martinsburg is fairly rapid. Weathering of the calcareous material results in a yellow to tan or buff color that is typical of the lower and middle portions of the formation. Ascending, the beds become increasingly argillaceous with the advent of arenaceous material in the middle portion. Toward the upper part of the latter, sandstone beds for the first time become prominently abundant. The gradation from the middle portion into the upper is marked lithologically by a change from dominantly argillaceous to dominantly arenaceous beds (Bassler, 1919, p. 156).

Corresponding to this lithologic change occurs the faunal change described below.

As shown in the measured sections, the upper portion, characterized by an essentially Maysville fauna, consists mostly of brown, iron-stained, fine-grained sandstone beds of variable thickness with some shaly partings. Cross-bedding is rather general, especially toward the top. Much of the sandstone contains flakes of mica and hematite and flat inclusions of slaty shale up to an inch in size. In addition, being somewhat arkosic in nature, it has a speckled appearance.

*Faunal description of the Martinsburg formation.*—Investigators of these rocks have recognized a threefold faunal division, namely, (1) an essentially Trenton fauna in the lower part, (2) an Eden fauna in the middle part, and (3) a Maysville fauna in the upper part. Thorough investigations have been made in the classic Cincinnati area where the terms "Eden" and "Maysville" have become well established through long usage. In the Cincinnati area, the Trenton is recognized as a well-defined time and lithologic unit. As these formations are followed eastward, the distinctions between the Trenton and the Cincinnati, on the one hand, and between the members of the Cincinnati, on the other, become less marked. In large measure the three lose their individualities and more or less combine into a whole which is known to the east as the Martinsburg formation. Our studies in the western and southern parts of the Appalachian Province of Virginia and extending northward into Pennsylvania show that, on both lithologic and faunal grounds, several divisions of the Martinsburg exist, for which, tentatively, we are using the three classic terms "Trenton," "Eden," and "Maysville" (Bassler, 1919, p. 163), pending the results of more complete study.

Inasmuch as the purpose of this investigation was to establish the relationships and significance of the upper Martinsburg, a detailed study was not made of the middle and lower portions in the Massanutten region. At Passage Creek only the upper or Maysville part of the formation is available for study. At Cub Run, on the other hand, both the upper and a considerable thickness of

the middle or Eden portions are well exposed.

The following fossils, all well-recognized Eden representatives (Bassler, 1919, p. 169), establish the identity of the Eden portion at Cub Run: *Aspidopora* cf. *A. newberryi* (Nicholson), *Pholidops cincinnatiensis* Hall, *Sowerbyella sericeus* (Sowerby) var., *Hormotoma gracilis* (Hall), *Cryptolithus tessellatus* Green, and *Ceratopsis chambersi* Miller.

On the other hand, the Maysville at both Passage Creek and Cub Run is recognized not so much by individual species as by a general faunal assemblage (Bassler, 1919, p. 170), which includes species of the following:

**BRACHIOPODS:** *Dalmanella*, *Lingula*, *Orthorhynchula*, *Plectorthis*, *Rafinesquina*, *Zygospira*. **PELECYPODS:** *Byssonychia*, *Colpomya*, *Ctenodonta*, *Cuneamya*, *Cymatonota*, *Cyrtodonta*, *Ischyrodonta*, *Orthodesma*, *Pterinea*, *Rhytimya*, *Whitella*. **GASTROPODS:** *Liospira*, *Lophospira*, *Oxydiscus*. **CEPHALOPODS:** *Paractinoceras*, *Spyroceras*. **TRILOBITES:** *Calymene*, *Isotelus*. **OSTRACOD:** *Drepanella*.

In contrast to the Maysville of our western sections, there is evidence of only one distinct faunal zone at Passage Creek and Cub Run. Because of its excellent development at the former locality, we have called it the Passage Creek Zone. This zone, at both localities, may be recognized readily by the presence of several abundantly fossiliferous and conspicuously iron-stained horizons, which weather into a porous condition. In the foregoing fossil list of Maysville forms, the only genera that have not been found in the Passage Creek Zone are *Lingula* and *Oxydiscus*.

Very few and scattered fossils were found in the increasingly arenaceous beds of the upper portion above the Passage Creek Zone. Among these are the following: *Buthotrephis* cf. *flexuosa* Hall, *Palaeophycus* sp., *Lingula* sp.

The upper 96 feet of the exposed section at Cub Run have produced no fossils.

*Discussion.*—The Eden at Cub Run is comparable in lithology and fauna to the shaly Eden of the western sections. The general fossil representation in the Maysville, however, is meager; pelecypods and

gastropods predominate with a relative scarcity of brachiopods and trilobites in contrast to their abundance in the argillaceous and calcareous material of comparable age farther west. The following, which are associated with the Maysville elsewhere, were not found at either of the Massanutten localities: *Platystrophia* sp., *Hebertella* sp., abundant Bryozoa, phosphatic masses (Butts, 1940, p. 208).

According to Butts (1933, p. 22), the Maysville is characterized "by the profuse and universal occurrence at the very top of *Orthorhynchula linneyi*." Bassler (1919, pp. 168, 170), in contrast, states: "This *Ortho-*

CUB RUN SECTION

Thickness			Description
Total	Interval	Horizon	
—	—	242.1	Contact with Massanutten sandstone.
242.1	95.3	—	Barren, massively bedded sandstone, rust-stained and prominently jointed.
—	—	146.8	Highest bed containing plant remains.
—	—	129.2	<i>Lingula</i> cf. <i>L. nickelsi</i> Bassler.
146.8	36.9	—	Moderately cross-bedded, medium to fine-grained sandstone.
—	—	109.9	Highest gastropod ( <i>Lophospira</i> sp. indet.).
—	—	90.7	Highest abundantly fossiliferous bed, 2 to 3 inches thick: argillaceous sandstone, weathering reddish brown ( <i>Colpomya faba</i> cf. <i>C. pucilla</i> Foerster).
109.9	49.6	—	Shale beds becoming less frequent and thinner. Sandstone generally lighter in color. Cross-bedding more evident.
—	—	60.3	Highest Passage Creek fauna bed.
60.3	17.0	—	Passage Creek Zone consists of fossiliferous, rotten, rusty-brown lenses in and between heavier sandstone beds. <i>Lophospira</i> , <i>Rafinesquina</i> , and <i>Paractinoceras</i> abundant.
—	—	43.3	Lowest Passage Creek fauna bed.
43.3	11.0	—	Heavy sandstone beds: very little shale.
—	—	32.3	Very prominent spheroidal weathering in sandstone beds.
32.3	7.3	—	Heavy sandstone beds with shaly partings.
—	—	25.0	Lowest pelecypod bed ( <i>Whitella massanuttenensis</i> , n. sp., and <i>W. nasuta</i> , n. sp., abundant).
25.0	15.7	—	Increase in thickness of sandstone beds. No fossils observed.
—	—	9.3	Highest typical Eden fauna, containing <i>Cryptolithus</i> , <i>Sowerbyella</i> , <i>Cornulites</i> .
9.3	9.3	—	A lithologic transition zone marked by an increase in sandstone.
0.0	0.0	0.0	Below this horizon is typical Eden lithology consisting of alternating light and dark beds of sandstone and shale, breaking into small, platy fragments. Eden thickness undetermined.

## PASSAGE CREEK SECTION

Total	Thickness		Description
	Interval	Horizon	
—	—	163.3	Lowest Massanutten sandstone outcrop taken as contact.
163.3	55.4	—	Entirely concealed, largely covered with Massanutten sandstone float.
—	—	107.9	Spring enclosure on west side of road containing highest Martinsburg outcrop.
107.9	12.9	—	Largely concealed, with a few scattered outcrops. Barren, fine-grained sandstone breaking into flat joint blocks.
—	—	95.0	Last fossils observed.
95.0	11.0	—	More or less massively bedded, fine-grained sandstone with a few thin beds containing Passage Creek assemblage.
84.0	8.0	—	Massive, fine-grained, gray to brown sandstone.
—	—	80.0	Extremely prolific 6-inch porous bed in which <i>Lophospira</i> is very abundant.
—	—	78.5	Very conspicuous porous bed.
76.0	6.0	—	A few thin porous beds with <i>Lophospira</i> abundant.
7.00	6.0	—	Massive sandstone with hematite particles and a few scattered <i>Rafinesquina</i> and pelecypods. Rusty weathering prominent.
64.0	10.0	—	Typical Passage Creek lithologic and faunal zone, containing frequent fossiliferous beds of variable thickness and extent, with <i>Paractinoceras</i> , then <i>Lophospira</i> , and then <i>Rafinesquina</i> conspicuous in ascending order.
—	—	54.0	At road level, beginning of more or less continuous exposures. Arkosic, fine-grained sandstone, thinly laminated throughout, weathering into blocky beds, speckled with hematite.
54.0	54.0	—	Concealed.
0.0	0.0	0.0	Lowest Martinsburg outcrop consisting of brown fine-grained sandstone beds, somewhat arkosic, weathering rusty. <i>Rafinesquina alternata mediotineata</i> , n. var., abundant; also <i>Dalmanella</i> sp.

*rhynchula* bed everywhere marks the dividing line between the Lower Maysville (Fairview) and the Upper Maysville (McMillan) divisions, the latter in the Appalachian region being an unfossiliferous, gray sandstone apparently of continental origin and equivalent to the Oswego sandstone of the New York section." In sections already examined elsewhere in the Appalachian region, we have found this *Orthorhynchula* zone usually well developed near the top of the formation (Bassler, 1919, p. 160). In the Massanutten region—specifi-

cally, in the Passage Creek section—one depauperate specimen of *O. linneyi* (James) was found. This occurred in the lower part of the Passage Creek Zone, which at the type locality is 106 feet, and at Cub Run about 200 feet, below the top of the Martinsburg.

This paucity of characteristic Maysville forms suggests striking differences in conditions of both environment and deposition between this area and those farther west.

Butts (1940, p. 202) reports the lack of other formations between the Martinsburg and the Massanutten in this region, and we have found neither Juniata nor Oswego beds as such in either of our sections. However, close examination of the Martinsburg of Little North Mountain, which lies between the western sections and Massanutten Mountain, may indicate whether the barren, somewhat cross-bedded, ferruginous sandstone beds lying above the fossiliferous part of the Passage Creek Zone are Martinsburg (Maysville) in age or are to be correlated with either the Oswego or the Juniata, or both, since these latter formations occur on Little North Mountain (Butts and Edmundson, 1939, p. 169). It is evident that the intermittent development of these intervening formations is a problem of such large scope that it is beyond the province of this paper to do more than note their apparent omission in the Massanutten syncline (Butts and Edmundson, 1939, p. 179).

In the two sections under discussion, variations in the lithology of the comparatively barren strata above the Passage Creek Zone suggest the possibility that they may have accumulated under deltaic conditions (Bassler, 1919, p. 161) with the source of the material closer to Cub Run than to Passage Creek. As evidence supporting this theory, the following observations are presented:

1. At Passage Creek the measured thickness of this zone is 68 feet, while at Cub Run it is almost three times as great, being 182 feet.

2. The sandstone beds contain scattered plant remains but no marine fossils.

3. As stated above, there is a striking absence of characteristic Maysville forms.

4. The material at Cub Run is more consistently arenaceous in character than that at Passage Creek.

5. There is a stronger development of cross-bedding at Cub Run than at Passage Creek.

6. At Cub Run the basal Massanutten is somewhat conglomeratic.

#### DESCRIPTION OF SPECIES

##### BRACHIOPODA

#### *Rafinesquina alternata mediolineata*, n. var.

Figs. 13, 14

All specimens are internal casts. Shell attaining large size, semioval, the average ratio of width to length for holotype and paratypes being about 1.4 to 1. Dimensions of holotype: width 36 mm, length 30 mm. Hinge line straight, equal to the greatest width of the valve. Cardinal angles rectangular to very slightly mucronate. Ventral valve gently and evenly convex, the beak moderately prominent; costellae small, rounded, and distinct, usually every fourth one more pronounced from the beak to the anterior margin. The pronounced costellae without bifurcations, but bifurcation of the smaller ones common in the anterior half of the valve. The outstanding surficial feature is a very prominent, straight, central costella extending the full length of the valve, but causing no extension of the anterior margin, which is evenly rounded. Faint concentric growth ridges indicated. Dorsal valve same as ventral valve in size and outline; flat, except for a very slight projection of the beak; finely and evenly costellate, lacking the alternations of the ventral valve.

*Locality*.—Passage Creek.

*Remarks*.—The varietal name *mediolineata* has been chosen because of the presence of the very conspicuous median striation on the ventral valve, which is lacking in *R. alternata* (Emmons). In other respects the two are similar.

This variety does not have the mucronate shape of *R. mucronata* Foerste; *R. squamula* James does not exhibit an alternation in the size of the costellae; *R. alternata centristriata* Ruedemann occurs much lower stratigraphically; and in *R. nasuta* (Conrad) the prominent central line is not a constant feature and the anterior margin is noticeably produced.

#### MOLLUSCA

##### PELECYPODA

#### *Byssonychia bowmani*, n. sp.

Figs. 4, 5

Cast of left valve. Shell small. Outline sub-quadrangular with rounded base. Beak small, rounded in section, acutely pointed, curving forward slightly and extending a short distance beyond the hingeline. Umbone very prominent, expanding evenly toward the entire ventral margin of the shell. Hinge line straight and about two-thirds the greatest length of the shell making an angle of approximately 90 degrees with the anterior margin. Height 32 mm; thickness 10 mm. Anterior outline about straight, the margin projecting slightly at its lower end to form the greatest length of the shell. From this point the ventral margin is strongly and convexly rounded, flattening somewhat as it approaches the posterior cardinal angle. Byssal opening indistinct. Costae fine, rounded, numbering from 65 to 70 and increasing very gradually in strength from the posterior to the anterior margins. Interior not seen.

*Locality*.—Passage Creek.

*Remarks*.—In outline this species is similar to *B. richmondensis* Ulrich, but in the latter the anterior margin is longer and the angle between the hinge line and the anterior margin is greater. Both *B. richmondensis* Ulrich and *B. praecursa* Ulrich are generally more elongate from beak to ventral margin. The specific characters of *B. bowmani* are the great number of costae (65 to 70, as compared with 38 to 42 for *B. praecursa* and about 50 for *B. richmondensis*), a shorter anterior margin, and a less elongate shell.

This distinctive species is named in honor of Dr. Isaiah Bowman, president of The Johns Hopkins University.

#### *Cuneamya umbonata*, n. sp.

Fig. 8

Cast of the interior of right valve. Shell of medium size, having a length of 25 mm and a height of 15 mm, larger at the anterior end and tapering to a rounded posterior point; beak very large, high, pointed and incurved, projecting 2.5 mm above the cardinal line. Apex of beak situated about one-third the length from the anterior end. Cardinal line straight for one-

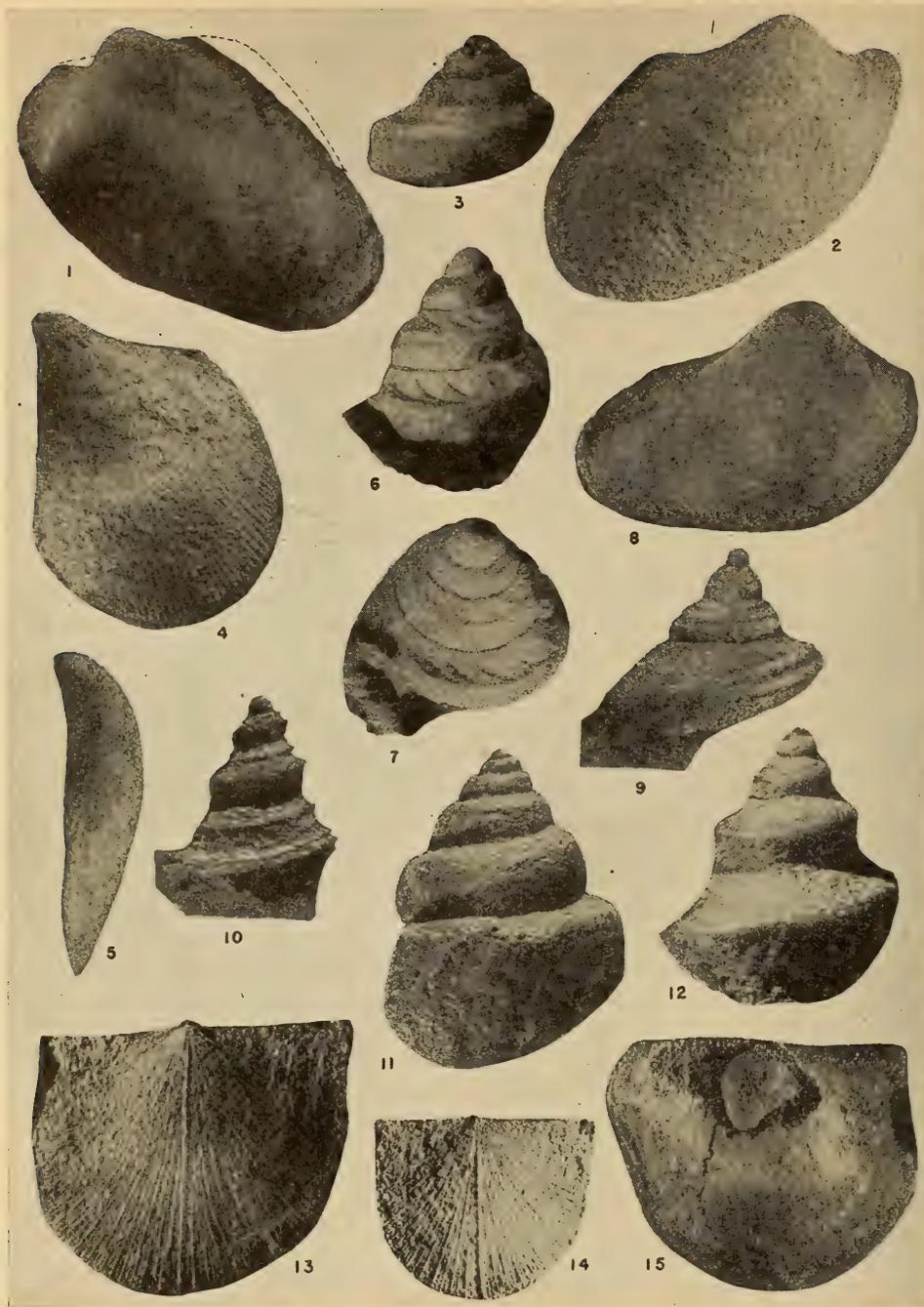


Fig. 1.—*Whitella massanuttenensis*, n. sp., cast of left valve of holotype. Fig. 2.—*W. nasuta*, n. sp., plastic cast of holotype, mold of right valve. Fig. 3.—*Lophospira expansa*, n. sp., cast of interior of holotype. Figs. 4, 5.—*Byssonychia bowmani*, n. sp., cast of left valve of holotype: 4, side view; 5, front view. Figs. 6, 7, 11.—*Lophospira tropidophora* (Meek), plastic casts of interior molds: 6, 7, two views of one specimen; 11, another specimen; all indicating common variations. Fig. 8.—*Cuneamya umbonata*, n. sp., cast of right valve of holotype. Fig. 9.—*Lophospira breviangulata*, n. sp., plastic cast of holotype, mold of interior. Fig. 10.—*L. trilineata*, n. sp., plastic cast of holotype, mold of exterior. Fig. 12.—*L. liosutura*, n. sp., plastic cast of holotype, mold of exterior. Figs. 13, 14.—*Rafinesquina alternata mediolineata*, n. var.: 13, holotype, external cast of ventral valve; 14, paratype, immature specimen. Fig. 15.—*Pterinea maternata*, n. sp., cast of left valve of holotype (umbone broken away, gastropod fragment lodged in opening).

All from Passage Creek except Fig. 2, which is from Cub Run.

half the length of the shell, posterior to the beak; posterior portion of the cardinal area slightly alate. Escutcheon well marked; lunule heart-shaped, distinct. Base of lunule forming anterior point of shell, the ventral margin curving convexly from this point to the posterior extremity. Umbonal ridge rounded, sloping to the posterior point. No trace of a sulcus, a horizontal longitudinal section being at no place concave. A line through the beak, through the widest part of the shell, makes an angle of about 20 degrees with the vertical. Greatest thickness of the valve 15 mm from which it tapers evenly and abruptly to the anterior, and gently to the posterior extremities. Faint concentric growth lines present.

*Locality*.—Passage Creek.

*Remarks*.—The striking prominence and convexity of the umbo distinguish this species from others of the genus.

***Pterinea maternata*, n. sp.**

Fig. 15

Cast of left valve. Shell subrhomboidal, exceedingly convex. Hinge line straight, its length being 18 mm. Greatest length of shell 22 mm; height 20 mm; thickness 7 mm. Anterior wing short and broadly rounded. Posterior wing short, triangular, extending a little beyond the margin. Posterocardinal area alate. Beak destroyed. Umbonal ridge not marked, the whole valve having a swollen appearance. Posteroventral and ventral margins evenly rounded. Anterior margin nearly straight and making an angle, if extended, of about 75° with the hinge line.

*Locality*.—Passage Creek.

*Remarks*.—The most distinctive characteristic of this species is its striking convexity.

***Whitella massanuttenensis*, n. sp.**

Fig. 1

Cast of left valve. Shell of medium size, very convex, subrhomboidal in outline, slightly the widest posteriorly; length measured from upper anterior to lower posterior angle 43 mm; greatest height 33 mm. Anterior margin gently rounded and nearly vertical in the upper half; sharply rounded at the extremity of the hinge. Ventral margin evenly and gently convex to the posterior extremity of the umbonal ridge. Postbasal angle strongly rounded. Posterior margin subparallel to the anterior margin, moderately

rounded at the extremity of the hinge. Beak small and very prominent, not strongly incurved, situated about one-third to one-fourth the length behind the anterior extremity. Umbonal ridge very slightly developed as compared with the majority of the species of the genus. Sinus area slightly flattened in the ventral half of the shell, situated about midway in the length and subparallel to the umbonal ridge. Indications of imbricating and concentric growth lines present.

*Locality*.—Passage Creek.

*Remarks*.—*Whitella compressa* Ulrich is more rounded, compressed, and slightly more erect than this species. *W. obliquata* Ulrich has much stronger umbonal ridges with the beak situated more anteriorly. *W. ohioensis* Ulrich is more rounded in outline and less convex.

***Whitella nasuta*, n. sp.**

Fig. 2

Mold of right valve. Shell medium, compressed convex, subrhomboidal in outline, elongate; length measured from upper anterior to lower posterior angle 43 mm; greatest height 28 mm. Widest at the posterocardinal angle. Hinge line almost straight. Anterior area flattened and produced into a rounded front margin. The ventral margin shows an evenly convex curve from the posterior extremity of the umbonal ridge to the anterocardinal angle. Posterior end of shell evenly rounded. Posterocardinal angle very wide. Umbone small, compressed, slightly incurved, protruding moderately above the hinge line. Umbonal ridge very low, disappearing in the posterior third. Umbone situated about one-third the length behind the anterior extremity.

*Locality*.—Cub Run.

*Remarks*.—This species bears a general resemblance to *W. massanuttenensis*, n. sp., but is distinguished by its nasute anterior end and more compressed shell.

GASTROPODA

***Lophospira breviangulata*, n. sp.**

Fig. 9

Cast of interior. Apical angle 90°±. Height 8 mm. Volutions no more than 4. Probably tricarinate; all carinae rounded. Toward the aperture there is an indication of a lower carina which seems to fuse with the peripheral one higher in the shell. The upper carina is sepa-

rated from the peripheral one by a distinct but very narrow concave area, the position of which makes the upper slope of the whorl very wide and slightly convex. The last whorl is greatly expanded. Sutures well indented. Whorls compressed longitudinally. Umbilicus and aperture not seen; surface ornamentation obscure.

*Locality*.—Passage Creek.

*Remarks*.—This species is distinguished by the position of the upper carina which causes the slope between it and the suture to be unusually wide.

***Lophospira expansa*, n. sp.**

Fig. 3

Cast of interior. Shell medium, volutions 4 to 5. Height 18 mm, diameter 16 mm. Apical angle about 90°. Whorls uniaxial. Earlier whorls compressed and rounded, the upper slope being a little greater than the lower. Sutures moderately indented. Last whorl greatly expanded with a prominent rounded peripheral keel.—Upper slope slightly concave and of such width as to be in striking contrast to the narrow and rounded surfaces of the earlier whorls which, exclusive of the last whorl, have an apical angle of about 75°. Lower surface of last whorl convex and sloping inward abruptly to the columella, giving the whorl a shallow or compressed appearance in relation to its comparatively great diameter. Surface markings indistinct.

*Locality*.—Passage Creek.

*Remarks*.—This species generally resembles *L. tropidophora* (Meek) but differs from it in the striking expansion of the last whorl.

***Lophospira liosutura*, n. sp.**

Fig. 12

Mold of exterior. Apical angle about 50°. Volutions 5. Spire rather elongate. Height 13 mm, diameter of last whorl 9 mm. Peripheral carina prominent. Upper surface of the last whorl flat from the inner margin of the keel approximately to the suture. Inclination of this upper surface very steep. Upper surface of earlier whorls convex and steep. Lower surface of whorls very slightly convex, inclined very steeply, and fused with the upper surface of the next whorl to form a smooth, unbroken sutural curve.

*Locality*.—Passage Creek.

*Remarks*.—This species is distinguished by

its smooth sutural curve and rather elongate spire. It compares only in general shape with *L. manitoulinensis* Foerste which is described from the Richmond of Ontario and Quebec. The latter, however, is much larger, having a height of 45 mm, and more closely resembles *L. sumnerensis* (Safford) and *L. tropidophora* (Meek) than does the present species.

***Lophospira trilineata*, n. sp.**

Fig. 10

Mold of exterior. Apical angle 30° to 35°. Height 7 mm. Volutions 4; angular. Lower carina, if present, hidden. Central carina on the outer extremity of the volution very angular and prominent having on each side a sharp elevated ridge with a narrow groove between. These ridges are placed a short distance inward along the slopes from the keel, the distance being slightly greater for the upper one. Upper carina removed a third of the width of the slope from the upper suture, and very sharp or angular. Surface of whorl between the keels decidedly concave. There is a rounded ridge intermediate between the sharp upper carina and the suture. Umbilicus and aperture not seen. Surface ornamentation obscure.

*Locality*.—Passage Creek.

*Remarks*.—This species may be compared specifically with those *Lophospiras* which possess a threefold central carina. *L. trilineata* differs from these in possessing a small, rounded but prominent ridge on the last whorl between the upper carina and the suture. *L. saffordi* Ulrich apparently is more robust and much larger with seven volutions. *L. pulchella* Ulrich and Scofield also is larger. *L. bicincta* (Hall) possesses a much greater apical angle, thus having a shorter and fatter appearance.

***Lophospira tropidophora* (Meek)**

Figs. 6, 7, 11

There is a notable lack of agreement between the description and illustrations of this form by Cumings (1907, p. 969) quoting from Meek (1872, p. 278), and those by Ulrich and Scofield, also following Meek (not Miller, see errata p. 1081 of reference). The description given by Ulrich and Scofield (1897, p. 978) follows:

“Height generally from 25 to 35 mm.; greatest width equalling from 75 to 80-100ths of the height; apical angle 75° to 80°. Volutions five, uniaxial; base produced, rounded; umbilicus

closed; columellar lip thick and slightly twisted below. Surface markings curved strongly backward to the peripheral band, coarse and rather irregular on the base of the last whorl, much less distinct on the nearly flat upper slope. When perfect the lines of growth are somewhat lamellose."

Our specimens are in general agreement with the foregoing description, but the upper slope of their whorls is concave and the lower slope of the last whorl is more erect.

We have found a number of well-preserved casts of the interior of *L. tropidophora* and one moderately well-preserved cast of the exterior at Passage Creek. The descriptions follow:

*Cast of exterior.*—Shell large. Height 30 mm, width 25 mm. Apical angle 70 to 75°. Volutions 5 to 6. Last whorl very ventricose, the upper portion of the lower slope erect. Whorls unia-angular, peripheral carina rounded, prominent and marginal. Upper slope concave; sutural edge distinct but not carinate; suture slightly impressed. On the earlier whorls, the ratio of upper slope to the lower is 2 or 3 to 1, giving a general pagodalike appearance to the shell. Growth lines on upper surface of the whorls are indistinct; on the lower surface of the last whorl they are very coarse, swinging slightly forward from the keel and then curving downward.

*Cast of interior.*—Last whorl very ventricose. The upper slope of the whorls comparatively narrow for the size of the shell; the ratio of its width to that of the lower slope for the last whorl being about 1 to 5. The upper slope is quite concave on the last whorl, less so on the earlier ones, and is crossed diagonally with backward-curving grooves. These are strongest in the midbreadth of the slope, disappearing toward the suture and the keel. The features of the upper slope show considerable variation. The main carina or keel is rounded with a slight edge on the upper surface and is situated a little inside of the greatest diameter of the whorl. The upper portion of the lower slope is comparatively erect and is the greatest diameter of the shell; the lower portion curves convexly inward. The earlier whorls are rounded and slightly compressed in appearance. There is no indication of a lower carina. The sutures are located at such a point that the ratio of the upper slope to the lower on the earlier whorls is about 1 to 1 or 1 to 1.5. Sutural edge slightly thickened but not carinate. The growth lines on

the lower slope of the last whorl swing slightly forward from the keel and then curve downward. The lower portion of the inner lip is thickened and reflexed.

FOSSIL LIST FOR PASSAGE CREEK AND CUB RUN

Fossil	Passage Creek	Cub Run
PLANTAE		
<i>Buthotrephis</i> cf. <i>B. flexuosa</i> Hall.....		x
<i>B. sp. indet.</i> .....		x
<i>Palaeophycus?</i> sp. indet.....		x
COELENTERATA—Graptozoa		
<i>Diplograptus</i> cf. <i>G. vespertinus</i> Ruedemann..		+
<i>D. sp. indet.</i> .....	*	
ANNELIDA		
<i>Cornulites</i> cf. <i>flexuosus</i> (Hall).....		+
BRYOZOA—Trepotomata		
<i>Bythopora</i> sp. indet.....	*	*
<i>Hallopore</i> sp. indet.....	*	*
BRACHIOPODA		
<i>Dalmanella meeki</i> Miller.....	*x	*x
<i>D. multisetata</i> Meek.....	*	*x
<i>Lingula</i> cf. <i>nicklesi</i> Bassler.....		x
<i>Orthorhynchula</i> cf. <i>O. linneyi</i> (James).....	*	+
<i>Pholidops cincinnatensis</i> Hall.....		+
<i>Plectorthis</i> sp. indet.....	*	+
<i>Rafinesquina alternata mediolineata</i> , n. var.....	*x	*x
<i>R. alternata</i> (Emmons) var.....		+
<i>Sowerbyella</i> sp.....		+
<i>Zygospira modesta</i> (Hall).....	*x	*+
MOLLUSCA—Pelecypoda		
<i>Byssonychia bowmani</i> , n. sp.....	*x	x
<i>B. praecurva</i> Ulrich.....	*	x+
<i>B. sp. indet.</i> .....	*	*
<i>Colpomya faba</i> cf. var. <i>puccilla</i> Foerste.....	*	x
<i>Ctenodonta albertina</i> Ulrich.....	*	
<i>Cuneameya scapha brevior</i> Foerste.....	*	
<i>C. umbonata</i> , n. sp.....	*	
<i>Cymatonya</i> cf. <i>pholadis</i> (Conrad).....	*	
<i>C. sp. indet.</i> .....	*	
<i>Cyrtodonta</i> sp.....	*	
<i>Ischyrodonta unionoides</i> (Meek).....	*	*
<i>I. sp. indet.</i> .....	*	x
<i>Orthodesma nasutum</i> (Conrad).....	*	x
<i>O. sp.</i> .....	*	
<i>Pterinea insueta</i> (Emmons).....	*	x
<i>P. maternata</i> , n. sp.....	*	
<i>Rhytimya</i> sp.....	*	
<i>Whitella massanuttenensis</i> , n. sp.....	*	x
<i>W. nasuta</i> , n. sp.....	*	*
MOLLUSCA—Gastropoda		
<i>Liospira vitruvia</i> (Billings).....	*	
<i>Lophospira brevisangulata</i> , n. sp.....	*	
<i>L. expansa</i> , n. sp.....	*	
<i>L. liosutura</i> , n. sp.....	*	
<i>Lophospira medialis</i> Ulrich and Scofield var.....	*	
<i>L. perangulata</i> (Hall) var.....	*	
<i>L. trilineata</i> n. sp.....	*	
<i>L. tropidophora</i> (Meek).....	*	*
<i>Oxydiscus</i> sp. indet.....		x
MOLLUSCA—Cephalopoda		
<i>Paractinoceras lamellosum</i> (Hall).....	*	*
<i>Spyroceras</i> sp. indet.....	*	
ARTHROPODA—Trilobita		
<i>Calymene</i> sp. indet.....	*	
<i>Cryptolithus tessellatus</i> Green.....		+
<i>Isotelus maximus</i> Locke.....	*	*
<i>I. megistos</i> Locke.....	*	
<i>Odontopleura</i> sp.....		+
ARTHROPODA—Ostracoda		
<i>Drepanella richardsoni</i> (Miller) var.....		*
<i>Ceratopsis chambersi</i> (Miller).....		+

\* = Passage Creek Zone.  
 + = Eden.  
 x = Maysville but not in Passage Creek Zone.

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BOTANY.—*A new plant of the genus Onoseris from Bolivia.*<sup>1</sup> S. F. BLAKE, Bureau of Plant Industry, Soils, and Agricultural Engineering.

The description of a new species of the composite genus *Onoseris* from Bolivia is published here in order to make the name available for a revision of the genus in course of preparation by Sr. Ramón Ferrera, of the Estación Experimental de la Molina, Ministerio de Agricultura, Lima, Peru.

*Onoseris fraterna* Blake, sp. nov.

Herba valida trimetralis ubique compacte albido-tomentosa, faciebus superioribus foliorum exceptis; caulis striatus supra angulatus medullosus foliosus; folia maxima lyrato-pinnatifida, segmento terminali hastato-deltaeideo cordato apice et in angulis acuto, lateralibus paucis oblongo-ovatis multo minoribus, basalibus pluribus minimis; panicula multicapitata pedalis et ultra ramis erectiusculis, pedicellis 1.5–6 cm longis prope apicem inconspicue subulato-bracteatis; capitula radiata ca. 42-flora 2.3 cm alta rubra; involucri 1.8–2 cm alti valde gradati ca. 7-seriati appressi albido-tomentosi phyllaria exteriora minima subulata bracteis apicis pedunculi omnino similia, cetera anguste oblongo-lanceolata ad lineari-lanceolata parum acuminata; corollae marginales 13 bilabiatae hermaphroditae antheris cassis, corollae interiores 29 tubulosae breviter 5-dentatae hermaphroditae; achenia breviter sericeo-pilosa; pappus stramineus.

“Herb 10 ft. high”; stem subterete, 1 cm thick, densely and compactly whitish-tomentose, solid, pithy; leaves (including the narrowly winged petiole) 57–64 cm long, submembranaceous, above bright green, sparsely and incon-

spicuously hispidulous with short conic hairs, beneath densely whitish-tomentose, the terminal segment 25–27 cm long, about 30 cm wide, repand-dentate with callous-tipped teeth, the lateral divisions about 2 pairs, 3–11 cm long, 2–5 cm wide, acute, repand-dentate, the segments toward base of petiole 7–9 pairs, triangular to linear, acuminate, 1.5 cm long or less; panicle about 50-headed, about 30 cm long and 24 cm wide, the axis and branches strongly angled, densely whitish-tomentose and pubescent with short, purplish, many-celled, not glandular hairs; subulate bracts toward tips of pedicels rather few and inconspicuous, 2–3 mm long, appressed; heads (moistened) campanulate-oblong, about 2.3 cm high, 1 cm thick; phyllaries rather persistently tomentose, more or less denudate on the often purplish margin and the broad median vitta, the latter often finely pilosulous with purplish hairs like those of the pedicels, the middle and inner phyllaries 1.8–2 mm wide; receptacle fimbriate; marginal corollas crimson, 20 mm long, thinly pilose dorsally, the tubular part 10 mm long, the outer lip spreading, elliptic, 3-denticulate, 10 mm long, 2.5 mm wide, 8–9-nerved, the inner lip entire, narrowly linear, acuminate, revolute, 8 mm long; disk corollas crimson, tubular, cylindrical, glabrous throughout, 17.5 mm long (tube 6.5 mm, throat isodiametric with tube, 9.5 mm, teeth 5, triangular, acute, erect, 1.5 mm long); achenes of ray and disk (scarcely mature) similar, subcylindrical, 5-ribbed, densely pubescent with erectish hairs, 6 mm long; pappus copious, several-seriate, somewhat graduated, straw-color, of slender hispidulous bristles, 1.5 cm long; anthers of marginal flowers 4, nonpolliniferous, 4 mm long, those of the disk flowers 5,

<sup>1</sup> Received September 6, 1943.

polliniferous, 7 mm long (tails 2 mm, sacs 3 mm, appendages 2 mm; filaments glabrous).

BOLIVIA: San Bartolomé (near Calisaya), basin of Río Bopi, Prov. S. Yungas, Dept. La Paz, alt. 750–900 meters, 1–22 July, 1939, *B. A. Krukoff* 10266 (type no. 154679–81, herb. U. S. National Arboretum).

Near *Onoseris silvatica* Greenm., of Costa Rica, and not distinguishable in foliage. In *O. silvatica* the pedicels are conspicuously setaceous-bracted above, and the phyllaries are at-

tenuate with (especially in the outer ones) subsetaceous tips. The geographically nearer *O. purpurea* (L. f.) Blake of Colombia is less closely related, the decidedly setaceous-tipped phyllaries being quickly glabrate except for abundant short many-celled usually purplish hairs. The three species constitute a compact group in this multiform genus characterized by their lyrate-pinnatifid leaves and numerous many-flowered, radiate heads.

ORNITHOLOGY.—*Critical notes on the avian genus Lophortyx.*<sup>1</sup> HERBERT FRIEDMANN, U. S. National Museum.

THE GEOGRAPHIC FORMS OF DOUGLAS'S QUAIL, *LOPHORTYX DOUGLASII* (VIGORS)

Examination of a good series of Douglas's quail, *Lophortyx douglasii*, reveals that there are not two races as currently thought but five.<sup>2</sup> It so happens that all the new forms are fairly southern and are here separated from what has hitherto passed as typical *douglasii*, leaving the northern race *bensoni* undisturbed. The new subspecies, for which none of the names previously proposed in this group seem to be applicable, are as follows:

*Lophortyx douglasii teres*, n. subsp.

*Type*.—U.S.N.M. (Biol. Surv. coll.) 155943, adult ♂, collected at Las Palmas, northwestern Jalisco, March 31, 1897, by E. W. Nelson and E. A. Goldman.

*Characters*.—Similar to *Lophortyx douglasii douglasii* but with shorter wing, 101–104 mm (as opposed to 109–114) in males, 98–102 (as opposed to 105.4–109) in females; with the longest secondaries reaching the tips of the primaries (in *douglasii* the primaries extend 15–20 mm beyond the secondaries) in the closed wing; and with the general coloration darker, the males with the reddish brown on the wings chestnut instead of Sanford's brown (as in

*douglasii*), the lower back and rump more brownish; the gray of the breast darker—neutral gray (pale neutral gray in *douglasii*) and the white spots on the abdomen with blackish ringlike edges; the females with the brown on the underparts noticeably darker—dark olive-brown.

*Measurements*.—Five males, including the type: wing 101–104 (102.6); tail 66–72 (68.6); culmen from base 14–14.5 (14.1); tarsus 25–29 (27.8); middle toe without claw 27–29 (28 mm). Three females: wing 98–102 (99.7); tail 65–67 (66.1); culmen from base 13.8–14.3 (14); tarsus 27.5–29 (28.3); middle toe without claw 26–27 (26.3 mm).

*Distribution*.—Northwestern Jalisco (Las Palmas; Las Peñas), possibly to Colima. No specimens, however, appear to have been taken yet in Colima. This State is included in current accounts of the range of the species on the sole basis of Grayson's statement, that he "also found it in the State of Jalisco and Colima, but not as far south as Tehuantepec." (In Lawrence's paper, Mem. Boston Soc. Nat. Hist. 2: 306. 1874.)

*Lophortyx douglasii impedita*, n. subsp.

*Type*.—U.S.N.M. (Biol. Surv. coll.) 157369, adult ♂, collected at San Blas, Tepic, Nayarit June 9, 1897, by E. W. Nelson and E. A. Goldman.

*Characters*.—Intermediate between typical *douglasii* and *teres*, combining the dark coloration of the latter with the wing tip of the former; in size it is entirely intermediate. In other words, *impedita* is a dark Douglas's quail with a noticeable wing tip; this combination of characters sets it off from either of its neighbors. As

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received September 6, 1943.

<sup>2</sup> I am indebted to the authorities of the American Museum of Natural History, the Museum of Comparative Zoology, and the California Academy of Sciences for the loan of important comparative material, supplementing that available in the collections of the U. S. National Museum and the Fish and Wildlife Service.

a matter of fact, it is even somewhat darker generally than *teres*.

*Measurements*.—Five males, including the type: wing 105.4–110 (107.9); tail 70–77 (74.2); culmen from base 14–15 (14.5); tarsus 29.5–34.7 (32.3); middle toe without claw 27–30 (28.8 mm). One female: wing 100.5; tail 68; culmen from base 13.5; tarsus 33; middle toe without claw 28 mm.

*Distribution*.—Known only from Nayarit.

***Lophortyx douglasii languens*, n. subsp.**

*Type*.—Mus. Comp. Zool. 24975, ad. ♂, collected at Trompa, Chihuahua, January 25, 1885, by R. R. McLeod.

*Characters*.—Similar to *L. d. douglasii* but with the gray of breast less pure gray, lightly washed with brownish, and with indistinct rufescent medioterminal spots on most of the feathers; and with the pale spots on the abdomen slightly buffier, and the pale postero-medial part of the abdomen slightly more extensive.

*Measurement*.—Two males: wing 110–111; tail 77.5–79; culmen from the base 15.5–15.8; tarsus 29–30; middle toe without claw 28.5–29.5 mm.

The separation of *teres*, *impedita*, and *languens* restricts the distributional range of typical *douglasii* to Sinaloa and north-western Durango (Casa Blanca). The State of Sonora is inhabited by *bensoni*. It may be recalled that van Rossem (Bull. Mus. Comp. Zool., 77 (7): 431–432. 1934) has decided, contrary to some of his own earlier conclusions, that *bensoni* of Sonora and *douglasii* of Sinaloa were not separable and has suggested moving the type locality of *douglasii* from Mazatlan to San Blas. Thus, the resulting *douglasii* of his paper is the bird here described as *impedita*, and his *bensoni* contains both the *bensoni* and the *douglasii* of this paper. It seems to me that he had insufficient grounds for attempting a reinterpretation of the type locality of *douglasii*. What he writes is this: "Regarding Vigors' type of *Ortyx douglasii*, which is in the British Museum; it is doubtful if it ever came from Mazatlan. It is typical, one might say super-typical, of the southern race. The locality as given in the original description was, of course, 'Monterey,' but

was later changed by Gambel to Mazatlan. Of course it may have come from Mazatlan, but all things considered, I believe San Blas, Nayarit, to be a better selection. The type is a female, a skin in poor condition and with the tail missing." It would seem from this that it would have been better had van Rossem described the "southern race" as new (equal to my *impedita* plus *teres*) and merely sunk *bensoni* into the synonymy of *douglasii*. However, I can not agree with his conclusion regarding the Sonora-Sinaloa birds either. I find Sonora birds (other than from the extreme southern part of that State) to be distinguishable from Sinaloa examples, and I therefore recognize five races in all.

KEY TO THE RACES OF *LOPHORTYX DOUGLASHI*

- a. Breast feathers with a scalloped pattern like those of abdomen (females).
  - b. Crest usually uniform dark sepia to fuscous ..... *bensoni*, ♀
  - bb. Crest usually spotted or incompletely barred with tawny.
    - c. Brown of underparts darker—dark olive-brown.
      - d. With a wing tip (i.e., primaries exceeding secondaries) of 15–20 mm. .... *impedita*, ♀
      - dd. With little or no wing tip. .... *teres*, ♀
    - cc. Brown of underparts paler—olive-brown to pale olive-brown. .... *douglasii*, ♀
- aa. Breast feathers uniform gray, not scalloped (males).
  - b. Breast very pale—smoke gray, with a faint bluish tinge. .... *bensoni*, ♂
  - bb. Breast darker—light neutral gray or darker.
    - c. Breast feathers mostly with indistinct pale rufescent terminal spots. .... *languens*, ♂
    - cc. Breast feathers mostly with no such spots.
      - d. With a wing tip of 15–20 mm.
        - e. General coloration averaging darker, gray of breast and abdomen neutral gray, white abdominal spots more or less ringed with blackish. .... *impedita*, ♂
        - ee. General coloration averaging paler, gray of breast and abdomen light neutral gray, white abdominal spots with no blackish rings. .... *douglasii*, ♂
      - cc. With little or no wing tip. .... *teres*, ♂

A NEW RACE OF GAMBEL'S QUAIL

Gambel's quail reaches its eastern limits in the very arid country of extreme western Texas, in the region about El Paso east to Jeff Davis County. A series of birds from

this area are consistently different in coloration from a long series of the typical race, from southern California, Arizona, Utah New Mexico, and extreme northwestern Mexico, and appear to be a recognizable race, which may be known as—

*Lophortyx gambelii ignoscens*, n. subsp.

*Type*.—U.S.N.M. 9363, adult, unsexed (but male by plumage), collected at San Elezario, Texas, December 1855, by Dr. C. B. Kennerly.

*Characters*.—Similar to *Lophortyx gambelii gambelii* but with the long feathers of the sides and upper flanks lighter in color—between Sanford's brown and chestnut (while in the nominate race these feathers are between chestnut and bay in color) and somewhat paler generally, especially so on the crown, breast, and back.

As in the other races of this species the amount of buffy color on the abdomen can be appreciated only in birds with fairly fresh plumage, as the color seems to bleach out to whitish, even in such a saturated buffy race as *fulvipectus*. The type of *ignoscens* is a bird in fairly fresh plumage; the rest of my specimens of this form are in bleached worn plumage, but the color of the elongated chestnut feathers is quite the same in all. There is no size difference between *ignoscens* and *gambelii*.

*Range*.—The extremely dry desert region, sometimes called the "eastern succulent des-

ert from Fort Fillmore, N. Mex., east to extreme western Texas—El Paso, Belen, San Elezario, and Fort Hancock—east to Presidio del Norte and to the Limpia River, Jeff Davis County. It does not extend farther eastward into Brewster County, and apparently does not go southward into adjacent areas of Mexico, but is limited to the area of low rainfall (under 10 inches a year). Thus, a male from Cajon Bonito Creek, Chihuahua, is *gambelii*. Similarly, in New Mexico its range is restricted to this very arid little belt. Specimens typical of *gambelii* in every way have been examined from the following localities in fairly nearby parts of southern New Mexico: Fort Bayard, Frisco, Garfield, Gila National Forest, Grafton, Joseph, Silver City, and near Tyrone. These indicate that the country to the north of this "eastern succulent desert" is inhabited by *gambelii*. A bird from the San Luis Mountain, just within the more arid region, is paler, and agrees with *ignoscens*.

The characters of *ignoscens* appear to be more pronounced in males than in females, although it must be admitted I have but three females of the new form for study. Two females from Cajon Bonito Creek, northern Chihuahua, are very similar to them, but the male from that locality is definitely *gambelii*. It may be that the two forms intergrade in the area around Cajon Bonito Creek.

Of the new race *ignoscens* I have seen eight males and three females.

ZOOLOGY.—*A new snake of the genus Tropidodipsas from Mexico.*<sup>1</sup> HOBART M. SMITH, University of Rochester. (Communicated by HERBERT FRIEDMANN.)

Among the snakes secured by Thomas MacDougall during the winter of 1941–42 on the Isthmus of Tehuantepec is one belonging to the section of *Tropidodipsas* characterized by the very short head, small posterior chinshields, and small eye. It does not agree with either subspecies of *sartorii* now recognized, the only other members of this section of the genus known from Mexico. I am indebted to Dr. E. H. Taylor for permission to describe it.

*Tropidodipsas macdougalli*, n. sp.

*Type*.—E. H. Taylor—H. M. Smith collection No. 28088, from Tehuantepec, Oaxaca, colert,"

<sup>1</sup> Received September 15, 1943.

lected by Thomas MacDougall during January, 1942.

*Diagnosis*.—Related to *T. sartorii*. Dorsal scales in 17 rows, absolutely smooth throughout length of body; black bands 27 on body, 9 on tail, generally a little more than twice length of light interspaces; ventrals 199; caudals 65, in a female; eye diameter about equal to its distance from labial border; head relatively short; posterior chinshields very small.

*Description*.—Head somewhat mutilated. Internasals a little less than half area of prefrontals, their common suture about two-thirds length of common median suture of prefrontals; length of sutures between rostral and internasals about equal to length of sutures between

an internasal and a prefrontal, and about equal to a common nasorostral suture; frontal relatively short, about as long as broad, sides smoothly convergent posteriorly and outlining a shield-shaped scale; parietals short, but little longer (6 mm) than broad (5 mm); maximum length of parietals about equal to distance from posterior tip of frontal to internasal-prefrontal suture. Nasal large, divided; loreal square on one side, rectangular on other; latter entering orbit between preoculars; two preoculars, subequal on one side, lower much the smaller on other side; two postoculars, relatively large; temporals 1-2, anterior in contact with both postoculars; supralabials 6-7, third and fourth (fourth and fifth) entering orbit; diameter of orbit equal to distance of eye from labial border; posterior labial about as broad as long, other labials higher than long.

Infralabials 8-9, first in contact on median line; mental small; anterior chinshields about twice as long as broad, in contact with 5-6 infralabials; posterior chinshields indistinguishable.

Dorsal scales in 17-17-17 rows, all perfectly smooth, even posteriorly, pitless; ventrals 199; anal entire; subcaudals 65, divided; female. Total length 697 mm, tail 132 mm.

Body pattern of complete black rings separated from each other by light areas now (late 1942) somewhat pinkish in color (not improbably discolored, as all bands, even at nape, are of the same shade); black rings on body 27, on tail 9, all very slightly narrower laterally than medially; medially the bands are usually a little more than twice as wide as the light interspaces, which generally cover about two scale lengths; on the belly the light interspaces average about as long as the dark rings.

The head is black above, except for a light spot on the posterior angle of the frontal; the color covers the parietals, but laterally extends over only the anterior temporal, anterior half of the penultimate supralabial, and all other scales anterior to these. The mental, anterior three or four infralabials on each side and a spot on each anterior chinshield are black.

*Remarks.*—The single specimen of this form known shows a relationship to *sartorii*, which like it has distinct black rings, 17 scale rows, a very short head, posterior chinshields absent or indistinct, and an essentially similar head scutellation. With *occidentalis* and *philippii*,

with 15 scale rows, there is obviously no close relationship. All other species known from or probably occurring in Mexico (*guerreroensis*, *fasciata*, *fischeri*) belong to another section of the genus, characterized by long heads, large eyes, and relatively large chinshields; moreover the patterns of these three species do not correspond with those of *macdougalli*.

From *sartorii* this specimen differs in number of black rings on body (27 as opposed to 13 to 24) and tail (9 as opposed to 4 to 8), number of ventrals (199 compared with 173 to 185), and number of subcaudals (65 in a female as compared with 54 to 63 in the same sex). The keels, which are fairly distinctly evident in *sartorii*, are indistinguishable in this.

Intergradation with *sartorii sartorii* is not improbable; in support of this is a specimen (U.S.N.M. 109908) from Tenosique, Tabasco, with 24-8 black rings; the ventrals (♂) are 180 the subcaudals 66. All other *s. sartorii* examined (8, from Alvarez and Tamazunchale, San Luis Potosí; Potrero Viejo, Veracruz; Emiliana Zapata, Tabasco; and Chuntuquí, Guatemala) have 22-7 black rings or fewer. Regardless of the possibility of intergradation of *macdougalli* and *s. sartorii*, the former is definitely not intermediate in character between the latter and *s. annulatus*, since neither has as many ventrals or dark rings as the new form, although geographically it appears more or less intermediate.

The exact provenance of the specimen is uncertain. It possibly was taken in one of the mountain ranges west or northwest of Tehuantepec, perhaps as far away as 20 miles (straight line). It seems unlikely that the species occurs in the close vicinity of the city of Tehuantepec, since the intensive collecting of recent years has not disclosed its presence there. Nevertheless the latter possibility remains, for the energetic collecting methods of Dr. Joseph R. Slevin has unearthed in the vicinity of Tehuantepec a specimen of another species of *Tropidodipsas*, also unrepresented in the voluminous recent collections from that area.

#### *Tropidodipsas guerreroensis* Taylor

Of considerable interest is a specimen, collected by J. R. Slevin at Mixtequilla, Oaxaca, on August 25, 1925 (Calif. Acad. Sci. 73653). The only other known in United States museums is the type, from Buena Vista, Guerrero.

It is much like the type as described by Taylor (Univ. Kansas Sci. Bull. 26: 470-473, fig. 7, pl. 50, 1939 [1940]). The body is somewhat compressed, the keels on the dorsal scales are rather well defined, the head is relatively elongate, the eyes are large, and the posterior chinshields are nearly half the length of the anterior. As in the type a pair of chinshield-like scales precedes the first ventral, following the other chinshields. The loreal is elongate, separated from eye by the preoculars, which are 2-3 in number; temporals 1-2-2, 1-2-3; supralabials 8-8, infralabials 9-9; the prefrontals are a little larger, about  $2\frac{1}{2}$  times as long as internasals. The dorsals are in 17 rows. The ventrals are 184, subcaudals 78. Since the specimen is a male, there are rather prominent knobbed keels above the anus, and numerous small, well-defined tubercles on the chin, throat and extreme anterior part of belly. Total length 603 mm, tail 153 mm.

The markings are much as in the type. The light gular area is not stippled, although the dorsal nuchal band (complete instead of interrupted medially) is finely mottled as in the type. The light bands are narrower posteriorly, most split medially with the halves alternating; they are not broken up into spots as in the type. Most of the dark rings reach the mid-venter, but only the anterior five are complete since the remainder is staggered; the light bands become wider on the lateral scale rows and on the belly.

The differences from the type exhibited by

this specimen are so few that they seem certainly conspecific. The somewhat greater regularity of the dorsal pattern, as well as the lower ventral count, in the Oaxaca specimen suggests more strongly than before a close relationship of *fasciata* and *guerreroensis*. This curious situation, in which a Yucatán form finds its closest relative on the Pacific coast of Mexico north of the Isthmus of Tehuantepec, has a parallel in other snake genera, as for instance *Lampropeltis* and *Stenorhina*. It is not impossible in this case, as in the others, that the forms involved actually intergrade somewhere on the Isthmus.

A number of references to *Tropidodipsas fasciata* (Sumichrast, Arch. Sci. Phys. Nat., 46: 246-247, 249. 1873; and Mocquard, Miss. Sci. Mex., livr. 16: 872-873, pl. 70, fig. 3, 1908) and *Leptognathus fasciatus* (Sumichrast, Bull. Soc. Zool. France 5: 184. 1880; and La Natureza 6: 44. 1882) from the Isthmus of Tehuantepec (Santa Efigenia, Cacoprieto) probably are referable to *T. guerreroensis*. The counts given by Mocquard (184 to 186 ventrals) for three specimens from "Mexico" and "Isthmus of Tehuantepec" agree with those of *guerreroensis*, and accordingly his illustrations probably are of that species. The identity of specimens recorded as *Leptognathus fasciatus* from Jicaltepec, Córdoba and San Andrés Tuxtla, Veracruz (Sumichrast, La Natureza 6: 44. 1882; and Ferrariperez, Proc. U. S. Nat. Mus. 9: 183. 1886) remains in doubt, but may well be correct. I can find no references in the literature that might apply to *T. macdougalli*.

#### ICHTHYOLOGY.—Review of the genera of blennioid fishes related to *Ophioblennius*.<sup>1</sup> EARL D. REID. (Communicated by LEONARD P. SCHULTZ.)

During the past few years I have attempted to identify certain blennioid fishes from the tropical Atlantic and Pacific Oceans. Many of these specimens were not identifiable with forms referred to the genus *Ophioblennius*. As the material was assembled and studied, it became more apparent that a review of this group of genera was needed. This report is a summary of my findings, based on material in the collections of the United States National Museum.

After carefully studying all the available material related to *Ophioblennius*, the following key was prepared, giving the salient characters that I have concluded are most useful in recognizing the various genera:

- 1a. Gill openings not restricted, forming a free fold across isthmus.
- 2a. Strongly hooked canine teeth in front of upper and lower jaws.
- 3a. Ventral fins composed of a concealed spine and two rays; lateral line incomplete. . . . . *Ophioblennius* Gill
- 3b. Ventral fins composed of a concealed spine and four rays; lateral line complete or nearly so, a few pores lacking posteriorly. . . . . *Leoblennius*, n. g.

<sup>1</sup> Published by permission of the Secretary of the Smithsonian Institution. Received July 30, 1943.

- 2b. Canine teeth absent in upper jaw, four strongly hooked canines near symphysis of mandible; lateral line very short  
 ..... *Blenniella*, n. g.
- 1b. Gill openings restricted, the membrane attached to and not forming a free fold across isthmus.
- 4a. Four strongly hooked canine teeth in front of both jaws; gill openings restricted, membrane attached near base of lower pectoral ray ..... *Gloriella* Schultz
- 4b. Canine teeth absent in upper jaw, a single series of conical teeth directed forward with a tendency to flare outward; gill openings wider but restricted, width of isthmus about equal to diameter of pupil  
 ..... *Giffordella* Fowler

### Genus *Ophioblennius* Gill

*Blennophis* Valenciennes, in Webb and Barthelot, Îles Canaries, Poiss., 1843, p. 60, name preoccupied (*B. webbia* Valenciennes).

*Ophioblennius* Gill, Proc. Acad. Nat. Sci. Philadelphia 12: 103. 1860 (genotype: *B. webbia* Valenciennes); substitute for *Blennophis* Valenciennes, not *Blennophis* Swainson, a genus of Clinidae.

The genus *Ophioblennius* is widely distributed in the tropical Atlantic along the west coast of Africa and from the West Indies to Trinidad. In the Pacific it occurs from the coast of southern California to the Galápagos, Chile to the Marquesas, and the Hawaiian Islands. No species, so far, has been found away from the island or group of islands from which the type was recorded. Most of the specimens as yet collected have been attracted to an electric light and captured in a dip net when this equipment was used from the ship's side while at anchor.

I find the dermal filaments, number of rays in the vertical and paired fins, and length of the lateral line among the characters studied most reliable for specific distinction. The recurved canine teeth at the symphysis of the jaws and the naked body together with the usually forked caudal fin will serve as characters for field recognition of *Ophioblennius* and related genera.

*Description*.—Body oblong, compressed, scaleless; snout short, high, abruptly decurved anteriorly. Lateral line incomplete, vertical fins long, dorsal composed of spines and soft rays, a notch at point of differentiation, anal similar to soft dorsal with two spines, dorsal and anal fins usually free from caudal, the latter lunate or forked. Upper jaw with 2 or 4 strongly hooked

canine teeth on the premaxillaries followed by a single series of minute conical teeth loosely attached to the gums and easily movable, these teeth grouped into units of several teeth each and spaced at short intervals so that each group appears as a single deeply incised tooth with 5 to 8 cusps. Lower jaw with 4 strongly hooked canine teeth near symphysis of the mandible, the outer pair more or less horizontal, their tips strongly bent or hooked toward the rictus, usually 1 or 2 curved canines at about midlength of the mandible, the posterior much the larger. Gill openings wide, free from the isthmus, the membrane forming a free united fold across latter in front of the insertion of the ventral fins. Ventral fins composed of a hidden spine and 2 rays. A strongly marked genus, perhaps allied to *Blennius*.

### KEY TO THE SPECIES REFERRED TO OPHIOBLENNIUS

- 1a. Four strongly hooked canine teeth in front of upper and lower jaws.
- 2a. Pectoral fins short, not reaching origin of anal fin.
- 3a. Dorsal XII, 19 or XII, 20; anal II, 20 or II, 21.
- 4a. Nape with a pair of tentacles on each side of midline. ....  
 ..... *ferox* Beebe and Tee Van
- 4b. Nape without tentacles on each side of midline. .... *watsoni*, n. sp.
- 3b. Dorsal XVI, 20; anal 26 (probably II, 24)  
 ..... *trinitatis* Ribeiro
- 2b. Pectoral fins long, reaching well past origin of anal fin.
- 5a. Dorsal spines X to XII.
- 6a. Dorsal spines XII.
- 7a. Anal II, 22 or 23; dorsal XII, 22 or XII, 23.
- 8a. Color brownish, a black ocellus on preopercle behind eye, caudal fin with longitudinal dark stripes. ....  
 ..... *steindachneri* Jordan and Evermann
- 8b. Color pallid, a dark area at occiput and a dark vertical bar at base of caudal fin. . . . *pinchoti* Fowler
- 7b. Anal II, 14 or 15.
- 9a. Dorsal soft rays 16; anal II, 15.
- 10a. A pair of tentacles at the nape on each side of midline, pectorals black, tipped with coarse punctulations. ....  
 ..... *xiphiodon* Clark
- 10b. A comb of tentacles at nape on each side of midline, color pallid. . . . *fernandezensis* Clark
- 9b. Dorsal soft rays 12 to 14; anal II, 14 or II, 15.

- 11a. Dorsal XII, 13; fringe of tentacles at nape gray-black; notch in dorsal fin shallow, less than half length of first soft ray... *vanderbilti* Fowler
- 11b. Dorsal XII, 13; fringe of tentacles at nape pale; dorsal fin with a definite space between spines and soft rays  
..... *clarki*, n. sp.
- 6b. Dorsal spines X.
- 12a. Dorsal soft rays 13; anal 14 (probably II, 14).... *phalacrus* Clark
- 12b. Dorsal soft rays 20; anal 20....  
..... *webbii* Valenciennes
- 5b. Dorsal XIV, 20; anal 21 (probably II, 21); no tentacles at nape.....  
..... *lanieri* Seale
- 1b. Two strongly hooked teeth on premaxillaries and four similar canines at symphysis of mandible; a fringe of 28 tentacles extending across nape, fringes pale, dorsal notched nearly to base of fin; dorsal XII, 13; anal II, 14..... *capillus*, n. sp.

#### *Ophioblennius ferox* Beebe and Tee Van

*Ophioblennius ferox* Beebe and Tee Van, *Zoologica* 10(1): 242-244, fig. 1928 (Haiti); Longley, Carnegie Inst. Washington Yearbook 32: 293-295. 1933 (name only).

U.S.N.M. 120028, 8 examples, 40 to 45.4 mm, Fort Landing, Saba Island, D. W. I., April 11, 1937; Smithsonian-Hartford Exped. Coll., Dr. Waldo L. Schmitt. U.S.N.M. 120029, 2 specimens, 44 to 45 mm, St. Eustatius, off Orangeted, D. W. I., April 12, 1937, Smithsonian-Hartford Exped. Coll., Dr. Waldo L. Schmitt.

*Description.*—The standard lengths in millimeters are 45; 44; 42.8; 45; 43.5; 45.4; 43.4; 41.4; 40; 42, respectively. The following measurements are expressed in hundredths of the standard lengths, respectively: Head 22.2; 24.1; 24.1; 23.4; 22.5; 21.8; 23.3; 23.0; 22.7; 23.8. Depth 20.5; 22.7; 21.0; 20.0; 20.5; 19.6; 20.7; 20.5; 19.0; 21.2. First dorsal spine 12.7; 13.6; 12.6; 13.3; 12.6; 13.0; 12.7; 12.3; 13.0; 13.1. Depth caudal peduncle 7.8; 7.5; 7.5; 7.3; 7.4; 7.1; 8.1; 7.7; 8.0; 7.6. Length of snout 6.0; 6.6; 7.0; 5.6; 6.2; 5.7; 6.2; 6.5; 6.2; 6.0. Interorbital 5.1; 5.5; 5.6; 5.1; 5.1; 4.8; 5.1; 5.3; 5.5; 5.5. Diameter of eye 6.7; 6.8; 6.8; 6.7; 6.4; 6.4; 6.5; 6.8; 7.0; 6.9. Pre-anus<sup>2</sup> 46.7; 45.5; 46.5; 47.4; 43.6; 46.7; 46.1; 48.1; 46.8; 46.2. Pre-dorsal<sup>2</sup> 24.2; 23.6; 23.8; 23.3; 24.4; 22.9; 23.7; 24.7;

23.8; 25.2. Length pectoral fin 18.7; 20.0; 19.4; 19.6; 19.6; 19.6; 19.7; 19.6; 19.3; 20.0. Base of anal fin 46.4; 48.2; 47.2; 47.6; 49.0; 48.4; 47.4; 46.9; 46.2; 49.3.

D. XII, 19 or 20; A. II, 20 or 21; P. 15; 15; Br. 5. Body moderately elongate, compressed, the profile convex before eyes, nearly straight from orbits to origin of dorsal fin, which is slightly behind the posterior margin of the preopercle, spines and soft rays of about equal height, the fin with a moderate notch at juncture of spines and soft portion, tips of last rays of vertical fins reaching nearly to caudal base, the peduncle notably deeper than long, anal similar to soft dorsal and preceded by two small spines. Caudal fin moderately forked, the lobes about even, its length about four-fifths that of the pectoral, the tips of which reach about opposite to, or fall a trifle short of, the anus, upper rays of pectoral rather weak, the first about equal to eye diameter, the following rays evenly graduated to the tenth or eleventh, which are longest, the lower rays are somewhat thickened. Ventrals I, 2, inserted well in advance of pectoral base, their tips reaching about opposite tip of lower pectoral ray or midway to the anus. Upper jaw nonprotractile, upper lip attached to snout anteriorly. Four strongly recurved canine teeth on the premaxillaries, followed by a single series of minute conical teeth set in groups of six or seven and loosely attached to the gums and easily overlooked. Mandible with four similar canines at the symphysis, the outer pair nearly horizontally deflected outward, their tips directed toward the rictus, these followed by one or two pairs of curved canines about midlength of the lower jaw, the mandible sharply compressed to a coulterlike edge and forming an angle just behind the lateral canines. Lips thin, closely adhering to the jaws, lower jaw slightly included, the gape small, little oblique, maxillary reaching anterior edge of pupil. Gills 4, a small pore behind last, gill rakers 14, small acute points. Pseudobranchiae developed. Nostrils well separated, the anterior about midlength of snout digitate with six graduated filaments, the longest reaching hind rim of posterior nostril, which is situated just before vertical through anterior rim of eye. Orbital tentacle simple, equals pupil diameter, nape with a pair of filaments on each side of midline about one-fourth length of orbital tentacle. Lateral line incomplete, arched

<sup>2</sup> Distance from tip of snout to anus or tip of snout to dorsal origin.

high over pectoral and ending below anterior rays of soft dorsal.

Color in alcohol light straw generally, lips and occiput with dark bluish shade, dark points forming a shaded area across occiput in front of dorsal and a sprinkle of brownish pigment inside gill cavity, at base of vertical fin rays and a dark shade or dot at base of caudal rays, forming a dark line that fails to reach the upper and lower margins of the fin. Peritoneum silvery but profusely dusted with dark pigment showing through the ventral surface of the abdominal wall as a dark area from base of ventral fins to anus.

*Remarks.*—This species differs from *watsoni* in having a pair of filaments on either side of the midline at the nape.

***Ophioblennius watsoni*, n. sp.**

Fig. 1

*Blennophis webbia* Steindachner (not of Valenciennes), Sitzb. math.-nat. Classe Akad. Wiss. 56(1): 354. 1867 (Barbados).

*Holotype.*—U.S.N.M. 89614, Anse à Galets, La Gonave Island, Haiti, W. I., March 22, 1930, standard length 46 mm. Coll. Watson M. Perrygo. Paratype: U.S.N.M. 120097, same data as holotype. Standard length 44 mm.

*Description.*—The following measurements are expressed in hundredths of the standard length, respectively: Head 21.5; 22.7; depth 17.6; 20.9; first dorsal spine 12.8; 12.5; depth caudal peduncle 6.5; 6.8; length of snout 5.0; 5.5; interorbital space 4.35; 5.0; pre-anus 43.5; 43.0; predorsal 22.8; 22.9; length of pectoral fin 20.9; 19.1; base of anal fin 48.5; 45.9.

D. XII, 19 or 20; A. II, 21; P. 15; 15. V. I, 2. Br. 5. Body naked, oblong, compressed. Profile convex, rather steep from upper lip to above eye, then nearly straight with oblique elevation to origin of dorsal fin, which is situated just before upper angle of gill opening. Dorsal spines slightly lower than soft rays, the fin with a shallow emargination at juncture of differentiation, the posterior spine notably weaker than those preceding, the posterior ray weak, terminating about midlength of the caudal peduncle, which is slightly longer than deep. Anal similar to soft dorsal, the rays preceded by 2 spines. Caudal fin forked, the lower lobe a trifle longer than the upper, about equal to length of pectoral fin which reaches to vertical of the anus, the rays graduated from the upper which is very feeble to tenth which is longest, lower rays somewhat

thickened. Ventrals inserted below posterior margin of the preopercle, their tips reaching anterior third of pectoral. Upper jaw nonprotractile, the upper lip free laterally, gape small, oblique, maxillary terminus below anterior margin of the pupil. Four strongly retrocurved canines on the premaxillaries, behind which is a series of minute conical teeth in groups of 7 or 8 teeth each, these units appearing to the unaided eye as single, deeply incised teeth with a short interval between each group, they are loosely attached to the gum and movable. Lower jaw with similar dentition, the outer pair of canines near symphysis of mandible deflected and partly concealed by the lower lip, a small canine about midlength of the mandible and a large curved canine immediately following. Gill rakers very small, 16 on the anterior arch. Pseudobranchiae developed. Nostrils well separated, the anterior with a digitate appendage, posterior nostril above anterior rim of the eye. Orbital filament very small, simple, its length about one-third pupil diameter. Nape without filaments. Lateral line incomplete terminating below third dorsal ray.

Color in alcohol light straw generally, upper lip with dark pigment, a dark shade transversely at occiput, some faint dark spots at base of dorsal fin supports and a dark vertical line at base of the caudal rays, not extending to the rudimentary elements, anal fin translucent. Gill cavity with dark specks, peritoneum silvery with dark pigment. Abdomen from insertion of ventral fins to just before vent with silvery sheen dusted with dark pigment.

*Remarks.*—This new species may be differentiated from all others referred to the genus *Ophioblennius* by means of the key on page 374. It is distinguished from *ferox* by the absence of filaments at the nape.

Named *watsoni* in honor of the collector, Watson M. Perrygo, of the United States National Museum.

***Ophioblennius trinitatis* Ribeiro**

*Ophioblennius trinitatis* Ribeiro, Arch. Mus. Nac. Rio de Janeiro 22: 177, fig. 1. 1919 (Trinidad).

*Description.*—Head  $\frac{1}{4}$  in the standard length. Dorsal XVI, 20; anal II, 24; ventral I, 2. Depth 4-4.5; mouth small, reaching vertical through anterior rim of the orbit. Four strongly hooked canine teeth on the premaxillaries and four similar canines at symphysis of the mandible.

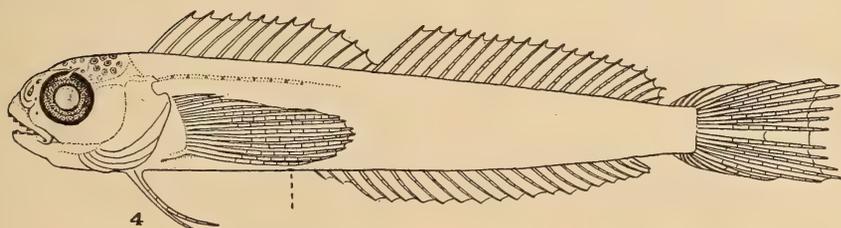
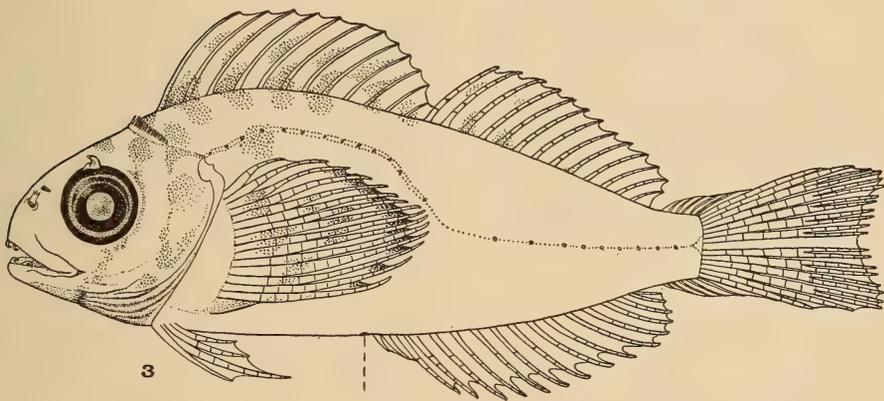
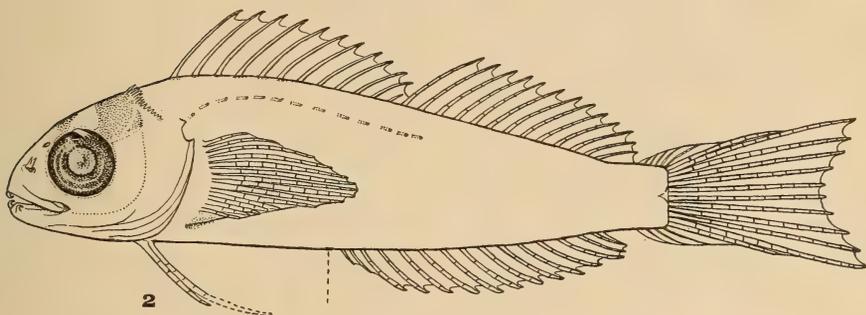
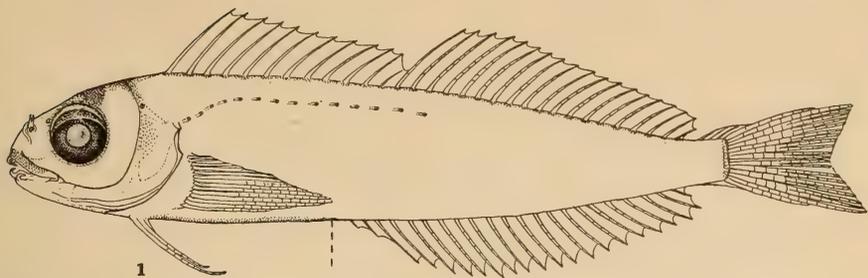


Fig. 1.—*Ophioblennius watsoni*, new species: Holotype (U.S.N.M. 89614), 46 mm. in standard length. Fig. 2.—*Ophioblennius capillus*, new species: Holotype (U.S.N.M. 120032), 21.8 mm. in standard length. Fig. 3.—*Leoblennius schultzi*, new genus and species: Holotype (U.S.N.M. 118037), 25.4 mm. in standard length. Fig. 4.—*Blenniella rhessodon*, new genus and species: Holotype (U.S.N.M. 118029), 22.6 mm. in standard length. Drawn by Mrs. Aime M. Awl, U. S. National Museum.

ble, the inner pair recurved, the outer pair larger and flaring outward at an angle, their tips curved posteriorly; these are followed by a pair of small curved teeth at midlength of the gape and a larger pair of curved canines immediately following. Upper lip delicately crenulated, a series of minute conical teeth loosely implanted on the gums and easily movable. Anterior nostril with filaments, a filiform tentacle above the eye. Interorbital space equal to diameter of the orbit. Pectoral fin pointed, not quite reaching origin of anal. Dorsal fin with a slight marginal indentation at juncture of spines and soft rays, the latter slightly more elevated, vertical fins free from caudal, the latter forked. Ventral fins subjugular, their length equal to postorbital length of the head.

Color (3 per cent formalin) flesh-colored, eyes black, an indistinct stain behind the orbit; a streak of the same color descends from the neck across the optic region and spreads over the isthmus; a series of 11 spots, moderately dark, along the side to base of the caudal fin; a series of similar spots along the back, alternating with those of the flank and encroaching upon the base of the dorsal; other fins immaculate. Total length 52 mm.

*Remarks.*—I have not seen an example of the present species; the description is based on a translation of the original description, together with additional features shown by the figure. Differs from *steindachneri* in the greater number of spines in the dorsal fin and in the greater number of rays in the anal.

### *Ophioblennius steindachneri*

Jordan and Evermann

*Blennophis (Ophioblennius) webbia* Steindachner, Ich. Beitr. 8: 41. 1879 (5 specimens, 70 mm. long, from Navidad near Mazatlán and the Tres Marias Islands).

*Ophioblennius steindachneri* Jordan and Evermann, U. S. Nat. Mus. Bull. 47(3): 2401. 1898 (Tres Marias Islands). (After Steindachner.)

A single example in good condition, U.S.N.M. No. 120030, standard length 59.4 mm., locality doubtful,<sup>3</sup> is preserved in the U. S. National Museum.

*Description.*—The following measurements

<sup>3</sup> This bottle contained a mixture of west coast fishes and an old label: "Paraguay, Bahia. Dr. E. Palmer." These specimens probably were obtained in the Gulf of California during Dr. Palmer's visit to the mouth of the Colorado River.

are hundredths of the standard length: Head 23.2; depth 20.6; first dorsal spine 13.5; depth caudal peduncle 6.9; snout 5.6; interorbital 3.7; eye 6.9; pre-anus 43; predorsal 20.5; length of pectoral 24.4; base of anal fin 49.5.

D. XII, 23. A. II, 23. P. 15; 15. V. I, 2. Br. 5. Body oblong, compressed, profile strongly convex from upper lip to above eyes, then nearly straight to origin of dorsal fin. Insertion of dorsal above margin of preopercle, the spinous and soft portions of about equal height, divided by a notch about half the depth of the fin, posterior ray free from caudal, its tip reaching rudimentary caudal rays. Caudal peduncle about one-third deeper than long, anal similar to soft dorsal and of equal length. Caudal fin moderately forked, outer rays notably shorter than the long pectoral, which reaches to opposite third anal ray, upper ray of pectoral about equal to diameter of the eye, ninth and tenth rays longest, lower 6 rays much stronger and somewhat thickened. Ventral fins inserted well forward, their midlength below pectoral base. Upper jaw nonprotractile, lip joined to tip of snout by broad frenum, free laterally. Gape moderate, little oblique, maxillary reaching about opposite anterior edge of pupil. Upper jaw with 4 strongly hooked canine teeth on the premaxillaries, the outer pair largest and strongly angulated. A series of minute loosely attached conical teeth implanted on the gums in groups of 7 or 8 teeth each and appearing as 5 or 6 deeply incised teeth on either side of the jaw, this series is not interrupted by the anterior canines. Four similar canines at symphysis of mandible, the outer pair deflected almost horizontally, their tips directed toward the rictus and nearly concealed by the lower lip. These followed by 2 curved canines at about midlength of the gape, the posterior one much the longest. Gill rakers about 12 (count not certain). Anterior nostril with 10 or 11 filaments, orbital tentacle simple about equal pupil diameter, 5 or 6 small hairlike filaments on either side at nape. Lateral line incomplete, convex anteriorly and running an eye diameter below dorsal fin terminating below fifth dorsal ray.

Color in alcohol dark chocolate generally, a dark ocellus on upper region of preopercle behind eye, outer caudal rays somewhat lighter.

*Remarks.*—This specimen agrees very well with the description of *steindachneri* and probably was taken on the west coast of Mexico by

Dr. E. Palmer. It was found in a bottle with five other blennies labeled "Paraguay, Dr. E. Palmer." Although Dr. Palmer collected in Paraguay and in the Gulf of California, the present specimen obviously could not have been taken in the southern locality.

This species is very close to *pinchoti* but has an entirely different color pattern. Other differences are indicated in the key on page 374.

#### *Ophioblennius pinchoti* Fowler

*Ophioblennius pinchoti* Fowler, Proc. U. S. Nat. Mus. 80(6): 13-14, fig. 3. 1932 (Galápagos)

*Holotype*.—U.S.N.M. 91819, 1 specimen, Black Beach Anchorage, Charles Island, Galápagos Islands, June 27, 1929, A. K. Fisher.

*Paratypes*.—U.S.N.M. 91820, same data, 16 cotypes.

*Other specimens*.—Four additional examples collected as follows: Marchena Island Anchorage, Galápagos Islands, December 3, 1934, 3 specimens, W. L. Schmitt, U. S. N. M. 101930; Tagus Cove, Albemarle Island, Galápagos Islands December 9, 1934, 1 specimen, W. L. Schmitt.

*Description*.—Of 11 examples measured, the standard length in mm. is 45; 45.1; 43.4; 42.3; 42.4; 40.8; 40; 39.6; 35.9; 39; 47. The following measurements are expressed in hundredths of the standard length, respectively: Head 25.1; 24.9; 25.8; 24.6; 24.8; 24.3; 24.5; 25.5; 26.7; 24.9; 26. Depth 22; 22.6; 22.6; 20.6; 20.3; 19.4; 19.3; 18.2; 15; 18.5; 21.3. First dorsal spine 13.8; 12.2; 12.7; 13; 13.5; 13.2; 13.3; 11.9; 14.5; 13.8; 10.6. Depth caudal peduncle 7.8; 8; 8.1; 8.3; 7.5; 7.6; 7.8; 7.6; 8.1; 7.2; 7.4. Length of snout 6.4; 6.4; 6.5; 6.1; 6.8; 6.1; 5.8; 6.1; 5.6; 6.4; 7.4; Interorbital width 5.8; 6; 6; 5.4; 5.2; 5.1; 6.5; 5.1; 5.6; 6.2; 5.3. Diameter of eye 7.1; 7.5; 7.8; 7.3; 7.5; 7.8; 8.5; 8.1; 8.1; 8.2; 7.9. Pre-anus 44; 42.6; 43.1; 40.7; 40.6; 41; 39.3; 41.7; 39.6; 40.6; 44.2. Predorsal 22.7; 23.3; 24.9; 24.1; 24.8; 24.3; 22.5; 24.2; 24.5; 25.1; 23.4. Length of pectoral fin 23.1; 22; 23.5; 23.4; 22.4; 23.3; 26; 22.8; 22.8; 21.8; 25.1. Base of anal fin 48.2; 48.6; 48.6; 53.2; 52.4; 50.7; 53.5; 50.8; 54.3; 51.8; 47.4.

D. XII, 22 or 23. A. II, 22 or 23. P. 15, 15 or 16, 16. Br. 5. Body oblong, compressed, profile of snout from upper lip to posterior nostril strongly convex then nearly straight to origin of dorsal fin, which is slightly behind occiput, spinous portion of dorsal fin a little lower than

soft rays, the juncture marked by a moderate notch, tip of last ray about reaching midlength of the caudal peduncle which is slightly deeper than long, anal similar to soft dorsal and of equal length, preceded by two spines, caudal fin forked, about equal to length of pectoral which reaches to opposite third anal ray. Upper rays of pectoral fin much shorter and weaker than lower rays which are long and somewhat thickened, the fifth and sixth rays longest. Ventral fins advanced, their insertion well in front of pectoral base, their tips reaching midlength of the latter or slightly more than half way to first anal spine. Upper jaw nonprotractile the upper lip free laterally. Four strongly hooked canine teeth at front of upper jaw, their tips pointing backward, the outer pair a trifle largest, vomer and palatines toothless. Lower jaw with four similar canines, the outer pair flaring outward nearly horizontally with their tips strongly bent toward the rictus and partly concealed by the lower lip, easily detected by passing the finger forward along the edge of the mandible, these are followed by a minute curved canine tooth about midlength of the gape immediately behind which is a long curved canine tooth, largest of the group. Gills four, a small pore behind last, rakers minute, 22 on first arch, pseudobranchiae well developed. Nostrils well separated, the anterior about midlength of snout supporting a digitate appendage on the inner edge with 8 filaments, posterior nostril just before perpendicular through anterior edge of eye, orbit with a simple tentacle as long as diameter of pupil. Four to six small filaments on either side of the nape about one-fourth as large as the orbital tentacle, their attachment alternately in a semi-double row. Lateral line incomplete, terminating below fifth dorsal ray.

Color in alcohol light straw generally, upper lip with some dark pigment, occiput, lateral line and a narrow strip on either side of dorsal with light chestnut-brown pigment, this very dense and forming a pronounced crescentic line across the back at the occiput, a narrow dark band at base of caudal fin excluding the middle, and the outer 2 or 3 rays above and below, a dark spot at base of the supports of the vertical fins. Peritoneum silvery with a sprinkle of chestnut colored pigment spots.

*Remarks*.—This species is close to *steindachneri* but differs in color pattern.

**Ophioblennius xiphiodon** Clark

*Ophioblennius xiphiodon* Clark, Proc. California Acad. Sci., ser. 4, 22(7): 483-484. 1938 (Peru).

A paratype of this species, U.S.N.M. 120026, was taken at Callao, Peru, in February, 1935, by the Templeton Crocker Expedition 1934-35.

*Remarks.*—Distinguished from *pinchoti* in the fewer supports in the vertical fins and in color pattern.

**Ophioblennius fernandezensis** Clark

*Ophioblennius fernandezensis* Clark, Proc. California Acad. Sci., ser. 4, 22(7): 184. 1938 (Juan Fernández Island).

A paratype of the present species, U.S.N.M. 120027, taken at San Juan Bautista (Cumberland) Bay, Juan Fernandez Island, January 31, 1935, by the Templeton Crocker Expedition 1934-35.

*Remarks.*—Very close to *xiphiodon* but differs strongly in the plain coloration and in the tentacles at the nape.

**Ophioblennius vanderbilti** Fowler

*Ophioblennius vanderbilti* Fowler, Acad. Nat. Sci. Philadelphia Monogr. 2: 242-243, pl. 11, figs. 26, 27. 1938 (Oahu and Christmas Islands).

I quote Fowler's description: "Depth 4 to  $4\frac{1}{8}$ ; head  $3\frac{1}{4}$  to  $3\frac{3}{8}$ , width  $1\frac{7}{8}$  to 2. Snout 4 to  $4\frac{1}{8}$  in head; eye  $2\frac{3}{4}$ , greatly exceeds snout or interorbital; maxillary reaches  $\frac{1}{2}$  to  $\frac{1}{3}$  in eye, length 3 in head; 4 canines in front of each jaw, each greatly bent or arched, each outer lower one flaring outward nearly to right angle; interorbital  $3\frac{3}{8}$  to  $3\frac{1}{4}$  in head, broadly convex. Gill opening forms free fold over isthmus.

"Body with smooth scaleless skin. Lateral line incomplete, superior, only running back as far as end of depressed pectoral. Fringed supraorbital flap nearly as long as pupil. Short nasal flap. Fringe of short filaments in single row transversely across occiput.

"D. XII, 13 or 14, third spine  $2\frac{2}{3}$  to  $2\frac{1}{2}$  in head, third ray  $1\frac{1}{8}$  to 2; A.14,<sup>4</sup> fin height  $2\frac{1}{2}$ ; caudal 1, slightly emarginate; least depth of caudal peduncle  $2\frac{1}{2}$  to  $2\frac{3}{8}$ ; pectoral 1  $1/10$  to  $1\frac{1}{8}$  rays 13; ventral  $1\frac{1}{3}$  to  $1\frac{2}{3}$  in head.

"Color of body russet, little paler on chest, breast and prepectoral, also on belly. Head drab nearly ecru drab below. Iris gray to silvery

white. Supraorbital filament and row of nuchal filaments gray black. Fins all light or pale brown, dorsals and anals grayish terminally."

*Remarks.*—This species is not represented in the national collections. Distinguished from *capillus* by the much shallower notch in the dorsal fin and by the grayish-black coloration of the dermal appendages.

**Ophioblennius clarki**, n. sp.

*Ophioblennius* sp. indet. Clark., Proc. California Acad. Sci., ser. 4, 22(7): 185. 1938 (Marquesas).

*Description.*—The present study indicates that Clark's undetermined specimen is a valid species. A single example was taken at Taiohae Bay, Nukuhiva Island, Marquesas, October 6-15, 1934. I quote Clark's description:

"Total length 32 mm.; body 26 mm.; head (9 mm.) 2.88 in head; depth (8) 3.25; eye (3) in head; snout (2) 4.5; maxillary (2.5) 3.6; interorbital (2) 4.5; D. XI-13, the spines long and slender, a short space between spinous and soft dorsal; A. I, 15<sup>5</sup>; V. 2, the rays long and slender; P. 16, base broad; C. truncate; branchiostegals about 4, gill membranes forming a fold across the isthmus a little anterior to base of ventrals; jaws about even. Two strong and markedly curved canines at symphysis of upper jaw, followed by two smaller ones; a pair of similar, strongly curved canines at symphysis of lower jaw; no secondary canine immediately behind it, but there appears to be a small one back at the posterior part of the jaw. About 27 muscular bands; no scales, but an arched lateral line of about 27 pores over the pectoral and backward. No color except the usual black area over the occiput; a small silvery patch on belly. A branched cirrus at nostril, a slender single one above eye, and comb of filaments at nape."

*Remarks.*—This species differs from *capillus* in having a definite space between the spinous and soft portions of the dorsal fin. No doubt there are XII spines in the dorsal instead of XI as given by Mr. Clark.

Named *clarki* in honor of the late H. Walton Clark, curator of fishes, California Academy of Sciences, San Francisco.

**Ophioblennius phalacrus** Clark

*Ophioblennius phalacrus* Clark, Proc. California Acad. Nat. Sci., ser. 4, 22(7): 184-185. 1938 (Nukuhiva).

<sup>4</sup> Probably this count is II, 14.

<sup>5</sup> Probably this count is II, 15 or II, 14.

I quote Clark's description: "Total length 32 mm.; body 26 mm.; head (9 mm.) 2.88 in body depth the same; eye (3) 3 in head; snout (2) 4.5; maxillary (2.5) 3.6; gape hardly reaching to eye; interorbital (2) 4.5; D. X, 13; A. 14; V. 2; P. 19; no scales, but lateral line short, arched over pectoral, the pectoral rather short, but broad. Branchiostegals 5, gill-membranes forming a shallow fold across the isthmus; caudal truncate or slightly emarginate. Teeth as usual in the genus, four stout, curved fangs about symphysis of upper and lower jaws, a palisade of small incisors in sides of jaws.

"Color: Posterior part of body cream color; head coarsely punctate with black spots, the largest of which are larger than pupil, the spots extending backward along base of dorsal."

*Remarks.*—Not represented in the national collections. Distinguished from all known representatives of the genus in the absence of dermal appendages and in the separate dorsal fins.

#### *Ophioblennius webbii* (Valenciennes)

*Blennophis webbi* Valenciennes, in Webb and Bathelot, Îles Canaries, Poiss., pp. 60–61. 1839 (Fort Ventura, Canary Islands); Günther, Cat. Fish. Brit. Mus. 3: 259 1861 (Canary Islands).

*Blennius webbii* Poggi, [article in Guidebook of Canary Islands], "Guia de Santa Cruz de Teneriffe" [p. d. 35]. 1881 (Canary Islands).

*Blennophis webbii* Vinciguerra, Atti Soc. Ital. Sci. Nat. 34: 321. 1892 (Canaries).

*Ophioblennius webbii* Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 1052–1053, fig. 434. 1936 (Tropical Atlantic) (Valenciennes); Norman, *Discovery* Rept. 12: 56. 1936 (Ascension Island).

*Blennophis webbianus* Valenciennes, op. cit. pl. 20, fig. 3 a–c.

*Blennophis webbi* Günther, Rept. Voy. *Chalenger* 1: 5. 1880 (Ascension Island).

*Remarks.*—I have seen no example of this species, and its occurrence in the Western Atlantic is doubtful. It differs from all known American species in having fewer dorsal spines and from all Western Atlantic forms in the much longer pectoral fins.

#### *Ophioblennius lanieri* Seale

*Ophioblennius lanieri* Seale, Allan Hancock Pacific Expeditions 9(1): 40, pl. 4, fig. 4. 1940 (Galápagos).

*Remarks.*—The present form is not represented in the national collections. An error occurs in the reported number of dorsal spines as

given in the original description, but plate 4, figure 4 by Seale (l. c.) is correct in this respect. Dr. W. M. Chapman, curator of fishes at the Academy, has kindly reexamined the holotype and reports 14 spines in the dorsal fin. The present form is distinguished from *pinchoti* in possessing a greater number of spines in the dorsal fin and lacking filaments at the nape.

#### *Ophioblennius capillus*, n. sp.

##### Fig. 2

*Holotype.*—U.S.N.M. 120032, *Albatross* Station 3921, night anchorage off Honolulu, T. H. Diamond Head Light, S. 62°, E. 3.9', May 6, 1902, surface, electric light. Standard length 21.8 mm.

*Description.*—The following measurements are expressed in hundredths of the standard length. Head 29.4. Depth 21.6. First dorsal spine 16.1. Depth caudal peduncle 10.6. Length of snout 6.9. Width of interorbital 7.8. Diameter of eye 10.6. Pre-anus 45.8. Pre-dorsal 30.7. Length of pectoral fin 25.7. Base of anal fin 39.0.

D. XII, 13. A. II, 14. P. 15, 15. V. I, 2. Br. 5. Body oblong, compressed, scaleless, profile gently convex from upper lip to nape, a weak depression at occiput and a slight keel in front of dorsal fin. Insertion of dorsal above mid-length of opercle, the spines a little higher than soft rays, the fin divided at point of transition by a deep notch, the last spine attached by membrane to the lower sixth of the first soft ray, posterior ray reaches rudimentary caudal elements. Anal similar to soft dorsal, the fin terminating pupil diameter short of lower caudal elements. Caudal peduncle slightly longer than deep, caudal fin lunate, equal length of head. Pectoral fin long, reaching opposite base of second anal ray, lower rays little thickened. Ventral fins inserted through vertical of occiput, reaching  $\frac{2}{3}$  distance to vent. Lips thin, free laterally. Upper jaw nonprotractile, maxillary, reaching to below anterior margin of pupil. Upper jaw with 2 strongly hooked canine teeth on the premaxillaries, followed by 5 or 6 groups of minute conical teeth concealed in the lips. Lower jaw with 4 similar canines at symphysis of mandible, the outer pair nearly horizontal and strongly hooked toward the rictus, the apex concealed in the lip, a very small pair of canines about midlength of the mandible easily overlooked and exposed only by depressing the

gum. Gill rakers obsolete. Anterior nostril with a bifurcate appendage, orbital appendage trifurcate, the middle filament longest. Nape with a transverse series of fringes crossing the midline, 28 filaments in the series. Lateral line incomplete arched above the pectoral terminating below anterior dorsal rays.

Color in alcohol light straw generally, a russet shade across occiput, some dark pigment along base of dorsal fin, abdomen from base of ventrals to anus with a silvery sheen, dermal appendages colorless.

*Remarks.*—Differs from *Ophioblennius vanderbilti* Fowler in having only two canines in the upper jaw, more rays in the pectoral fins, nasal and orbital appendages, and in the much deeper notch in the dorsal fin. Other differences will be found in the key on page 374.

Named *capillus* in reference to the hairlike row of filaments across the nape.

#### *Leoblennius*, n. g.

*Description.*—Body scaleless, moderately elongate, compressed, the back somewhat elevated. Vertical fins moderate, composed of spines and soft rays. Dorsal fin with a notch at juncture of differentiation. Ventral fins jugular, formula I, 4. Pectoral fins large, reaching past anal spines. Branchiostegal rays 5. Gill openings wide, free, forming a moderate fold across the isthmus. Gill rakers in moderate number. Teeth all conical, 4 strongly hooked canines on the premaxillaries and 4 similar canines at symphysis of mandible. Upper jaw nonprotractile, lips free laterally. Anterior nostrils orbits and nape with dermal appendages, the latter with a series of filaments crossing the midline. Lateral line complete or nearly so, arched anteriorly over the pectoral fins, several pores missing posteriorly.

A well-marked genus of tropical blennies whose affinities seem to be close to *Gloriella* on the one hand and *Ophioblennius* on the other, but differing from the former in the character of the gill openings and from the latter in having 4 rays in the ventral fins.

*Genotype.*—*Leoblennius schultzi*, n. sp.

#### *Leoblennius schultzi*, n. sp.

Fig. 3

*Holotype.*—U.S.N.M. 118037, *Albatross Station* 3921, night anchorage off Honolulu, T. H., Diamond Head Light, S. 62°, E. 3.9', May 6,

1902, surface, electric light. Standard length 25.4 mm.

*Paratype.*—U.S.N.M. 120096, same data as holotype. Standard length 26.0 mm.

*Description.*—The following measurements are expressed in hundredths of the standard length, respectively: Head 32.7; 31.9. Depth 32.7; 31.2. First dorsal spine 19.3; 18.5. Depth caudal peduncle 11.4; 11.5. Length of snout 9.84; 9.2. Width of interorbital space 11.8; 10.8. Diameter of eye 11.4; 11.2. Pre-anus 50.4; 53.8. Pre-dorsal 28.7; 29.6. Length pectoral fin 27.5; 30.4. Base of anal fin 38.2; 38.1.

D. XII, 13. A. II, 15. P. 15; 15. V. I, 4. Br. 5. Body scaleless, oblong, compressed, rather short and deep in comparison with other members of the present group. Dorsal profile well arched, convex from upper lip to above posterior nostril then oblique to origin of dorsal fin which is above preopercle margin. Dorsal spines notably higher than soft rays, the fin divided by a deep notch, last spine joined to first ray by membrane at lower  $\frac{1}{3}$ , last ray attached to caudal peduncle by membrane just before base of upper rudimentary rays of caudal fin, peduncle much deeper than long. Anal fin similar to soft dorsal, last ray free of membrane posteriorly and failing to reach lower caudal rays by pupil diameter. Caudal fin emarginate, its length about equal that of pectoral which reaches to above base of fourth anal ray, its outline symmetrical, lower rays very little thickened. Ventrals inserted below second dorsal spine, their tips reaching midlength of the pectoral fin. Upper jaw nonprotractile, lips free laterally, mouth small gape to below anterior rim of orbit. Four strongly hooked canine teeth at tip of upper jaw and four similar canines near symphysis of mandible, the outer pair deflected outward, no lateral canines evident at midlength of lower jaw. Gill rakers very minute, about 14 on lower arch, pseudobranchiae developed. Nostrils well separated, the anterior with a small, flat terminally fringed filament, orbital tentacle compressed, flap-like, short and blunt, a fleshy band across the nape almost connecting the lateral lines, the margin of which supports 32 filaments or fringes, slightly decreasing in length terminally. Lateral line conspicuously arched above the pectoral fin, its posterior portion indistinct with several pores missing along axis of body. Muscular impressions distinct posteriorly, about 18 from above vent to hypural.

Color in alcohol yellowish generally, a dusky band across occiput and a similar band across nape just before the band of cirri and joining the posterior rim of the eye, a small dusky area on lateral line below fourth dorsal spine, one on midline before dorsal fin, and a series of dusky shades along the back extending up on the membrane between first and second spines with transparent membrane between third and fourth spines, the color scheme alternating throughout length of the fin, gradually fading out on the soft rays. There are two dusky bands across the pectoral fin and a small black spot near the tip of each ray conspicuously marks the outline of the fin, three russet shades on opercle and a dash of the same color downward from lower rim of the eye, orbital tentacle dark at base, tip lighter, fringes on the nape plain yellowish, no dark pigment on upper lip nor at base of caudal fin.

*Remarks.*—This new species differs from all related species as indicated in the key on page 374.

I take great pleasure in naming this interesting species in honor of Dr. Leonard P. Schultz, curator of fishes, United States National Museum.

#### *Blenniella*, n. g.

*Description.*—Body scaleless. Dorsal with 13 spines, a deep notch between spinous and soft portions. Gill openings free from the isthmus. Teeth all conical, arranged in groups of 6 to 8 each; teeth of the units graduated the anterior tooth of each unit longest, the posterior one shortest; each group appearing as a deeply incised tooth with 6 to 8 minute cusps arranged step-fashion, as viewed laterally; lower jaw with similar teeth and in addition 4 strongly retrocurved canines at symphysis of mandible. This genus is intermediate between *Ophioblennius* and *Giffordella*. It is distinguished from the former by the absence of canines in the upper jaw and from the latter by the unrestricted gill openings.

*Genotype.*—*Blenniella rhessodon*, n. sp.

#### *Blenniella rhessodon*, n. sp.

Fig. 4

*Holotype.*—U.S.N.M. 118029, *Albatross Station* 3921, night anchorage off Honolulu, T. H. Diamond Head Light, S. 62°, E. 3.9', May 6, 1902, surface, electric light. Standard length 22.6 mm.

*Paratypes.*—U.S.N.M. 120031. Standard lengths 21.4 to 22.7 mm.

*Description.*—Seven examples were measured and their standard lengths in mm. are as follows: 22.6; 22.6; 22.7; 21.4; 22.0; 21.4; 21.9. The following measurements are expressed in hundredths of the standard length, respectively: Head 21.2; 20.8; 21.1; 19.7; 21.4; 23.4; 22.4. Depth of body 16.8; 15.5; 15.0; 15.5; 15.8; 15.9; 15.5. Height first dorsal spine 9.74; 10.2; 10.6; 10.3; 9.56; 11.2; 9.6. Depth caudal peduncle 7.5; 7.5; 7.9; 8.0; 6.8; 6.5; 8.2. Length of snout 4.4; 4.4; 4.84; 4.7; 4.54; 5.14; 5.0. Interorbital width 5.75; 6.2; 6.17; 6.6; 5.9; 5.6; 5.94. Diameter of eye 8.4; 8.4; 7.93; 8.9; 8.2; 7.94; 8.68. Pre-anus 40.1; 41.6; 42.3; 43.2; 42.7; 43.4; 43.8. Pre-dorsal 22.1; 22.6; 22.0; 23.0; 21.8; 22.4; 22.4. Length pectoral fin 25.7; 27.0; 26.9; 29.1; 27.3; 27.6; 26.5. Base of anal fin 43.8; 44.7; 45.4; 46.4; 45.4; 46.2; 46.6.

D. XIII, 19. A. II, 20. P. 13; 13 or 13; 14. V. I, 2. Br. 5. Body naked, oblong, compressed, rather slender, back not elevated, profile of snout gently convex before eyes, slightly oblique to origin of dorsal then nearly straight to caudal base. Origin of dorsal fin above midlength of opercle. Spines little lower than soft rays, the fin divided by a deep notch nearly to its base, last ray attached to peduncle by membrane and not quite reaching upper supplemental rays of caudal fin. Anal similar to soft dorsal but not extending quite so far back, the last ray free from peduncle which is slightly longer than deep. Caudal fin truncate or weakly emarginate its length about equal to that of the head. Pectoral fin long, reaching to above third anal ray. Ventral fins inserted below midlength of opercle and in contact with the membranous fold across the isthmus, their extremity reaching half the distance from their base to the vent. Gape small, lips free laterally, the maxillary reaching nearly to opposite center of pupil. Teeth in the upper jaw minute, conical disposed in groups of 6 to 8, the anterior tooth of each group notably longer than the posterior tooth, the intervening teeth graduated, the apexes of the teeth in each unit forming an oblique edge. These groups form a continuous series in the upper jaw, about 6 units on either side. Lower jaw with similar teeth and in addition 4 strongly hooked canines near the symphysis of the mandible, the outer pair horizontal, their apexes directed posteriorly and somewhat concealed by the lower

lip. Gill openings free, forming a fold across the isthmus, gill rakers minute, 12 on anterior arch, pseudobranchiae developed. Anterior nostril with a simple filament, orbital filament simple, nape without cirri. Lateral line high, terminating below posterior dorsal spines. Twenty-four myomeric impressions between anus and hy-pural.

Color in alcohol light straw generally, immaculate except upper surface of the head where the postfrontal region is sprinkled with minute black dots. The occipital region has slightly larger black spots surrounded by circles of chestnut brown, giving the impression of small bull's-eyes or targets.

*Remarks.*—This new species can be recognized from other related genera of blennoid fishes by the key on page 374.

Named *rhessodon*, ragged tooth, in reference to its uneven dentition.

#### Genus *Gloriella* Schultz

*Gloriella* Schultz, Copeia 1941(1): 17–18. 1941.

Four strongly hooked canine teeth on the premaxillaries and a single series of small conical teeth not interrupted by the canines. Four similar canines near symphysis of the mandible. Gill openings restricted laterally, not extending below base of lower pectoral ray. Lateral line incomplete. Nape with a fringe of cirrus extending across the midline; anterior nostril with a fringe of tentacles. Caudal fin rounded, the middle rays longest. Other characters those of the genotype.

*Genotype.*—*Cirripectes caninus* Herre.

#### *Gloriella canina* (Herre)

*Cirripectes caninus* Herre, Philippine Journ. Sci. 59(2): 284. 1936 (type locality: Ternate Island, Moluccas); 70(4): 342. 1939.

#### Genus *Giffordella* Fowler

*Giffordella* Fowler, Proc. U. S. Nat. Mus. 80(6): 14, fig. 4. 1932 (Nukuhiva Island, Marquesas Islands) (genotype: *Giffordella corneliae* Fowler).

#### *Giffordella corneliae* Fowler

*Giffordella corneliae* Fowler, Proc. U. S. Nat. Mus. 80(6): 1–16, fig. 4. 1932 (Marquesas).

Original description: “Depth 4 to 4½; head 3¼ to 4; width 1¼ to 1½; snout 3 to 3½ in head; eye 2½ to 3 in head, greater than snout to subequal with interorbital; maxillary reaches back ½ to ¼ in eye length, 2½ to 2⅞ in head; teeth rather large, simple, conic, curved, uniserial in jaws and lower as 10 flaring outward each side; interorbital 3 to 3½ in head, well convex. Gill openings large, extends forward about opposite hind eye edge, isthmus width about half eye. Body scaleless. No flaps or tentacles.<sup>6</sup> Lateral line not evident, side medianly with axial longitudinal impression. D. 14, 14, fin height about ⅔ of head and divided by deep median notch, a little behind vertical of anal original; A. 14, each membrane notched terminally, fin height about one-half of head; caudal slightly less than head, hind edge slightly emarginate; least depth of caudal peduncle 2 to 2⅔ in head; pectoral slightly longer than head, lower median rays longest, reaches little beyond anal origin; ventral nearly long as head, of 2 simple rays.

“Largely transparent brownish or colorless. Dark pigment spots on cranium. Iris silver gray to white.

“*Type.*—U.S.N.M. 91821, collected near light, Nukuhiva, Marquesas Islands, September 25, 1929. Also 11 paratypes, same data, 16 to 22 mm.

“Named for Mrs. Cornelia Bryce Pinchot, first lady of Pennsylvania.”

<sup>6</sup> In connection with the present studies, the holotype of *Giffordella corneliae* Fowler, U.S.N.M. 91821, was reexamined and the following characters (not mentioned in the original description) were observed: Anterior nostril with a small simple filament on the inner edge, a well-developed simple orbital tentacle attached to the membrane of the eye superiorly, and a single similar filament at the occiput on either side of the midline. Four small strongly hooked canines near symphysis of the mandible, the outer pair more or less horizontal. Lateral line distinct anteriorly with 5 or 6 pores. D. XII, 14; A. II, 14; P. 14.

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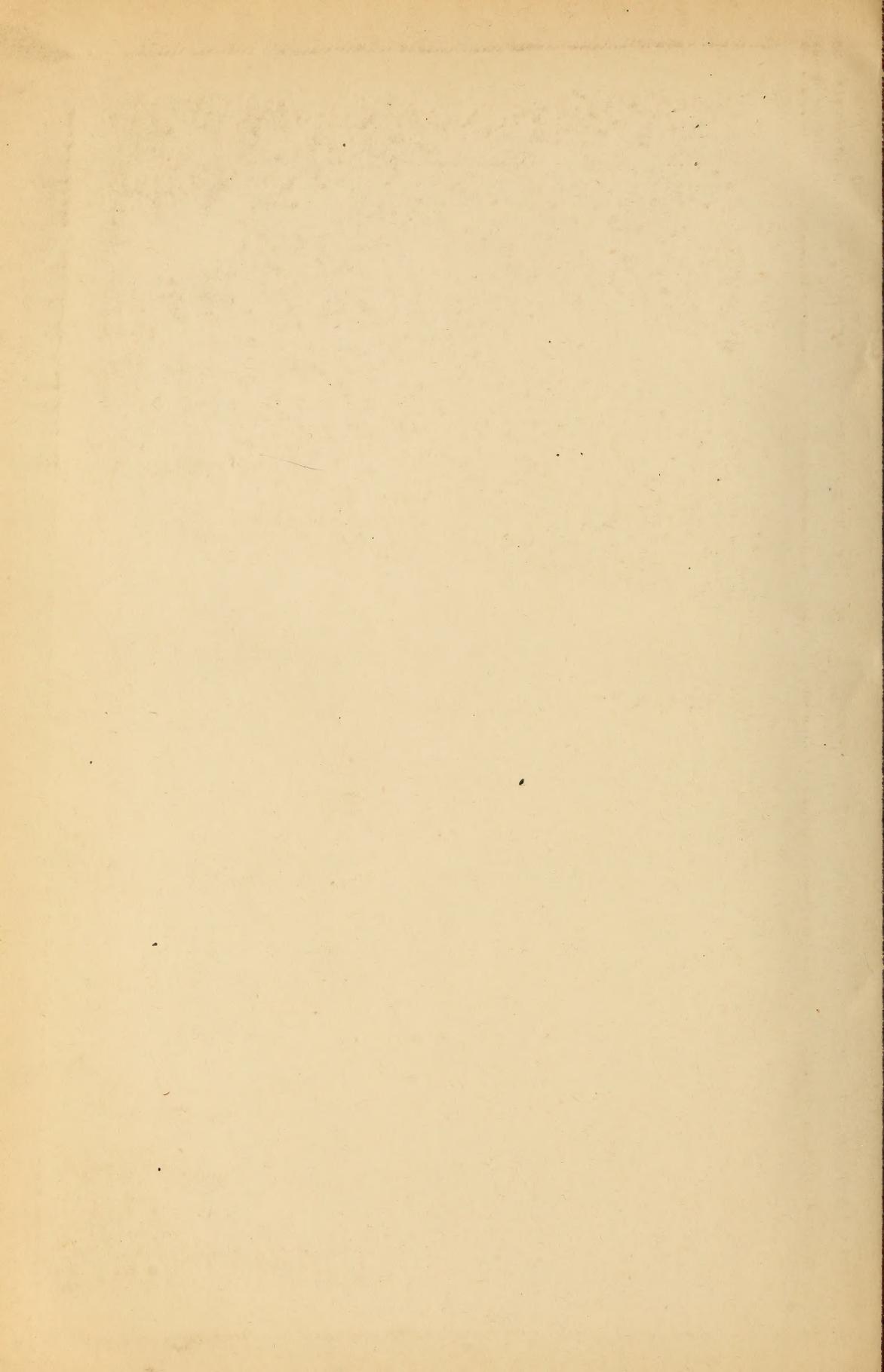














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