ANNALS

OF THE

CARNEGIE MUSEUM

VOLUME XXVII

1938-1939

PUBLISHED BY THE AUTHORITY OF THE
BOARD OF TRUSTEES OF THE CARNEGIE INSTITUTE
PITTSBURGH, PA.
MAY, 1940

ARRANGED FOR PUBLICATION BY

Arthur W. Henn

CARNEGIE
INSTITUTE PRESS

TABLE OF CONTENTS

LIST OF PLATES

LIST OF FIGURES IN TEXT

LIST OF GENERA AND SPECIES NEW TO SCIENCE

nals of the Carnegie Museum — 3/12/38

vol. 27

ART. I. A NEW SCIURAVUS FROM UTAH

BY J. J. BURKE

The new species of *Sciuravus* described in the following pages was discovered by the writer in 1931 in the course of explorations of the Eocene strata of northeastern Utah by a Carnegie Museum paleontological field party. Associated with this specimen were various other mammalian fossils, a preliminary list of which was given in a previous paper.[1] The illustrations which accompany this article are the work of Mr. Sidney Prentice.

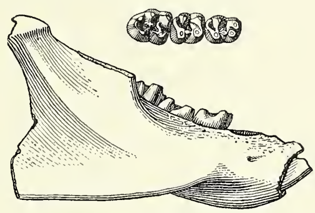


FIG. 1. *Sciuravus eucristadens* Burke. Lateral view of the mandibular ramus and occlusal view of RM_{1-3} of the holotype, C. M. no. 11871. × 2.

Order SIMPLICIDENTATA Lilljeborg

Family SCIURAVIDÆ Miller and Gidley

Genus SCIURAVUS Marsh

Sciuravus eucristadens sp. nov.

Holotype: Right mandibular ramus with the incisor and three molars in place, Carnegie Museum Cat. Vert. Foss. no. 11871.

Horizon: Green River Eocene Series.

Locality: About two miles southeast of Powder Springs, Uinta County, Utah (Sec. 8, T.7S., R.25E. S. L. M.).

Diagnosis: Near *Sciuravus undans* Marsh in size; blade from en-

[1]Burke, J. J., "Preliminary Report on Fossil Mammals From the Green River Formation in Utah." Ann. Carnegie Museum, Vol. XXV, art. III, pp. 13-14, 1935.

Issued December 31, 1937.

toconid extended to hypoconid to form hypolophid[2] in M_{1-2}; blade from entoconid connected by tubercle with ectolophid in M_3; posterior spur from protoconid reaching floor of central valley in M_2, connecting with tubercle in floor of central valley in M_3; central valleys crowded; relatively wide posterior valleys in M_1 and M_3; stylids absent from exits of external and central valleys; M_3 considerably larger than M_1 or M_2; cusps and crests in general robust, predominant over basins.

The mandibular ramus of this specimen is found to be light and slender when compared with those of other specimens of *Sciuravus*, but much of this is doubtless correlated with the age of the specimen (M_3 is scarcely worn, and P_4 was probably not yet securely anchored in place, and in consequence was lost from the ramus). The mental foramen is situated a little anterior to the alveolus for P_4. The masseteric fossa extends forward beneath M_1, but is well defined, despite the youth of the animal. The angle in general conforms rather well to that of the specimen figured by Matthew (Bull. Amer. Mus. Nat. History, vol. IV, p. 59, fig. 13, 1910) as of *Sciuravus nitidus*. The coronoid process is broken away at the base, but the fracture indicates that it was long antero-posteriorly. The ascending ramus rises to a moderate height, and the condyle is somewhat compressed transversely, anteriorly. The dental foramen pierces the ramus near the level of the tooth row. The inferior border of the angle is thickened, and shows no marked deviation from the plane of the ramus, although it is slightly bent medially.

The incisor is broken away a little below the superior alveolar wall. The tooth is of the slender type characteristic of early incisor growth; the anterior face shows the tendency toward flattening found in the incisors of *Sciuravus* from the Bridger Eocene.

The diastema is short, and seems to agree essentially with that found in Bridger specimens.

The P_4, as indicated, has been lost, but the alveolus would indicate that it was near M_1 in size.

The first molar is a rectangular tooth, in this respect agreeing with *Sciuravus undans* Marsh. The main cusps are well developed, and alternating, those of the paramere being somewhat in advance of the cusps of the protomere. The protoconid and the hypoconid have to

[2]The term "hypolophid" as used here and in subsequent places in this paper, is employed in essentially the same sense as by E. L. Troxell in Amer. Jour. Sci., ser. 5, V. art. 32, pp. 386-387, 1923.

some degree preserved their entity as crudely conical cusps, and have not yet merged well with the connecting crests. The entoconid resembles an asymmetrical pyramid; it is drawn out along the buccal edge to form a robust hypolophid blade which extends to the hypoconid. Similarly, the blade of the metaconid extends toward the protoconid. A mesoconid is present, and from the hypoconid a hypoconulid crest curls postero-internally.

A central valley, rather than a basin, is distinguishable; the steep slopes of the entoconid and metaconid eliminate the basining which to a degree characterizes this part of the molar crown in Bridger specimens of *Sciuravus*.

The posterior valley is considerably wider, antero-posteriorly, than in *Sciuravus* generally, and is more basin-like than the central valley.

The anterior valley, as such, is slight. The blade of the metaconid, as noted above, extends toward the protoconid, and is directed as though it were to connect with the protoconid between the prongs of two spurs from that cusp, one of which is directed postero-internally, the other antero-internally. It is the latter spur which finally connects with the metaconid, however, and the junction is made with the anterior flank of the metaconid, rather than in line with the blade. The posterior spur from the protoconid is prominent, short and stubby. It extends toward the central valley, though not enough to impede the latter, and is rather too intimately associated with the protoconid to be said to descend on the flank of the metaconid. The anterior valley, therefore, is confluent with the central valley, although its floor proper is considerably higher than that of the latter.

The mesoconid in this case is a distinct cusp, despite its connection with both protoconid and hypoconid. It is roughly lozenge-shaped, with its anterior and posterior angles connecting with the protoconid and the hypoconid respectively. Internally, it pushes somewhat into the central valley, and its external angle has the effect of bifurcating the external valley. The posterior branch of the external valley is the stronger.

The hypoconulid crest shows a decided bowing posteriorly, which broadens the posterior valley, but the latter is again narrowed toward its internal exit. Near the hypoconid a small tubercle, marked off by notches, shows on this crest.

The M_2 of this species is a larger tooth than M_1, and has more of a square outline. There is less alternation of protomere and paramere cusps, and the cusps of the protomere show greater fusion with their connecting crests. The metaconid is enlarged over that in M_1, the entoconid reduced. The hypolophid blade of the entoconid is more crest-like, while the blade of the metaconid is more extended buccally and thinner. The central and posterior valleys are deeper, but the posterior valley is narrower than in M_1. The lingual cusps are more crowded at the outlet of the central valley than in M_1.

As in M_1, while the blade of the metaconid is directed toward the protoconid, the actual connection with the latter cusp is made by way of the anterior spur from the protoconid, which meets with the anterior metaconid flank.

The posterior spur from the protoconid here reaches to the floor of the internal valley. The spur is crudely robust, rather than delicately attenuate, and crowds the central valley. As in M_1, the anterior valley is confluent with the central valley, but in M_2 a gutter or channel joins the two.

The mesoconid still preserves its identity, although it is now triangular, rather than lozenge-shaped, having lost the angle which intruded upon the central valley in M_1. The protoconid and the hypoconid each connect with an angle of the triangle, while the third angle bifurcates the external valley. The posterior branch of the external valley is now cutting back to such an extent as to tilt the mesoconid obliquely to the antero-posterior plane of the tooth.

It is to be noted that in this tooth the hypolophid crest from the entoconid, transversely directed for most of its course, is sharply deflected posteriorly near the hypoconid to make the connection with the latter cusp. Anterior to the point of deflection there is some swelling of the crest toward the central valley, vaguely suggestive of a tubercle.

The hypoconulid crest is less bowed posteriorly in this tooth than in M_1, and the posterior valley, as mentioned above, is narrower. There are still indications, near the hypoconid, of the tubercle and grooves found on the crest in M_1.

The last molar of this specimen is a large tooth—considerably larger than either M_1 or M_2, and relatively larger than the last molar of any other specimen of *Sciuravus* that I recall having seen, despite frequent size variations that are found in this tooth. It is also quite a distinctive tooth as regards pattern, but unfortunately, variations in the pattern of M_3 of *Sciuravus* are all too common. In the present instance, doubtless some of the characteristics of the pattern are of specific value, but without a more extensive series of specimens than is at my disposal I hesitate to attempt distinguishing them. The tooth approaches M_2 in outline. The alternation of the trigonid cusps is somewhat less distinct. The fusion of the protomere cusps with the connecting crests is much more complete than in M_1 or M_2. As compared with the condition in M_2, the metaconid has continued to enlarge, while the entoconid is reduced.

The hypolophid in M_3 does not consist of a continuous blade attenuated from the entoconid to the hypoconid. There is an extension of the entoconid wall transversely toward the protomere, but it is a short blade; it is connected with a tubercle-like cusp which in turn connects, not with the hypoconid, but with the ectolophid. The anterior valley is more prominent than in M_2. The central valley is about as deep as in the latter molar, while the posterior valley is much wider than in M_2. There is less crowding of the paramere cusps at the outlet of the central valley than in M_2. The posterior valley of M_3 is also deeper than the central valley of M_3. As in M_2, the blade of the metaconid extends toward the protoconid throughout most of its transverse course, but near that cusp it is diverted anteriorly to join with the anterior protoconid spur or crest.

The posterior spur from the protoconid is rather unusual. The spur proper reminds one of that found in M_1, although it is less prominent. It is, however, a short, stubby process, extending postero-internally. This short spur in turn is connected with a tubercle which arises from the floor of the central basin. The tubercle and the spur have fused to the extent of resembling a single crest, which still preserves the identity of its primary elements. The tubercle crowds the central valley, and crowds against the flank of the metaconid. The spur and the tubercle give the channel descending from the anterior valley something of a winding course and an uneven floor.

Although it is still possible to make out vaguely the mesoconid element, the entire connection between the protoconid and the hypoconid is best referred to as the ectolophid. The latter is now elevated into a crest approaching the level of the main protomere cusps, and is disposed more obliquely to the antero-posterior axis of the tooth than were the mesoconid-ectolophid elements in M_2. The anterior branch of the external valley is now practically non-existent, while the posterior branch cuts well postero-internally, anterior to the hypoconid, in the same direction as the posterior valley.

The "hypolophid" tubercle, which connects the (in this tooth) short blade of the entoconid with the ectolophid, joins the ectolophid just anterior to the branch of the external valley. In addition to sending out spur-like connections with the entoconid blade and the ectolophid, this tubercle is somewhat elongated antero-posteriorly; it sends a short spur forward into the already crowded central valley and another posteriorly into the posterior valley. Both spurs die out in the valleys without making further connections.

The hypoconid blends into the hypoconulid crest, the two together making up the high postero-external wall of the crown. The crest is obliquely directed in this part of its course, roughly paralleling in direction the course of the combined posterior protoconid spur and tubercle. Postero-internally, however, a large, cusp-like tubercle conjoins with the crest, diverting the outlet of the posterior valley more anteriorly, and forming an anteriorly bending continuation of the crest. At its junction with the tubercle, the crest is raised into the semblance of a smaller tubercle, and small denticulations show on it nearer the protoconid.

There are certain details of the molar pattern of this species that are of interest. The trend of the posterior spur from the protolophid, for example, is somewhat unusual, even for *Sciuravus*. The fact that it is connected with the tubercle in the central valley in M_3, suggests rather strongly the mode of formation of the spur in M_2, *i.e.* that the protolophid element and the tubercle have fused to form the spur. There is, however, little to indicate such fusion in the spur in M_2 beyond the rather marked uniform thickness of the latter—a character which one would not expect to find in a single spur extending its reach. In M_1 there is no indication of the tubercle in the central valley.

A second feature of the pattern to be noted is the "hypolophid" tubercle of M_3. The latter connects the hypolophid blade of the metaconid with the ectolophid, rather than with the hypoconid; there may be some indication of the tubercle in M_2, although the connection is with the hypoconid; but in M_1 the hypolophid has much of the appearance of being an element entirely of entoconid origin, and connects with the hypoconid.

There are specimens in the Carnegie Museum collections from the

McCarty's Mountain Oligocene, which have been referred to *Ischyromys*, and which show resemblances to these pattern details in the lower molars of the species under description. The Oligocene forms show, in M_3, the spur from the protoconid connected with a tubercle in the central valley; the same condition, moreover, is found in M_2, but in M_1 the spur alone seems represented, and it does not extend into the central valley. In other words, the pattern details in the lower molars of the Oligocene forms are essentially the same as in *Sciuravus eucristadens* m., with the difference that in the Eocene form, there is no central valley tubercle distinct from the protolophid in M_2; also, it should be emphasized that in the McCarty's Mountain specimens, in all three molars, there is a decided tendency for the protolophid spur to extend across to the metaconid flank, rather than directly toward the central basin. Nevertheless, in M_{2-3}, the side of the spur flanking the central valley connects with the central valley tubercle.

There is also well shown, in M_3 of these Oligocene specimens, a tubercle, connecting the blade of the entoconid with the ectolophid. This tubercle can be distinguished, not alone in M_3, but on the remainder of the cheek-teeth, including P_4. In M_2 of one specimen it shows as a distinct conule except for its junction with the entoconid blade, but its usual behavior in the cheek teeth is to connect with the ectolophid.

The fact that in M_3 in *Sciuravus eucristadens* m., and in the last molar in the McCarty's Mountain Oligocene species, we find the entoconid blade connecting with the ectolophid by the way of a tubercle, raises the question as to what was the earlier condition of the protomere connections of the entoconid in M_{1-2} of *Sciuravus eucristadens* m. In M_2 of this species, as I have noted, there is a swelling on the connecting crest which might represent the tubercle, whereas in M_1 the crest connecting with the hypoconid has much the appearance of originating from the entoconid. However, this does not mean that the tubercle has not been present in the past history of the tooth; on the contrary, it may have been present and may have undergone complete fusion with the crest, or it may have been suppressed. In any case, I believe there are good grounds for suspecting that this tubercle, which joins with the spur from the entoconid in the lower molars of the form from the McCarty's Mountain Oligocene, may well represent the condition in this region of the molars of *Sciuravus eucristadens* m.

during the past history of M_1 and M_2, as it has and still does in M_3 of the latter species.

Something of this sort might also be said of the combined posterior protoconid spur and central valley tubercle of the molars of the species from the McCarty's Mountain Oligocene. Although there is no definite evidence that the long spur running into the central basin from the protoconid in M_2 of *Sciuravus eucristadens* m. is composed of the posterior protoconid spur and central valley tubercle (the elements found in M_3 of *Sciuravus eucristadens* m.) nevertheless the peculiar thickness of the long spur in M_2 is strongly suggestive of the former existence of both elements which have now fused to form one. If such has been the case, then the posterior protoconid spur and the central valley tubercle found in M_2 of the McCarty's Mountain Oligocene "Ischyromys" specimens may also represent the retention of a pattern feature once found in the previous history of M_2 of *Sciuravus eucristadens* m.

It is most interesting to note that in both the form from the McCarty's Mountain Oligocene, and in *Sciuravus eucristadens* m. the central valley tubercle is not represented in M_1. The posterior protoconid spur of this tooth is short and rather stubby, and has no connection with the floor of the internal basin. This suggests the possibility that the central valley tubercle was not present in M_1 of either form at the time of their derivation from a common ancestral form, although it might also be pointed out that the tubercle could have been present in both, and have been independently lost through suppression.

The tooth pattern details touched upon here suggest a fertile field of investigation not only as regards the ultimate relationships of the *Sciuravidæ* and the *Ischyromyidæ*, but also in respect to the various elements making up the *Ischyromys* pattern. Involved is the problem of reducing the *Ischyromys* pattern to some of its basic elements and the tracing out of the fate of these components in the various groups in which the pattern is found. It would not be surprising if intensive study of such details of the *Ischyromys* pattern would reveal characters of considerably more taxonomic importance than has generally been attributed to these minutiæ.

Other than in tooth pattern proper, and in the rather unusual size of M_3, the species seems to differ from the known Bridger Eocene representatives of the genus principally in showing less of a tendency toward basining of the molar teeth, with a consequent cusp-crest predominance. Whether there is any progressive tendency on the part of *Sciuravus* to develop greater basining of the cheek teeth at successive geologic levels I do not know, since up to the present time no comparison of representatives of the genus from various Bridger horizons has been attempted. The Utah form appears less specialized than the Bridger Eocene species as regards this trend, but in other respects *Sciuravus eucristadens* m. seems somewhat aberrant when compared with the latter forms and might represent a divergent phlyetic branch within the genus.

MEASUREMENTS

	mm.
Length of cheek dentition (including P_4 alveolus)	9.7
Length of molar series	7.7
M_1 transverse	1.9
M_1 antero-posterior	2.4
M_2 transverse	2.1
M_2 antero-posterior	2.3
M_3 transverse	2.2
M_3 antero-posterior	3.0
Depth of lower jaw at M_1	5.5
Depth of lower jaw at M_3	5.8

ART. II. NEOTROPICAL HOMOPTERA OF THE CARNEGIE MUSEUM

PART 7. REPORT ON SPECIES OF THE SUBFAMILY GYPONINÆ

BY HERBERT OSBORN

Annals of the Carnegie Museum
Vol. XXVII, p.11–62

Issued February 11, 1938
Pittsburgh, Pa.

ART. II. NEOTROPICAL HOMOPTERA OF THE CARNEGIE MUSEUM

PART 7. REPORT ON SPECIES OF THE SUBFAMILY GYPONINÆ

(PLATES I-V).*

BY HERBERT OSBORN

The neotropic members of this group include a large proportion of the known species and, for the genus *Gypona* and allies particularly, we may consider the neotropic realm and especially the South American region, as the natural home of the group, if not its center of evolution.

The species are (many of them) of large size and are often marked with beautiful tints of color though these are seldom present in such strikingly brilliant and bizarre patterns as are to be found among the *Cicadellinæ*. They are characterized by somewhat flattened bodies, the ocelli on the disk of the vertex (except in *Scaroidana*) and the border between vertex and front usually acute, sometimes very thin and sharp, but in some rounded or bluntly angled.

Most of the species have been described from coastal localities and probably a large portion of them are from an arboreal habitat. A number of the species included here are from the interior and some of them, from the upper Amazons, Bolivia and Colombia, may represent a plains or grassy habitat. Unfortunately we have very few records that give any certain indication as to the ecologic relations of the species.

The subfamily is based on the old genus *Gypona* of Germar and has, until recently, been composed largely of species in that genus, the representatives of other genera being very few in number. Dr. E. D. Ball divided the old genus *Gypona* first (1920) into subgenera, and later (Ball and Reeves, 1927) these were raised to generic rank which, considering the great number of species and the fact that fairly good differential characters are indicated, may be counted an advantage in the classification of the group. With the addition of genera, which include South American species not covered by Ball, we may present the following key to genera.

*Illustrations have been made by Mr. J. N. Knull and Mrs. Celeste Taft.

Issued Feb. 11, 1938.

KEY TO THE NEOTROPIC GENERA OF GYPONINÆ.*

1. Pronotum strongly inclined, declivate, lateral angles produced. 2
   Pronotum not or but slightly declivate 3
2. Head triangular, vertex distinctly angulate .... *Proranus*
   Head broadly rounded before, vertex short .... *Clinonana*
3. Dorsal surface pitted, pustulate or rugose 4
   Dorsal surface not pitted, usually finely striate or punctate ... 6
4. Front narrow, deeply excavate, pronotum and elytra rugose. *Rhogosana*
   Front flat, pronotum and elytra not coarsely rugose 5
5. Front narrow, pronotum and elytra pustulate .... *Xerophloea*
   Front broader, wedge-shaped, pronotum striate ...... *Dragonana*
6. Elytral areoles reticulate, at least on apical part ...... *Gyponana*
   Elytra areoles not reticulate 7
7. Anterior margin of head acute, sometimes foliaceous 8
   Anterior margin of head thick, vertex rounded to front or margin obtuse 9
8. Elytral areoles without dots or spots .... *Gypona*
   Elytral areoles including dots or spots .... *Prairiana*
9. Ocelli on disk separate from anterior border of vertex, elytral areoles sometimes dotted or irrorate .... *Ponana*
10. Ocelli on the anterior border of vertex and very close to eyes, elytral areoles not dotted .... *Scaroidana*

Genus PRORANUS Stål[1]

Proranus STÅL, Bidrag. Till. Rio Janeiro, Hemipt. II, 1858, p. 49.
Type, *P. adspersipennis* Stål.

Proranus adspersipennis Stål

Proranus adspersipennis Stål, Rio Janeiro, Hemipt. II, 1858, p. 49.
Epiclines godmani Fowler, Biol. Cent. Am., Homop. vol. 2, 1903, p. 293.

Head narrow, triangular, obtusely angulate in front; prothorax large, hexagonal; hind border slightly concave. Genitalia: female,

**Penthimia* also included in this subfamily is known in the Neotropic realm by very few species and is not represented in the Carnegie Museum. It is separated from *Ponana* by the short thick body with elytra bent and overlapping at tip.

[1]I can find no record of the description of the genus by Spinola and Stål gives "Spin" as author. I believe this species must be taken as the type species of the genus and the genus credited to Stål.

last ventral segment much longer than preceding, notched at middle; male, plates narrow, compressed, bluntly pointed, minutely hairy, extending to tip of pygofer.

Color: dull green; elytra sparsely dotted with fuscous; upper surface of face and pleural pieces punctate; elytra opaque and punctate for the clavus and inner part of corium.

Length, female, 12 mm.; male, 10 mm.

This species was first described from Mexico by Stål and later by Fowler from specimens taken in Guatemala and Panama. Carnegie Museum specimens are from Chapada, Brazil, June and July, acc. no. 2966 (H. H. Smith Coll.); and Provincia del Sara, Bolivia, 450 m. (Steinbach). The author's collection includes specimens from Brazil.

Genus CLINONANA gen. nov.

Pronotum very broad, humeri prominent, disk strongly declivate; head small, transverse, anterior border rounded; vertex flat, ocelli near center of disk. Elytra broad, veins elevated, areoles punctured and rugose. Type species of genus, *Clinonana magna.*

The species upon which the genus is based are large, and the pronotum remarkably elevated posteriorly, strongly declivate to head, much as in *Proranus* but the head is quite different and other structural details seem to exclude it from that genus. While having some apparent affinities for the Oriental genus *Epiclines* it cannot, I think, be considered congeneric.

Clinonana magna sp. nov. (Plate I, fig. 2)

Head short, rounded in front; vertex one-half longer at middle than next the eye; ocelli one-half way between fore and hind border, about as far from each other as from the eye; front hollowed, striate at sides; clypeus one-half longer than sides; loræ elongate. Pronotum very broad; lateral angles produced; margins slightly reflexed; a depressed area bordering the anterior margin; hind border distinctly concave; scutellum large, acuminate at tip; elytra broad; veins somewhat elevated; areoles punctured and rugose. Genitalia: female, last ventral segment twice as long as preceding, produced at the side and at middle; the middle lobe broad and shallowly notched at center; male plates broad, nearly parallel, carinate; tips rather blunt, slightly divergent, reaching beyond end of pygofer.

Gray-brown; disk of pronotum darker brown; scutellum with yellowish basal angles and apex; elytra with a large velvety brown spot mid-way on the costa, preceded by a yellowish hyaline patch and with a yellow nervure extending into the front portion; outer apical cells fuscous at tips; face light brownish tinged with red; legs brownish; tibiæ darker; abdomen light brownish, somewhat marmorate with red.

Length, female, 16 mm.; male, 14 mm.

One specimen, female (holotype), Mana River, French Guiana, March 1917, acc. no. 6008; one male (allotype) Pied Saut, Oyapok River, French Guiana (S. M. Klages), Feb. 1918, Carnegie Museum, acc. no. 6173.

These specimens, while approaching *Proranus* and *Epiclines*, do not strictly belong to either on account of the broader, less triangular head, and the differences in structure of the parts of the face.

Clinonana declivata sp. nov. (Plate I, fig. 1)

Head and pronotum strongly declivous; head large, broadly rounded in front, about twice as long at middle of vertex as next the eye; ocelli behind the middle, a little farther from each other than from the eye; margin thick, flattened; antennæ in rather deep pits; front hollowed at base; clypeus nearly twice as wide as long, sides parallel; tip truncate. Pronotum long, lateral margins nearly straight, divergent, postero-lateral margin emarginate; hind border concave; disk transversely, coarsely, striate and punctate; scutellum long; apex long, acuminate; disk minutely rugose and striate; elytra with veins distinct, margined with punctures. Genitalia: female, last ventral segment as long as preceding; lateral angles produced and a median lobe with a broad notch at center.

Greenish-yellow; margin of head, the ocelli, humeral angles, narrow line at tip of scutellum and wing veins, black; lines on the legs and hind border and ventral segments, red; elytra yellowish, transparent, veins concolorous.

Length, 13 mm. Width at humeri, 5 mm.

Described from one specimen, female (holotype), Prov. del Sara, Bolivia (Steinbach), Nov. 30, 1912, Carnegie Museum acc. no. 5064.

Genus RHOGOSANA gen. nov.

Body flattened, sides nearly parallel; head as wide as pronotum; vertex depressed, anterior border acutely angled; front excavate at base; face strongly reflexed; eyes prominent; elytra long, nearly parallel margined, apex obliquely subtruncate, venation coarse. Type species *Rhogosana rugulosa*.

Rhogosana rugulosa sp. nov. (Plate IV, fig. 22)

Head broad, obtusely angulate; vertex nearly half longer at middle than next the eye, distinctly depressed at middle and before ocelli; ocelli behind the middle, as far from each other as from eye. Front deeply excavate at base, antennæ in deep depressions and overhung by ridge. Front narrow, tapering to clypeus; clypeus long, sides sinuate, disk carinate; cheeks rugose. Pronotum twice the length of vertex with depressions near anterior border and coarse transverse striæ on disk, hind border deeply concave, lateral angles prominent, lateral margins sinuate; scutellum with broad smooth patch at basal angles, anterior disk coarsely punctate or subrugose; apical part transversely rugose; elytra rugose, margins of veins punctured; tips of claval veins distinctly curved. Female, last ventral segment nearly twice the length of preceding, deeply sinuate on hind margin, middle lobe rounded behind; pygofer short, sparsely setose at base, densely setose at tip.

Color, dull yellowish or fulvous, ocelli brilliant, eyes brown; pronotum with four longitudinal stripes widened posteriorly; basal angles of scutellum brown; elytra dull yellowish; clavus tinged with pinkish; clavus, corium and apical cells with numerous coarse fuscous spots or blotches. Beneath dark brown; femora, tips of tibiæ, coxæ and margins of ventral segments and hind tarsi infuscate. A stripe above ocelli, tibiæ, base of hind tarsal segments and dorsum of abdomen, dull yellowish.

Length, 18 mm. One specimen, female (holotype), Pied Saut, Oyapok, French Guiana, Jan. 1918 (S. M. Klages), Carnegie Museum acc. no. 6111.

This species, while evidently belonging to the Gyponinæ differs so radically from any of the species known to me that it is made the type of a new genus. It has something of the general fascies of the Jassine genus *Koebelia* and of the *Fulgorid* genus *Cyrpoptus* but the position of the ocelli and other fundamental characters ally it to the Cicadellidæ and the subfamily Gyponinæ. It should probably be placed between *Xerophloea* and *Prairiana* although showing little relationship to either.

Genus XEROPHLOEA Germar

Xerophloea GERMAR, Zeit. Z. Ent., p. 190, 1839.

Related to *Gypona*, the margins of head flattened, very thin and foliaceous; ocelli near base of vertex; surface, especially above, densely pitted and pustulate. Genotype *X. viridis* (Fab.)

Xerophloea viridis (Fabricius)

Ceropis viridis Fabricius, Ent. Syst. iv, p. 50, 1794.
Xerophloea grisea Germ., Zeits. Z. Ent. 1, p. 190, 1839.
Parapholis peltata Uhler, Bul. U. S. Geog. Surv. Ill., p. 461, 1877.
Xerophloea viridis Osborn & Ball, Proc. Iowa Acad. Sci., iv, p. 179, pl. 19, fig. 1, 1897.
Xerophloea viridis Lawson, Pan Pacific Ent., vii, p. 167, 1931.

Light green, males often more or less infuscate. Head flattened, margins very thin; pronotum rugose, pitted; elytra with veins distinct, the areoles pustulate. Length, female, 7 mm.; male, 6.5 mm.

Nymphs with very broad head, densely hairy; abdomen narrow.

This species has been variously named on account of its wide distribution and the extent of variation especially in color of males.

Specimens in the Carnegie Museum collection from "Prov del. Sara, Bolivia, 450 m. (Steinbach)."

I have specimens from the West Indies, Guatemala, and many localities in the United States, and its distribution may be given as ranging from northern United States to Argentina in South America, including the West Indies as well as the mainland, since records cover Jamaica, Barbados, Puerto Rico and Cuba.

Dr. Lawson (1931) has reviewed the genus and described a number of species from southwestern United States but all specimens referred to here are, I believe, the widely distributed *viridis*.

Xerophloea tuberculata sp. nov. (Plate IV, fig. 23)

Larger than *viridis* and dark gray with a prominent tubercle or elevation near apex of front. Head broad, vertex produced, obtusely angulate, disk rough; front narrowing from antennæ to clypeus with a rather flat carina and a distinct elevation near apex; clypeus narrow slightly passing cheek; pronotum rough pitted and pustulate; scutellum finely and clavus coarsely pitted and pustulate. Female, last ventral segment half longer than preceding, rounded behind.

Mottled gray and fuscous. Vertex with an irregular median stripe; elytra with a diffuse oblique band on clavus and the apical half mostly dark brown with a whitish hyaline patch on costa beyond the middle; apical veins whitish; beneath gray, apices of femora infuscate.

Length, female, 8 mm. Described from one female (holotype) from Bartica, British Guiana, in author's collection, collected by H. M. Parish, July 5, 1901.

Aside from the larger size and difference in coloration this species is at once separated by the hump on the apical part of the front.

Genus GYPONA Germar (*sens. lat.*)

GERMAR, Mag. Ent., iv. p. 73, 1821.
BURMEISTER, Gen. Ins., i, gen. 16, 1838.
WALKER, List Homop. Ins. Brit. Mus., p. 834, 1855.
AMYOT ET SERVILLE, Hist. Nat. Ins. Hemiptères, p. 579, 1843.
STÅL, Hemip. Fabriciana, ii, p. 84, 1868.
SPANGBERG, Bihang. Till. K. Sv. Vet. Akad. Handl., v, no. 3, p. 5, 1878.

This genus, founded by Germar (1821) presents an extended and very bewildering array of tropical species. The most extended paper on the group is the one by Spangberg (1878) which includes mention of ninety-six species, and of these eighty are credited to the neotropic region; in a later paper (1881) are seventeen species, eleven neotropic; and another (1883) eleven new species, seven neotropic. A large proportion of these species were first described by Stål (1854) or Spangberg (1878). Both omit any reference to the species described by Walker in the British Museum "List of Homoptera" (1851-8) and in the "Insecta Saundersiana" (1858) which contains a large number credited to neotropic fauna. Berg (1879) records the species known for Argentina. Fowler (1902) includes a large number of species in the "Biologia Centrali Americana" with many described as new. Uhler, Van Duzee, Gibson and others have added some species and Dr. E. D. Ball (1920) has given a careful revision of the species for North America north of Mexico but most of these species are limited to the Nearctic region.

It is evident that Mexico, Central America and northern South America furnish the greatest wealth of species and it also seems probable from the records heretofore given and the material before the writer from the Carnegie Museum and in his own collection from neotropic localities, that many of the species have very limited geographic or ecologic distribution. These records however serve to extend the range of many of the species and no doubt future exploration will add greatly to the range and probably to the number of species credited to this region.

For a key to the genera, as recognized in this paper, see, *ante* page 12.

Genus GYPONANA Ball

Gypona (*Gyponana*) BALL, Ann. Ent. Soc. Am., xiii, p. 85, 1920.
Gyponana, BALL and REEVES, Ann. Ent. Soc. Am., xx, p. 489, 1927.

Distinguished by the reticulated elytral areoles. The species are all green, usually pale and the elytra often milky hyaline. Genotype, *Gyponana octolineata* (Say).

Gyponana lineata (Burmeister)

Gypona lineata Burmeister, Genera Insectorum I, [pl. xiv.], Genus 16.
Gypona lineata Spangberg, Species Gyponæ, Bih. Till K. Sv. Vet. Akad. v, no. 3, p. 5, 1878.

Head elongate, rounded, very faintly angulate, flat; vertex nearly as long at middle as between the eyes; ocelli near the hind border, as near together as to the eye; pronotum slightly longer than vertex; elytra densely reticulate to the base. Female, last ventral segment longer than preceding, truncate, with a shallow notch at middle. Male plates narrow, spoon-shaped, upturned, with a small appendage at tip.

Color: pale green with seven fulvous lines on the pronotum and four on the vertex, the inner pair including the ocelli; elytra hyaline with the veins and reticular veinlets green.

Length, female, 9 mm.; male, 8 mm.

Specimens from Buenos Aires, Argentina, collected by W. S. Blatchley, and also from Espirito Santo, Brazil; Cruz Alto, Rio Grande do Sul, in author's collection. One placed in Carnegie Museum.

Gyponana chiriquensis (Fowler)

Gypona chiriquensis Fowler, Biol. Cent. Am., Homop., ii, 1908, p. 298.

Large, fusiform; head narrow, nearly as long as broad; vertex rounded, subangulate, flat, edge sharp; ocelli much nearer to base than apex, about as far from each other as from eye; pronotum scarcely longer than vertex, widening behind; elytra reticulate on apical third, subhyaline, narrowing toward apex and bluntly rounded. Genitalia: female, last ventral segment half longer than preceding; male, last ventral segment half longer than preceding, plates short, enlarged and rounded apically, half as long as pygofer; pygofer short, sinuate on lower margin, enlarged apically.

Pale yellowish green with very faint traces of stripes on pronotum and with the elytral veins pale orange yellow.

Length, female, 14-15 mm.; male, 13 mm.

Specimens from Provincia del Sara, Oct. 13, Dec. 12, Steinbach, Carnegie Mus., acc. nos. 5064 and 6443; Santa Cruz de la Sierra, Bolivia, 450 m., acc. no. 4549. The author's collection contains specimens from Yungas de la Paz, Bolivia, 1000 m.; Bartica, British Guiana, Aug. 22, 1901, H. S. Parish Collector; and Pachitia, Peru and Coroica, Bolivia; giving it a wide range from Panama to Peru and British Guiana. Fowler's description was based on the female only from Volcan de Chiriqui, Panama. Two specimens from "Napa R., Peru" and one from Teffe, Brazil are in Dr. DeLong's collection.

Gyponana boliviana sp. nov. (Plate II, fig. 11)

Large, fusiform; head narrow, paraboloid; vertex as long at middle as between the eyes; eyes small; ocelli near hind border, nearer to each other than to the eye, pink. Pronotum about as long as vertex, widening behind. Elytra narrowing to apex, reticulate on apical third, costal area broad with a few weak, oblique cross-veins near apex. Genitalia: female, last ventral segment short, scarcely as long as preceding, trisinuate, the three sinuations of equal depth and the four lobes equally produced; pygofer short, robust; male, last ventral segment as long as preceding, rounding, truncate medially; plates thick at base, narrowed and acute apically, three-fourths as long as pygofer; pygofer narrow, ventral border nearly straight or slightly sinuate.

Greenish yellow with distinct golden yellow stripes on vertex, eight on pronotum and two on scutellum; elytra subhyaline; veins golden yellow; beneath, pale yellow; tarsi of middle legs of male, fuscous; prothorax with a narrow whitish border. Female slightly darker than male.

One female (holotype) Cochabamba, Bolivia, in the author's collection. One male (allotype) from Inachaca, Bolivia, alt. 2500 m. (J. Steinbach), Carnegie Mus. acc. no. 6873. There seems to be no basis for separating these specimens, although they come from different localities, since they agree very perfectly in structural details, and the slight difference in color cannot be considered of specific value. The species is an interesting addition to the group with reticulate veins on elytra. It differs from *chiriquensis* in the narrower, more paraboloid vertex, nearness of ocelli to each other, and the golden yellow stripes on vertex and pronotum.

Gyponana brachycephala (Spangberg)

Gypona brachycephala Spangberg, Gyponæ, Bih. Till K. Sv. Vet. Akad., Handl. V, no. 3, p. 9, 1878.

Head short, sublunate; vertex but little produced; ocelli equally distant from each other, the eyes and the anterior border; pronotum subquadrate, anterior margin longer than posterior; elytra sparsely reticulate toward apex, membrane rather wide. Male, last ventral segment almost equal in length to the preceding with the hind border rounding and subtruncate.

Pale yellow or stramineous with eight faint golden-yellow stripes on the pronotum, indistinct or obsolete.

Length, male, 12.5 mm. A specimen from Bahia, Brazil, Nov. 1907, Carnegie Mus. acc. no. 3441, is referred to this species. Spangberg's description was based on a male from "Bogota."

Genus GYPONA Germar (*sens stricta*)

Gypona (*sens lat.*) GERMAR, Mag. Ent., 4, 1821, p. 73.
Gypona (*sens lat.*) BURMEISTER, Gen. Ins., i, 1838, gen 16.
Gypona (Gypona) BALL, Ann. Ent. Soc. Amer., xiii, 1920, pp. 83-100.
Gypona (*sens stricta*) BALL and REEVES, Ann. Ent. Soc. Amer., xx, 1927, p. 489. (*Should be* Germar, *not* Burmeister.)

The genus, as here restricted, includes those forms without reticulate elytral areoles and without dots or lines in the areoles, but with acute margins between vertex and front. Type of the genus (as limited by Ball), *Gypona glauca* Fab.

Gypona glauca (Fabricius) (Plate II, fig. 12)

Cercopis glauca Fabricius, Syst. Rhyng., p. 91, 16, 1803.
Gypona glauca Burmeister, Hand. der Ent. II, 1, 1835, p. 114.
Gypona glauca Stål, Hemiptera Fabriciana II, 1868, p. 84.
Gypona glauca Spangberg, Species Gyponæ, Bih. Till. K. Svenska, Vet. Akad., Handlingar V, no. 3, 1878, p. 15.
Gypona glauca Fowler, Biol. Cent. Am., Homop. II, 1903, p. 303.

Head broad, eyes small; vertex broad, evenly rounded before; ocelli behind the middle, a little nearer to each other than to eye; front slightly depressed at base, rounded to clypeus; clypeus borders nearly parallel. Pronotum transversely striate, emarginate behind; scutellum acuminate. Genitalia, female, last ventral segment sinuate, produced into rather long broad teeth each side of a broad median notch. Male, last ventral segment nearly twice as long as the preceding, rounded behind; plates short with blunt tooth-like processes at tip.

Color, yellowish; border of vertex, narrow border of pronotum and inner part of elytra infuscate. Elytra hyaline, veins of inner half and cells at apex more deeply infuscate. Beneath yellowish, tips of tibiæ and tarsal joints dusky; two lines on fore and middle tibiæ. Males darker than females and variable in extent of black.

Length, female, 12 mm.; male, 10.5 mm. Numerous specimens from Las Juntas (Steinbach coll.) Dec. 1913, Carnegie Museum acc. no. 5066; and S. Antonio de Guaporé, Brazil, July 26, 1909 (Haseman), "Sweeping on island in Rio Guaporé," Carnegie Museum acc. no. 4043. A specimen from "Manaos, Brazil" and one from "Napa R., Peru" are in Dr. D. M. DeLong's collection.

This well known and apparently common species has a wide distribution in Central and South America.

Gypona pulchella sp. nov. (Plate IV, fig. 24)

Head broad, almost as wide as pronotum; vertex produced, about one-fourth longer at middle than next the eye, broadly rounded; ocelli at middle and as far from each other as from eye; front depressed at base; pronotum nearly twice the length of vertex, rather deeply concave behind. Female, last ventral segment as long as preceding, hind border sinuate, central part a little more deeply than sides.

Color, bright sulphur yellow; vertex, pronotum and costal border of elytra tinged with light orange; clavus and inner part of corium beyond the cross-veins rich golden brown, a basal patch suffused with fuscous; apex smoky, beneath pale sulphur yellow, the two last ventral segments tinged with pale orange. Abdomen above orange, disc blackish; legs pale yellow, tips of tibiæ and tarsal joints brownish.

Length, 9 mm. One specimen, female (holotype), Mana River, French Guiana, May, 1917, Carnegie Museum acc. no. 6008. This is a very beautiful species with much the pattern of *glauca* but it is much smaller and differs in many details from that species. Two specimens (paratypes), one female from Prata Brazil, and one with abdomen missing from Yuvimagnas Peru in Dr. DeLong's collection.

Gypona thoracica (Fabricius) (Plate III, figs. 13-14)

Cercopis thoracica Fabricius, Syst. Rhyng., 1803, p. 91, 15.
Gypona thoracica Burmeister, Gypona, 2, 1838. Gen. 16.
Gypona thoracica Stål, Hemip. Fabriciana, II, 1869, p. 84.
Gypona thoracica Spangberg, Gyponæ, 1878, p. 75.
Gypona fusiformis Spangberg, Gyponæ, 1878, p. 29.

Large, head narrower than pronotum; vertex long, paraboloid, flat, margin thin; ocelli behind the middle and farther from each other than from eye; pronotum scarcely half longer than vertex, widening posteriorly, distinctly striate; scutellum almost entirely minutely punctate. Elytra mostly hyaline, veins strong, apex narrow. Genitalia: female, last ventral segment at sides nearly twice as long as preceding, rather deeply emarginate across its hind border with a slight sinuation at middle where the segment is about as long as the preceding; male, last ventral segment long, hind border rounded; plates narrow, tapering, reaching tip of pygofer.

The females are mostly deep olive yellow to greenish, sometimes with golden luster, the elytra hyaline with the inner veins black. The males are extremely variable in color, especially the pronotum which may vary from bright golden yellow to dense black, the darker ones having a pale median line from vertex to scutellum.

Length, female, 17 mm.; male, 15 mm. The Carnegie Museum collection includes a good series of both sexes from Santarem, Brazil (S. M. Klages Coll.), July, 1919, acc. no. 6324.

My collection includes also a number of specimens of both sexes from Bartica, British Guiana, collected by H. M. Parish, April and July 1901. Two females and one male from "Manaos, Brazil" are in Dr. DeLong's collection.

The sexes are strikingly different in appearance and the males remarkably variable in color but aside from the agreement in essential structure the fact that only females of Spangberg's *fusiformis* and only males of the *thoracica* form appear in extended series and that both are evidently taken in the same localities at the same dates convinces me that they should be placed together.

There are doubtless other names to be added to the synonomy owing to the great variability of the male. Walker's *smaragdula* seems to be a very good description of some varieties of the male and Spangberg's *mirabilis* fits the light forms of males in all particulars except the width, given as 7 mm., a width that is all out of proportion for any species in the genus that I have ever seen. This is possibly an error in printing.

The records so far indicate a distribution from Guiana to the Amazons, as *thoracica* is credited to Guiana and Brazil, Spangberg's *fusiformis* to "Cayenna" and "Amazon," and if we include the records for *mirabilis* and *smaragdula* we have "Cayenna" and "Para."

Gypona vulnerata Walker. (Plate I, fig. 3)

Gypona vulnerata Walker, Ins. Saund. Hem., 1858, p. 102.
?*Gypona viridescens* Walker, List Homop. Sup. 1858, p. 257.
?*Gypona obesa* Spangberg, Ent. Tids., 1883, p. 102.

Female, head long; vertex much produced, rounded, nearly semicircular or slightly parabaloid, more than one-half as long as width between eyes; ocelli a little behind the middle and nearly as far from each other as from the eye; front depressed at base, flattened on the disc, roundingly narrowed to clypeus; clypeus, margins parallel, apex truncate; loræ narrow; cheek borders nearly straight; pronotum one-half longer than vertex, hind border emarginate; elytra slightly longer than abdomen, vitreous. Genitalia: female, last ventral segment with lateral lobes twice as long as preceding segment, slightly produced and notched at center; outer part of lateral lobes thin and transparent.

Yellowish-green; margin of vertex red, partly black, ocelli red; eyes fuscous, base ferruginous; pronotum with narrow margin orange yellow; elytra hyaline, central part of clavus somewhat infuscated; disc of metathorax and basal bands on abdomen blackish; beneath yellowish-green, tarsi ferruginous.

Length of body 10 mm. with wings, 10.5 mm. Width of pronotum 4 mm.

This description is drawn from a series of specimens, Provincia del Sara, Bolivia, 450 m., J. Steinbach, Carnegie Museum acc. no. 6443. It agrees so closely with Walker's description that it seems correctly placed here, although the female segment does not agree with the figure given by Fowler in the "Biologia." However his figure is from a Mexican specimen and it is quite possible that it may represent a different species.

The following description applies to the form we consider the male of this species:

Male very similar in structure to *vulnerata* and we believe the male of that species. The head long, vertex strongly striate; ocelli a little behind the middle, nearly as distant from each other as from the eye; front depressed at base, flattened on the disc; clypeus with parallel margins; pronotum emarginate behind; elytra mostly hyaline. Genitalia: male, last ventral segment as long as preceding, plates rather short, thick and bluntly pointed, as long as pygofer.

Dull yellow or greenish, the upper part of head, pronotum, scutellum and base of elytra dark brown or fuscous and black; vertex with a central yellowish line, a small dot over base of antennæ and a dot each side on hind border; ocelli red; the fuscous spot on elytra extends slightly beyond tip of scutellum as in typical *vulnerata;* apical cells blackish, and the dorsum except the lateral and basal abdominal segments, black. Beneath yellow; tarsi and male plate ferruginous-brown.

Length, 9 mm. Described from two specimens, males, Provincia del Sara, Bolivia, Steinbach, Dec. 1912 and Feb. 1913, Carnegie Museum acc. no. 5064.

These specimens agree so perfectly with the *vulnerata* female described above, in all structural characters, that I feel quite confident that they must be the male of that species. However, the difference in color makes it desirable to describe it separately. *Vulnerata* as here defined, has some striking similarities with *verticalis* and *unicolor* and probably represents a derivation from the same stock, possibly the original stock for those species, and occupies for tropical America the place those species fill in Mexico and southern United States.

Gypona aurifera sp. nov. (Plate IV, fig. 26)

Head broad, almost as wide as pronotum, eyes small; vertex broad, roundingly angulate, half longer at middle than next the eye, margin depressed; ocelli behind middle, a little farther from each other than from the eye, twice as far from each other as from base; front depressed at base; pronotum two-thirds longer than vertex; elytra tapering to narrow tips, fifth apical cell short and acute at tip, due to fusion of fourth with marginal vein. Female, last ventral segment nearly half longer than preceding, hind border sinuate at sides and excavate at middle half-way to base; male, plates short, broad, rounded at apex, not reaching tip of pygofer which has the lower border produced and tinged with red.

Color, golden yellow. Scutellum tinged with fulvous in basal angles; ocelli red, a black dot each side on pronotum in line with inner border of eye and a black streak on base of clavus. Elytra subhyaline, faintly smoky on appendix and tips of apical cells. Beneath golden yellow, tips of tibiæ and tarsi tinged with green. Margin of the excavation on last ventral segment brownish.

Length, to tip of elytra, female, 12.5 mm.; male, 11.5 mm.

One female (holotype), one male (allotype), Provincia del Sara, Bolivia, 450 m. (J. Steinbach), Carnegie Museum acc. no. 6443. Two females Rio Bermejo, Argentina, J. Steinbach, also appear to belong here, although they are a trifle smaller and lack the black dots on the pronotum.

Gypona fulvotincta sp. nov. (Plate V, fig. 34)

Head narrower than pronotum; vertex produced, depressed at margin, broadly rounded; ocelli behind middle, little farther from each other than from eye; front slightly depressed at base; pronotum twice as long as vertex, distinctly concave behind. Male, last ventral segment a little longer than preceding with extremely shallow indentations on hind margin forming a broad median lobe. Plates widened toward apex, tips rounded, thin, translucent, scarcely as long as pygofer.

Bright golden fulvous; ocelli red; eyes black; elytra with large infuscate patch on apical half of clavus and inner part of corium extending obliquely to costa on base of first apical areole. Apical areoles and apical part of anteapicals smoky; beneath golden yellow, legs a little paler, tarsi dusky, abdomen above tinged with red.

Length, 9 mm.

Described from two specimens, males (holotype and paratype) Puerto Suarez, Bolivia, 150 m. (Steinbach), Carnegie Museum acc. no. 3844.

Gypona bigemmis Spangberg (Plate II, fig. 7)

Gypona bigemmis Spangberg, Species Gyponæ, 1878, p. 34.

Head rather broad, rounded before; vertex half longer at middle than next eye, with slightly depressed margin; ocelli near middle, as far from each other as from eye; pronotum nearly twice as long as vertex, deeply concave behind. Female, last ventral segment a little longer than preceding, hind border emarginate with a central rounded lobe nearly as long as lateral angles. Male, last ventral segment a little longer than preceding, plates narrow, with parallel margins, blunt tips reaching tip of pygofer.

Pale yellow. Male tinged with fulvous, ocelli rosy, eyes brown, tips of elytra a little smoky, a black dot at base of clavus.

Length, female, 7.5 mm.; male, 6.5 mm. Two females, June, one male, July 1898, Bonda, Colombia, Carnegie Museum acc. no. 1999. Spangberg described the male only. The females associated here agree so perfectly in all respects that I feel confident of their relation.

Gypona lineosa sp. nov. (Plate II, fig. 9)

Head broad, nearly as wide as pronotum, long, paraboloid; vertex about two and one-half times as long at middle as next the eye; vertex margin very thin; ocelli at middle, twice as far from each other as from eye. Pronotum as long as vertex, hind border faintly concave. Male, last ventral segment produced at middle into a broad tooth, little longer than preceding segment; plates very short, bluntly rounded behind with slender appendage at tip; pygofer short with numerous bristles bordering the margin.

Pale green; vertex with a median fulvous line, scarcely touching apex; ocelli and eyes brown; lateral border of pronotum and costa yellowish; beneath pale greenish yellow.

Length, 7.5 mm. One male (holotype) Bartica, British Guiana, April 18, 1901 (Parish, collector). Distinguished especially by long vertex. Type in author's collection.

Gypona hyalina sp. nov. (Plate IV, fig. 29)

Head broad; eyes small. Vertex half longer at middle than next eye, margin depressed; ocelli behind the middle, as far from each other as from eye, nearly twice as far from each other as from base. Pronotum half longer than vertex. Elytra narrowing to tip. Female, last ventral segment truncate or faintly sinuate with median notch extending one-third way to base.

Color, pale yellow, some specimens faintly greenish and others tinged with brownish; ocelli margined with orange red. A small black dot each side of pronotum behind eye. Elytra hyaline, veins faintly greenish.

Length, 10 mm. Five specimens, females (holotype and paratypes) Santarem, Brazil, July 1919 (S. M. Klages), Carnegie Museum acc. no. 6324. Somewhat like *aurifera* but smaller, elytra entirely transparent and the notch in female segment much smaller.

Gypona vitrea sp. nov. (Plate IV, fig. 24)

Head narrow, rounded, subangulate; vertex produced nearly twice as long at middle as next eye, margin depressed; ocelli before the middle, nearly twice as far from each other as from base. Pronotum half longer than vertex. Female, last ventral segment as long as preceding, truncate, faintly sinuate on hind margin.

Greenish yellow; vertex and anterior part of pronotum tinged with fulvous; eyes and ocelli red; a black dot on pronotum each side and a conspicuous black dot on base of clavus. Elytra vitreous hyaline tinged with greenish yellow except at tip; veins greenish yellow.

Length, 7 mm. One female (holotype) Provincia del Sara, Bolivia, Steinbach, Carnegie Museum acc. no. 5064.

Gypona viridula sp. nov. (Plate IV, fig. 32)

Head narrow, short, broadly rounded; vertex slightly longer at middle than next the eye, bluntly depressed; ocelli before the middle, twice as far from each other as from eye; front flattened at base. Pronotum three and a half times as long as vertex. Elytral veins rather indistinct, internal apical areole very narrow. Female, last ventral segment long, nearly three times as long as preceding, with a broad deep excavation to more than one-half the distance to the base; pygofer broad; ovipositor short, not reaching tip of pygofer.

Pale yellowish green; vertex with greenish white border, a submargin of green; ocelli rosy; pronotum, anterior border, a transverse arcuate line, posterior angles, two stripes, and the apex of scutellum, propleura and lower part of face, green; disc of vertex, pronotum and clavus, and base of corium, pale greenish olive. A spot at the posterior angle, a narrow median line toward base, hind border on each side of base, broken margin at base of clavus, some scattered spots at base of clavus and corium, ivory-white. Apex of elytra hyaline, veins toward tip and base of appendix, fuscous. Appendix with whitish band beyond which it is smoky.

Length, to tip of elytra, 8.5 mm. One specimen, female (holotype) Quatra Ojos, Bolivia (Steinbach), Nov. 1913, Carnegie Museum acc. no. 5065. A specimen, female, from "Napa R., Peru" almost identical in color pattern and size but with a different female segment is in the collection of Dr. D. M. DeLong.

Gypona flavicosta Stål

Gypona flavicosta Stål, Rio Jan. Hemip., Pt. 2, 1862, p. 46.
Gypona flavicosta Spangberg, Species Gyponæ, 1878, p. 38.

Rather slender, head nearly as wide as pronotum, distinctly flattened, vertex produced, nearly twice as long at middle as next the eye, evenly rounded before; ocelli half way from base to border, as far from each other as from eye; front rather narrow, half longer than broad; pronotum half longer than vertex, distinctly concave behind border. Genitalia, female, last ventral segment slightly longer than preceding at the sides, lateral angles obtuse, hind border faintly sinuate and with broad notch at middle.

Golden yellow above; pale yellow beneath; anterior border of vertex, margin of pronotum and costa pale yellow; border of vertex with narrow brown line scarcely visible from above; ocelli dark red; eyes reddish brown; antennæ yellow at base, setæ black; legs pale yellow, tips of tarsi dusky; elytra subhyaline, slightly smoky at tip which lacks concolorous yellow color, veins concolorous.

Length, 7 mm. One specimen, Cayenna, February 1917, Carnegie Museum acc. no. 5873.

Gypona pulchra Spangberg

Gypona pulchra Spangberg, Species Gyponæ, Bihang Till K. Sv. Vet.-Akad., Handl. Band 5, no. 3, 1878, p. 32.

Head narrower than pronotum; vertex rounded, one-third longer at middle than at eye; ocelli at middle and as near to each other as to eye. Pronotum nearly twice as long as vertex. Female, last ventral segment broadly sinuate and with a median emargination.

Color olive-brown tinged with reddish especially on the elytra. Apices of elytra subhyaline and faintly smoky.

Length, female, 9 mm. A specimen from "Las Juntas, Bolivia (Steinbach coll.) Dec. 1913, Carnegie Museum acc. no. 5066," and one "Santarem, July 1919, S. M. Klages, acc. no. 6324" are referred to this species.

Gypona germari Stål

Gypona germari Stål, Stett Ent. Zeit., XXV, 1864, p. 84.
Gypona germari Spangberg, Species Gyponæ, Bih. Till K. Sv. Vet.-Akad., Band 5, no. 3, 1878, p. 26.

Slender; head narrow; vertex nearly twice as long at middle as next the eye; ocelli a little nearer base than tip, as far from each other as from eye; pronotum about one-third longer than vertex; elytra narrow, much longer than abdomen, not reticulate; male, last ventral segment as long as preceding, slightly convex; plates widened at base, contracted beyond middle, with slender tips extended beyond tip of pygofer.

Color, pale green; elytra hyaline; veins concolorous or faintly yellow; beneath pale.

Length, 9 mm. One male, Minca, Colombia, June 1898, acc. no. 1999. One male, Don Diego (100 ft.), Dept. Magdalena, Colombia, July 1898, Carnegie Museum acc. no. 1999.

Dr. Ball suggests that *germari* should be a synonym of *verticalis* and the latter species appears first in Stål's "Hemiptera Mexicana." However, aside from the differences in size and other characters noted by Stål in his description, there seems sufficient question as to their identity in specimens I have examined to retain the species. Possibly a study of internal genitalia may be desirable for final determination.

Gypona peruviana sp. nov. (Plate III, figs. 19, 19a)

Head broad, vertex broadly rounded, slightly produced, nearly half longer at middle than next the eye, margin very thin, slightly reflexed, ocelli behind the middle and nearer to each other than eye. Pronotum twice as long as vertex, widening posteriorly, hind border concave. Female, last ventral segment sinuate emarginate with a deep incision at the middle reaching one-third the way to base. Pygofer broad, apical half with shorter setæ.

Sordid yellow, margin of vertex and the ocelli red. Two obscure orange stripes on vertex, pronotum and scutellum.

Length, female, 12 mm. One female (holotype) Callango, Peru, in author's collection. This species appears to resemble *lugubrina* Spangberg, which was described from a male from Bogota and which is given a total length of 9.5 mm., which is too great a difference in size to warrant assumption that the species are identical.

Gypona cruzana sp. nov. (Plate I, fig. 6)

Head much narrower than pronotum; vertex nearly twice as long at middle as at eye, rounded; ocelli behind the middle and nearer to each other than to eye; pronotum nearly twice as long as vertex. Female, last ventral segment long, deeply roundingly emarginate on hind border (fig. 6a).

Testaceous yellowish, scarcely paler below; anterior margin of vertex and the ocelli red. Elytra hyaline, the veins nearly concolorous.

Length, female, body 10, to tip of elytra, 11 mm.

Described from one female (holotype) in author's collection Ohio State University from "Cruz Alta R. G. doSul". This is very similar to *peruviana* in every respect except that the vertex is a little more broadly rounded; there are no visible orange stripes and the female last ventral segment is very different.

Gypona sierra sp. nov. (Plate III, fig. 15)

Head very broad, nearly as wide as pronotum; vertex short, margin depressed; ocelli scarcely behind the middle, as far from each other as from eye; front slightly depressed at base, short, rounded to clypeus. Pronotum about twice as long as vertex, outer margin subparallel and compressed, hind border slightly concave; elytra smooth. Male, last ventral segment little longer than preceding, hind border slightly sinuate; plates overlapping, sides nearly parallel; tips subtruncate, not reaching tip of pygofer.

Color, pale yellowish, with lateral margin of pronotum, costa and margins of abdomen more decidedly yellow; face and legs pale yellow; appendix of elytra fuscous.

Length, to tip of elytra, 8 mm. One specimen, male (holotype) Santa Cruz de la Sierra, Bolivia, 450 m. (J. Steinbach), Nov. 1910, Carnegie Museum acc. no. 4549. The head is unusually broad for the genus and the pale color with the fuscous appendix are the most pronounced features.

Gypona concolor Spangberg

Gypona concolor Spangberg, Species Gyponæ, 1878, p. 24.

Head narrower than pronotum, vertex rounded, ocelli at middle and farther from each other than from eye, pronotum half longer than vertex. Male, last ventral segment scarcely longer than preceding, plates narrow, almost pedicellate at base, wide at middle and tapering to acute tip, the outer border with dense long delicate setæ.

Pale yellowish white, faintly tinged with golden, without spots or dots. Elytra milky hyaline.

Length, male, 9 mm. to tip of elytra. Prov. del Sara, Bolivia (Steinbach), Carnegie Museum acc. no. 5064.

Spangberg describes only a female from "Bogota" and says the male is unknown "Mas. ignotus." As the specimens in hand are males there may be some question as to their identity but they agree so well with the description given for the female and the male genitalia are so different from those of *germari*, a closely related species, that I place them here.

Gypona ecuadora sp. nov. (Plate II, figs. 10, 10a)

Head much narrower than pronotum. Vertex rounded or broadly paraboloid, the ocelli at middle and farther from each other than from eye; pronotum half longer than vertex, widening distinctly to base, hind border faintly concave; scutellum distinctly wider than long. Female, last ventral segment short with hind border distinctly concave; pygofer moderately long and the apical half rather thickly set with short setæ. Pale yellowish green without dark markings.

Length, female, 8 mm. One female (holotype) from "Balsapamba, Ecuador, R. Haensch S," in author's collection.

Gypona vittulata Stål

Gypona vittulata Stål, Ofv. K. Vet. Akad. Forh., 1854, p. 253.
Gypona vittulata Stål, Rio Janeiro Hemip. T. 2, 1862. p. 47.
Gypona vittulata Spangberg, Species Gyponæ, 1878, p. 44.

A small light yellow species with faint or obsolete orange stripes, four on vertex and six on pronotum. The species was described from Rio Janeiro and length given as 10 mm. I have a specimen from Minas Geræs a little smaller but agreeing with Stål's description and there are three specimens in the Carnegie Museum that are still smaller but agree so perfectly in other characters that I place them here. One Prov. del Sara, Bolivia, one "Rio Guaparé near Porta Principe, Brazil" and one "Don Diego, Dept. Magdalena, Colombia, S. A."

Gypona ancona sp. nov. (Plate III, figs. 18, 18a)

Head narrower than pronotum; vertex long, paraboloid; ocelli behind middle and farther from each other than from eye; pronotum one-fourth longer than vertex, widening posteriorly, hind border concave; scutellum as wide as long, apex acute. Female, last ventral segment bisinuate, pygofers short and broad, extending a little beyond tip of ovipositor, the apical point with series of short setæ. Pale green or greenish yellow without spots.

Length, female, 9 mm. One specimen, female (holotype), from Ancon, Canal Zone, Panama, in author's collection. The longer vertex and genital characters separate this from *angulata* or *germari*.

Gypona bahia sp. nov. (Plate IV, fig. 25)

Head subangulate, vertex produced, half longer at middle than next the eye, margin blunt; ocelli before the middle, nearly twice as far from each other as from eye; front convex. Pronotum twice as long as vertex, hind border faintly concave, elytra smooth. Male, last ventral segment broad, longer than preceding, broadly rounded behind; plates narrow, tapering, tips subtruncate, upper angle acute, reaching nearly to tip of pygofer.

Color, brown, subpruinose, front margin of vertex, inner margin of eye, and stripe on the pleuræ, fuscous. Elytra subhyaline, vinaceous; beneath yellowish, a line on hind femora, outer row of spines, tips of tarsi and joints and clavus, dusky.

Length, 6.5 mm. One specimen, male (holotype), "Rio San Franc, Bahia, Brazil, Dec. 9, 1908," Carnegie Museum acc. no. 3766.

Gypona signoreti Stål

Gypona signoreti Stål, Stett. Ent. Zeit., XXV, 1864, p. 83.

Gypona signoreti Spangberg, Species Gyponæ, Bih. Till. K. Sv. Vet.-Akad., Band 5, no. 3, 1878, p. 42.

Gypona signoreti Ball and Reeves, Ann. Ent. Soc. Am., XX, 1927, p. 494.

Gypona unicolor Ball, Ann. Ent. Soc. Am., XIII, 1920, p. 89. (=var. *pilulæ* Ball and Reeves)

Gypona signoreti var. *pilulæ*, Ball and Reeves, Ann. Ent. Soc. Am., XX, 1927, p. 494.

Head broadly rounded before, ocelli near the middle of vertex, nearer to eye than to base and farther from each other than from eye. Female, ventral segment longer than preceding, apex at middle deeply, and at sides feebly sinuate. Male, last ventral segment half longer than preceding, hind border rounded.

Greenish, yellowish green and orange to reddish, tinged with golden, the disc of elytra usually somewhat darker than other parts and the apical elytral areoles more or less infuscate. Abdomen above, red.

Length, 8 to 10 mm. A specimen from Atoyac, Mexico, in author's collection and a series from Ancon, Canal Zone, taken by the author in May 1927. Two placed in Carnegie Museum collection. Also one specimen, Elvecia near Mt. Turumiquire, Estado de Sucre, Venezuela, coll. M. G Netting. Stål described it from Mexico, Fowler records it from Panama and Venezuela, Ball and Reeves speak of it as distributed through Mexico, West Indies and on to South America, but without naming definite localities. The variety *pilulæ* was collected by Ball at Chads, Utah, which brings it into southwestern United States.

Gypona equestris (Fabricius) (Plate II, fig. 8)

Cercopis equestris Fabricius, Syst. Rhyng., 1803, p. 92.
Gypona equestris Stål, Hem. Fab., t. 28, 1869, p. 84.

Head rounded before; vertex half longer at middle than next the eye; depressed at border, margin obtuse; ocelli at middle, as far from each other as from the eye. Pronotum nearly twice as long as vertex, hind border distinctly concave. Female, last ventral segment little longer than preceding, with a rather broad middle lobe.

Deep fulvous without dots or markings; ocelli rosy; eyes brown, elytra subhyaline, a little smoky toward tip; abdomen red on disc above, fulvous at sides; yellow below; legs fulvous.

Length, 8 mm. Three specimens from Bartica, British Guiana, March 20-30, 1901, May 12 and 29, 1901, H. H. Parish collector, in author's collection. A specimen from Squatos, Brazil, in the DeLong collection is also placed here.

Genus Prairiana Ball

Prairiana (subgenus) Ball, Ann. Ent. Soc. Am., XIII, 1920, p. 409.
Prairiana Ball and Reeves, Ann. Ent. Soc. Am., XX, 1927, p. 489.

Front long and narrow, eyes small, widely separated, the elytral areoles with dots, lines, or spots.

Type of the genus *Prairiana* (*Gypona*) *cinerea* Uhl.

Prairiana sordida (Stål)

Gypona sordida Stål, Ofv. Vet. Akad. Forh., 1854, p. 252.
Gypona sordida Spangberg, Species Gyponæ, 1878, p. 74.

Head broad; vertex hardly longer at middle than next the eye, broadly subangulate, distinctly depressed between ocelli; ocelli half way from base to border, as far from each other as from eye; front slightly depressed at base. Pronotum twice as long as vertex; hind border slightly sinuate. Female, last ventral segment half longer than preceding, lateral angles rounded, hind border sinuate, median lobe short and faintly notched. Male, last ventral segment slightly longer than preceding, convex behind; plates narrow, elongate, slightly upturned, bristled at tip, and extending beyond tip of pygofer.

Color, dull gray; vertex and pronotum pale gray with minute rufous points; hind border of pronotum blackish; scutellum and elytra dull gray; elytral veins scarcely darker; beneath dull gray, pleural stripe and venter, blackish.

Length, female, 10.5 mm.; male, 9 mm. Recorded by Stål and Spangberg for Rio Janeiro and Minas Geraes. A long series in the Carnegie Museum, acc. nos. 6443 and 5064, Nov. and Dec. 1911, from Prov. del Sara, Bolivia, 450 mm. (J. Steinbach). Also a specimen in author's collection from "Sta Cruz, Bolivia."

Prairiana nigrifrons sp. nov. (Plate V, fig. 45)

Head narrow, produced, vertex more than twice as long at middle as at eye, subangulate, margin depressed; ocelli behind the middle, twice as far from each other as from eye, a little nearer to the eye than to the base; front depressed at base, bordered by distinct ridge; clypeus with sides parallel; loræ elongate; cheeks rather narrow. Pronotum little more than half longer than vertex, hind border slightly concave. Elytral veins conspicuous. Male, last ventral segment somewhat produced, hind border rounded; plates elongate and narrow, tips slightly divergent, overlapping, thin and transparent, extending to tip of pygofer.

Dark gray. Vertex with median black line expanded at apex; pronotum with black line from anterior border to one-third distance from the border followed by a whitish line to base, and irregular double stripe behind the eyes. Scutellum with a dark curved spot in the angle. Elytra brownish gray with numerous fuscous dots in the aeroles and short, irregular, mostly transverse, ivory-white spots or dots on the disc of areoles and along inner border of clavus. Front with the disc distinctly black, the margins gray with fuscous arcs; clypeus with black spot on disc; legs testaceous with fuscous dots and partial broken annulæ.

Length, 11.5 mm. One specimen, male (holotype), Provincia del Sara, Bolivia (Steinbach), Carnegie Museum acc. no. 5064 and one specimen (paratype) Santa Cruz de la Sierra, Bolivia, 450 m. (J. Steinbach), Carnegie Museum acc. no. 5569. A female specimen (allotype) from Prata, Brazil, and a male from Squatos, Peru, in Dr. DeLong's collection. The female has the last ventral segment bisinuate with a little deeper emargination at the middle.

Prairiana basalis sp. nov. (Plate IV, fig. 27)

Head wide, vertex somewhat produced, nearly twice as long at middle as next the eye, ocelli very near the base, about one-fourth distance from base to eye, as far from each other as from eye, margin thin, front depressed at base, pronotum two and a half times as long as vertex, distinctly concave behind. Elytra somewhat rugose. Genitalia: female, last ventral segment one-half longer than preceding at sides, bisinuate on hind border, the broad middle lobe rounded. Pygofer short, thick, with few bristles. Male, last ventral segment one-half longer than preceding, truncate; plates long, sides parallel, tips rounded, slightly overlapping, reaching tip of pygofer.

Color, greenish tinged with brown, vertex, pronotum, scutellum and elytra with irregular patches and lines of fuscous, more pronounced on the appendix and apical cells. Beneath greenish, front reddish brown, mesosternum black, bordered with greenish, legs greenish with fuscous patches at the tips. Tips of tibiæ and tarsal joints brownish fuscous.

Length, female, 14 mm.; male, 13 mm. Six specimens, two females (holotype and paratype), one female, Dec. 1917, and one female, March 1918 (paratypes), and one male (allotype) Pied Saut Oyapok, French Guiana (S. M. Klages) Dec. 1917, Carnegie Museum acc. no. 6111. Three males apparently belong here but are a little larger than the type, from Provincia del Sara, Bolivia, Nov. 1913, Nov. 1909, 450 m., Carnegie Museum acc. no. 4549.

Prairiana robusta sp. nov. (Plate IV, figs. 31, 31a)

Robust; pronotum sloping; head broad, about one-third longer at middle than next the eye; ocelli close to base, as far from each other as from eye; vertex margin thin, base of front depressed, margins curved, sides of clypeus nearly parallel. Pronotum little more than twice length of vertex, distinctly concave behind, coarsely striate; scutellum coarsely punctate on disc, subrugose at tip with smoother patches in basal angles; elytral veins strong, punctured each side except at tip. Female last ventral segment one-half longer than preceding, deeply bisinuate, middle lobe broad, rounded behind; pygofer short, polished at base, scantily bristled on apical half. Male plates long, strap-like, overlapping, as long as pygofer.

Color, gray brown, dots and splashes on vertex, pronotum and scutellum fuscous; elytra hyaline; veins brownish; apical cells with faint fuscous dots and splashes. Beneath greenish yellow, front and clypeus brown, darker at borders. Mesosternum and apex of hind femora infuscate.

Length, 14 mm. One specimen, female (holotype), Santa Cruz, Bolivia, in author's collection. This species is rather unusually thick bodied, with pronotum decidedly sloping. One female (paratype), "Obidos Brazil," and one male (allotype) "Squatos Peru," in Dr. DeLong's collection.

Prairiana nigrina (Stål)

Gypona nigrina Stål, Ofvers. Vet. Akad. Forh., 1854, p. 252.
Gypona nigrina Spangberg, Species Gyponæ, Bi. Till. K. Sv. Vet. Akad., Hand. v, no. 3, 1878, p. 70.

Small; head rounded; vertex somewhat depressed; ocelli near the middle and about equally distant from each other and the eye. Pronotum a little more than half longer than vertex, distinctly striate. Male, last ventral segment half longer than preceding, hind border truncate or faintly sinuate; plates narrow, upcurved and reaching tip of pygofer.

Dull yellowish above and darker fuscous or blackish below. The vertex, pronotum and scutellum fuscous and densely dotted with fuscous or black and the areoles of the elytra with numerous fine maculations and lines. Length, 6.5 mm.

This species was described from Buenos Aires and specimens in the Carnegie Museum collection are from La Plata, Argentina, accession no. 4770.

Prairiana punctipennis (Stål)

Gypona punctipennis Stål, Stett. Ent. Zeit., vol. 25, 1864, p. 82.
Gypona punctipennis Spangberg, Species Gyponæ, 1878, p. 61.

Head broad, vertex produced, half longer at middle than next the eye, evenly rounded before; ocelli before the middle, about twice as far from each other as from the eye; front slightly depressed at base. Pronotum nearly twice as long as vertex, scarcely concave behind; female last ventral segment about one-fourth longer than preceding, faintly sinuate, or nearly truncate, the median part slightly produced and edged with black.

Color, brownish gray above, pale yellow beneath, the vertex with median line expanding at apex, a spot before ocelli, a short oblique dash each side at base behind ocelli, several distinctly inscribed lines with numerous punctures on pronotum and dots in elytral areoles, dark fuscous; a little more distinct and larger spot on cross-vein; a patch beyond tip of clavus and borders of apical areoles smoky. Abdomen above blackish, segments margined with yellow; tips of hind tibiæ and dots at base of spines dusky. (=*dohrni* Stål?)

Length, 8 mm. One specimen, Cacagualita, Colombia, Carnegie Museum acc. no. 1999, May 19.

Prairiana mystica (Spangberg)

Gypona mystica Spangberg, Species Gyponæ, 1878, p. 71.
?*Gypona atitlana* Fowler, Biol. Cent. Am., Homop., 1903, p. 305.
?*Gypona abjecta* Fowler, Biol. Cent. Am., Homop., 1903, p. 309.

Gray, closely mottled, light fuscous, head narrower than pronotum. Vertex about one-fourth longer at middle than next the eye; ocelli as far from each other as from eye and just before middle of vertex. Female, segment slightly longer than preceding, rather deeply emarginate with an elongate central tooth, notched at center. The vertex is rather finely punctate, the pronotum irrorate and the elytra maculate in the cells with fuscous.

Length, female, 9 mm. Specimens are referred to this species from Puerto Suarez, Bolivia, 150 m., J. Steinbach, Carnegie Museum acc. no. 3844; Bahia, Brazil, Dec. 8th, 1907, Carnegie Museum acc. no. 3533; and one male, Provincia del Sara, Bolivia, Steinbach, Carnegie Museum acc. no. 5064, Oct. 1915.

Species described as *atitlana* and *abjecta* appear to belong with this species as indicated by Dr. Ball.

Prairiana interspersa (Stål)

Gypona interspersa Stål, Ofv. Vet. Ak. Forh., 1854, p. 252.
Gypona interspersa Spangberg, Bih. Till. Ksv. Vet. Akad. Handl. Band 5, no. 3, 1878, p. 65.

Very similar to *mystica* but ocelli more widely separated, head nearly as wide as pronotum, distinctly depressed; ocelli slightly farther from each other than from eye, scarcely in front of the middle. Female, ventral segement as long as preceding, deeply incised toward the middle with a broad central lobe which is notched at tip.

Length, female, 10 mm. Two specimens, Puerto Suarez, Bolivia, 150 m. (J. Steinbach), Carnegie Museum acc. no. 3844.

Prairiana moesta (Spangberg)

Gypona moesta Spangberg, Species Gypona, Bih. Till. Ksv. Vet. Ak. Handl. Band 5, no. 3, p. 66.

Very similar to *interspersa* but with the hind border of the last ventral segment of female not deeply incised, but with a shallow emargination and a slightly produced medium lobe, minutely notched at the center.

Two specimens, Janaria, Bahia, Brazil, Dec. 11, 1907, Carnegie Museum acc. no. 3523. One specimen, Janaria, Minca, Brazil, Dec. 17, 1907, Carnegie Museum acc. no. 3702.

Two specimens of males, Chapada, Brazil, acc. no. 2966, Nov. The male was not described by Spangberg, but the three males in hand referred to this species agree very closely with the female in general characters and I believe should be placed here. The last ventral segment is convex, the plates rather long, nearly parallel and distinctly involute.

Prairiana histrio (Burmeister)

Gypona histrio Burmeister, Genera Insectorum, t.1, 1838, Gyp. 5, Gen. 16.
Gypona histrio, Spangberg, Species Gyponæ, 1878, p. 75.

Head broad, slightly produced, vertex one-fourth longer in middle than next eye, disc depressed; ocelli half-way from base to border, as far from each other as from eye; front depressed at base. Pronotum nearly three times as long as vertex. Male, last ventral segment one-half longer than preceding, hind border faintly sinuate; plates flat, strap-like, narrowing gradually to rounded tips which reach tip of pygofer.

Color dark brown, vertex and pronotum with dark fuscous spots; elytra with alternating yellowish and brownish fuscous spots, beneath dull yellowish more or less tinged with brown, legs lineate and dotted with fuscous.

Length, 11 mm., male. One specimen, R. Japacani, E. Bolivia (J. Steinbach), Feb. 1915, Carnegie Museum acc. no. 5573.

This specimen appears to answer very closely to Burmeister's short description. The species was unknown to Spangberg according to his monograph of 1878. Burmeister gave "Habitat in Brasilia" as locality.

The original description reads "G. histrio = corpore rufo, vertice pronotoque antice fusco-punctata; elytrorum areolis alternatim fuscis et flavis; pedibus flavescentibus, fusco-lineatis, tibiis posticis fuscis, flavo spinosis. Long 5″: ♀."

Two males "Coroica, Bolivia" in the author's collection agree with the Carnegie Museum specimen, and a specimen from Vicosa, Minas Geraes, Brazil, collected by Edson Hambleton, may also be referred to this species.

Prairiana subtacta (Walker)

Gypona subtacta Walker, List Homop. Brit. Mus., Suppl., 1858, p. 256.

Head short, rounded before; vertex slightly depressed behind margin, bluntly angled to front, a little longer at middle than next the eye; ocelli at the middle, as far from each other as from eye. Pronotum twice as long as vertex, hind border emarginate. Female, last ventral segment at sides nearly twice as long as preceding, lateral angles rounded, hind margin deeply bisinuate, a distinct central notch reaching one-third way to base. Male, last ventral segment as long as preceding, truncate; plates rather broad at base, minutely ciliate, tapering to angular tips which are thin, somewhat transparent and upcurved.

Color brown, ocelli reddish. Pronotum with series of fuscous dots near anterior border; elytra, brownish hyaline, marmorate with fulvous and fuscous, these alternating especially in the costal areole. Beneath yellowish brown.

Length, 10 mm. Provincia del Sara, Bolivia, Dec. 1911 (Steinbach), Carnegie Museum acc. no. 5064.

Prairiana rosacea sp. nov. (Plate IV, fig. 30)

Head narrow, rounded before; vertex produced, twice as long at middle as next the eye, slightly depressed at border; ocelli slightly before middle, as near to each other as to eye; front slightly depressed at base. Pronotum two-thirds longer than vertex. Elytral veins strong, punctured each side to near the apex. Appendix very narrow. Female, last ventral segment nearly twice as long as preceding, bisinuate, a broad central lobe with a shallow notch at middle, or broadly rounded; male plates long, exceeding pygofer, parallel-sided, apex rounded.

Pale yellow tinged with rosy. Vertex, pronotum, scutellum with minute punctures or irrorations with rosy red. Elytral veins narrowly yellow, bordered with closely set rosy punctures. Areoles subhyaline, becoming more transparent toward tip where veins are distinctly blood red. Front punctate with reddish brown or subfuscous dots, cheeks with red dots; abdomen with segments yellowish, narrowly margined with rose red.

Length, female, 9.5 mm.; male, 7.5 mm. Four females (holotype and paratypes) Provincia del Sara, Bolivia (Steinbach), Dec. 1911, Carnegie Museum acc. no. 5064. Two specimens 450 m. (J. Steinbach), Carnegie Museum acc. no. 6443. Two males (allotype and paratype) from same locality. The males are much smaller but agree very perfectly in all details of marking and were apparently taken at the same time as the females, so it seems proper to place them here.

Prairiana griseola sp. nov. (Plate III, fig. 20)

Similar to *rosacea* but much smaller and without prominent rosy tint. Head broad, vertex rounded; ocelli before middle, as far from each other as from eye; front slightly depressed at base. Pronotum two-thirds longer than vertex. Elytral veins conspicuously punctured. Appendix very narrow. Male, last ventral segment as long as preceding, slightly convex; plates rather broad at base, tapering to bluntly rounded, slightly diverging tips, exceeding the pygofer, inner border slightly overlapping and subhyaline.

Color pale gray, tinged with reddish, elytral areas with faint fuscous dots; vertex, pronotum, scutellum, margins of nerves, punctate with fuscous; front punctate with fuscous. Abdomen pale gray slightly tinged with rosy.

Length, 7 mm. One specimen, male (holotype), Provincia del Sara, Bolivia (Steinbach), Carnegie Museum acc. no. 5064.

Prairiana variegata sp. nov. (Plate V, fig. 43)

Head subangulate; vertex, one-third longer at middle than next the eye, depressed on disc; ocelli a little behind the middle, as far from each other as from eye; front slightly depressed at base, with faint, thin lateral carinæ, apex contracted to clypeus, distinctly widened at tip. Pronotum three times length of vertex, hind border slightly concave. Elytra rather broad, narrowing apically. Male, last ventral segment scarcely longer than preceding, hind border broadly rounded; plates narrow at base, widening and then tapering gradually to bluntly rounded slightly upturned tips almost as long as pygofer; pygofer with coarse dark setæ on outer face; female, last ventral segment short with a prominent median lobe.

Color coarsely maculate or blotched irregularly with fuscous, whitish and pale fulvous; vertex with a distinct central line, border and borders of ocelli, dark fuscous; pronotum anteriorly with transverse fuscous band, including a series of whitish points; scutellum at basal angles fuscous; whitish maculæ on elytra forming a broad rather poorly defined-shaped figure. Beneath pale brown; face darker brown with frontal arcs deeply infuscate, femora blackish with apical third whitish; tibiæ dull yellowish with fuscous annuli near tip; hind tibiæ with spots at base of spines and tips of tarsal joints fuscous.

Length, 9 mm. One male (holotype), Provincia del Sara, Bolivia (Steinbach), Carnegie Museum acc. no. 5064. One male (paratype), Puerto Suarez, Bolivia, 150 m., J. Steinbach, Carnegie Museum acc. no. 3844. The latter specimen, while distinctly shorter than the other, agrees perfectly in all details of color markings and genitalia. A female (allotype) of this species, is in the Osborn Collection at Ohio State University, Iquitoa Rio Itaya, Peru. Another smaller specimen (abdomen missing) in Osborn collection from "Sta Cruz, Bolivia," apparently belongs here.

Prairiana jansoni (Fowler)

Gypona jansoni Fowler, Biologia Centrali Americana, Homoptera, II, 1903, p. 306.

Head broad; vertex produced, depressed, anterior margin broadly rounded; ocelli behind the middle as near to each other as to the eye. Front at base. Pronotum twice as long as vertex, distinctly emarginate behind. Elytra somewhat rugose on basal half. Male, last ventral segment as long as preceding, truncate; plates narrow, sides parallel, tips slightly spoon-shaped, reaching tip of pygofer.

Color, pale brownish; disc of pronotum a little paler and tinged with yellow; elytra with oblique band composed of transverse broken lines, scattered dots at base and apex of clavus and on anteapical cells; apical cells subhyaline with scattered fuscous dots; beneath pale yellow; femora except at tip, dark brown; venter tinged with yellow.

Length, 10.5 mm. to tip of elytra. A specimen from Quatro Ojos, Bolivia (Steinbach), Nov. 1913, Carnegie Museum acc. no. 5065, is referred to this species. The size appears to be a little large. Fowler's description was based on females from Nicaragua, with which he connects a male from Guatemala but does not describe it in full.

Genus PONANA Ball

Ponana (subgenus) BALL, Ann. Ent. Soc. Amer., xiii, 1920, p. 93.
Ponana BALL and REEVES, Ann. Ent. Soc. Amer., xx, 1927, pp. 489, 496.

Body generally less flattened than *Gypona;* head usually short, vertex blunt or rounded to front, ocelli on the disc before the middle, elytra elongate, narrow, veins and sometimes areoles marked with darker dots or spots. Genotype *Ponana* (*Gypona*) *scarlatina* Fitch.

Ponana marmorata (Spangberg)

Gypona marmorata Spangberg, Species Gyponæ, Bih. till K. Sv. Vet.-Akad. Handl., Band 5, 1878, p. 59.

Head fairly broad, vertex short, margin parallel uniformly rounded before; ocelli half way from base to margin, slightly more than twice as far from each other as from eye; front slightly depressed on disc, rugose at sides; clypeus nearly twice as long as wide; pronotum broad, concave behind. Female, last ventral segment one-half longer than preceding, lateral angles produced, rounded, hind border deeply sinuate, each side of a median produced deeply notched lobe.

Color, dull ferruginous fuscous with numerous brown fuscous mottlings; beneath pale brownish, tips of tibiæ and two bands on fore femora infuscate.

Length, female, 13 mm. A specimen from Bonda, Colombia, June 10, Carnegie Museum acc. no. 1999.

Ponana notatula sp. nov. (Plate V, fig. 42)

Head short, obtuse; vertex as long at middle as next the eye; ocelli half way from base to apex, close to eyes, fully three times as far from each other as from eye, as far from eye as from base; front broad at base, not depressed, but slightly flattened on disc. Pronotum four times length of vertex, hind border distinctly concave. Male, last ventral segment one-half longer than preceding, broadly rounded behind; plates rather narrow, tapering to rounded tips with margins delicately ciliate and tips with a long brush of cilia; pygofer nearly twice as long as plate, rather densely ciliate.

Color, pale gray brown, numerously dotted on vertex, pronotum and elytra with fuscous; elytral veins of disc darker; beneath, pale yellowish, tips of hind tibiæ blackish.

Length, 11 mm. One specimen, male (holotype) Puerto Suarez, Bolivia, 150 m. (Steinbach), Carnegie Museum acc. no. 3844.

Ponana alboguttata (Spangberg)

Gypona alboguttata Spangberg, Species Gyponæ, Bih. Till K. Sv. Vet.-Akad. Handl., Band 5, 1878, p. 58.

Head narrow, vertex very short, obtuse: ocelli, half-way from base to margin, more than twice as far from each other as from margin of eye; front flattened; clypeus slightly swollen on disc. Pronotum broad, somewhat swollen, coarsely rugose, about five times as long as vertex. Elytra exceeding abdomen. Genitalia: female, last ventral segment half longer than preceding, lateral angles obtusely rounded, hind margin sinuate, produced at center forming two broad teeth at side of broad median notch. Male, last ventral segment half longer than preceding, hind border truncate; plates narrow, elongate, blunt, tips reaching two-thirds of way to tip of pygofer.

Color, dark chocolate brown, pronotum with numerous darker punctures, scutellum with white dot on each side, elytra with white point at base of clavus, about ten white dots on costal cell and a few scattered dots on disc and in base of apical cells; a transverse ivory white spot on cross-vein and another smaller one in the apical part of the inner discal cell. Beneath paler, dull yellowish, legs yellowish with fuscous dots.

Length, female, 13 mm.; male, 12 mm. A number of specimens, male and female, from Provincia del Sara, Bolivia (Steinbach), Oct. 1913, Carnegie Museum acc. no. 5064. One specimen "Napa R., Peru" in Dr. DeLong's collection.

Ponana grossa sp. nov. (Plate III, fig. 21)

Head short, distinctly arched; vertex scarcely longer at middle than next the eye, minutely rugose; anterior margin angular and slightly upturned; ocelli large before the middle, more than twice as far from each other as from the eye; front rugose at base, depressed on the disc, faintly carinate on the middle line; clypeus elevated at base, carinated toward apex; sides parallel; apex truncate; loræ narrow; cheeks rather broad, outer margins sinuate. Pronotum large, about five times as long as the vertex, rugose and densely punctured; hind border slightly concave; scutellum minutely rugose and punctate, disc depressed, apex acuminate. Elytrical veins conspicuous; a few extra cross-veinlets but not uniformly reticulate. Genitalia: female, last ventral segment nearly twice as long as preceding at sides; posterior angles broadly rounded, median two-thirds somewhat excavated, sinuate and broadly notched at middle; pygofer short, thick, sparsely setose toward tip.

Dark brown, tinged with purplish; the vertex with three fuscous stripes, the outer ones including the ocelli. Pronotum with elevations yellowish; elytra with a series of ivory yellow dots, two of which are on the clavus, and two on the disc of corium; tips subhyaline; outer apical cell including a black patch on the border. Beneath light yellowish; the face mostly dark fuscous; the legs striped and dotted with fuscous; pygofers brown, abdomen above blackish on the disc, reddish brown toward the border.

Length to tip of elytra, 14 mm., width 5 mm. One specimen, female (holotype), Nova Olinda, Rio Purús, Brazil, (S. M. Klages), June 1922, Carnegie Museum acc. no. 6962. Paratypes; one, Las Juntas, Bolivia (Steinbach), acc. no. 5066, and one from Mana River, French Guiana, March 1917, Carnegie Museum acc. no. 6008.

This is a very large and striking species nearly related to *albo-guttata*, quite distinctly marked by the coarse puncturing of the pronotum and the color pattern and with different female segment.

Ponana sarana sp. nov. (Plate V, fig. 40)

Head very short, vertex as long at middle as at eye, ocelli close to middle, more than twice as far from each other as from eye; front convex; pronotum about five times as long as vertex, distinctly concave behind. Female, last ventral segment nearly twice as long as preceding, deeply bisinuate, middle lobe notched; male, last ventral segment half longer than preceding, broadly rounded behind; plates narrow, tapering from base to blunt apex, not reaching tip of pygofer; margin of plate and apex of pygofer rather densely set with bristles.

Vertex and pronotum mostly pale fulvous or yellowish with numerous dark brown dots and irrorations; hinder border of pronotum with dark brown or fuscous edged with light brown; scutellum with fuscous patches; elytra densely maculate with coarse fuscous spots in the areoles; beneath pale yellowish, femora and tibiæ lined and dotted with fuscous.

Length, female, 13 mm.; male, 12.5 mm. One female (holotype), Provincia del Sara, Bolivia, 450 m., (J. Steinbach), Nov. 1909, Carnegie Museum acc. no. 4549. Two males (allotype and paratype), Santa Cruz del la Sierra, Bolivia (Steinbach) 450 m., Nov. 1910, Carnegie Museum acc. no. 4549.

Ponana bicolorata sp. nov. (Plate V, fig. 35)

Head very short, vertex as long at middle as next eye, ocelli at middle more than twice as far from each other as from eye; front a little flattened at base. Pronotum nearly five times as long as vertex, depressed polished areas on anterior border, hind border concave. Male, last ventral segment slightly longer than preceding, plates subtubulate, tapering to narrowly blunt tips, three-fourths length of pygofer.

Vertex and pronotum, except hind margin, bright yellow; outer border of vertex tinged a little with orange; disc of pronotum little darker than anterior border; hind border of pronotum dark brown or chocolate brown. Scutellum and elytra brown, disc of elytra somewhat darker and bluish pruinose, apical cells with fuscous dots. Beneath light yellow, fore and middle femora with a fuscous patch, hind tibiæ with black bases to spines, a black spot at tip and abdomen above black, segments edged with yellowish. Beneath light yellow.

Length, 11.5 mm. One specimen, male (holotype). Upper Rocana, N. Para, Brazil in Carnegie Museum. This specimen is quite similar to *hebes* Fowler, but the color contrast is sharper and head apparently shorter than in that species. Also this species is much smaller than the measurement given for *hebes*. Three males (paratypes) "Napa R. Peru" in Dr. DeLong's collection.

Ponana sulfurea sp. nov. (Plate V, fig. 36)

Head short, vertex as long at middle as next eye, ocelli at middle, more than twice as far from each other as from eye; front little flattened on disc. Pronotum four times as long as vertex, deeply concave behind scutellum, punctured on disc, lateral angles polished, apical part rugose; elytra polished. Male, last ventral segment as long as preceding, plates narrow, tapering to apex, tips bluntly rounded, reaching almost to tip of pygofer.

Vertex and pronotum, except at base, bright sulfur yellow with scattered brownish dots; head, border of pronotum, scutellum and elytra, brown; ocelli margined with red; face, legs and abdominal segments pale yellow, the latter bordered with orange. Fore femora near tip, spines of hind tibiæ, tips of tibiæ and tarsal spines, brown or fuscous. Abdomen, above, brown edged with bright yellow.

Length, 14 mm. Two specimens, males (holotype and paratype), Huyutanahan, Rio Purús, Brazil, Saint Cloudies, Jan. 1922, Feb. 1922, Carnegie Museum acc. no. 6963. A large, handsome species, especially marked by the contrasting bright yellow and rich brown color of upper surface.

Ponana ornata sp. nov. (Plate V, fig. 37)

Head short, vertex as long at middle as next the eye; ocelli nearly at middle, more than twice as far from each other as from eye; front flattened. Pronotum five times as long as vertex, concave behind. Male, last ventral segment nearly one-half longer than preceding, hind border truncate; plates short, tapering from base to narrow, slightly divergent tips, reaching little more than half-way to tip of pygofer. Tips of plates and base of pygofer with fine cilia; tip of pygofer with coarse bristles.

Vertex and pronotum yellow, deeply tinged with orange, hind border of pronotum brown, inner edge pale yellow, scutellum and elytra brown. Elytra somewhat suffused with yellowish, veins brown and areoles dotted with brown or, toward apex, with fuscous. Beneath pale yellow. Tips of fore and middle femora banded with fuscous; fore, middle and hind tibiæ lined with fuscous. Hind tibiæ and base of spines fuscous.

Length, 14 mm. One specimen, male (holotype), Cochabamba, Bolivia, Aug. Sept., '99. One specimen (paratype), Songo, Bolivia. One specimen (paratype), Madre de Dios, SE. Peru, in the author's collections. This handsome species is quite similar in coloration to *sulfurea* but more deeply tinged with orange and genital plates very much shorter. The brown color margin of pronotum is crenulate, deeply notched at middle and edged with light yellow.

Ponana affinula sp. nov. (Plate V, fig. 39)

Like *hebes* but smaller. Head very short, vertex as long at middle as at eye; ocelli at middle or slightly before, very far apart, fully three times as far from each other as from eye; front somewhat flattened. Pronotum four and a half times as long as vertex, hind border distinctly concave.

Vertex and pronotum pale yellow, densely set with brown dots, a somewhat dusky patch on disc and a curved line on each side near anterior border; hind border black, crenulate anteriorly; scutellum blackish, apex brownish, with a whitish spot on each side; elytra marmorate with light yellow and fuscous; veins brown; beneath yellowish with numerous dots and spots of fuscous.

Length, 12 mm. One specimen (holotype), Songo, Bolivia, in author's collection. Very similar in pattern to *hebes* but smaller and the markings of the pronotum and vertex are somewhat different.

Ponana labella sp. nov. (Plate V, fig. 31)

Rather slender; head narrow, subangulate; vertex depressed outside of ocelli, half as long at middle as next the eye; elevated anteriorly; ocelli before middle, nearly twice as far from each other as from eye or from base; front slightly depressed at base, flattened on disc, rather narrow; clypeus widening apically. Pronotum two and a half times length of vertex, coarsely striate on the disc and punctured on anterior margin; scutellum rather deeply striate; elytral veins coarse. Female, last ventral segment twice as long as preceding, lateral angles rounded, hind border deeply excavate with a broad tongue-like lobe at middle; pygofer sparsely setose on apical half.

Color dark fuscous; vertex and pronotum with dull yellowish patches and irrorate spots. Scutellum pale brown with darker discal spots on basal angles. Elytra with numerous dark fuscous spots of irregular shape, scattered through areoles on pale yellowish ground; veins dark brown; tips of coxæ and base of pygofer paler.

Length, 12 mm. One female (holotype), Coroico, Bolivia, in author's collection.

Ponana piceata sp. nov. (Plate V, fig. 38)

Head wide, short; vertex as long at middle as next the eye, ocelli before the middle, very far apart, three times as far from each other as from eye. Front flattened on disc; clypeus swollen at base. Pronotum four times as long as vertex, hind border distinctly concave; elytra smooth, polished, nervures bordered with punctures. Male, last ventral segment produced, rounded, longer at middle than preceding; plates short, broad at base, narrowed to blunt tips, scarcely reaching tip of pygofer.

Pitch black; anterior border of vertex, spot at margin of pronotum, base of elytra, reddish brown; a light yellowish subhyaline patch beyond clavus on the base of fifth apical and appendix. Front blackish on disc, brownish at sides with dark arcs; tip of clypeus, border and lower part of cheeks brown. Abdomen dark brown, venter somewhat infuscate, legs fuscous, fore and middle tibiæ a little lighter.

Length, 9 mm. to tip of elytra. Described from one specimen, male (holotype), Provincia del Sara, Bolivia, 450 m., Nov. 1909 (Steinbach), Carnegie Museum acc. no. 4549.

Ponana bruneola sp. nov. (Plate V, fig. 41)

Head short, obtuse anteriorly; vertex scarcely longer at middle than next the eye, transversely striate; ocelli before middle, quite near to anterior border, more than twice as far from each other as from eye; front broad, somewhat flattened on the disc. Pronotum four times as long as vertex, hind border concave; elytra broad, little longer than abdomen; last ventral segment nearly two times length of preceding, hind border bisinuate, a median lobe with broad shallow notch; pygofer short, apical half bristled.

Color, dark brown; vertex and anterior part of pronotum a little darker; elytral veins dark brown; cross-veins of disc fuscous, apical cells fumose; beneath brown, the femora, hind tibiæ and basal parts of abdominal segments, apical part of last ventral segment and sides of pygofer, infuscate; faintly pruinose above and below.

Length, 8 mm. One specimen, female (holotype), Bonda, Colombia, June 1898, Carnegie Museum acc. no. 1999. A female specimen (paratype), Cayenne, Feb. 1917, acc. no. 5873, is slightly smaller (7 mm.) and has a little more distinct fuscous band on vertex, is somewhat lighter below with a band on vertex, a darker ventral segment and darker smoky apical cells, but agrees so closely with specimens described above that I place them together. Also two specimens (paratypes), Coroico, Bolivia, 7 mm., in author's collection.

Ponana vinula Stål

Gypona vinula Stål, Stet Ent. Zeit., vol. XXV, 1864, p. 81.
Gypona vinula Spangberg, Species Gyponæ, 1878, p. 51.

Head rather narrow, subangulate, vertex little longer at middle than next the eye, ocelli at middle nearly twice as far from each other as from eye. Pronotum twice as long as vertex, truncate or slightly emarginate behind. Female, last ventral segment a little longer than preceding, hind border slightly produced at middle.

Color, variable, light specimens stramineous with minute fuscous dot behind ocelli; ocelli brown; a median line on vertex brown; two large dots on anterior border of pronotum and two short streaks each side and some transverse irrorations fuscous; hind margin black, ocelli blackish in angles; inner border of elytra infuscate, veins dusky; beneath whitish.

Length, female, 8 mm.; male, 7.5 mm. Several specimens from

Prov. del Sara, Bolivia, 450 m. (J. Steinbach), placed here. A specimen from Mazatenango, Guatemala, Feb. 3, 1905, in Ohio State University Collection, collected by J. S. Hine; also one, Los Juntas, Bolivia (Steinbach), one "Rio Paraguay, on boat one day below San Luis de Caceres, Brazil," May 17, 1909 (Haseman).

Ponana præusta (Spangberg)

Gypona præusta Spangberg, Species Gyponæ, Bih. Till. Vet Akad., 1878, p. 47.

Robust, head short; vertex obtuse, ocelli before middle, about twice as far from each other as from eye; front broad, slightly flattened at base. Pronotum three times as long as vertex. Female, last ventral segment slightly concave.

Dull yellowish; ocelli fuscous, eyes gray brown; pronotum, scutellum and elytra gray with faint fuscous margins on cross nervures and apical veins; beneath dull yellowish, margins of front and clypeus, band on femora, tip of tibiæ, and dots at base of tibial spines, tips of tarsal joints and claws, dusky.

Length, 5.5 mm. One specimen, Bahia, Brazil, Dec. 8, 1907, Carnegie Museum acc. no. 3702.

Ponana obtusa (Spangberg) (Plate III, fig. 16)

Gypona obtusa Spangberg, Species Gyponæ, Gen. Hom., 1878, p. 55.

Head broad, vertex short, obtuse; ocelli before middle, twice as far from each other as from eye; pronotum nearly three times as long as vertex, slightly concave behind. Female, last ventral segment one-third longer than preceding, truncate behind; male, plates narrow, tapering to blunt rounded tips, scarcely reaching tip of pygofer.

Color, pale gray, dot on posterior border of vertex behind ocelli with small round spot on pronotum behind eye with dot at base of clavus, tips of claval veins and cross nervures, fuscous; borders of veins especially toward apex faintly fuscous; elytra hyaline, veins slightly darker, beneath pale gray.

Five specimens from Bonda, Colombia, June, Carnegie Museum acc. no. 1999. One specimen from Provincia del Sara, Bolivia, 150 m. (J. Steinbach), Carnegie Museum acc. no. 3844; one specimen, Provincia del Sara, Bolivia, 450 m. (J. Steinbach), Nov. 1909, acc. no. 4549; one specimen, Provincia del Sara, Feb. 1913, acc. no. 5064; one specimen, Santa Cruz de la Sierra, Bolivia, 450 m. (J. Steinbach), Nov. 1910, acc. no. 4549.

Spangberg's description was from specimens credited to "Bogota."

Ponana venosa (Stål)

Gypona venosa Stål, Ofv. Vet. Ak. Forh., 1854, p. 252.
Gypona venosa Spangberg, Species Gyponæ, Bih. Till., 1878, p. 55.

Head short, vertex scarcely longer at middle than next the eye; ocelli before middle, twice as far from each other as from eye. Pronotum three times as long as vertex. Female, last ventral segment one-half longer than preceding, hind border deeply sinuate, middle lobe produced, as long as lateral angles, faintly notched at middle. Male, last ventral segment as long as preceding, truncate; plates narrow, tapering to acute tips, reaching tip of pygofer.

Dull gray, slightly suffused with ferruginous on vertex, and pronotum, polished. Vertex with an oblique dash of fuscous behind ocelli, a series of dots and lines on anterior border of pronotum; basal angles of scutellum, dot at base of clavus, tips of claval veins, cross-veins of corium and distinct border of elytral veins, fuscous; apex subhyaline and slightly smoky; beneath dull gray; tips of hind tibiæ and tarsal claws dusky.

Length, female, 6.5 mm.; male, 7 mm. One specimen, female, Taperina, Brazil, Carnegie Museum acc. no. 2966. Four specimens, male, Minca, Colombia, May 1898, Carnegie Museum acc. no. 1999. One specimen (mutilated), Cacagualita, Colombia, May 1898, Carnegie Museum acc. no. 1999. The males from Minca are slightly larger but agree so closely in other respects that it seems safe to place them here. Also one female, "Rio Bermejo, Prov. Salto, Argentina, May 1914 (J. Steinbach)" and two males from "San Rafael, Cumanacoa, Sucre, Venezuela, coll. M. G. Netting" appear to belong here.

Ponana fusconotata sp. nov. (Plate III, fig. 17)

Head very short, blunt; vertex as long at middle as next eye; ocelli before middle, more than twice as far from each other as from the eye. Front convex. Pronotum nearly four times length of vertex. Male, last ventral segment as long as preceding, faintly convex; plates broad, outer margins rounded to blunt, rounded tips, reaching apex of short pygofer.

Dull gray brown, a minute round dot each side on pronotum behind the eye; tips of claval veins, cross-veins of corium and apical cross-veins fuscous. A fuscous patch about middle of costa is preceded by a small ivory white spot. Beneath, pale grayish brown; base of spines, tips of tibiæ and tarsal claws dusky.

Length, 6 mm. Two specimens, males (holotype and paratype), Puerto Suarez, Bolivia, 150 m. (J. Steinbach), Carnegie Museum acc. no. 3844. This resembles *Gypona obtusa* Stål. The most marked difference being in the dusky spot and ivory patch on costa and lack of dots behind ocelli.

Ponana punctatella sp. nov. (Plate V, fig. 44)

Head narrow, short; vertex a little longer at middle than next the eye, obtusely angulate, margin bluntly rounded; ocelli before middle, twice as far from each other as from eye. Pronotum nearly twice as long as vertex; clavus and costal areole densely punctate. Female, last ventral segment little longer than preceding, hind border sinuate slightly produced at middle, pygofer very short, with few bristles toward tip.

Light fulvous tinged with reddish irrorations on pronotum; eyes and ocelli red, elytral veins red; beneath stramineous.

Length, 7 mm. One female (holotype), Bahia, Brazil, Dec. 8, 1907, Carnegie Museum acc. no. 3533.

Ponana nana (Fowler)

Gypona nana Fowler, Biologia Centrali Americana, Homoptera, Vol. II, 1903, p. 315.

Head rather broad; vertex wide, little longer at middle than at eye, broadly rounded; ocelli before middle, wide apart, fully twice as far from each other as from eye; front broad, margins rounded to clypeus; loræ large, margins slightly elevated; pronotum little more than twice as long as vertex, hind border emarginate. Male, last ventral segment much produced, more than twice as long as preceding segment, hind border sinuate, subangulate and produced at middle; plates small, almost completely concealed by the last ventral segment which extends almost to tip of pygofer.

Color above, mostly rich chocolate brown with metallic iridescence; vertex, anterior border of pronotum, and base of scutellum with fuscous lines and dots; basal half of costa yellow, apical half dark fuscous interrupted by whitish hyaline toward tip. Beneath pale yellowish; front dark fuscous; tarsal claws dusky.

Length, 4.75 mm. One specimen, Minca, Colombia, May 1898, Carnegie Museum acc. no. 1999. This is a very handsome little species, one of the smallest in the genus.

Genus SCAROIDANA gen. nov.

Head short, as wide as pronotum, vertex rounded to front, transversely striate; ocelli very close to border between vertex and front; front broader than long; antennal pit under a prominent ridge; pronotum broad, uniformly transversely striate; elytra longer than abdomen, narrowed to rounded tip, costa strongly curved, veins not conspicuously elevated.

Deeper bodied than common for *Gyponinæ*, otherwise somewhat related to the *hebes* group in *Ponana*. Type of genus, *Scaroidana flavida*, sp. nov.

The specimens described below, which represent the present known forms to be placed in the genus, seem to have some resemblance to *Scaris* but to have such definite differences as to exclude them from that group. They are thicker-bodied than the *Gyponinæ* generally and the position of the ocelli might be considered as placing them in the *Jassinæ*, but in general fascies they appear to me to belong close to the short vertex forms of *Gyponinæ*. Possibly additional discoveries of related forms may change this view but for the present this seems their most appropriate place.

Scaroidana flavida sp. nov. (Plate I, fig. 4)

Head as wide as pronotum, short; vertex scarcely longer at middle than next the eye, bluntly rounded to front; ocelli on the extreme border, very wide apart, nearer the eye than the middle; front broad, flattened, slightly elevated at the sides, a distinct ridge over the antennal pit; clypeus broad, wider than long, truncate at the apex; antennæ small, setæ very short. Pronotum nearly twice as wide as long, broadly arched in front, lateral margins long, slightly divergent, hind border broadly concave. Scutellum acuminate at apex. Elytra rather narrow, narrowing toward tip, longer than abdomen. Genitalia: female, last ventral segment about as long as preceding, convexly produced on the hind border; male, last ventral segment as long as preceding, narrowed slightly behind, hind border truncate, plates narrow, compressed, tips bluntly rounded, slightly upturned, reaching tip of pygofer.

Pale dull yellowish; bases of abdominal segments above more or less yellow; elytra yellowish subhyaline. Abdomen above in the male with orange bands on the segments.

Length, female, 13 mm.; male, 11 mm. Described from four specimens, one female (holotype), Prov. del Sara, Bolivia, 450 m., Nov. 1909, Steinbach, Carnegie Museum acc. no. 4549; two males (allotype and paratype), Puerto Suarez, Bolivia, 150 m., J. Steinbach, acc. no. 3844; and one male (paratype), apparently teneral, Villa Bella, Bolivia, Oct. 6, 1909, Carnegie Museum acc. no. 4043. Paratype in the author's collection.

Scaroidana fulvula sp. nov. (Plate I, fig. 6)

Head as wide as pronotum, short; vertex not produced, as long at middle as next the eye; ocelli wide apart, much nearer the eye than the middle of the vertex, on border between vertex and front flattened, broad; clypeus broad, scarcely longer than width, apex emarginate. Pronotum broad, lateral borders slightly divergent, hind border distinctly concave; scutellum with apex acuminate, disc with a strong curved suture. Elytra long, tapering toward tip. Genitalia: female, last ventral segment a little longer than preceding, narrowed, curved toward tip; male, plates narrow, compressed, tips upturned, blunt, slightly passing the tip of pygofer.

Color; dull yellow tinged with fulvous, becoming darker on the elytra, the tips of which are somewhat infuscate in the areoles. Beneath lighter yellow. Abdomen above orange-red on the disc, margins yellow in the female, tinged with reddish in the male.

Length, female, 12.5 mm.; male, 10 mm. Described from two specimens, one female (holotype), Villa Braga, Brazil, Dec. 1919, Carnegie Museum acc. no. 6544; one male (allotype), Prov. del Sara, Bolivia (Steinbach), Oct. 1913, Carnegie Museum acc. no. 5064. These specimens differ rather distinctly in size but correspond so completely in details of structure and coloration that it seems quite certain that they belong to the same species. Also one specimen (paratype) in author's collection, secured through a German dealer, from Coroico, Bolivia.

REFERENCES

AMYOT ET SERVILLE, Histoire Naturelle des Insectes Hemiptères, 1843, p. 579.

BALL, E. D., Ann. Ent. Soc. Am., XIII, 1920, pp. 83-100.

BALL, E. D. and REEVES, J. A., Ann. Ent. Soc. Am., XX, 1927, pp. 488-502.

BERG, C., Hemiptera Argentina, Enumeravit speciesque novas, Ann. Cien. Argentina.

—Reprint, VI-VIII, 1879, pp. 1-216.

—Hemiptera Argentina, Addenda et Emendanda, Ann. Cien. Argentina, 1884, p. 164.

BURMEISTER, H., Genera Insectorum 1, 1838, Gen. 16.

FABRICIUS, J. C., Systema Rhyngotorum, 1803, p. 95, no. 15.

FOWLER, W. W., Biologia Centrali Americana, Homoptera, II, 1903, p. 296.

GERMAR, E. F., Magazine der Ent., 4, 1821, p. 73.

LAWSON, P. B., The Genus Xerophloea in North America, Pan Pacific Entomologist, VII, 1931, pp. 159-169.

OSBORN, HERBERT, Ann. Ent. Soc. Am., XIX, 1926, p. 342.

SPANGBERG, J., Species Gyponæ, Bihang Till K. Sv. Vet. Akad., Handl. 5, no. 3, 1878, pp. 1-76.

—Species novas vel minus cognitas Gyponæ, Generis Homopterorum, Ent. Tidsk., 1881, pp. 23-38.

—Species novæ Generis Gyponæ, Ent. Tidsk., 1883, pp. 101-109.

STÅL, C., Bidrag Till Rio Janeiro Hemipter-Fauna, Ofv. Vet. Akad. Handl. 3, 1860, pp. 45-49.

—Hemiptera Mexicana, Stettiner Entom. Zeit., XXV, 1864, pp. 81-84.

—Hemiptera Fabriciana, II, 1868, pp. 84-85.

VAN DUZEE, E. P., Catalogue of Hemiptera of North America, 1917. (Cites Genera, type species, genera and bibliography of species north of Mexico).

WALKER, F., List of Homoptera of the British Museum, 1851-1855.

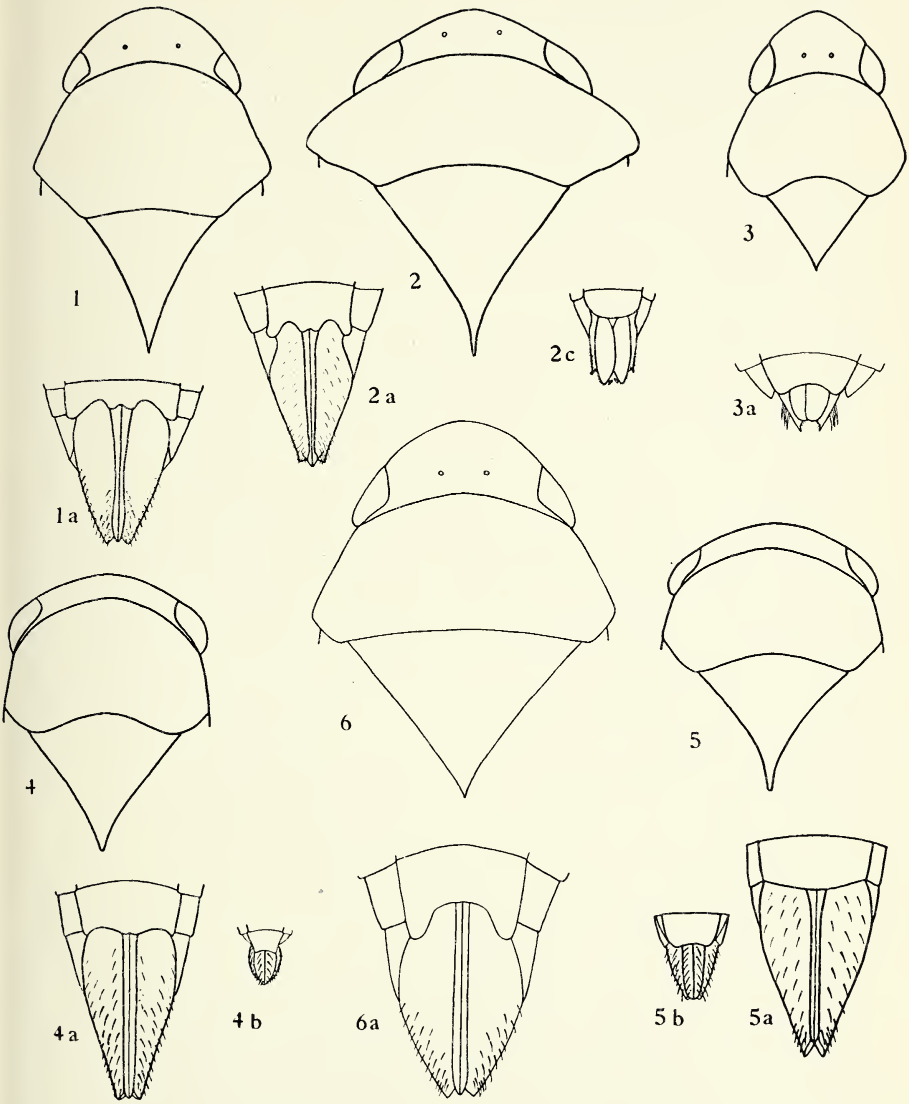
—Supplement, 1858.

—Insecta Saundersiana, 1858, p. 102.

EXPLANATION OF PLATE I

DRAWINGS BY J. N. KNULL

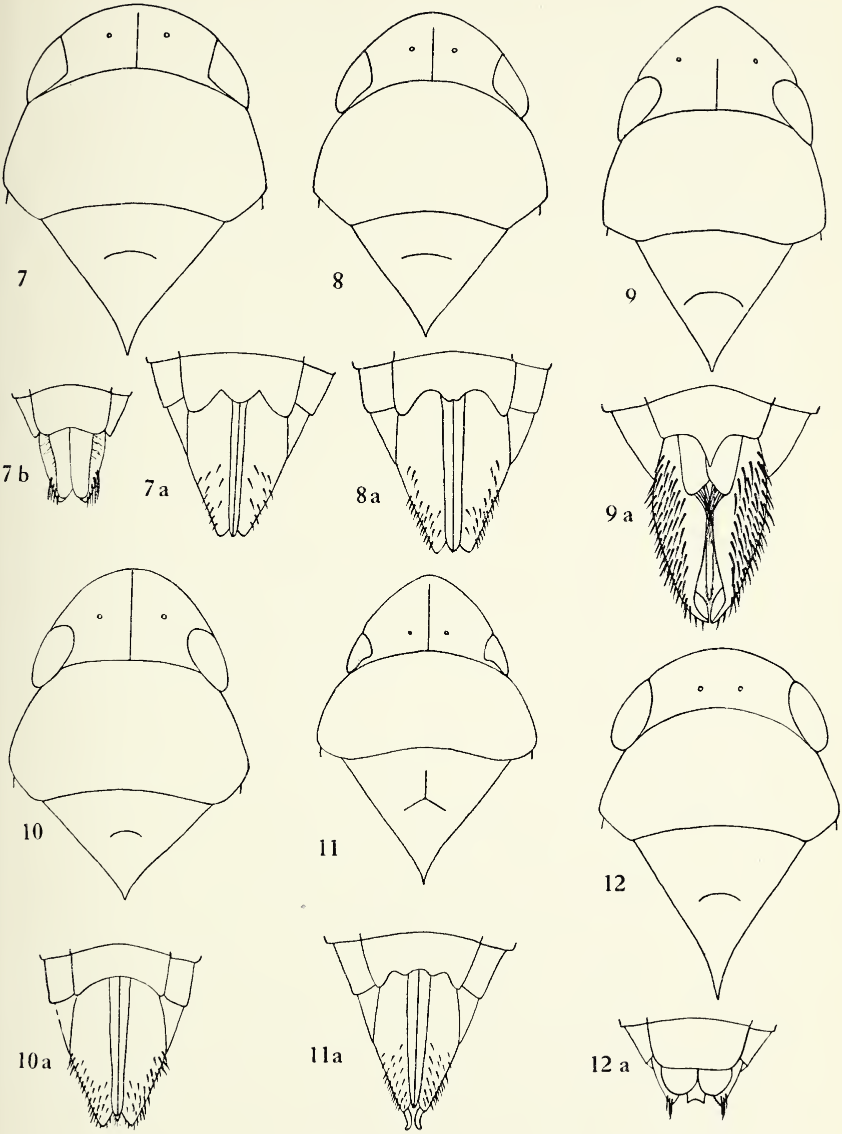
FIG. 1. *Clinonana declivata* sp. nov. 1a, female genitalia.
FIG. 2. *Clinonana magna* sp. nov. 2a, female; 2c, male genitalia.
FIG. 3. *Gypona vulnerata* 3a, male genitalia.
FIG. 4. *Scaroidana flavida* sp. nov. 4a, female; 4b, male genitalia.
FIG. 5. *Scaroidana fulvula* sp. nov. 5a, female; 5b, male genitalia.
FIG. 6. *Gypona cruzana* 6a, female genitalia.


1
2
3
2a
2c
3a
1a
6
4
5
4a
4b
6a
5b
5a

EXPLANATION OF PLATE II

DRAWINGS BY J. N. KNULL

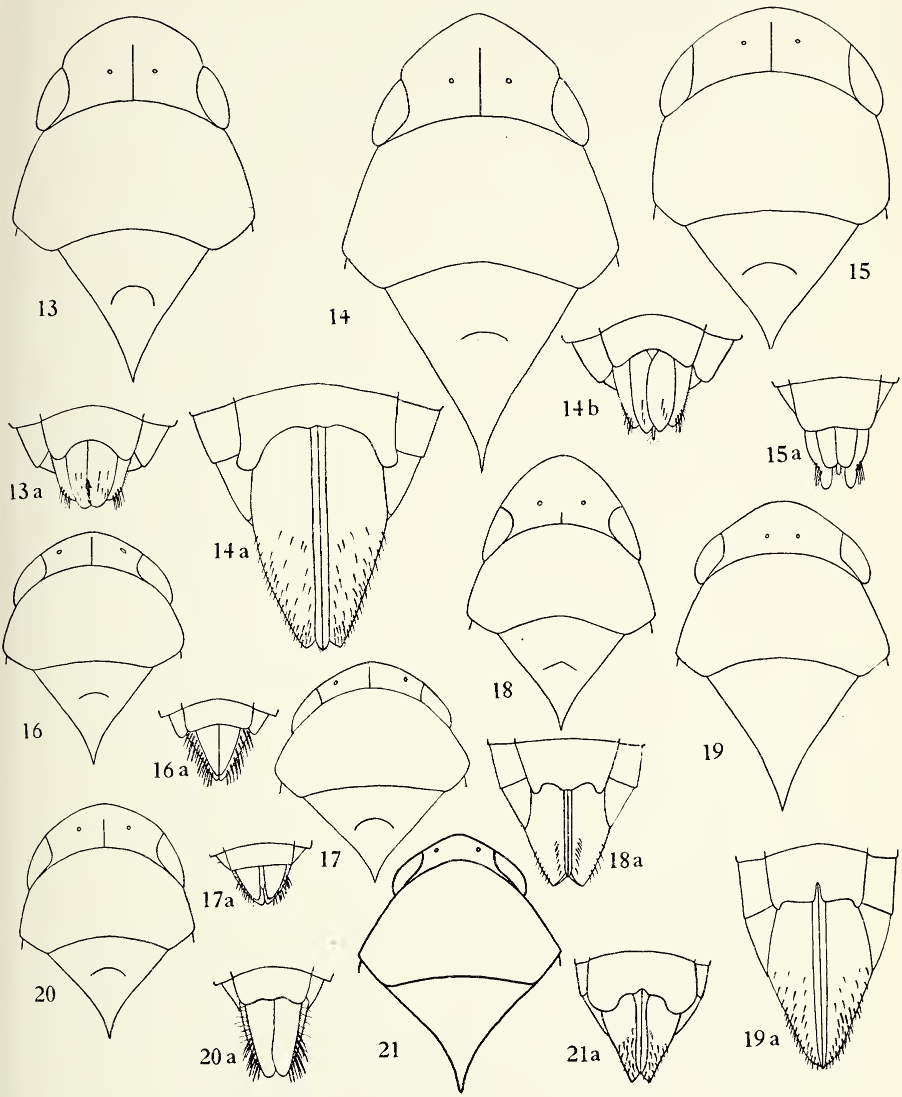
FIG. 7. *Gypona bigemmis* Spg. 7a, female; 7b, male genitalia.
FIG. 8. *Gypona equestris* Fab. 8a, female genitalia.
FIG. 9. *Gypona lineosa* sp. nov. 9a, female genitalia.
FIG. 10. *Gypona ecuadora* sp. nov. 10a, female genitalia.
FIG. 11. *Gyponana boliviana* sp. nov. 11a, female genitalia.
FIG. 12. *Gypona glauca* Fab. 12a, male genitalia.


7
8
9
7 b
7 a
8 a
9 a
10
11
12
10 a
11 a
12 a

EXPLANATION OF PLATE III

DRAWINGS BY J. N. KNULL

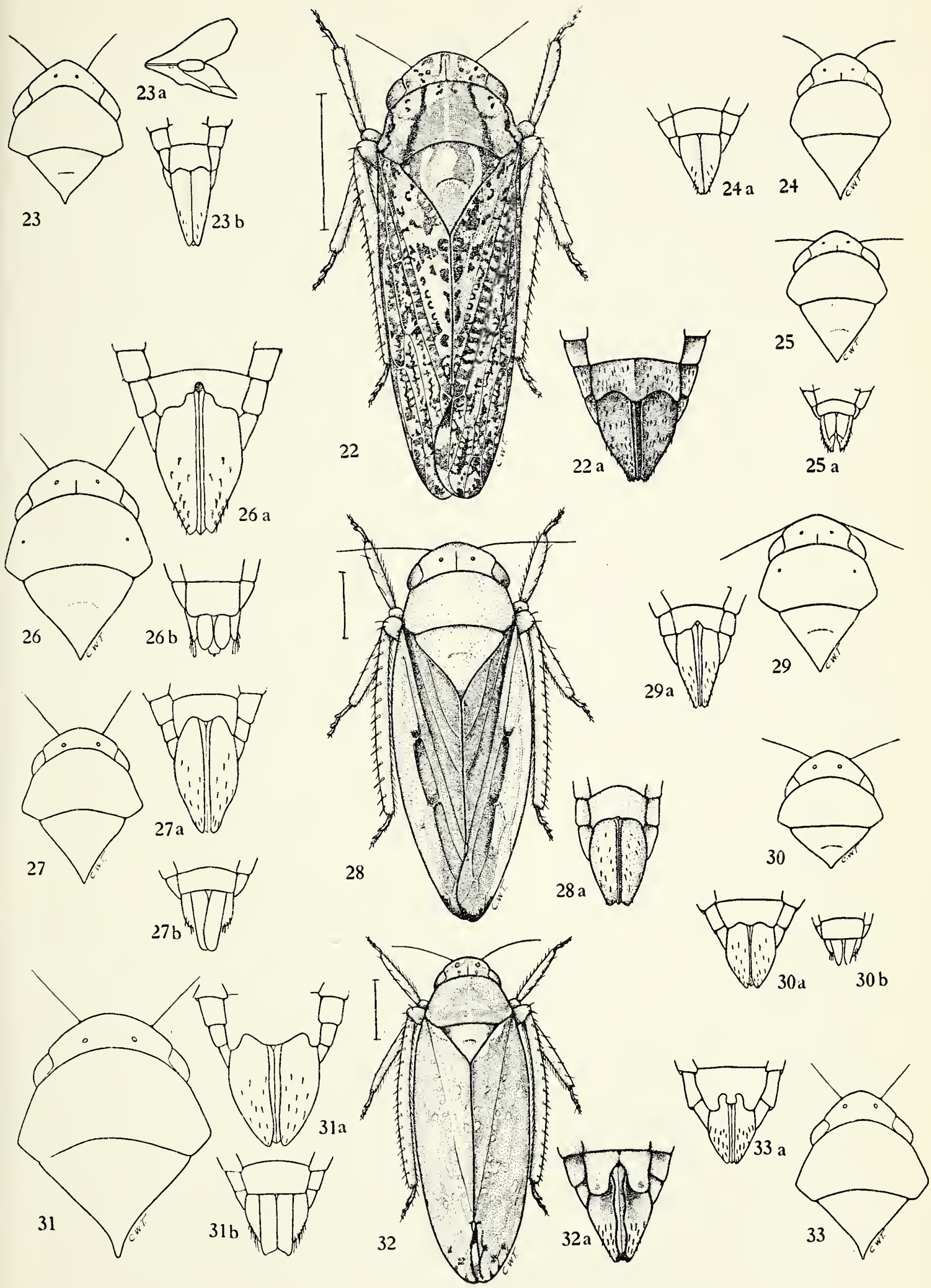
FIG. 13. *Gypona thoracica* Fab. 13a, male genitalia.
FIG. 14. *Gypona thoracica* Fab. 14a, female genitalia.
FIG. 15. *Gypona sierra* sp. nov. 15a, male genitalia.
FIG. 16. *Gyponana obtusa* Stål, 16a, male genitalia.
FIG. 17. *Ponana fusconotata* sp. nov. 17a, male genitalia.
FIG. 18. *Gypona ancona* sp. nov. 18a, female genitalia.
FIG. 19. *Gypona peruviana* 19a, female genitalia.
FIG. 20. *Prairiana griseola* sp. nov. 20a, male genitalia.
FIG. 21. *Ponana grossa* sp. nov. 21a, female genitalia.


13
14
15
14b
13a
14a
15a
16
18
19
16a
17
18a
20
17a
21
20a
21a
19a

EXPLANATION OF PLATE IV

DRAWINGS BY MRS. CELESTE TAFT

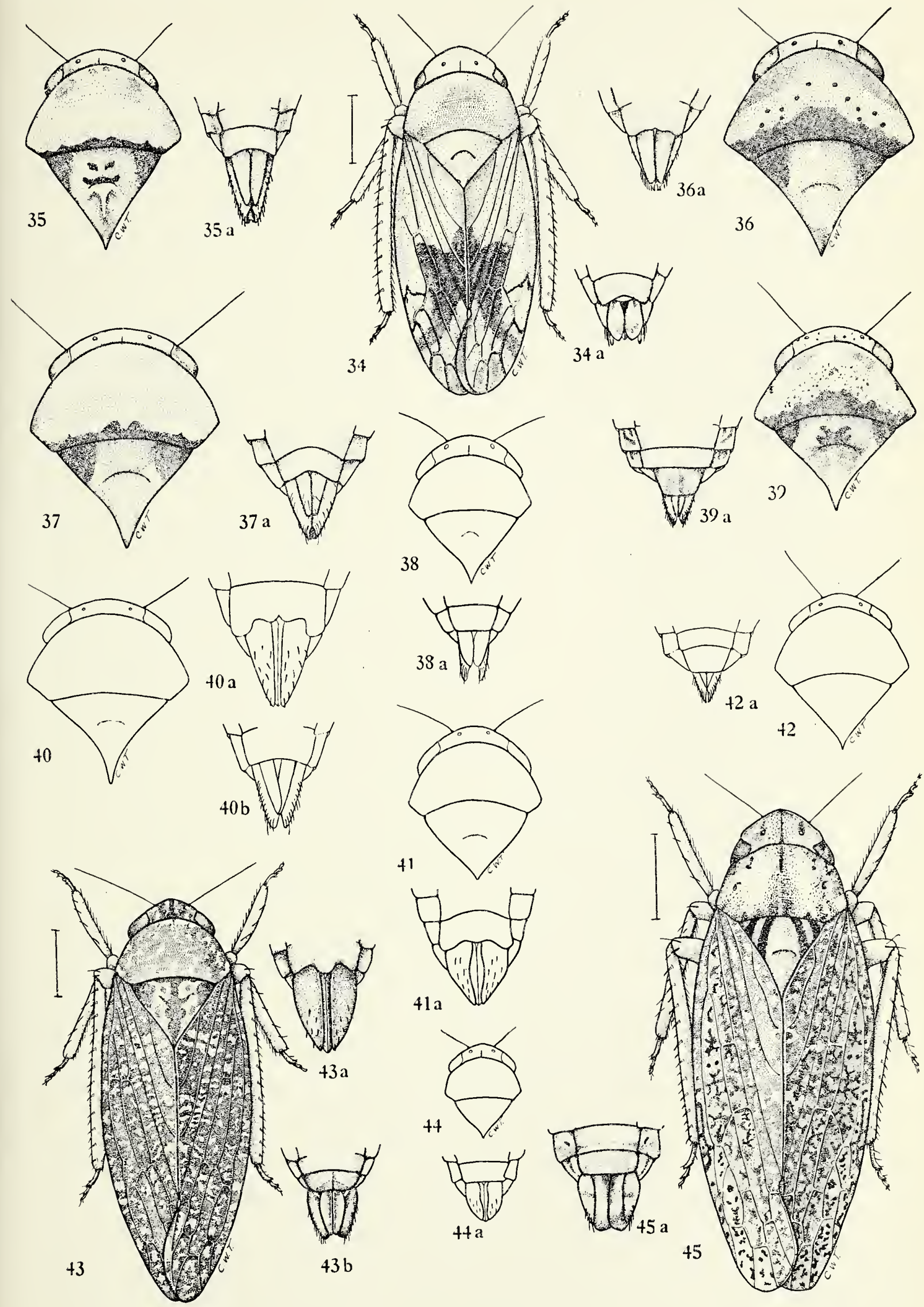
FIG. 22. *Rhogosana rugulosa* 22a, female genitalia.
FIG. 23. *Xerophloea tuberculata* 23a, profile; 23b, male genitalia.
FIG. 24. *Gypona vitraea* 24a, female genitalia.
FIG. 25. *Gypona bahia* 25a, male genitalia.
FIG. 26. *Gypona aurifera* 26a, female; 26b, male genitalia.
FIG. 27. *Prairiana basalis* 27a, female; 27b, male genitalia.
FIG. 28. *Gypona pulchella* 28a, female genitalia.
FIG. 29. *Gypona hyalina* 29a, female genitalia.
FIG. 30. *Prairiana rosacea* 30a, female; 30b, male genitalia.
FIG. 31. *Prairiana robusta* 31a, female; 31b, male genitalia.
FIG. 32. *Gypona viridula* 32a, female genitalia.
FIG. 33. *Ponana labella* 33a, female genitalia.


23
23 a
23 b
22
22 a
24 a
24
25
25 a
26 a
26
26 b
27
27 a
27 b
28
28 a
29
29 a
30
30 a
30 b
31
31 a
31 b
32
32 a
33
33 a

EXPLANATION OF PLATE V

DRAWINGS BY MRS. CELESTE TAFT

FIG. 34. *Gypona fulvotincta* 34a, male genitalia.
FIG. 35. *Ponana bicolorata* 35a, male genitalia.
FIG. 36. *Ponana sulfurea* 36a, male genitalia.
FIG. 37. *Ponana ornata* 37a, male genitalia.
FIG. 38. *Ponana piceata* 38a, male genitalia.
FIG. 39. *Ponana affinula* 39a, male genitalia.
FIG. 40. *Ponana sarana* 40a, female; 40b, male genitalia.
FIG. 41. *Ponana bruneola* 41a, female genitalia.
FIG. 42. *Ponana notatula* 42a, male genitalia.
FIG. 43. *Prairiana variegata* 43a, female; 43b, male genitalia.
FIG. 44. *Ponana punctatella* 44a, female genitalia.
FIG. 45. *Prairiana nigrifrons* 45a, male genitalia.


35
35 a
34
36a
36
34 a
37
37 a
38
39 a
39
40 a
40
38 a
42 a
42
40 b
41
41 a
43
43 a
44
44 a
45 a
43 b
45

ART. III. OCCURRENCE OF THE FAMILY PUPILLIDÆ IN WEST VIRGINIA

BY STANLEY TRUMAN BROOKS AND GORDON M. KUTCHKA

Annals of the Carnegie Museum
Vol. XXVII, p. 63-85

Issued March 17, 1938
Pittsburgh, Pa.

ART. III. OCCURRENCE OF THE FAMILY PUPILLIDÆ IN WEST VIRGINIA

By Stanley Truman Brooks and Gordon M. Kutchka

Text-figures 1–22

The members of the family *Pupillidæ*, due to their small size and complicated apertural armament, will be difficult for the inexperienced student of Conchology to study and identify. However, the beauty of these shells and the nicety of their structure will yield much pleasure to any one interested.

As an aid in the understanding of the terminology of the various apertural structures, a figure naming the folds and lamellæ is shown below. By observing the shell under some degree of magnification and by referring both to the description and the figure, the various "teeth" may be identified. By placing the shell upon a thin layer of modelling clay of the non-drying variety and manipulating it with a needle or a soft camel's hair brush, the shell may be studied or cleaned in preparation for study; the clay being "tacky," prevents the minute specimen from blowing away when the student breathes upon it. Heating the clay slightly makes it more adhesive. Shells mounted in this manner have not seemed to deteriorate from any action of the modelling clay, but it would be inadvisable to mount shells permanently in this manner without more knowledge of the chemical action of the medium. Separated specimens may be mounted upon small slips of cardboard in the same way and may be stored in vials for future study.

As with the *Carychiidæ*, these minute specimens are best collected by sifting forest loam or drift material deposited along water courses. Under a low power lens the concentrated material may be searched and the shells removed with a moist camel's hair brush. The sieve used should have at least twenty meshes to the inch, and for the *Carychiidæ* and juvenile *Pupillidæ* forty meshes to an inch. Sieves used for the testing of cement are very fine for this purpose.

If any of the specimens are living they may be allowed to dry or they may be placed in about 50 or 70% alcohol for a few hours and

Issued March 17, 1938.

then dried. No attempt should be made to remove the minute bodies. When ready for study the shell should be cleaned of any adherent debris and the aperture cleaned with a soft brush. This cleaning should be thorough as identification depends upon seeing all of the characters of the shell.

Active forms may be found under many conditions in nature; on plants, stones, logs, and in the detritus along fences. Some species are seldom found on the ground and may be found adhering to plants from several inches to several feet above the earth. A careful watch for these small forms will reward the collector with valuable additions to his hobby as well as interesting and important data on their dispersal over North America; the ultimate aim of every precise collection.

The work of Dr. Victor Sterki and of Dr. H. H. Smith in the collecting of *Pupillidæ* was mentioned in the list of donors published last year, (Brooks, 1935). Since that time other students have been active in the field. The contributions of each collector are designated by his initials, "VS," "HHS," etc.

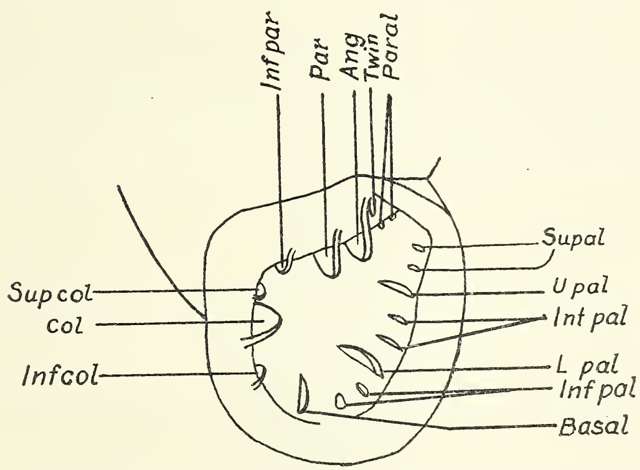
Mr. Kutchka, the junior author, spent some twelve weeks in the field and is responsible for an addition of some 16,000 specimens of land molluscs, a goodly number of which are the minute forms. Mr. G. R. Hunt, of Fairmont Teachers College, Fairmont, West Virginia, has contributed many valuable records and one new species, (Brooks and Hunt, 1936). Mr. M. S. Briscoe, of Storer College, Harpers Ferry, has been an energetic collector and has added many new records for his state. Mr. Neil D. Richmond and Mr. Paul Ridgeway, both of West Virginia, have also aided us by collections of both specimens and siftings. The senior author wishes to acknowledge the assistance that the above named individuals have rendered and has indicated the contribution of each one by the use of the initials of his name. All of those not designated are from Mr. Kutchka's findings.

In the following descriptions much use has been made of the "Manual of Conchology." In many cases adaptations, without acknowledgement, have been made from the descriptions, but those familiar with the extensive work of Dr. H. A. Pilsbry will undoubtedly recognize some of his erudite phraseology "peeping" from the lines of terminology; in all other cases full credit has been given to those drawn upon in this study. The reader should remember that this is written and directed to the students of land snails of West Virginia and not to the trained specialist. However, the latter will undoubtedly learn some new facts in the distribution of many of these forms. In this connection, we wish to draw attention to the new records of both southern and northern species in West Virginia.

Records in the Carnegie Museum

Pupillidæ

1935		1936	
Genera	2	Genera	4
Species	3	Species	18
Localities	6	Localities	199



Schematic figure showing armature of the Pupillid aperture.

Genus GASTROCOPTA Wollaston

Shell small, perforate or at least having a small umbilical chink present; cylindric or ovate-conic and having "angular and parietal lamellæ more or less completely united into one biramose, bifid, lobed or sinuous lamella. Columellar lamella present; palatal folds developed (except in *G. corticaria*); lip well expanded." (Pilsbry) The young shells are never toothed.

Most species of this genus, when found in nature, have the shell covered with debris; the mucus of the animal attaching it to the shell. This does not occur in *Vertigo*.

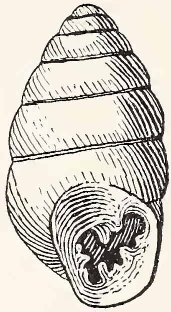
Subgenus ALBINULA Sterki

This includes the whitish, translucent species of *Gastrocopta* which have the inner end of the parietal lamella curved towards the periphery. These are the largest of the genus. Forms include *Gastrocopta armifera*, *G. contracta*, and *G. holzingeri*.

Gastrocopta armifera (Say)

Shell thin, paraffin-white, glossy, oblong with the apex obtusely conic; striæ weak, very oblique and irregular; whorls 6 to 6½, only moderately convex, the last compressed around the axis; aperture irregularly rounded, lip thin, expanded, the margins approaching and sometimes connected by a thin short callus across the parietal wall; angular lamella united with the parietal, joined to the outer lip; columellar lamella seen within the shell as a heavy tooth, retracted at the base; basal fold low and may be slightly indicated; the palatal folds stand on a white deposit, lower one short, pointing toward the columella, upper one shorter; above this may be a suprapalatal tubercle. Height 3.3-4.4 mm., width 2.2 mm.

Type locality: "Pennsylvania" (Say 1821); Dr. Pilsbry chooses



Germantown as the exact vicinity, as the specimens from that region most closely resemble the description.

Range: Eastern Canada, south to Florida and west to New Mexico.

West Virginia records

Greenbrier County; Alderson (NDR) (GMK)
Hampshire County; Romney
Jefferson County; Harpers Ferry, Bardane, Meyerstown, Summit Point, Keystone, Millville, Shepherdstown, Bakerton, Rippon, Mechanicstown, Engle, Bolivar, Leetown, Kearneysville, Aldridge, Morgan Grove, Jamestown, Middleway,

Johnstown, Skeetersville, Kabletown, Mount Pleasant, Bloomery, Halltown, Shenandoah Junction, Silver Grove (MSB)

Kanawha County; Tornado

Pendleton County; Franklin, Judy Gap, Upper Tract

Remarks: This is the largest species of the genus and may be recognized both by its size and color. Several specimens from Upper Tract and Franklin approach the form *clappi* (Sterki). This form is characterized by the columellar tooth being straight nearly to the base whereas in *armifera* the greatest projection forward is well above the base.

Gastrocopta contracta (Say)

Shell tapering from the body whorl to the apex, with 5 to 5½ bluish-white, convex, glossy, finely striated whorls; the body whorl straightened in its last half, pinched at the base and impressed over the lower palatals and on both sides of a low ridge close behind the peristome; aperture rounded-triangular, and almost closed by the

large teeth characteristic of this species; angular lamella arcuate, joining the lip, large, filling much of the aperture; the two palatal folds are connected by a low callus deposit, lower one larger, deeper in shell than smaller upper one; columellar lamella large, thin, very deeply placed, subvertical, the upper end curving forward; lip thin and well expanded. Height 2.5 mm., width 1.4 mm.

Type locality: "Occoquan, Virginia" (Say 1822).

Range: Eastern Canada, south to Florida and west to Mexico.

West Virginia records

Braxton County; Frametown, Gassaway

Grant County; Petersburg (PR)

Greenbrier County; Alderson (GMK, GRH, NDR)

Hampshire County; Romney

Jefferson County; Bloomery, Shenandoah City, Bardane, Meyerstown, Summit Point, Shepherdstown, Uvilla, Middleway,

Duffields, Keystone, Leetown, Reedson, Aldridge, Morgan Grove, Jamestown, Engle, Skeetersville, Kabletown, Halltown (MSB)
Marion County; Kingmont (GRH)
Mineral County; Burlington
Monroe County; Alderson, Peter's Mountain (GRH)
Monongalia County; Morgantown (HHS)
Morgan County; Largent (GRH)
Pendleton County; Franklin, Judy Gap, Upper Tract
Pocahontas County; Dunmore Spring, Marlinton, Greenbank (GMK), Mill Point (GRH)
Putnam County; Poca
Randolph County; Huttonsville
Summers County; Talcott, Wolf Creek

Remarks: This species is very characteristic; the shape, the projected half of the body whorl, and the aperture nearly closed by the teeth, easily set it apart from related forms.

Gastrocopta holzingeri (Sterki)

"Shell narrowly perforated, turreted-cylindrical, whitish, very minutely striate, shining; apex rather pointed, whorls 5, regularly increasing, rounded, the last somewhat narrowed and a little ascending towards the aperture, compressed at the base but not carinated, at some distance from the outer margin provided with an oblique, rather prominent, acute crest corresponding in direction to the lines of growth, extending from the base to the suture, formed by a whitish callosity; behind the crest the whorl is flattened, and corresponding to the lower palatal lamella, impressed. Aperture lateral, small, peristome moderately reflected; lamellæ 6; one parietal, rather long, very high, in its middle part curved outward, towards the aperture bifurcated, the outer branch (angular lamella) reaching the parietal wall; one columellar, longitudinal, rather high, its upper end turning in nearly a right angle towards the aperture, but not reaching the margin; basal exactly at the base, short, high and dentiform; lower palatal long, ending in a callus, highest about its middle; the upper short, rather high on the callus; above the upper one is a suprapalatal, quite small, dentiform, nearer the margin." Height 1.7 mm., width 0.8 mm. (Sterki, *in part*).

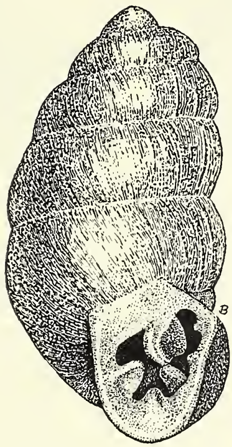
Type locality: Will County, Illinois ? (Sterki 1889).

Range: Western New York and Ontario, south to West Virginia and west to Kansas and New Mexico.

West Virginia record: Grant County; Petersburg (PR)

Gastrocopta holzingeri agna (Pilsbry and Vanatta)

Remarks: This species differs from *contracta* in its smaller size, its more cylindric appearance and by the presence of a strong basal fold. *Gastrocopta holzingeri agna* (Pilsbry and Vanatta 1907) was the first of this species to come to light and the illustration is of this form and not the typical *holzingeri.* It differs from the typical in being more



slender, and in the form of the columellar lamella, which ascends straightly and runs forward, while in *holzingeri* it ascends further and has an arched shape. Height 1.75 mm., width 1.0 mm. Described from Trinidad, Colorado. To state any range for this form would only be conjecture. In that it occurs in Colorado, Kansas, and West Virginia it would seem to be a racial form that may be derived from the parent species any place (?) within the limits of the distribution of that species.

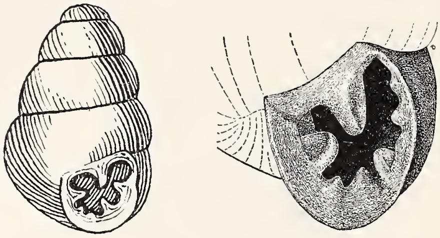
West Virginia record: Pendleton County; Upper Tract.

Subgenus VERTIGOPSIS "Cockerell" Sterki

This group is characterized by the weak parietal lamellæ, the angular may be small or wanting and the parietal short and simple. Pilsbry states that this group is not directly related to the other American groups of the genus as they seem to have been derived from the Asiatic group *Sinalbinula.* Forms are *Gastrocopta pentodon,* and *G. tappaniana.*

Gastrocopta pentodon (Say)

Shell clear horn color or whitish, oblong-conic with an obtuse apex; umbilicus slightly open; whorls five, convex, the body whorl with a crest parallel with and behind lip of aperture; aperture short with (typically) 5 teeth, the angular lamella simple, straight, columellar



lamella thin and horizontal, palatal folds situated upon a low ridge of callus, lower fold compressed, entering more deeply than the upper one; accessory denticles developed in the subcolumellar, basal and interpalatal positions. Height 1.5-1.8 mm., width 0.8-1.10 mm.

Type locality: "Pennsylvania" (Say 1821).

Range: Eastern Canada, south to Florida and west to Arizona.

West Virginia records

Braxton County; Frametown, Gassaway
Greenbrier County; Alderson (GMK, NDR), in part *gracilis*
Hampshire County; Romney, in part *gracilis*
Harrison County; Bristol—Lake Floyd (NDR)
Jefferson County; Shenandoah City, Bardane, Shepherdstown, Leetown, Reedson, Kearneysville, Aldridge, Charles Town, Bolivar, Bloomery (MSB), some are *gracilis*
Kanawha County; Tornado
Marion County; Kingmont (GRH)
Marshall County; Moundsville (VS)
Monroe County; Alderson (*gracilis*) (GMK), Peter's Mountain (GRH)
Monongalia County; Morgantown (HHS), Cooper Rock (NDR)
Morgan County; Largent (GRH)
Nicholas County; Craigsville, Lockwood, Summersville (*gracilis*)
Pendleton County; Franklin (*gracilis*), Judy Gap (*gracilis*), Upper Tract
Pocahontas County; Dunmore Spring, Greenbank, Hillsboro, Marlinton (GMK), Mill Point (GRH)

Remarks: This species is fairly easy to determine due to the blue-whitish color and smaller size. In West Virginia it is the most numerous of this genus. However, for the amateur, it will at first be difficult to realize the great number of variations in the dentition of the shell that occur in this species. Mr. E. G. Vanatta (1906) has figured these in several plates in the "Nautilus" and in the "Manual of Conchology" and states that he could have added many more.

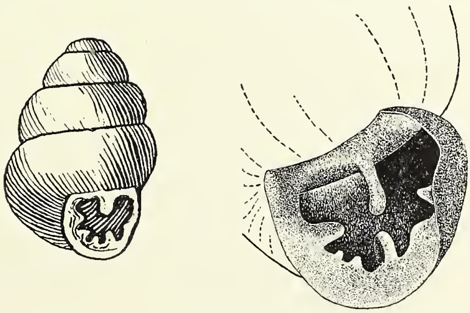
Gastrocopta pentodon (Say) form *curvidens* is figured here but as Pilsbry says (1916, Man. Conch.), "The increase in number of accessory denticles or teeth culminate in the form called *curvidens*, as there is absolutely no line to be drawn between *pentodon* and *curvidens*. It may be stated as proven that some colonies consist of "*pentodon*" and intermediate forms; some of "*pentodon*," intermediate and "*curvidens*" forms; and some of the intermediate and "*curvidens*" forms. We have found no large gathering of wholly typical *pentodon* or entirely *curvidens*."

Gastrocopta pentodon gracilis was described by Sterki from New Philadelphia, Ohio. He states that it is "long, slender, nearly cylindrical, with only 5 typical lamellæ, no accessory ones." It is a larger and more cylindrical shell than typical *pentodon*, and constitutes a large percentage of the West Virginian *pentodons*.

Neither of the forms seem to be important enough taxonomically to give them any special ranking in this short paper. It is to be seen, however, that this is an extremely variable species (*pentodon*), and should lend itself to studies of an ecological nature. Some very interesting quantitative studies in relation to habitat are available in a group of this kind.

Gastrocopta tappaniana (C. B. Adams)

Shell small, *larger than pentodon*, umbilicated, markedly conic but with obtuse apex; whorls 5 to 5½, convex, suture well impressed; aperture suborbicular, the whorl above cutting off about one-third



of the circle, aperture one-third the length of the shell, thickened within with 5 or 6 palatal teeth situated upon the callus; parietal tooth large, strong, perpendicular; columellar tooth large, blunt. Height 1.7-2.0 mm., width 1.1-1.2 mm.

Type locality: Vermont (Adams 1842).

Range: Ontario, south to Alabama and west to Arizona.

West Virginia records

Greenbrier County; Alderson (NDR)
Hampshire County; Romney
Jefferson County; Bloomery, Charles Town, Kabletown, Leetown (MSB)
Wetzel County; Siver Hill (NDR)

Remarks: This species may be confused with *pentodon*, but can be separated on the basis of its shape, size, and the arrangement of the teeth. The two species also differ in station (Pilsbry 1916), "*tappaniana* being found in low, moist places, under wood, often with *Vertigo ovata*, while *pentodon* lives in dryer situations." This species is not known from the southern Atlantic States. Dr. Sterki has described a shorter, more ovoid form from wet places in the region of New Philadelphia, Ohio, as the form *curta*.

Subgenus Privatula Sterki

This subgenus is characterized by a single species; *Gastrocopta corticaria*.

Gastrocopta corticaria (Say)

Shell cylindrical, ovate, tapering to an obtuse apex; whorls 5½, thin whitish and only faintly marked with growth lines; whorls convex, with no crest behind the lip of the aperture; aperture oval, lip thin, expanded and widely separated at the parietal extremities; angular and parietal lamellæ united into one, bilobed, small and not very conspicuous lamella; columellar lamella low, situated within the aperture. Height 2.5 mm., width 1.0 mm.

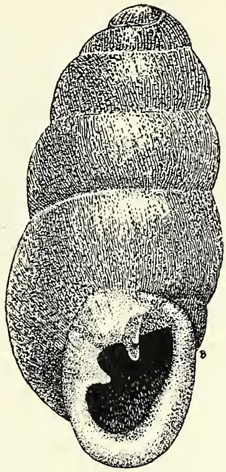
Type locality: "Philadelphia, Pa." (Say 1816).

Range: Ontario, south to Georgia and west to Minnesota.

West Virginia records

Jefferson County; Bloomery, Halltown, Reedson (MSB)
Monroe County; Alderson
Pendleton County; Franklin, Judy Gap, Upper Tract
Pocahontas County; Marlinton

Remarks: This is the most nearly toothless species in the genus. Dr. Pilsbry says that it may be found crawling upon trees a foot or



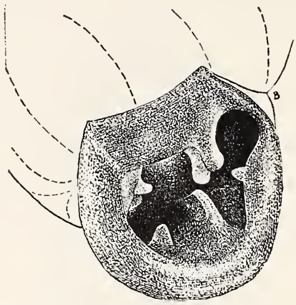
so above the ground and rarely occurs in great numbers. The latter is borne out by our collections in West Virginia although most of our specimens were from siftings. We believe that this is the first record from the southern Alleghenies as Upper Tract (our first locality) is at about 2000 feet altitude.

Subgenus GASTROCOPTA Wollaston

This subgenus is also characterized by a single species; *G. procera.*

Gastrocopta procera (Gould)

Shell cylindric, with convex-conic apex, brownish, glossy and very irregularly and lightly striate; whorls 5-5½, convex, the last flattened over the palatal fold, and impressed over basal folds with a low crest behind the lip; aperture with 5 teeth, parietal lamella sinuous, appearing bifurcate in front view which (appearance) is produced by the projection of the basal portion and the sinuosity of the lamella; columellar lamella stout, transverse, nearly a whorl long, below it a small tubercle may or may not be seen in the front view; upper palatal short, occurring exactly opposite the spur of the parietal and rather deep within; lower palatal longer, more deeply situated; basal fold short, as deeply situated as the upper palatal; strong, cinnamon-colored, callus ridge thickens peristome in front of the lip teeth but is excavated near the upper insertion. Height 2.3-2.5 mm., width 1.0-1.1 mm.



Type locality: Baltimore, Maryland (Gould 1840).

Range: Maryland to Kansas and south to Alabama—north to Illinois, but not common north of the Ohio River.

Remarks: This will not be mistaken for *G. rupicola* for that is a lighter-colored shell, white lipped and less cylindric.

Collected by M. S. Briscoe from ten localities in Jefferson County. So far it has not been found in the western part of the state.

Genus Vertigo Müller

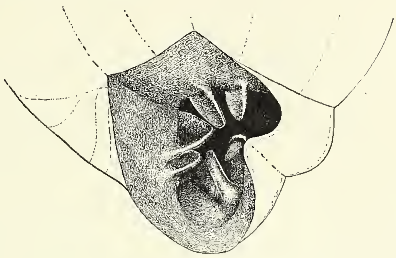
Shell small, ovate, glossy-brown, with an obtuse apex; aperture bears 6 teeth, typical of the Family, although any or all may be wanting and the angular lamella is not marginal if present; outer lip straightened or arcuate.

Subgenus Vertigo Müller

Forms are *Vertigo clappi*, *V. morsei*, *V. ovata*, *V. elatior*, *V. gouldii*, and *V. tridentata*.

Vertigo clappi Brooks, S. T., and Hunt, G. R.

"Shell brown, shining, striated, striæ forming slight riblets on the last two whorls; umbilicus open, deep; whorls 5½, the last strongly constricted behind the lip; aperture biarcuate, small, only slightly expanded; upper palatal fold long, blade-like, curved, springing from the heavy ridge formed by the intersection of the two arcs but beginning quite far back of the lip; the two columellar lamellæ are blade-like, rounded, similar in shape and lie horizontally and close together; infraparietal and angular lamellæ prominent but due to the small size of the aperture are close together and closely approach the columellar and palatal margins of the aperture." Height 1.5 mm., width 0.8 mm. (Brooks and Hunt, 1936).



Type locality: Renick, Greenbrier County, West Virginia.
Range: West Virginia.

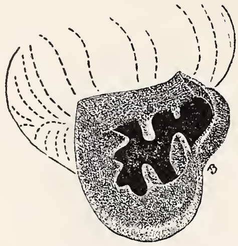
West Virginia records

Greenbrier County; Renick (GRH)
Hampshire County; Romney
Pendleton County; Judy Gap

Remarks: Once seen this shell will never be confused with any of the others of West Virginia. The sculpture is like that of "*V. rugosula*, but the two columellar lamellæ are nearer together, the lower palatal fold is more immersed and differs also in shape and size. It appears nearer to *V. alabamensis* Clapp, a much more ventricose shell, with differently formed columellar lamellæ. The shape is unusual for this group of *Vertigo*" (Pilsbry in letter). Dr. George H. Clapp, after whom this species is named, is well known for his molluscan studies and for his great collection now in this museum. He is the Honorary Curator of Molluscs in the Carnegie Museum and, financially, made possible a part of the present study.

Vertigo morsei Sterki

Shell large, cylindrical-turriculate, with a rather acute apex, striæ sparse, obsolete, shining, translucent; six whorls, slowly increasing, last scarcely higher than penultimate; suture deep; aperture biarcuate, lip flared; on external palatal wall is a moderate crest, behind it a deep and large impression over the palatal folds, and toward the lip a deep groove corresponds to the intersection of the two arcs; inside is a distinct callus of the same color as the shell; typically 9 teeth, three on parietal wall (as in *ovata*), the largest whitish; two on the columella, the superior one strong, vertical above, the inferior one thin, high, and directed obliquely upward; basal small, sometimes double, rarely absent; palatals high, long, curved and directed upward, suprapalatal



small, nodule-like (after Sterki). Height 2.7 mm., width 1.3 mm.

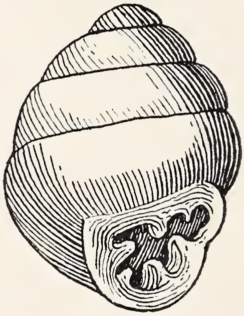
Type locality: Kent County, Michigan (Sterki, 1894).

Range: Michigan, Indiana, New Jersey, Illinois, Ohio, and West Virginia.

Remarks: This species stands close to *ovata* and is the largest *Vertigo* known. So far it has been collected only at Leetown, Jefferson County by M. S. Briscoe.

Vertigo ovata Say

Shell brown, ovate; whorls 5, suture impressed; aperture biarcuate, triangular-ovate, the intersection of the two circles forming an indentation near the lip of the body whorl; teeth five to none; one or two columellar lamellæ, two or three parietal lamellæ, and two to



five basal and palatal folds, in some only the two large palatals, one large parietal and one columellar lamella are present, the rest reduced to mere denticles or slight callus deposits. Height 2.2 mm., width 1.4 mm.

Type locality: "Philadelphia" (Say, 1822).

Range: Labrador, south to Alabama, west to Arizona, and north to

Alaska. Pilsbry states (1919): "*V. ovata* has the greatest range in latitude and climate of any *Vertigo* or other *Pupillid* snail in the world, as far as I know."

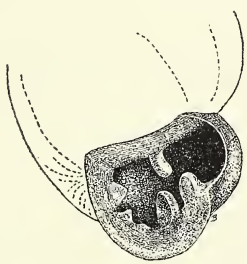
West Virginia records

Hampshire County; Romney
Pendleton County; Judy Gap
Summers County; Wolf Creek

Remarks: The shape of this species alone is sufficient to separate it from any of the others. A very characteristic form and we are surprised to find it so sparsely distributed in West Virginia.

Vertigo elatior Sterki

An umbilicated, ovate-conic shell, smooth, polished; 5 whorls, suture deep; aperture semicircular, slightly divided into two arcs,



with 5 teeth, one on the parietal wall; columellar lamella strong, oblique; basal fold small; two palatal folds, prominent, blade-like, the upper approaching the extremity of the parietal. Height 2.15 mm., width 1.2 mm.

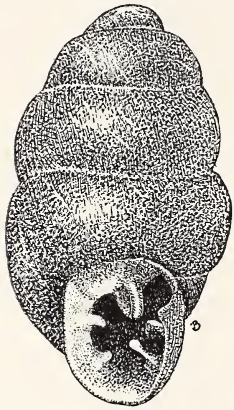
Type locality: New Philadelphia, Ohio (Sterki, 1894).

Range: From Maine, west to British Columbia, south to Mexico and West Virginia.

Remarks: Collected only in Jefferson County, Leetown, by M. S. Briscoe. This is a larger and more elevated shell than *V. ventricosa* (Morse), of which it was described as a subspecies by Sterki. Pilsbry says that it should now be considered as a species. The specimens at hand are undoubtedly from a marl deposit as they all have the appearance of being fossil or subfossil.

Vertigo gouldii (A. Binney)

Shell light chestnut-brown, shining; whorls 4-5 with oblique striæ, body whorl occupying nearly half of the total altitude of the shell, apex obtuse; aperture biarcuate, the two halves meeting in the center



of the outer lip; teeth 5, white, one on the transverse margin, two on the columellar and two on the palatal region; lip thickened, not reflected; umbilicus slightly open. Height 1.85 mm., width 1.0 mm.

Type locality: Brookline, Massachusetts (Binney, 1843).

Range: Quebec, south to Alabama and west to British Columbia.

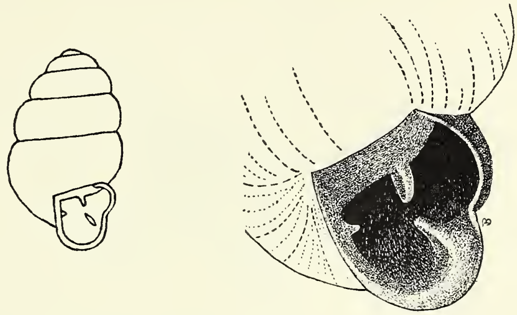
West Virginia records

Greenbrier County; Alderson (GMK) (NDR)
Jefferson County; Shenandoah City (MSB)
Kanawha County; Tornado
Marion County; Kingmont (GRH)
Nicholas County; Summersville
Pendleton County; Franklin, Judy Gap, Upper Tract
Pocahontas County; Marlinton, Dunmore Spring
Randolph County; Helvetia (VS)
Summers County; Wolf Creek

Remarks: The surface of this species is very distinctly striate but the aperture is not as arcuated as one would suppose from the description.

Vertigo tridentata Wolf

Shell narrowly ovate to tapering oblong, honey yellow shading to brown, surface smooth, glossy, only very slightly striate; 5 whorls, the last slightly flattened externally over the lower palatal fold and with a distinct crest behind the lip; outer lip projects forward and slightly inward near the middle; parietal lamella high, rather short; columellar lamella blunt, directed downward; lower palatal fold



strongly developed; upper palatal fold quite small or sometimes wanting; the latter stands upon a slightly distinct palatal callus; no angular or basal folds. Height 1.8-2.2 mm., width 1.1 mm.

Type locality: Canton, Illinois (Wolf, 1870).

Range: Quebec, west to Texas and, in the East, south to West Virginia.

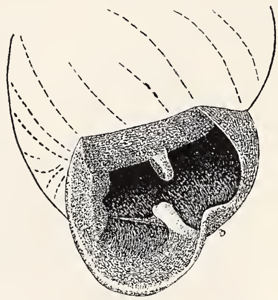
Remarks: The single specimen observed by me is from M. S. Briscoe, Jefferson County, Reedson, and bears four teeth; the upper palatal being quite well-developed; five whorls of a greenish brown color, polished; the three teeth usually are enough to separate this species from the others. The author of the species collected it "in shady copses on green weeds, climbing as high as three feet from the ground. I collected 12,000 from standing weeds and not one from the ground, although it was searched well to find them."

Subgenus VERTILLARIA Pilsbry

Characters are the same as there is only one species of this group in America. It was originally described from Florida. The northern limits are indicated by the following locality from West Virginia. The only form; *V. oscariana.*

Vertigo oscariana Sterki

"This is the most peculiar of our species. It is the size of *milium,* but oblong with either end nearly equally pointed. The last whorl being considerably narrowed and flattened towards the (biarcuate) small . . . . aperture. Shell thin, delicate, of pale horn color, as is the palatal wall and margin; the latter simple and straight, with a very slight, thin callus inside, lamellæ 3, whitish, rather small: one parietal (short and rather high), one columellar (blunt and thick with



the lower end vertical, the upper slanting slightly inward) and one lower palatal (which is set deep in the throat)." (Sterki). Height 1.5 mm., width 0.8 mm.

Type locality: Mosquito Island, Volusia County, Florida (Sterki 1890).

Range: Florida, west to Texas, north to West Virginia.

West Virginia records

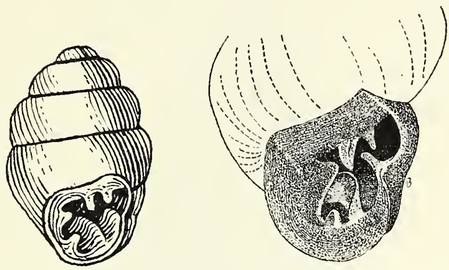
Greenbrier County; Alderson
Monroe County; Alderson
Pendleton County; Franklin
Summers County; Talcott

Subgenus ANGUSTULA Sterki

The characters are those of the species; *Vertigo milium.*

Vertigo milium (Gould)

Shell small, globosely-oval, color light cinnamon; whorls 4½ to 5, wrinkled obliquely, convex, suture deep; apex bluntly rounded; aperture half the width of the last whorl, formed of two intersecting arcs; outer lip well marked with groove at intersection of arcs, rest of the lip simply arcuate, white, slightly everted; "angular lamella high, short, and situated inward from the insertion of the outer lip. The parietal is high and long, entering deeply. The high columellar lamella enters horizontally at first, then turns downward, being crescent shaped. (Its downward continuation was mistaken by Gould for a "tubercle at its base"). The upper palatal fold is long and high, slightly curved. Lower palatal is a little immersed, high, thin, and enters to the dorsal side, where it curves downward. Both palatal folds are rather thick and tapering at their outer ends. The basal



fold is somewhat immersed, short and high. There is sometimes a small, tubercular suprapalatal fold." (Pilsbry). Height 1.4-1.75 mm., width 0.9-1.0 mm.

Type locality: Oak Island, near Chelsea, Boston, Massachusetts (Gould, 1840).

Range: Maine to Florida and west to Arizona and Mexico.

West Virginia records; Greenbrier County; Alderson (NDR); Hampshire County; Romney.

Genus COLUMELLA Westerlund 1887

This genus and the Genus *Vertigo* both belong under the subfamily *Vertigininæ*. As a group these are characterized by the absence of the inferior tentacles. The shells of this group are compact, ovate or cylindric, and all are of small size. The only species of the genus *Columella* that exists in our region is *C. edentula* described below:

Columella edentula (Draparnaud)

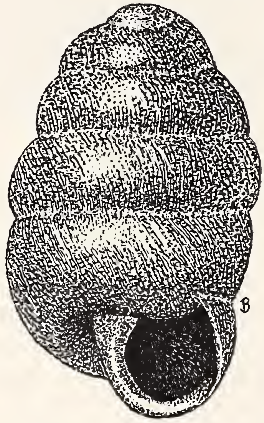
Shell small, oblong-cylindric, tapering only slightly to an obtuse apex, the last two whorls quite cylindrical; whorls smooth, thin, shining, dark or reddish-brown, but may have whitish streaks; whorls 5-6½, convex; aperture oblique, rounded, cut off above by the preceding whorl; lip thin, sharp, not expanded, toothless, the region near the columella reflected. Height 1.8-2.2 mm., width 1.1-1.35 mm.

Type locality: "France" (Draparnaud, 1805).

Range: A circumboreal species.

West Virginia records

Braxton County; Gassaway
Hampshire County; Romney
Jefferson County; Reedson (MSB)
Nicholas County; Lockwood, Summersville
Pendleton County; Franklin
Pocahontas County; Marlinton, Mill Point
Summers County; Talcott



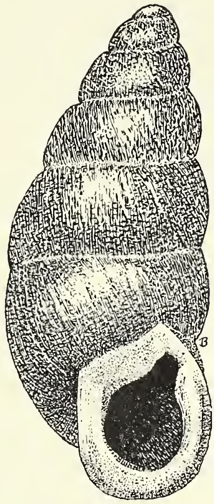
Remarks: In the United States this species is rare in the southern states. In our collections from West Virginia it is sparse, one or two specimens only being found in each of the localities mentioned. They inhabit the soil rather than the surface although they may ascend bushes and trees during wet weather.

Genus PUPOIDES Pfeiffer 1854

The genus *Pupilla*, which is found in so many of our northern states, has not yet been found in our area. Species of the genus *Pupoides*, which with *Pupilla* is contained in the subfamily *Pupillinæ*, are characterized by the presence of the inferior tentacles and by the large size of the shell.

Pupoides marginatus (Say)

Shell only minutely perforate, elongate-ovate, slowly tapering to an obtuse apex; 5½ to 6 whorls, brownish and only slightly marked with striæ, convex, the last somewhat compressed and tapering to the narrowly rounded base; aperture ovate; lip reflected, expanded, strongly thickened within and strongly arched near the upper columellar insertion, its internal callus excavated and narrowed there. Parie-



tal callus rather strong but transparent, bearing a short angular tubercle connected with the outer lip. Height 5 mm., width 2.2 mm.

Type locality: "Upper Missouri" (Say, 1821).

Range: Ontario to the Gulf of Mexico and west to Colorado and Arizona.

West Virginia records

Hampshire County; Romney

Jefferson County; Bloomery, Bardane, Meyerstown, Summit Point, Shepherdstown, Keystone, Bakerston, Middleway, Mechanicstown, Leetown, Kearneysville, Aldridge, Morgan Grove, Jamestown, Kabletown, Halltown, Charles Town (MSB)

Pendleton County; Judy Gap

Remarks: One will hardly confuse this species with any other of the *Pupillidæ* as its shape and the toothless aperture easily separate it. Many of the specimens from West Virginia vary slightly from the description, being narrower and shorter.

BIBLIOGRAPHY

ADAMS, C. B.

1842. *G. tappaniana*, in Thompson's History of Vermont, p. 158.

BINNEY, AMOS

1843. *V. gouldii*, Proceedings of the Boston Society of Natural History, Vol. I, p. 105.

BROOKS, S. T.

1935. *The Shelled Molluscs of West Virginia in the Collection of the Carnegie Museum*, Annals of the Carnegie Museum, Vol. 24, pp. 61-68.

BROOKS, S. T. AND HUNT, G. R.

1936. *V. clappi, A New Land Snail from West Virginia*, Annals of the Carnegie Museum, Vol. 25, p. 121.

DRAPARNAUD J. P. F.

1805. *C. edentula*, Histoir Naturelle Mollusques fluviatile et terrestrial, France, p. 59, pl. 3, figs. 28-29.

GOULD, A. A.

1840. *V. milium*, Boston Journal of Natural History, Vol. III, pt. 3, p. 402, pl. 3, fig. 23. *G. procera*, l. c., p. 401, pl. 3, fig. 12.

PILSBRY, H. A.

1916. *Gastrocopta*, Manual of Conchology, Vol. XXIV, pp. 1-87.

1919. *Vertigo*, Manual of Conchology, Vol. XXV, pp. 69-150.

1921. *Pupoides*, Manual of Conchology, Vol. XXVI, pp. 108-113.

1926. *Columella*, Manual of Conchology, Vol. XXVII, pp. 232-248.

PILSBRY, H. A. AND VANATTA, E. G.

1907. *Bifidaria agna*, The Nautilus, Vol. XX, No. 12, pp. 140-142, figs. 1-3.

SAY, THOMAS

1816. *G. corticaria*, Nicholson's American Encyclopedia, Vol. II, pl. 4, fig. 5.

1821. *G. armifera*, *G. pentodon*, *P. marginatus*, Journal Academy of Natural Sciences Philadelphia, Vol. II, pp. 162, 376, 172.

1822. *G. contracta*, Journal of the Academy of Natural Sciences Philadelphia, Vol. II, p. 374. *V. ovata*, l. c., p. 375.

STERKI, V.

1889. *G. holzingeri*, The Nautilus, Vol. III, No. 4, pp. 37-39, See p. 96 also.

1894. *V. morsei*, The Nautilus, Vol. VIII, No. 8, p. 89.

1894. *V. elatior*, The Land and Fresh Water Mollusca in the Vicinity of New Philadelphia; a contribution to the Natural History of Tuscarawas Co., Ohio, p. 5.

1890. *V. oscariana*, Proceedings Academy Natural Sciences Philadelphia, Vol. 42, p. 33.

1909. *Bifidaria clappi*, The Nautilus, Vol. XXII, No. 10, p. 108, pl. 8, fig. 4.

VANATTA, E. G. AND PILSBRY, H. A.

1906. *Bifidaria pentodon* (Say), *Bifidaria pentodon gracilis* Sterki, *Bifidaria tappaniana* (C. B. Adams), The Nautilus, Vol. XIX, No. 11, pp. 121-128, pls. 6-7.

WOLF, JOHN

1870. *V. tridentata*, American Journal of Conchology, Vol. V, p. 198, pl. 17, fig. 1.

ART. IV. *BRACHYHYOPS*, A NEW BUNODONT ARTIODACTYL FROM BEAVER DIVIDE, WYOMING

BY EDWIN H. COLBERT

Annals of the Carnegie Museum
Vol. XXVII, p. 87-108

Issued March 17, 1938
Pittsburgh, Pa.

ART. IV. *BRACHYHYOPS*, A NEW BUNODONT ARTIODACTYL FROM BEAVER DIVIDE, WYOMING

By Edwin H. Colbert*

Text-figures 1-5

*American Museum of Natural History, New York

INTRODUCTION

The Carnegie Museum palæontological expedition of 1934, under the leadership of Mr. J. LeRoy Kay, discovered a rather well preserved skull of a bunodont artiodactyl on Beaver Divide, Wyoming. The specimen was found in association with a primitive type of oreodont, in the uppermost portion of the Uinta formation at the locality mentioned, at a situation very close to the boundary between the Uinta and the overlying Oligocene beds.

Through the kindness of Dr. A. Avinoff, Director of the Carnegie Museum, and of Mr. J. LeRoy Kay, of the Department of Vertebrate Palæontology of the same institution, the above mentioned specimen has been given to me for the purposes of study and description. I wish to thank them for the courtesies extended to me in connection with this study.

The illustrations accompanying this description were made by Mr. Sidney Prentice of the Carnegie Museum.

Brachyhyops Colbert[1].

Diagnosis: Of medium size, the skull being of a length comparable to that of the skull of a modern peccary. Dentition $^{3(?)-1-4-3}$; lower dentition unknown. Cheek teeth closely comparable to those of *Chœropotamus*, *Helohyus*, *Achænodon* and *Parahyus*, being near to the latter in size. Cranium broad, having widely separated parietal crests. Orbit closed posteriorly; situated above the last two molars. Muzzle relatively short, so that the postorbital length exceeds somewhat the preorbital length of the skull. Zygomatic arch vertically

[1] βραχύ'ς—short; ύός—hog; ὄψ—aspect.

Issued March 17, 1938.

expanded behind and below the orbit, somewhat in the manner of the entelodonts. Skull transversely broad, due to the lateral expansion of the arches. Glenoids shallow and broad and relatively low, being about on a level with the occlusal line of the upper cheek teeth. Paroccipital processes short and pterygoids weak. Posterior nares extending to the middle of the upper third molar. Basicranium primitive, the arrangement of the foramina being like that in the dichobunids.

Generic type: Brachyhyops wyomingensis Colbert.

Brachyhyops wyomingensis Colbert.

Colbert, E. H., 1937, Amer. Jour. Sci., XXXIII, pp. 473-474.

Type: Carnegie Mus., no. 12048, a skull, virtually complete; paratypes, none.

Horizon: From the uppermost level of the Uinta formation, immediately beneath the basal Oligocene agglomerate at Beaver Divide.

Locality: One half mile north of Wagon Bed Springs, Wyoming.

Diagnosis: The specific diagnosis is the same as that given for the genus.

FIG. 1. Beaver Divide, near Wagon Bed Springs, Wyoming. The cross shows the position at which *Brachyhyops wyomingensis* was discovered.

DESCRIPTION

The Skull

As was mentioned in the diagnosis, the new genus now under consideration is of medium size, being more or less comparable in this respect to the modern peccary. It is much larger than the primitive Eocene dichobunids, such as *Homacodon*, much smaller than the genus *Achænodon*, and closely comparable in size to the European form, *Chœropotamus*, and, as judged on the basis of the upper teeth, to *Parahyus*, of the Lower Eocene of North America.

As seen from the dorsal side, the skull of *Brachyhyops* is very broad in comparison to its length. The zygomatic arches are widely expanded as in *Chœropotamus*, or as in *Achænodon uintense*, but except for this character the skulls of *Brachyhyops* and this latter form are quite different from each other in their dorsal aspect. In *Achænodon* the zygomatic arch sweeps around in a rather broad, even curve, from the infraorbital foramen to the postglenoid border. In *Brachyhyops* the arch expands laterally from the infraorbital foramen to a point opposite the posterior border of the orbit, and then it continues posteriorly in a straight line parallel to the midline of the skull. At the back the postglenoid border is transverse and its junction with the lateral portion of the zygomatic arch takes the form of a distinct right angle. The heavy postorbital processes of the frontal and the zygomatic are joined to form a strong postorbital bar.

Noteworthy characters of this skull are to be seen in the widely separated temporal crests, and the vertical expansion of the zygomata. Evidently there was a great enlargement of the temporal and masseter muscles in *Brachyhyops*, which resulted in extraordinary developments of the bony attachments for these muscles. In *Chœropotamus*, *Helohyus* and *Achænodon*, the sagittal crest is high, as in many Eocene mammals, but there is no particular vertical expansion of the zygomatic arch. In the entelodonts the jugal is expanded (whether this is entirely an adaptation for an enlarged masseter may be questioned) and the sagittal crest is strong. In many advanced artiodactyls there are separate parietal crests, formed by a primary longitudinal division of the sagittal crest and a subsequent lateral spreading of the two crests away from the median line, due to the expansion of the brain case. In these cases, however, the division of the sagittal crest and the lateral separation to form two parietal crests is an adaptation either to an increase of the brain itself, or to the secondary development of enlarged sinus cavities. In *Brachyhyops*, a primitive form with a small brain, it would seem as if the development of the parietal crests was an independent response to an enlargement of the temporal muscles, in no way correlated with a needed increase of cranial capacity, a conclusion based on the fact that the crests are narrow and high, not low ridges on an expanded cranium. A low median ridge in the position of the sagittal crest, may be seen on the skull roof between the two parietal crests.

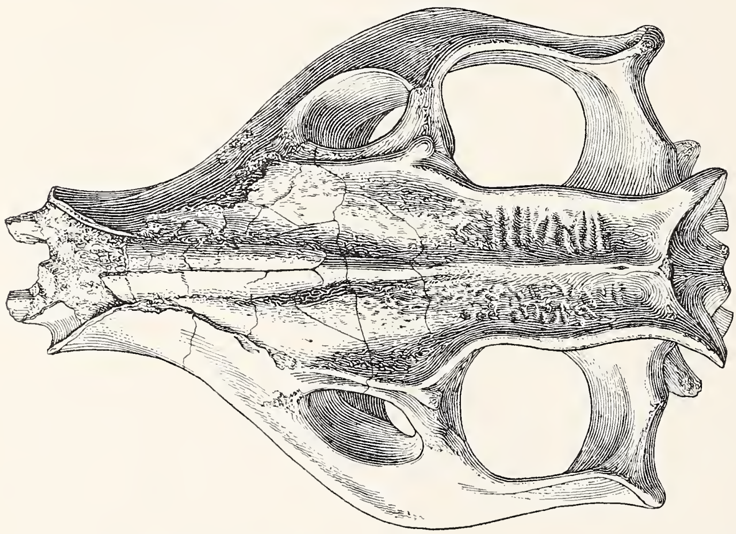


FIG. 2. *Brachyhyops wyomingensis* Colbert. Type skull, Carnegie Mus. No. 12048. Dorsal view, two-fifths natural size.

The frontal and parietal region between the two crests would seem to have been somewhat concave, although crushing has altered this portion of the skull considerably, making it difficult to restore the cranial roof to its original condition. The lambdoidal crest is bowed forward strongly. It might be well to mention in passing that the top of the skull is characterized by a sort of sculptured surface; that is, there are excrescences in the form of low, heavy ridges above the orbits and on the parietals between the parietal crests.

As seen from the side, the appearance of the skull has been greatly altered by crushing, but when the effect of this crushing is disregarded, it may be assumed that the skull was rather low. The orbit is rather centrally located, that is, it is more or less midway between the front and the back of the skull. The muzzle of *Brachyhyops* is short and the postorbital region is relatively long, in which respects this genus is like the primitive dichobunids, and *Achænodon*. The orbit is closed, as was mentioned above, and the infraorbital foramen is above the third premolar.

The most striking feature about the skull of *Brachyhyops* as seen in a lateral view is the expansion of the malar, as was mentioned above. As in the Entelodontidæ, this expansion is in the jugal beneath and behind the orbit, and it does not extend to the zygomatic process of the squamosal to any pronounced degree. The zygomatic process has a concave depression on its lateral surface, opposite the glenoid.

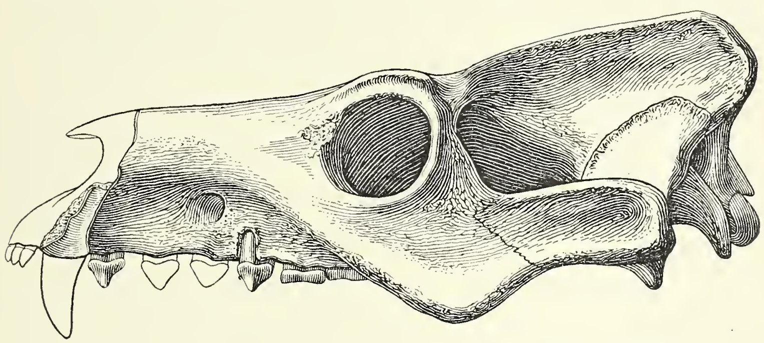


FIG. 3. *Brachyhyops wyomingensis* Colbert. Type skull, Carnegie Mus. No. 12048. Side view, two-fifths natural size.

The external auditory meatus is located between the postglenoid and paroccipital processes and is directed laterally.

The palatal view of the skull of *Brachyhyops*, like the dorsal view, reveals the great breadth of the skull. Due to the expansion of the zygomatic arch, there is a broad area on the ventral side of the jugal, external to the molar teeth and beneath the sphenopalatine foramen, and it continues back, on the ventral side of the jugal and on to the ventral portion of the zygomatic process to merge into the shallow glenoid. The transverse glenoid is extremely shallow and the post-glenoid process is transversely broad. The pterygoid processes are of moderate size.

The posterior nares extend to a point opposite the mid-portion of the last molars. The paroccipital processes are short and stout, and directed strongly towards the rear, a character of primitive ungulates. The tubercles of the basioccipital (for the attachment of the rectus capitis ventralis major muscles) are small but well defined.

Turning now to a consideration of the foramina, it is to be noted that the posterior palatine foramina are opposite the anterior border of the second molar. Since the skull is badly crushed, the ethmoid and optic foramina are not discernible, but the foramen rotundum and the foramen lacerum anterius are plainly visible, enclosed in a common vestibule. The foramen ovale is situated just medially to the internal border of the glenoid, while the foramen lacerum medius and the opening for the eustachian canal are behind it and separated from it by a bony ridge. The foramen lacerum posterius is isolated and located opposite and median to the postglenoid process, while the stylomastoid foramen is postero-lateral to the foramen lacerum posterius. The condylar foramen would seem to be single.

This arrangement of the basicranial foramina, described above, is characteristic of a primitive mammal, in that there is little tendency towards fusion or concrescence of the various openings in the cranial floor. In this respect *Brachyhyops* may be compared with other primitive Eocene bunodont artiodactyls, such as *Achænodon*, *Helohyus* and *Cebochœrus*.

It would seem as if the bulla in *Brachyhyops* was either cartilaginous or so fragile (if bony) that it was destroyed, in which respect *Brachyhyops* is similar to other primitive artiodactyls, such as the dichobunids.

In this discussion of the basicranium of *Brachyhyops* it might be well to point out the fact that this genus displays its relationships to the primitive bunodont artiodactyls by reason of the lack of any appreciable compression of the structures on the floor of the brain case. Thus it may be contrasted with the achænodonts and the entolodonts, in which the basicranium is greatly compressed by the backward shift of the glenoids.

The occipital view of the skull of *Brachyhyops* demonstrates again its low, broad character. The condyles are of normal size and development.

The Dentition

The teeth of the specimen under consideration are fragmentary and badly worn, so that unfortunately they are not of much help in a study of this new genus. The last premolar and the last two molars are present on the right side of the skull, and the first and last molars are present on the left side. The alveoli of the other cheek teeth and of the left canine are preserved, and thus some deductions as to the dental formula and the arrangement of the cheek teeth are possible.

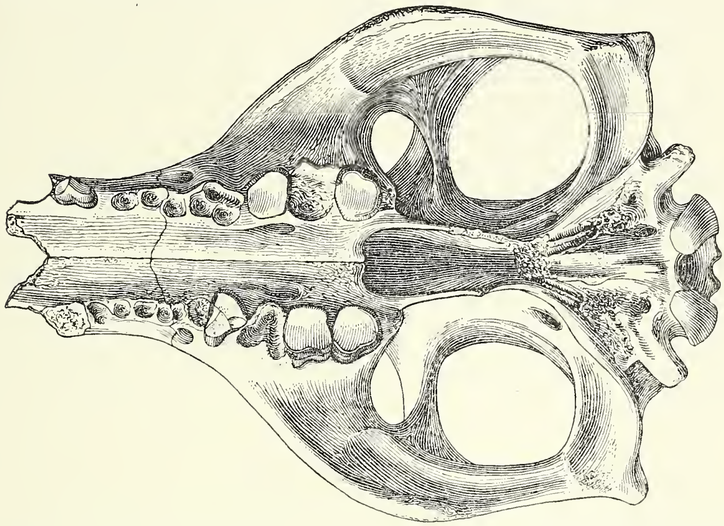


FIG. 4. *Brachyhyops wyomingensis* Colbert. Type skull, Carnegie Mus. No. 12048. Palatal view, two-fifths natural size.

There are four premolars and three molars in *Brachyhyops*. There was seemingly a large canine. There was very probably a full set of incisors, although it is impossible to make a definite statement about these teeth.

The canine, premolars and molars are in a closely set series, without diastemata between them, and in this respect *Brachyhyops* is like *Chœropotamus*, *Achænodon*, *Helohyus* and other Eocene bunodont artiodactyls. A crown view of the teeth of *Brachyhyops* shows that they are very similar in outline to the teeth of *Chœropotamus* and of *Achænodon robustus*, as figured by Peterson (1919), except of course that in the latter form the teeth are much larger. The single upper molar of *Parahyus vagus*, as figured by Marsh, also has an outline quite similar to the outline of the second molar in *Brachyhyops*. Marsh identified the tooth that he described as a third upper molar, but this identification may possibly be wrong.

From the alveoli it would seem that the first, second and third premolars in *Brachyhyops* were simple, double rooted teeth, elongated somewhat antero-posteriorly. Probably each tooth consisted of a single cone, laterally compressed, with anterior and posterior keels, the anterior edge being slightly convex and the posterior one slightly concave, with a slight heel or shelf at the back near the base of the tooth. The fourth premolar is a three rooted tooth, the single root being internal. Although much worn, it gives indications of having a large, single outer cone and a smaller inner cone.

The molars are quadrate, and wider than they are long. They were probably quinquetubercular, like the molars of *Chœropotamus* and *Parahyus*, with the protocone, protoconule, paracone, metacone and metaconule comprising the crown of each tooth. The posterior half of the last molar is much reduced, so that the metacone is much smaller than the paracone. The surfaces of the teeth are so greatly worn that it is impossible to make any remarks about the development or the arrangement of the cusps. The third molar shows a slight antero-external cingulum.

Measurements

Brachyhyops wyomingensis

Carnegie Museum no. 12048, skull

SKULL	mm.
Length, condyle—front edge of canine	229
Length, condyle—incisors (estimated)	240
Length, preorbital portion of skull (approximate)	105
Length, postorbital portion of skull	135
Width, at glenoids	151
Width, zygomatic arches below orbits	161
Width, palate at first molar	24
Width, occipital condyles	48
Width, frontals at postorbital bar	83
Width, parietals between parietal crests	52
Diameter of orbit (approximate)	35
Depth, jugal beneath postorbital process	45
DENTITION	
P^4, length	15
width	15
M^1, length	14
width	17
M^2, length	16
width	20
M^3, length	15
width	18

Comparisons

Now that a description of *Brachyhyops* has been presented, it might be well to compare this new genus with other genera of primitive bunodont artiodactyls for the purpose of determining, if possible, the forms to which it is most closely related. The genera or groups that may be considered in this comparison are as follows:

1. The Dichobunidæ —particularly *Homacodon* and *Wasatchia.*
2. The Chœropotamidæ —both the Helohyids as exemplified by *Helohyus* and the Chœropotamids as typified by *Chœropotamus* and [*Parahyus*].
3. The Cebochœridæ —*Cebochœrus.*
4. The Entelodontidæ —Achænodontinæ and Entelodontinæ.
5. The Tayassuidæ —*Perchœrus.*

The Anthracotheriidæ and the Agriochœriidæ.

1. Dichobunidæ

The Dichobunidæ, being small, primitive, early Eocene artiodactyls are naturally more generalized in many of their characters than is *Brachyhyops.* The common characters in the form now under consideration and these early artiodactyls are the primitive heritage features that might be expected to persist in an upper Eocene genus. Thus the basicranium of *Brachyhyops* is similar to that in *Homacodon* in that it shows the primitive separation of the foramina, the lack of a bony bulla, short, backwardly projecting paroccipital processes and very little anteroposterior compression. In this latter character, however, *Brachyhyops* does show a certain amount of compression, particularly because of the backward migration of the glenoids into a position of close proximity to the auditory region. In most of the cranial and dental characters the dichobunids are much more primitive than is *Brachyhyops* and thus are no more closely related to this genus than to other upper Eocene bunodonts.

2. Chœropotamidæ

There are many resemblances, as well as certain differences, to be seen between *Brachyhyops* and the European genus, *Chœropotamus.*

For this reason it may be well to devote a considerable amount of attention to a detailed comparison between these forms.

Brachyhyops is like *Chœropotamus* in the following ways:

1. Size.
2. The outlines of the cheek teeth.
3. The central position of the orbit above the second and third molars.
4. The shape of the glenoid—a broad, flat articulation merging anteriorly into the lower surface of the zygomatic arch.
5. The transversely broad postglenoid articulation.
6. The low position of the glenoid on a horizontal line with the occlusal surface of the teeth.
7. The short, backwardly projecting paroccipital processes.
8. The probable lack of an ossified bulla.
9. The arrangement of the basicranial foramina.

Brachyhyops differs from *Chœropotamus* as follows:

1. The relatively short, wide skull. In *Chœropotamus* the skull is elongated in the region of the muzzle.
2. The expansion of the zygomatic arch, both laterally and vertically.
3. The closed orbits.
4. The double parietal crests.
5. The broad occiput.
6. The closed dental series, a corollary of the short muzzle.

It is difficult to know just how these resemblances and differences may be evaluated against each other. Should the primitive, basic heritage characters by which the two genera resemble each other be given greater weight than the more specialized habitus characters? It would seem, taking all factors into account, that the heritage characters do give evidence of some degree of relationship between *Brachyhyops* and *Chœropotamus*, and that the specializations in the former genus, such as the expansion of the zygoma, the closed orbits, and the broad cranial roof with its double crests are habitus characters that have been molded over an essentially chœropotamid skull, and that they have been obtained at a relatively late date in the phylogenetic history of the genus.

Now we may consider briefly the resemblances and differences between *Brachyhyops* and *Parahyus*. This latter genus contains two species, *Parahyus vagus*, known from a mandibular ramus, and *Parahyus aberrans*, based on a single upper molar tooth. Both of these species are from the Wasatch formation of Lower Eocene age. *Parahyus* has usually been referred to the Achænodontidæ (or grouped with *Achœnodon*, whatever might be the systematic position of this latter genus) but it may be noted here that Matthew[2] questioned this reference in 1909. It seems to me much more likely that *Parahyus* is a true chœropotamid, because it is closely comparable to *Chœropotamus*, not only in size but also in the shape and structure of the upper and the lower teeth.

Helohyus, also, would seem to be a primitive chœropotamid, as Matthew suggested in 1925[3], and as such is comparable to *Brachyhyops*.

All in all, therefore, there is much reason to think that *Brachyhyops* is closely comparable to *Chœropotamus* and thus may be considered as probably a member of the Chœropotamidæ, and moreover, there is additional evidence to show that this new genus is also closely related to *Parahyus* and *Helohyus*, also probably members of the Chœropotamidæ.

3. Cebochœridæ

Turning now to a comparison of *Brachyhyops* with *Cebochœrus* we see that points 3, 4, 5, 6, 7 and 9 listed as resemblances between *Brachyhyops* and *Chœropotamus* also hold as characters linking it with *Cebochœrus*. In addition certain other characters also serve as points of resemblance between these genera; for instance *Cebochœrus* has a short, broad skull as is the case with *Brachyhyops*. There are many differences, however, that serve to separate these genera. Of these may be mentioned points 3 and 4 cited as separating *Brachyhyops* from *Chœropotamus*, and in addition the following:

1. Size. *Brachyhyops* is much larger than *Cebochœrus*.
2. The vertical expansion of the zygomatic arches below the orbits.
3. The general shape of the preorbital portion of the skull.
4. The shape and structure of the cheek teeth.
5. The normal first premolars; these are caniniform in *Cebochœrus*.

It would seem that the differences separating *Brachyhyops* from *Cebochœrus* are greater than those separating it from *Chœropotamus*, as

[2]Matthew, W. D., 1909, Bull. 361, U. S. Geol. Survey, p. 95.

[3]Matthew, W. D. 1925, Amer. Mus. Novitates, No. 198, pp. 7-8.

might be expected, since both of the former genera show various specializations along separate lines of adaptive radiation.

4. **Entelodontidæ**

Achænodontinæ

Brachyhyops is like *Achænodon* in the following particulars:

1. The outlines of the cheek teeth.
2. To some extent in the great lateral expansion of the zygomatic arches.
3. The position of the orbit above the second and third molars.
4. To some extent in the shape of the glenoid; that is, in its shallowness and the transversely broad postglenoid process.
5. The position of the glenoid on a horizontal line with the occlusal surface of the teeth.
6. The position of the infraorbital foramen above the third premolar.
7. The closed dental series.

In certain respects, however, there are decided differences between the two genera. *Brachyhyops* differs from *Achænodon* in the following ways:

1. In its small size. Linearly the skull of *Brachyhyops* is less than half as large as the skull of *Achænodon.*
2. The anterior lateral expansion of the zygomatic arches.
3. The deep vertical expansion of the jugal beneath the orbit.
4. The closed orbit.
5. To some extent in the shape of the glenoid; that is in its extreme flatness and its antero-external boundary merging with the under surface of the zygoma.
6. The shape of the occiput. The difference here is partly a result of the great size in *Achænodon.*
7. The development of the separate parietal crests.
8. The rugose sculpture on the roof of the cranium.
9. The relatively shorter muzzle.
10. The presence of a first premolar.

Most of the resemblances outlined above are due to basic heritage characters that are common in many of the primitive bunodont artiodactyls. Some of them, such as the outlines of the cheek teeth and the shape of the glenoid, might be regarded as showing certain relationships between the two genera. On the other hand, there are many differences between *Brachyhyops* and *Achænodon*, differences that are clearly indicative of divergent specializations along separated lines of adaptive radiation. Thus it would seem evident that any relationship established between these two genera must needs be carried back through their separate phylogenetic lines to their less specialized and therefore more closely related ancestors. *Brachyhyops* is seemingly a chœropotamid that has developed certain highly specialized characters—a point that was stressed in certain preceding paragraphs of this paper. *Achænodon* on the other hand, approaches closely the true entelodonts of the Oligocene.

Entelodontinæ

In comparing *Brachyhyops* with the Oligocene entelodonts, resemblances are to be found in the closed orbits, the expansion of the jugal beneath the orbit, the low, transverse glenoid and the location of the infraorbital foramen above the third premolar. The first two of the above mentioned characters, namely the closed orbits and the expansion of the jugal beneath the orbit, are very probably parallelisms and thus are not indications of relationships between the genera. The other resemblances do not form a very strong link between *Brachyhyops* and the entelodonts. There are so many differences between *Brachyhyops* and the entelodonts that there is little doubt but that they are phylogenetically distinctly removed from each other. Among the characters whereby the entelodonts differ from this new genus may be mentioned the great size, elongation of the face and consequently of the teeth, the entirely different structure of the teeth, the position of the orbit back of the molars and its forward direction, the configuration of the cranium and the occiput, and finally the arrangement of the basicranium.

Of course these enumerated differences are all advanced habitus characters of the entelodonts, and it is quite conceivable that they may be secondary specializations from a *Brachyhyops*-like ancestral form. However, since *Brachyhyops* is contemporaneous with *Achænodon* (a genus closely related to the entelodonts) and also with *Chœropotamus*, and since it is more nearly comparable to the latter than to the former of these two genera, it would seem reasonable to suppose that this new Uinta genus is of chœropotamid rather than of entelodont relationships. Naturally, because of its many primitive bunodont heritage characters, *Brachyhyops* is probably fairly close to the ancestor of the achænodonts and the entelodonts.

5. Tayassuidæ, Anthracotheriidæ, Agriochœridæ

Now there comes the question of certain more modern or advanced groups that might conceivably show resemblances to *Brachyhyops*. The most primitive pigs and peccaries indicate a mode of development that is quite out of line with the general *Brachyhyops* habitus. In the primitive pigs-peccaries the tendency is towards elongation of the muzzle and of the cheek teeth with consequent changes in the form of the whole skull. The Agriochœridæ and the Anthracotheriidæ are buno-selenodont artiodactyls, which it seems certain that *Brachyhyops* is not. In some of the agriochœrids there is a closing of the orbit and an expansion of the zygomatic arches, but any resemblances to *Brachyhyops* are very obviously due to convergence.

In the anthracotheres the tendencies are towards elongation of the face but not of the teeth, and the retention (except in the most advanced genera) of a rather primitive skull form. The probability that the Anthracotheriidæ are descended from a chœropotamid may account for any basic resemblances that exist between *Brachyhyops* and the anthracotheres.

Relationships of Brachyhyops

From the description and the comparisons set forth in the preceding pages of this paper, it becomes evident that *Brachyhyops* is an upper Eocene bunodont artiodactyl quite distinct from any of the genera of Bunodonta heretofore known to us. It would seem probable, however, that this new genus is a somewhat aberrant chœropotamid, possibly descended from *Parahyus* of the middle Eocene. Its assignment to the Chœropotamidæ must be regarded as somewhat provisional. *Parahyus* is here regarded as being more probably related to the Chœropotamidæ than to the Achænodontinæ.

In many of its characters *Brachyhyops* shows primitive heritage features common to numerous bunodont artiodactyls of the lower and middle Eocene of North America and Europe. But in size, the form of the teeth, the position and shape of the glenoid and the characters of the basicranium there would seem to be definite chœropotamid relationships. Certain skull characters are more or less similar to the corresponding characters in the entelodonts, particularly to the genus *Achænodon*, but numerous specializations in the skulls of both *Brachyhyops* and *Achænodon* would indicate that those genera have diverged greatly from their mutually related Middle or Lower Eocene ancestors.

Notes on the Relationships of the Bunodont Artiodactyls

The primitive bunodont artiodactyls have for many years caused a great deal of confusion to students who would attempt a classification of them. The various views as to their relationships have been exceedingly diverse, so that these early artiodactyls have been gathered together or split apart in all manners of combinations. Perhaps it may be well at this point to consider briefly a few of the most outstanding systems of artiodactyl classifications, with particular reference to the "bunodont" forms, in order that there may be an understanding of the basis for the use of the family and subfamily names appearing in the accompanying discussions.

In 1910 there appeared two comprehensive classifications of the Artiodactyla, namely, that of Osborn in his "Age of Mammals" and that of Stehlin in his great monograph on the Eocene mammals of Switzerland. Osborn grouped the primitive bunodont artiodactyls under one division which he called "Primitive Artiodactyls"—obviously an unnatural group. He subdivided the "Primitive Artiodactyls" into the "Bunodont Families," the "Bunoselenodont Families," and the "Selenodont Families." This classification included the Trigonolestidæ, Leptochœridæ and Dichobunidæ under the Bunodont group—a fairly satisfactory association. The Anthracotheriidæ constituted the Bunoselenodont group and the Anoplotheriidæ the Selenodont group. The Entelodontidæ, however, were separated from the other primitive artiodactyls and placed in the "Suina" together with the pigs, peccaries and hippopotami, where certainly they do not belong. Moreover there was a separate division of "Oreodonta" quite distinct from the anthracotheres and anoplotheres, to which the oreodonts are related.

Stehlin's classification, based mainly on characters of the teeth, demonstrates the faults of any classificatory system having so restricted a foundation. There are three great divisions of the artiodactyls, the Hypoconifera containing the two families, Dichobunidæ and Elotheriidæ, the Cainotheridæ and finally the Euartiodactyla comprising all of the remaining artiodactyls families. Naturally in this classification the bunodonts are divided between the Hypoconifera and the Euartiodactyla, all in all a somewhat inconvenient arrangement.

Since it has some bearing on the discussions presented on other pages of this paper, there might be mentioned Depéret's monograph of 1917 on the Ludian fauna, in which *Chœropotamus* and *Cebochœrus* are included in the "Famille des Hyotherides."

In the 1925 revision of Zittel's "Text-Book of Palæontology" the artiodactyls are divided in part as follows:

Tribe 1. Bunodontia
  Family 1. Suidæ Family 2. Leptocohœridæ
  Family 3. Hippopotamidæ

Tribe 2. Bunoselenodontia
  Family 1. Anthracotheriidæ Family 2.
  Anoplotheriidæ Family 3. Dichobunidæ

Here the Dichobunidæ are separated from the Leptochœridæ, yet these two families are certainly closely related to each other. Another fault of this classification is that some of its "families" are too inclusive; thus the entelodonts and the peccaries are included in the Suidæ.

In 1927 Miss Pearson, using the basicranial characters as indices to taxonomic relationships, made a twofold division of the artiodactyls. In one of her groups the "Amastoid Artiodactyla," were included the Chœropotamidæ, Cebochœridæ, Anthracotheriidæ, Mixtotherium, Entelodontidæ, Hippopotamidæ and Suidæ. In the other group, the "Mastoid Artiodactyla," were placed the Dichobunidæ, Anoplotheriidæ, Cænotheriidæ, Agriochœridæ, Oreodontidæ, Tylopoda, Pecora and *Dacrytherium*, *Tapirulus*, and *Amphimeryx*. As in the case of Stehlin's classification, this arrangement suffers by being based on a single character.

In 1929 Dr. Matthew divided the Artiodactyla into five suborders, namely the Palæodonta, Hyodonta, Ancodonta, Tylopoda and Pecora. In the Palæodonta were placed the Dichobunidæ and the Entelodontidæ, while the Hyodonta consisted of the Tayassuidæ, Suidæ and Hippopotamidæ. This classification is probably the most logical of any of the systems so far considered, and it represents the results of many years devoted to the study of fossil and recent ungulates. Unfortunately Dr. Matthew never elaborated his classification.

His arrangement was followed by Simpson in 1931, but this latter author reduced Matthew's suborders Palæodonta and Hyodonta to superfamily rank, making them the Dichobunoidea and the Suoidea respectively, and included them in a single suborder, the Bunodonta. He also placed the Leptochœridæ in the "Artiodactyla inc. sed."

In the recent textbook, "Vertebrate Palæontology," by Dr. A. S. Romer, the Artiodactyla are divided into two suborders; the Ruminantia in which the mastoid is exposed and the Suina in which the mastoid is excluded from the outer surface of the skull. It is at once evident that this classification follows the "mastoid" and "amastoid" divisions of the order, proposed by Miss Pearson. This arrangement, while theoretically sound, is practically inconvenient since it is based on a single character, which important as it may be, should not be allowed to overshadow the totality of diagnostic characters. Thus, in some of the primitive forms the division on the basis of the mastoid bone ignores very strong and undoubtedly important resemblances in the other skull elements, in the dentition and in the skeleton.

Scott's classification of 1913 and Hay's of 1930 are not considered in this discussion, since they are restricted to mammals of the Western Hemisphere and of North America respectively.

It is difficult to choose between Matthew's separation of the bunodont artiodactyls into two suborders, the Palæodonta and Hyodonta, and Simpson's inclusion of them in one suborder, the Bunodonta. In favor of Matthew's arrangement is the fact that it separates the essentially primitive, extinct bunodonts from the specialized, persistent forms. On the other hand, Simpson's arrangement places all of the bunodont forms together, so that they are set off as a group against the ancodont artiodactyls. Perhaps Matthew's arrangement is somewhat the better of the two, since it does recognize the distinction between the primitive and the advanced types.

Whatever arrangement of suborders is used, it seems to me that when superfamilies are considered, the dichobunids and the entelodonts are logically separable. In other words, these two groups deserve more than family distinction, accorded them in Matthew's and Simpson's classifications. Thus on the basis of subordinal and superfamilial relationships, the bunodont artiodactyls might be divided as follows:

Order Artiodactyla
- 1. Suborder Palæodonta
  - a. Superfamily Dichobunoidea
  - b. Superfamily Entelodontoidea

2. Suborder Hyodonta
   a. Superfamily Suoidea
   b. Superfamily Hippopotamoidea*

The basis for the above division of the Palæondonta may be presented in the following form:

Order ARTIODACTYLA

Suborder PALÆODONTA

Superfamily Dichobunoidea

Small, primitive artiodactyls. Skull usually of generalized form; certain specializations appear in the most advanced and latest genera. Basicranial foramina separate, basicranium normal, paroccipital processes short and projected posteriorly, auditory bulla usually cartilaginous. Orbit centrally located. Complete dental formula; upper molars with five or six cusps (protoconule and hypocone). Feet tetradactyl, metapodials not coalesced.

Superfamily Entelodontoidea

Large, specialized bunodont artiodactyls. Skull greatly modified, even in the most primitive genera. Basicranium compressed and foramina more or less coalesced, paroccipital processes short but massive, auditory bulla developed. Orbit usually displaced towards the posterior portion of the skull. Dental formula either complete or reduced; molars, upper and lower, four-cusped and elongated. Feet didactyl, but with the metapodials not coalesced.

This twofold division of the Palæodonta would seem to be a more or less natural one, whereby the small, primitive and ancestral types are separated from the large, specialized forms. In this connection it might be pointed out that the ancestral dichobunids first appear in the lower Eocene and persist on to the top of the Eocene, whereas the derivative entelodonts do not appear until the upper Eocene and develop to the height of their evolutionary expression in upper Oligocene and lower Miocene times.

Various families and subfamilies may be created to include the genera belonging to the Dichobunoidea, according, for the most part, to the individual preference of the author. The arrangement given

*In my opinion the Hippopotamuses probably belong to the Ancodonta, as descendants of the Anthracotheres, rather than to the Hyodonta, as descendants of the Pigs. See Colbert, E. H., 1935, Amer. Mus. Novitates, no. 799, pp. 10-23; also Trans. Amer. Phil. Soc., N. S., XXVI, pp. 288-294.

below is presented here as the basis on which the comparisons of various genera have been made in other pages of the present paper.

a. Superfamily Dichobunoidea
  a¹. Family Dichobunidæ Turner, 1849.
  b¹. Family Chœropotamidæ Owen, 1840-5.
  c¹. Family Cebochœridæ Lydekker, 1883.
  d¹ Family Leptochœridæ Marsh, 1884.

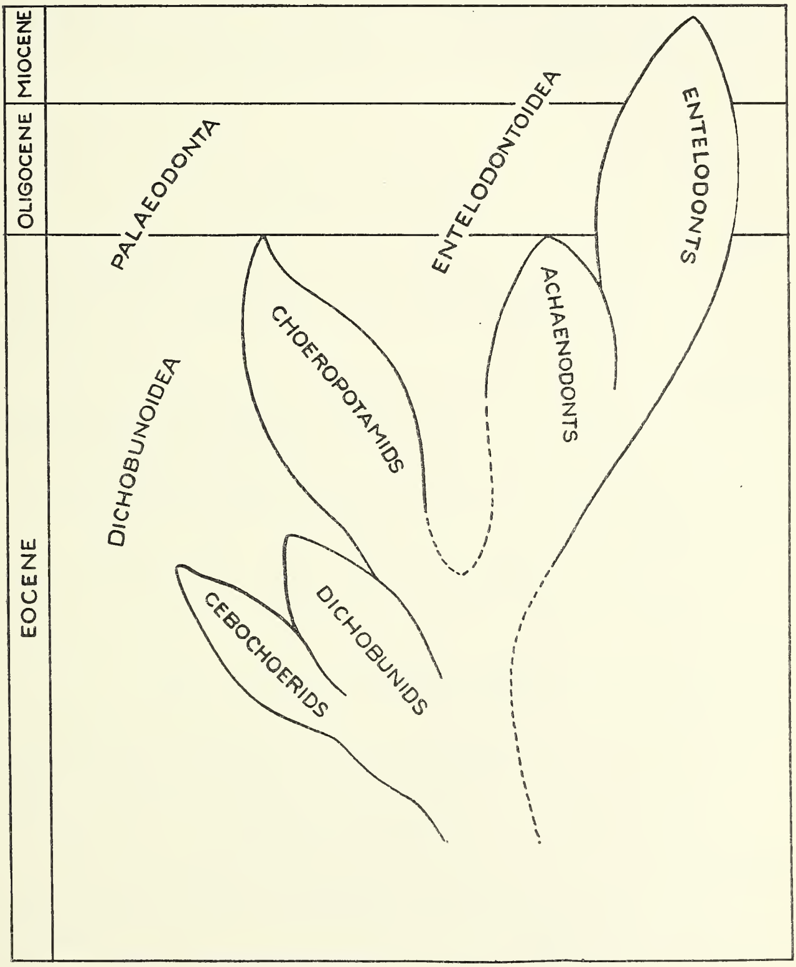


FIG. 5. Phylogeny of the bunodont artiodactyls.

This classification is anything but perfect, and is offered merely as a background for the collateral discussions that have to do with the relationships of *Brachyhyops*. Various possibilities immediately suggest themselves in regard to the above arrangement of the Dichobunoidea. For instance, it might be preferable to divide both the Dichobunidæ and the Chœropotamidæ into several families. On the other hand, the Cebochœridæ might be included in the Chœropotamidæ, while the Leptochœridæ might be placed under the Dichobunidæ. Then again, the Leptochœridæ may properly be excluded from the Dichobunoidea, as was done by Simpson in 1931.

BIBLIOGRAPHY

COLBERT, E. H.

1937. Notice of a New Genus and Species of Artiodactyl from the Upper Eocene of Wyoming. Amer. Jour. Sci., XXXIII, pp. 473-474.

COPE, E. D.

1873. Fourth Notice of Extinct Vertebrata from the Bridger and Green River Tertiaries. Pal. Bull. No. 17, pp. 1-4.

1884. The Vertebrata of the Tertiary Formations of the West. Book I. Rep. U. S. Geol. Surv. Terr. III, p. 343, Pls. LVII, LVIIa.

1885. The Lemuroidea and the Insectivora of the Eocene Period of North America. Amer. Nat., XIX, pp. 457-471.

CUVIER, G.

1822. Ossemens Fossiles Second Edition, III, p. 260.

DEPÉRET, C.

1917. Monographie de la Faune de Mammiferes Fossiles du Ludien Inferieur d'Euzet-les-Bains (Gard). Ann. Univ. Lyon, N. S., I, Fasc. 40, pp. 1-288, Pls. I-XXIV.

MARSH, O. C.

1876. Notice of New Tertiary Mammals. Amer. Jour. Sci. (3), XII, pp. 401-404.

1894. Description of Tertiary Artiodactyls. Amer. Jour. Sci. (3), XLVIII, pp. 259-274.

MATTHEW, W. D.

1909. (In Osborn and Matthew) Faunal Lists of the Tertiary Mammalia of the West. Bull. U. S. Geol. Surv., No. 361, pp. 91-120.

1924. Third Contribution to the Snake Creek Fauna. Bull. Amer. Mus. Nat. Hist., L, pp. 59-210.

1925. New Mammals from the Irdin Manha Eocene of Mongolia. Amer. Mus. Novitates, No. 198.

1929. Reclassification of the Artiodactyl Families. Bull. Geol. Soc. Amer., XL, pp. 403-408.

OSBORN, H. F.

1883. *Achænodon*, an Eocene Bunodont. Contrib. E. M. Mus. Geol. Arch. Princeton Coll. Bull. No. 3, pp. 23-35, Pl. VI.

1895. Fossil Mammals of the Uinta Basin. Bull. Amer. Mus. Nat. Hist. VII, pp. 71-105.

1910. The Age of Mammals. MacMillan, New York.

PEARSON, H. S.

1923. Some Skulls of *Perchœrus* (*Thinohyus*) from the White River and John Bay Formations. Bull. Amer. Mus. Nat. Hist., XLVIII, pp. 61-96.

1927. On the Skulls of Early Tertiary Suidæ, together with an Account of the Otic Region in some other Primitive Artiodactyla. Phil. Trans. Roy. Soc., London, Ser. B., CCXV, pp. 389-460.

PETERSON, O. A.

1919. Report upon the Material Discovered in the Upper Eocene of the Uinta Basin by Earl Douglass in the Years 1908-1909 and by O. A. Peterson in 1912. Ann. Carnegie Mus., XII, pp. 79-82, figs. 11, 12, Pl. XXXIX.

ROMAN, F.

1922. Monographie de la Faune de Mammiferes de Mormoiron. Mem. Soc. Geol. France, XXV, No. 57, pp. 1-37, Pls. I-VIII.

ROMER, A. S.

1936. Vertebrate Paleontology. University of Chicago Press, Chicago. pp. 340-342, 446.

SCOTT, W. B.*

1898. The Osteology of *Elotherium*. Trans. Amer. Phil. Soc., XIX, pp. 327-405.

1937. A History of Land Mammals in the Western Hemisphere. Revised Edition. MacMillan, New York, p. 393.

SIMPSON, G. G.

1931. A New Classification of Mammals. Bull. Amer. Mus. Nat. Hist., LIX, pp. 259-293.

SINCLAIR, W. J.

1914. A Revision of the Bunodont Artiodactyla of the Middle and Lower Eocene of North America. Bull. Amer. Mus. Nat. Hist., XXXIII, pp. 267-295.

STEHLIN, H. G.

1910. Die Saugetiere des Schweizerischen Eocæns. Abhand. Schweiz. Pal. Gesellsch. XXXVI, pp. 839-1164, Pls. XV-XX.

TROXELL, E. L.

1920. Entelodonts in the Marsh Collection. Amer. Jour. Sci., (4), L, pp. 243-255, 361-386, 431-445, Pl. III.

*Since this paper was submitted for publication, the new edition of Professor Scott's "History of Land Mammals in the Western Hemisphere" has been issued. On page 393 of his work, Professor Scott notes the resemblances and differences between *Brachyhyops* and the entelodonts (in which group he includes *Achænodon* and *Parahyus*). He includes *Brachyhyops* provisionally in the "entelodont family."

ART. V. AN UPPER DEVONIAN SPECIES OF AOROCRINUS

By Winifred Goldring
New York State Museum, Albany, N. Y.

(Plate VI)

Species of *Aorocrinus* have been described from the Middle Devonian (Hamilton beds) and the lower Mississippian (Waverly, Kinderhook, Keokuk, Burlington). Recently an Upper Devonian species was submitted to the writer by E. R. Eller of the Carnegie Museum. This species is added to the list, even though differing from the other described species in the maximum number of arms to the ray, because in the character of the arms and the dorsal cup it fulfils the requirements of this genus more than of any other. The tegmen, part of the dorsal cup, and column, are missing but the species is very characteristic and additional specimens could be identified without difficulty. The genus *Aorocrinus* was created by Wachsmuth and Springer (Crinoidea Camerata of North America, 1897, vol. II, p. 470) for species previously referred to *Dorycrinus* and *Gennæocrinus*, and in the discussion was characterized as an immature *Dorycrinus*, preceding it in time and foreshadowing the peculiarities of that genus.

Aorocrinus multicostatus sp. nov. (Plate VI, figs. 1-4)

This species is based upon a single, incomplete, but characteristic specimen. Half of the dorsal cup and arms are preserved as a cast.

The *dorsal cup* when complete was probably turbinate and distinctly rounding at the sides since the ridges on the radial series are not prominent. Basals fused to three elements; inconspicuous, extending little beyond the column. Radials hexagonal or heptagonal in shape, depending upon their relation to the basals, of medium size and wider than high. First primibrach quadrangular, less high and narrower than the radial; primaxil pentagonal smaller than the primibrach. The rays preserved have been interpreted to be the anterior, right anterolateral, and right posterior. In the anterior and right anterolateral rays the primaxil gives rise on the right to a secundi-

Issued April 2, 1938.

axil and on the left to two secundibrachs. In the left half-ray both inner and outer arms show four wedge-shaped tertibrachs and then become closely biserial. In the right half-ray the inner arm has four wedge-shaped tertibrachs and then becomes closely biserial; the outer arm has three tertibrachs, the third axillary, each of the resulting arms showing two or three wedge-shaped quatribrachs before the arms become biserial. The brachials appear to be incorporated up to the third or fourth wedge-shaped tertibrach in the left half-ray and the first or second quatribrach in the right half-ray. The right posterior ray is incompletely preserved. The primaxil bears on the right two secundibrachs, the second axillary. The secundaxil gives rise on the outside to four wedge-shaped tertibrachs and then the arm becomes closely biserial; on the inside to three tertaxils, the third giving rise to two arms. This branching is the reverse to that seen in the anterior and right anterolateral rays where the outer arm branches a second time. The left half-ray in the right posterior radius is not preserved.

The interbrachials are few in number and are separated from the tegmen by the arching of the brachials above, except probably in the anal interradius which is not preserved. The primary interradial is large, reaching up nearly to the top of the primaxil and is followed by two plates, with one in the next range. One interradius (right anterior) seems to show the succeession three, two, one. There are four interbrachials between the half-rays, two intersecundibrachs and two intertertibrachs. The right half-ray shows two intertertibrachs and one interquatribrach; the left half-ray shows two intertertibrachs. Only the base of the anal plate is shown, but this indicates that the anal plate is larger than the radials.

No part of the *tegmen* is preserved.

The total number of *arms* can only be estimated. There are five arms in the anterior and right anterior rays and therefore probably in the left anterior ray. The right posterior ray shows three arms in the right half-ray and could therefore have a total of four, five or six; but with the type of branching seen in the other rays at least five is to be expected. The compactly biserial arms are strong for the size of the species, one from each opening and unbranched throughout their length, as far as preserved (40 mm). They are slender at their origin and taper again distad. The rounded backs flatten somewhat at a distance of 10 mm. The pinnules are shown well in the anterior ray. They are long and slender and composed of long ossicles.

The *column* is round and the little that is preserved indicates thin ossicles.

The *ornamentation* is quite striking. A distinct ridge, less prominent because of the radiating ridges on the other plates, extends up the radial series to the free arms. All of the plates of the dorsal cup, even those in the higher interradial areas, are marked with strong ridges radiating from center to center of the plates where they show a tendency to become nodose. The ridges are most prominent in the interradial areas, particularly on the primary interradials.

Horizon and locality: From the Upper Devonian sandstone along the road between Center City, McKean County, and Kinzua, Warren County, Pa. Collected by E. N. Wallis.

Type: Holotype and only known specimen in the collection of the Carnegie Museum, Pittsburgh, Pa., number 11064.

Remarks: At first glance *A. multicostatus* suggests "*Actinocrinus*" *daphne* described by Hall from the Waverly (Mississippian) of Ohio (Preliminary Report on Waverly Crinoids of Ohio: 17th Rept. N. Y. State Cabinet Nat. Hist., 1864, p. 52; Crinoidea of the Waverly Group: Pal. Ohio, Vol. II, p. 163, pl. 11, fig. 11). It differs in the number of arms, number and size of the interradial plates, and to a less degree in the character of the ornamentation.

Among Devonian species *A. multicostatus* resembles *A. formosus* in shape of cup, but suggests *A. armatus* in the size of the primary interbrachial. From all described species of the genus it differs in the number of the arms and the strong and distinctive ornamentation of radiating ridges.

EXPLANATION OF PLATE VI

Aorocrinus multicostatus Goldring
Photographs by E. J. Stein
New York State Museum, Albany, N. Y.

FIG. 1. Cast of specimen showing half of dorsal cup and arms.

FIG. 2. Plasticine "squeeze" of the same.

FIG. 3. Plasticine "squeeze" of only the dorsal cup and bases of the arms, showing to better advantage the basals and lower arm plates.

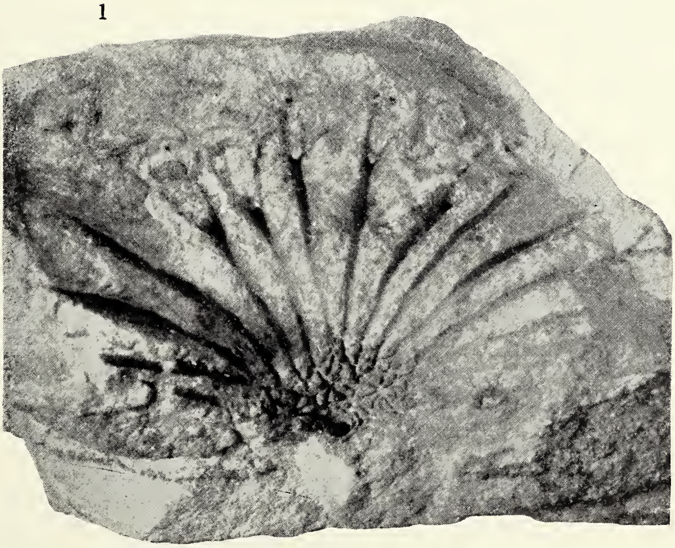
FIG. 4. Plasticine "squeeze" of arm in anterior (?) ray, showing the character of the pinnules.

4

3

2

1



ART. VI. A PROBLEMATICAL CAT-LIKE MANDIBLE FROM THE UINTA EOCENE, *APATÆLURUS KAYI*, SCOTT

By William Berryman Scott
Princeton University

(Plate VII)

Apatælurus kayi Scott, Science, N.S., Vol. 85, May 7, 1937, p. 455.

Director Avinoff of the Carnegie Museum, Pittsburgh, very kindly sent me for description a remarkable fossil, collected by Mr. J. Leroy Kay, of the Carnegie Museum staff, from the Middle Uinta beds (Section B) of northeastern Utah, in the summer of 1936. At first, I took for granted that this jaw belonged to an unmistakable sabre-tooth, specialized in an astonishing degree for an Eocene genus, and prepared a description of it on that hypothesis. In the course of the study, however, doubts regarding the correctness of this reference began to arise, doubts which were shared by my colleague, Professor G. L. Jepsen, who suggested that both rami of the mandible be photographed with X-rays, a procedure by which important information was obtained.

The drawings accompanying this article were made by Sydney Prentice of the Carnegie Museum.

The specimen consists of the two separate halves of a lower jaw, the left half containing two of the cheek teeth and the right four. The dental formula is not altogether certain, but appears to be: $i?_2$, c_1, p_4, m_2; incisors and canines are all missing and represented only by the alveoli, the number of which is not quite free from doubt, but, according to appearances, there were two, possibly three, close-set and laterally compressed incisors and a much larger canine, also narrow and compressed, but far smaller than the lower fang of an ordinary carnivore, whether creodont, or fissiped. That the upper canines were laniary sabres is indicated by the protective flanges on the lower jaw, and this inference is corroborated by the evident reduction of the lower canine.

The number of premolars would seem to be different in the two rami; on the left side all the premolars have been lost, and alveoles for only

Issued May 6, 1938.

three are preserved. Of these, the foremost one is small, for a single-rooted tooth, and is separated by a short gap from the next succeeding one. This is, presumably, the socket of p_1, while that for p_2, which must have been lost during the lifetime of the animal, was filled up by a secondary deposit of bone. The alveoli of p_3 and p_4 are double-rooted and the latter are much the larger, though the two for p_3 are larger than the minute tooth in the right ramus would lead one to expect. The molars, m_1 and $_2$, are in place and almost exactly like those of the right side.

In the right half of the mandible four teeth are preserved, molars $_1$ and $_2$ and premolars $_3$ and $_4$; in addition, the alveoli of p_1 and $_2$ are visible, the former single-, the latter double-rooted. The foremost premolar (p_3) is minute, but is implanted by two roots, nevertheless. The crown has the compressed conical shape characteristic of the predaceous dentition, but retains a number of vestigial features, which indicate that it has undergone reduction from a more complicated type of tooth; the apex of the cone is bifid and two ridges enclose a posterior valley; there is a conspicuous posterior basal cusp and a very small anterior one, an enamel tubercle rather than a cusp. The last premolar (p_4) is a greatly enlarged copy of the third; it is triconodont, with three cusps in the same antero-posterior line, the middle one of which is very much the largest, and the anterior basal cusp is far larger than in p_3; a fairly deep valley, on the inner side, is enclosed between the principal and posterior cusps. The three cusps are decidedly convex on the outer side and both of these premolars, p_3 and $_4$, have a backward inclination like the last premolar of *Eusmilus* and both are almost completely unworn, though a very slight degree of abrasion is observable on p_4. The contrast between p_4 and m_1 in regard to wear is very conspicuous.

The first molar (m_1) is decidedly smaller than p_4 and very much smaller than m_2. A suspicion that this might perhaps be a milk-tooth was refuted by the X-ray negative, which clearly showed the stout roots of the tooth and demonstrated the absence of any tooth-germ in the jaw. The lower end of the posterior root is seen in the photograph to be recurved, a difference from all of the other teeth. The crown is much abraded, but all its elements are still distinct and it is decidedly like the same tooth in *Hyænodon*, it is a small carnassial, worn on the outer side by the shearing of the anterior upper sectorial, p^4; the blade is made up of two compressed, sharp-edged, trenchant cusps, of which the posterior one has a bifid apex. This division persists in spite of the extensive wear which the tooth has suffered, for the abrasion is confined to the buccal, or external, side of the crown; in addition to the shearing blade, there is a relatively large heel, which is a single-pointed cusp.

The second molar, m_2, is much the largest of the cheek-teeth and anteriorly is overlapped by the heel of m_1. The shape and general aspect of this tooth are very feline, but not more so than in such creodonts as *Hyænodon* and *Patriofelis.* The crown is a shearing blade, made up of two cusps and much worn on the outer side, but so abraded as to keep the cutting edge sharp. The posterior cusp shows a vestige of the bifid apex, which is so distinct in m_1; a very faintly marked groove being the unmistakable remnant of this division. The talon also is reduced to vestigial proportions, but is very distinct.

So far as the cheek-teeth are concerned, there is nothing surprising or unusual about this jaw; these teeth differ no more than generically from those of *Patriofelis* or *Oxyæna,* but the mandible itself is little short of astonishing. My first impression, as noted above, was that the fossil must be referable to the machairodont subfamily of the Felidæ, and I was greatly surprised to find so highly specialized a sabre-tooth in the upper Eocene, for the resemblance of this mandible is not so much to *Hoplophoneus* as to *Eusmilus,* much the most advanced and specialized of all the Oligocene machairodonts, whether in the Old World or the New. One notable difference between the sabre-tooths and the true cats is in the length of the jaws, which in the former are not nearly so abbreviated as in the latter; and this, in turn, is associated with the different manner of using the jaws and canine teeth. A true feline *bites* and holds its prey with firmly closed jaws, for which action the reduced leverage of the short jaw is favourable. A sabre-tooth could not bite, for the great upper tusks barred entrance to the mouth.

The hypothesis of Matthew and Merriam, now so widely accepted, has been all but demonstrated by the remarkable *Nimravus* skull from the upper White River beds, now in the museum of the State School of Mines, Rapid City, So. Dak. This skull, which was described and figured by Scott and Jepsen,[1] shows a terrible wound through the left frontal bone, which, according to surgical opinion, must have been inflicted at least a month before the victim's death. The shape and

[1]Trans. Amer. Philos. Soc. N.S. Vol. XXVIII, p. 148, Pl. XXI.

size of the wound make it highly probable that it was caused by a stabbing blow from the tusk of *Eusmilus*, the large sabre-tooth contemporary of *Nimravus*. The position of the glenoid cavity and mandibular condyle made it possible for the machairodonts to drop the lower jaw so far as to free the points of the upper canines. As the late Professor W. D. Matthew suggested, the sabre-tooth cats must have used their sabres as a venomous snake uses his fangs, striking a stabbing blow with the whole head. The mechanism of the jaws and areas of muscular attachment combine to support the Matthew-Merriam hypothesis, and the nature of the wound mentioned above makes it well-nigh certain. As will be seen, an understanding of the jaw-mechanism in the sabre-tooth cats is essential to the interpretation of *Apatœlurus*, which displays so extraordinary a resemblance to the machairodonts, though belonging to a very different and but distantly related suborder of the Carnivora.

The mandible of *Apatœlurus* is deceptively like that of *Eusmilus* and is astonishingly far advanced in specialization for an Eocene mammal. The anterior face of the horizontal ramus is squarely transverse and forms a right angle with the buccal side of the jaw, the demarcation between the two surfaces making a conspicuous ridge, which is almost as prominent as in *Eusmilus*. The anterior surface, or mental area, differs from that of the latter in several details; it is, so far as preserved, plane vertically, not made concave by the prominent projection of the incisive alveolar process. The mental foramen and groove seen in the White River genus are absent. The symphysis is prolonged vertically so far as the bone remains, and is relatively more extended antero-posteriorly than in the latter. The flange, which served as a protection for the sabre, is, unfortunately, broken away on both sides, so that its shape and size are indeterminable. It was, however, unmistakably present, and it may be inferred from the intact portions of the borders, that it was not so largely developed as in *Eusmilus*, and its external, or buccal, surface was not so deeply concave. The dentary portion of the ramus is relatively shallower and more slender than in *Eusmilus*.

The ascending ramus, while very similar, in general, to that of *Eusmilus*, differs in a number of details. The masseteric fossa is much more deeply impressed and has more definite borders. The coronoid process has a stronger backward inclination and is even more reduced in height; though, as the process has suffered some loss in both rami, it is not feasible to estimate the exact difference. The condyle has an even more inferior position than in *Eusmilus*, farther below the level of the teeth, but, in shape, it is very much as in that genus; its position is nearly horizontal, and most of its transverse length is external to the plane of the coronoid; the dorso-ventral diameter of the condyle diminishes rapidly to the outer side, the ventral border being steeply inclined. In *Eusmilus* and *Hoplophoneus* the condyle has a similar shape. As in those genera, the angular process is short and projects very little behind the condyle, the emargination above which is much deeper than in the White River machairodonts, setting off the condyle more distinctly. The angle has a decided inflection, so much so as to suggest marsupial affinities, but the teeth forbid any such reference. A broad channel runs forward from beneath the condyle to the inferior dental foramen, which is placed much nearer to the ventral border than in the Oligocene cats, and the channel is more clearly marked than in them.

MEASUREMENTS			mm.
Inferior dental series, length i_1 to m_2, incl.			102
Canine alveolus, ant.-post. diameter			10
Canine alveolus, transverse diameter			5
Lower cheek-teeth series, length			59
Lower premolar series, length			34
Lower molar series, length			30
Lower third premolar, ant.-post. diameter			5
Lower third premolar, transverse diameter			3
Lower fourth premolar, ant.-post. diameter			12
Lower fourth premolar, transverse diameter			6
Lower first molar, ant.-post. diameter			12
Lower first molar, transverse diameter			5
Lower second molar, ant.-post. diameter	Right 20	Left	19
Lower second molar, transverse diameter	8		7

The measurements of the lower jaw are made in comparison with those of *Eusmilus dakotensis* (Princeton Univ. Mus. No. 11,079).

	Eusm. mm.	*Apat.* mm.
Mandible, extreme length from condyle	175	149
Mandible, depth of horiz. ramus below m_1	32	27
Mandible, thickness of horiz. ramus below m_1	15	13
Mandible, breadth of ramus at chin	20	13
Mandible, condyle, transverse width	30	25
Mandible, condyle, height above ventral border	31	18
Mandible, ventral width of angle	12	12

For this remarkable fossil the name *Pseudœlurus* would be very appropriate, were not that term preoccupied by a genus of felines. It is proposed, therefore, to name the genus *Apatœlurus* (from ἀπάτη, deceit) which expresses the same idea; the species *kayi*, which is defined by the measurements, is named in honour of Mr. J. L. Kay, of the Carnegie Museum, who discovered the type and only known specimen.

The form of the mandible, with its characteristic flanges, demonstrates, beyond peradventure, that in this animal the upper canines were laniary sabres, and the position of the mandibular condyle shows that the jaws could be opened as widely as in any of the machairodonts. No doubt these "sham sabre-tooths," as they may be called, used their tusks in delivering a stabbing blow such as the machairodonts almost certainly did. Cope has already used "false sabre-tooths" for *Nimravus* and its allies, otherwise that term might well be applied to these Eocene imitators of the true machairodonts.

SYSTEMATIC POSITION OF APATÆLURUS

Though it seems incredible that this astonishing fossil does not represent a sabre-tooth cat, yet such is the inevitable conclusion from the facts above detailed. Not only is this animal not a machairodont, it is not even one of the fissiped carnivores. The highly specialized sectorial, which is so very feline in character and appearance, is not the first lower molar (m_1) as it is in all of the Fissipedia, but the second (m_2) as in those of the Creodonta which possess shearing carnassials. To the Creodonta, therefore, this genus must be referred, but the family to which it belongs is not so obviously indicated. The relatively very small first molar is an important point of resemblance to the Hyænodontidæ, to which it is quite possible that *Apatœlurus* should be referred. All things considered, however, it seems more likely that this genus is one of the Oxyænidæ, which are so much more numerous and diversified in the North American Eocene. Lacking the upper teeth and skull, no definite choice between these alternatives can be made, but to one or other of these families the Uinta fossil almost certainly belongs.

The principal oxyænid of the Bridger (middle Eocene) is *Patriofelis*, and it may be that *Apatœlurus* represents the sabre-tooth branch of the same stock. The "*Ælurotherium*" of Adams suggests itself as a near ally of the Uinta genus, but it would not be possible to regard this Bridger animal as ancestral to the Uinta *Apatælurus*. The obscurity which has veiled *Ælurotherium* has lately been cleared away by Mr. Robert H. Denison, a graduate student in Columbia University, who is making an intensive examination of the Oxyænidæ. He writes me: "The Princeton specimen (No. 11,875) which was originally described by Wortman as ?*Patriofelis leidyanus*, and later removed to a new genus, *Ælurotherium*, by Adams, was considered by both authors to consist of p_3 to m_1. However, Matthew's contention that these teeth were milk molars of *Patriofelis ferox* is completely substantiated by a specimen of the latter species in the U. S. National Museum (No. 13,818) containing d_c and m_1 erupting, and three milk molars which correspond very closely in size and other respects with the three teeth of the type of *Ælurotherium leidyanum*."

Another Bridger genus which is of interest in this connection is the *Machairoides* of Matthew, in which he reported that the small flanges of the mandible indicate that the upper canines were, at least, beginning to take on the sabre-like form.

General Considerations

For more than half a century, palæontologists have been familiar with the conceptions of parallel and convergent evolution. Cope, in particular, insisted upon the reality and frequency of these processes, which may be briefly defined as the independent acquisition of similar characters in unrelated groups. Zoölogists, as a class, long resisted any admission of the possibility of such independently repeated acquisitions, though nowadays the reality of convergence as a normal mode of evolution is very generally accepted. Indeed, it is in danger of being overworked. Admitting that convergence has not infrequently taken place, the question immediately arises as to how far it can be carried. It is not yet possible to fix limits to the process, other than to say that identity is very rarely, if ever, attained.

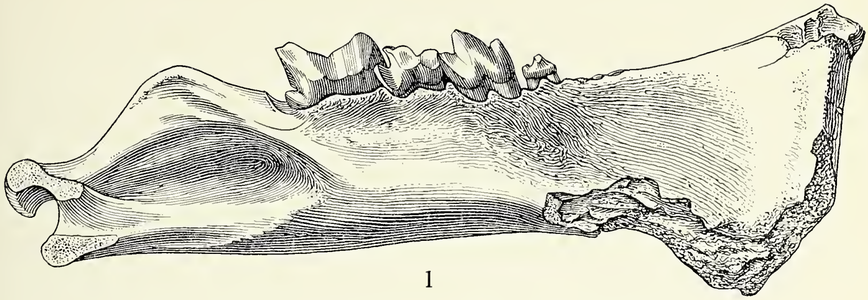
In the case of *Apatælurus* we have two alternative explanations of its paradoxical features: Either (1) it is a real machairodont, or (2) it is a creodont which has imitated sabre-tooth characteristics. That the second alternative is the less unlikely one, is the writer's conviction. On the first hypothesis, it will be necessary to assume that the creodont family, oxyænid, or hyænodontid, developed a highly specialized type of dentition, reducing the first lower molar (m_1) and converting the second (m_2) into a cat-like sectorial and then, reversing the process, transforming the reduced first molar into an enlarged sectorial and diminishing the large second molar to a useless vestige. While we are not in a position to declare that such a mode of development is impossible, it can be said that no instance of such a reversal is known.

On the other hand, equally astonishing cases of convergence have been well-nigh demonstrated. The marsupial sabre-tooth *Thylacosmilus*, discovered by Mr. E. S. Riggs in the Catamarcan Pliocene of Argentina, is a most surprising imitation of *Eusmilus*, not only in the great, sabre-like upper tusk and in the form of the mandible with its immense protective flanges, but also in all of the mechanism for opening the mouth so widely as to clear the points of the sabres and delivering a stabbing blow with the head. That this mechanism should have been independently developed a third time, is unexpected, but there is no ground for maintaining that it could not have happened.

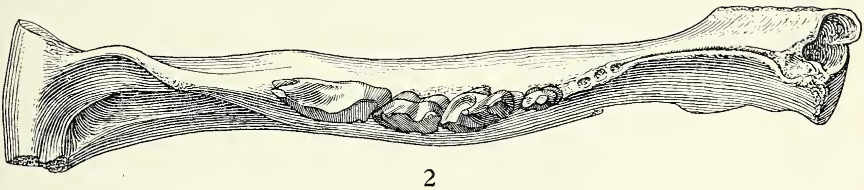
EXPLANATION OF PLATE VII

Apatælurus kayi, Scott
Carnegie Museum, No. 11920
(All figures, three-fourths natural size)

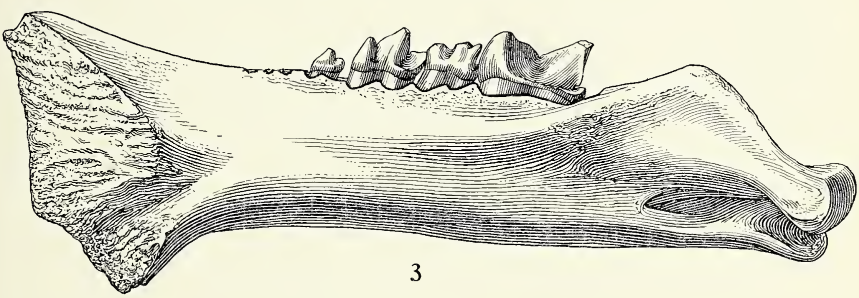
FIG. 1. Outer view of right ramus.
FIG. 2. Occlusal view of right ramus.
FIG. 3. Inner view of right ramus.
FIG. 4. Outer view of left ramus.



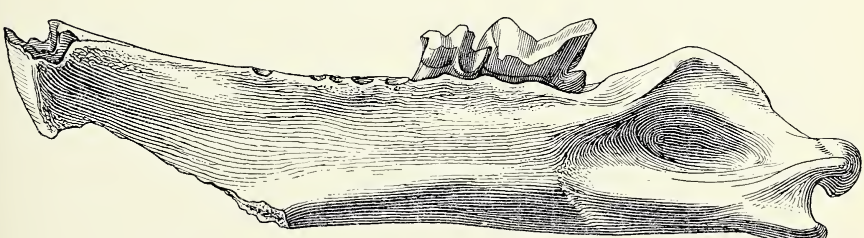
1



2



3



4

ART. VII. EXOTIC FORMS OF SYRPHID FLIES

By Frank M. Hull
University of Mississippi

(Plate VIII)

While I was visiting the Carnegie Museum, Dr. Hugo Kahl called my attention to some interesting material in flies of the family Syrphidæ, and I am greatly indebted to him for the privilege of studying this collection which comprises material which has accumulated in the Carnegie Museum collection over a period of years. Most of the material is from Cameroon, Africa, or the Rivers of French Guiana, and Brazil.

Eristalis argyropila sp. nov. (Plate VIII, fig. 10)

Female. Eyes short, brownish, pilose. Upper occiput, except for a narrow eye, contiguous, silver pubescent line stopping at eye-angle, jet black velvet. Just below ocelli the vertex is shining black or bluish, followed by a rectangular black velvet crossband. Remainder of front with its low rounded central raised spot, except for the narrow silver pubescent side margins, shining black. The side margins reach the black velvet. Antennæ dark brown; arista pale yellow, bare. Middle of face and prominent round tubercle vitreus shining black, on either side with vertical bands of brilliant, dense, silvery pubescence. Cheeks a shining black bare triangle. Lower occiput and up to within a short distance from top, entirely silvery pubescent.

Thorax opaque black with a complete ashen band before the suture and another behind. Thorax black before the scutellum. The latter opaque, clear pale lemon yellow, with a narrow jetblack base. Pile of thorax and scutellum black on the black areas, pale on the pale areas; that of scutellum pale yellow.

Abdomen opaque black; second, third, and fourth segments with narrow transverse bands of shining black, not reaching the sides, and on the second expanded laterally into a black spot. Each of these segments with exceedingly narrow yellow hind borders. The black fifth segment is broken by a median transverse shining band.

Femora shining black, baso-dorsally pale pilose and a few long silvery hairs underneath the hind pair. Tibiæ shining reddish brown, the hind pair ending transversely, not produced at all, with an inner middle cicatrix. Hind femora about post middle on outer surface

Issued May 18, 1938.

with a curvi-linear depression. Tarsi dark brown. Wings quite hyaline, an intense, very small, sharply delimited black stigma.

Length, 9.5 mm. One female. Mana River, French Guiana, May 1917, S. M. Klages collector. Type in the Carnegie Museum. An interesting and beautiful little species.

Nosodepus montensis sp. nov. (Plate VIII, figs. 1, 12)

Female. Head large and broad. From a vertical profile (looking down) the head is broad and flat, most of it taken up by the broad flat eyes. Antennal prominence moderately conspicuous. Facial tubercle large, low, evenly rounded. Face considerably descending below eyes. Eyes long, but their pile pale. Whole head, front, vertex, face, cheeks shining black, the upper face on the sides very dark mahogany red. Middle of face with an extremely broad band of pale pubescence from antennal to oral margin. Antennæ black. Third joint markedly widened and expanded and somewhat pointed apicoventrally. Arista long, black, bare. Pile of vertex, occiput above and below, and that which occurs narrowly beneath the antennæ and along the eye margins, very long and pale. Face and cheeks bare.

Thorax and abdomen everywhere shining black, together with the simple, light brownish yellow scutellum covered with very dense, very long yellowish pile. Squamæ yellow with brownish fringe. Halteres brownish.

All the femora are very dark reddish brown, becoming yellow at the apex. Tibiæ pale honey yellow. Tarsi all black. Pile of legs except on tarsi, and at base of femora and on their dorsal borders, very long shaggy, pale yellow; elsewhere black. Hind metatarsi below with very dense, long bristles. Middle tibiæ apically with a marked claw of six to seven long black round tipped spines. The hind tibiæ lack this development, though a few short spines are present.

Wings tinged with yellow, and with brown about the veins. Marginal cell open. Surface villose.

Length, 13 mm. One female. Colonia Tovar, Aragua, Venezuela, 6000-7000 feet, May 6, 1929, Ernest Holt—Carnegie Museum Expedition. Type in the Carnegie Museum.

I place this form in Speiser's *Nosodepus* provisionally. The species has the appearance of a *Criorhina*. The facial strips of long pile are to be noted. It is obviously not Speiser's *N. minotaurus*. Speiser thinks the genus is close to *Helophilus*.

Volucella kahli sp. nov. (Plate VIII, fig. 5)

Female. Vertex and front, except for a short distance on the sides above the antennæ, dark shining brown or black, the upper front and vertex convex, beginning abruptly where on mid-front a concavity has been shaved out. Eyes pale pilose. Antennæ dark brown; arista paler, eighteen rayed above, unusually long, and a smaller short row, between dorsal and ventral rows. Face considerably produced downward and with a large obtuse anterior production (in profile) in the middle. Middle of face broadly black, and a very broad stripe between cheeks and face from eye to oral margin shining black. Remainder of pile cream color.

Dorsum of thorax shining blue black with coppery reflections, the humeri and sides of the dorsum broadly, base of scutellum broadly, and a narrow margin as well as all the upper pleuræ, pale cream color. Disc of scutellum brownish, the marginal depression deep, its marginal bristles (three on each side) and those of the margin of thorax black and quite long. Pile of dorsum, pleuræ, and largely that of scutellum pale yellow. Squamæ pale yellow, with brown fringe. Halteres cream color; opaque.

First segment of abdomen and basal half or two-thirds of second, the lateral corners more extensively, pale cream yellow, but more brownish at the junction with the dark color. An oblique oval brown spot on each lateral basal angle of the fourth segment, directed inward. Remainder of abdomen dark brown, bluish in reflection. Legs entirely dark brown, almost black, black pilose.

Wings: the anterior margin strongly yellow, a large rounded blackish spot near apex, but nowhere touching the margin. The stigma is brown.

Length, 8 mm. One female. Mana River, French Guiana, June 1917, S. M. Klages collector. Type in Carnegie Museum.

Volucella brunnicolor sp. nov. (Plate VIII, figs. 8, 9)

Male. Eyes touching for most of length of upper head, thick, long, pale pilose. Vertical triangle exceedingly small, light brown, convex, the close set ocelli, honey yellow. The front very limited to a small space above the antennæ. Upper facets of eye enormously enlarged. Entire face pale, orange brown, shining, subtranslucent. A suggestion of a brown stripe separates cheek and face. Face beneath antennæ pale pubescent. Face pale pilose. Antennæ light orange, the pale arista, with twenty pale colored rays on dorsal side.

Dorsum of thorax, abdomen except as noted, pleuræ, scutellum, legs, everywhere light orange brown. The pile of pleuræ long reddish golden. That of dorsum of thorax long, fine, erect, blackish, with pale hairs intermixed. Scutellum long, fine black, pilose without depression (the merest trace of a depression is indicated or suggested). The bristles of scutellum and sides of thorax reddish. Squamæ concolorous with pleuræ. Halteres ivory colored. Abdomen marked with a narrow transverse black spot on either side of post margin of second segment, again of third segment, and a vertical mark similarly on fourth segment, none of them reaching side margin; all of them black pilose.

Legs slightly darker on apico-third of tibiæ, the tibiæ black haired. Legs elsewhere pale haired, the tarsal segments with a circlet of black bristles on extreme tips past the golden reddish ones that cover these joints.

Length, 9 mm. One male. Santarem, Brazil, H. H. Smith collector. Type in Carnegie Museum.

Volucella braziliana sp. nov. (Plate VIII, fig. 4)

Female. Eyes bare. Vertex and upper part of front highly polished, dark brown, almost black. Lower front similar, but lighter brown, with a dark spot in the middle right over the antennæ. Face and cheeks light brownish yellow, a narrow stripe from eye to oral margin, separating them; a wider stripe, median from epistoma to base of antennæ everywhere shining and polished. Face pale pubescent, the cheeks posteriorly and the oral section of the post occiput quite pale honey yellow, the humeri and lower prothorax opposite these parts correspondingly colored. Antennæ pale brownish yellow, the inner margin of first joint and a tiny spot at the tip of the third joint, black and not diffuse. Base of arista pale, black apically, fourteen rayed above. Dorsum of thorax and the unusually long, subquadrate scutellum and its strong depression (sub-gen. Phalacromyia) all dark bluish black, with coppery and greenish reflections. Pile of thorax short, sparse, erect, pale, the lateral bristles including a few on margin of scutellum black. Pleura shining dark brown with pale brassy pubescence and similar pile. Squamæ pale brown with darker fringe. Halteres pale lemon yellow, opaque but subtranslucent.

First segment of abdomen and base of second, except on the sides and except for a posterior median indentation, pale brownish yellow, thickly short erect yellow pilose. Remaining segments concolorous with dorsum of thorax, the last half of second, all of third subappressed, black bristly; all of the fourth short, erect, pale pilose.

Legs dark shining brown, pile mostly dark, the apical third of fore tibiæ and the hind basitarsi more yellowish brown.

Wings pale brownish yellow tinged, the stigma and a spot in the same cell just distal to it, and one or two very small spots about the cross veins, brownish.

Length, 6 mm. One female. Hyatanahan, Rio Purús, Brazil, April 1922. S. M. Klages collector. Type in Carnegie Museum.

Paragus minutus sp. nov. (Plate VIII, fig. 2)

Male. Eyes narrowly touching. Upper facets enlarged. Vertex a narrow wedge, shining black. Ocelli placed forward, just below them the vertex is silvery pubescent. Front extremely small, shining blackish. Antennæ dark brown, the third joint a little lighter beneath and four times as long as the second joint, about two and a half times as long as first and second. Arista brown, basally thickened, a little longer than third joint. Third joint perfectly oval, deepest in the middle. Face convex, produced furtherest anteriorly just above the oral margin, giving the appearance of a very obtuse production. In color, shining cream colored. There is a faint suggestion of a narrow median stripe, but it is confined to immediately beneath antennæ and just above oral margin. Cheeks very narrow, together with whole oral margin, black. Pile of face sparse, pale.

Thorax, scutellum and abdomen black, shining, punctate, the punctures growing deeper on the scutellum and abdomen where they are quite conspicuous. There are a few very short stubby black teeth on the sides of the scutellum near the base, and one or two such tuberculate nodules on the margin. Pile of thorax very short, erect, pale, bushy tuft of pale brassy pile on the pleuræ behind the humeri. Squamæ pale cream color. Halteres brownish. Narrow lateral margins of abdomen and hypopygium brown, pale pilose, the latter pale pubescent. The appressed black bristles of the dorsum, located in the sparse punctures, are so short as to almost escape notice.

Legs mostly shining dark brown, the narrow apices of the femora, basal third of all the tibiæ and apical third of fore and mid-tibiæ pale yellow. Apical third of all the tibiæ and apical third of fore and mid tibiæ pale yellow. Apical third of hind tibiæ reddish, concolorous with the reddish yellow or brownish orange hind tarsi; other tarsi brown.

Wings hyaline, stigma brown. Last section of fourth longitudinal vein closing first posterior cell, sigmoid in shape.

Length, 5 mm. including antennæ. One male. Lolodorf, Cameroon, Nov. 17, 1913, Dr. A. I. Good collector. Type in Carnegie Museum.

Baccha velox sp. nov.

Male. Vertex and front black or dark brown. Face light yellow, shining, tubercle prominent, a dark median stripe on face. Antennæ dark brown, third joint rather elongate, twice as long as wide. Arista pale. Occipital fringe and prethoracic fringe or collar long, white haired.

Dorsum of thorax black with a purplish reflection on the sides. Scutellum dark brown. Pleuræ largely brown, a large pale yellow spot on mesopleuræ, the pteropleuræ at least dark brown, the remainder varying degrees of brown. Squamæ pale brown. Halteres similarly colored, ventral scutellar fringe long, but very sparse, and pale in color.

Abdomen practically as long as wings, the second segment of nearly the same width throughout, except that for a short distance at the base it widens to not quite twice its middle width; abdomen five to six times as long as middle width. The third and fourth segments subequal, each slightly shorter than second, the fifth segment not quite as long as wide. First segment pale yellowish, subtranslucent, the second and the base of the third narrowly subtranslucent dark reddish brown. The remainder of the third segment, a narrow posterior annulus on the second, and all of the fourth and fifth and hypopygium, very dark brown, shining, with a faint violaceous tinge. Pile of abdomen rather long, very sharp bristly and quite appressed, but on the sides of the first, second, and third segments it is long, erect, and pale brassy in color. Legs pale yellow, pale brassy haired, the tibiæ outwardly more brownish, strongly brownish on nearly the whole of the hind pair and on the outer half of the hind femora. Ventral base of last two tarsal joints black bipunctate.

Wings strongly margined with brown anteriorly; remainder of wing uniformly light yellowish brown.

Length, 15.5 mm. One male. Efulen, Kamerun, June 24, 1912, Dr. H. L. Weber collector. Type in Carnegie Museum.

Tityusia regulus Hull (Plate VIII, figs. 3, 11)

Psyche, vol. XLIV, no. 4, 1937, p. 119.

This is a curious *Helophiline* Syrphid, apparently making three genera that bear the curious globuliferous hairs on the ventral surface of the hind tarsi. The ventral surface of the abdomen bears a curious circular (bare within) tuft of hairs.

Syrphipogon fucatissimus Hull (Plate VIII, fig. 6)

Psyche, vol. XLIV, no. 4, 1937, p. 120.

This is a mimic of *Euglossa fasciata*. It is, moreover, the largest *Microdontine* fly I have ever seen.

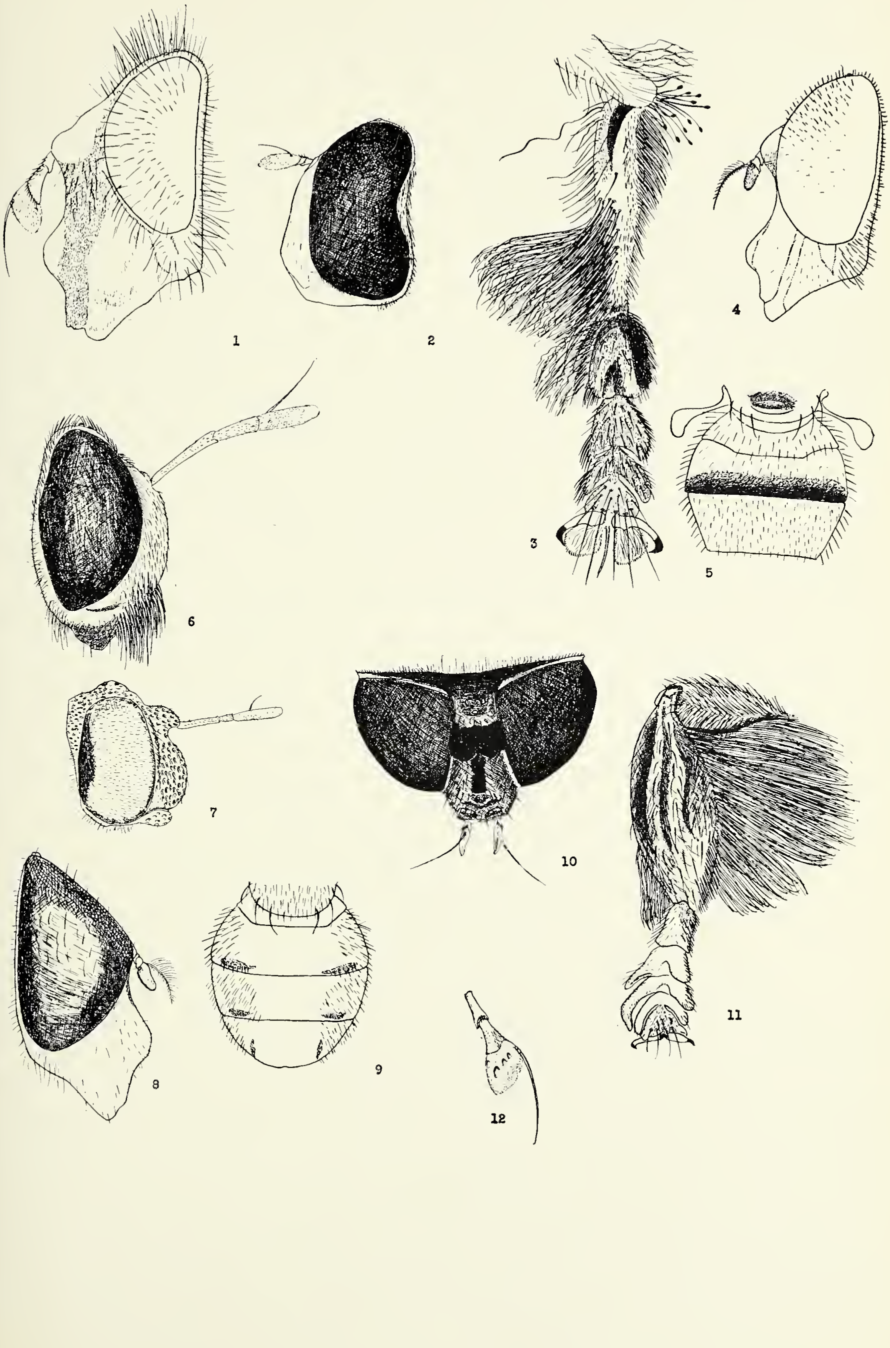
Chrysidimyia chrysidimima Hull (Plate VIII, fig. 7)

Psyche, vol. XLIV, no. 4, 1937, p. 116.

This is one of the many unusual species collected by Mr. S. M. Klages.

EXPLANATION OF PLATE VIII

FIG. 1. *Nosodepus montensis* sp. nov. (profile of head).
FIG. 2. *Paragus minutus* sp. nov. (profile of head).
FIG. 3. *Tityusia regulus* Hull (hind tarsi).
FIG. 4. *Volucella braziliana* sp. nov. (profile of head).
FIG. 5. *Volucella kahli* sp. nov. (base of abdomen).
FIG. 6. *Syrphipogon fucatissimus* Hull (profile of head).
FIG. 7. *Chrysidimyia chrysidimima* Hull (profile of head).
FIG. 8. *Volucella brunnicolor* sp. nov. (profile of head).
FIG. 9. *Volucella brunnicolor* sp. nov. (abdomen).
FIG. 10. *Eristalis argyropila* sp. nov. (dorsal view of head).
FIG. 11. *Tityusia regulus* Hull (anterior tarsus).
FIG. 12. *Nosodepus montensis* sp. nov. (antennæ, inner surface).


1
2
3
4
5
6
7
8
9
10
11
12

ART. VIII. A REVIEW OF THE XIPHOSURAN GENUS BELINURUS WITH THE DESCRIPTION OF A NEW SPECIES, *B. ALLEGANYENSIS*

By E. R. Eller

Annals of the Carnegie Museum
Vol. XXVII, p. 129-150

Issued May 12, 1938
Pittsburgh, Pa.

ART. VIII. A REVIEW OF THE XIPHOSURAN GENUS BELINURUS WITH THE DESCRIPTION OF A NEW SPECIES, *B. ALLEGANYENSIS.*

By E. R. Eller

(Plates IX-XIV)

Introduction

An interesting specimen of a Xiphosuran was uncovered in a plantation of *Prismodictya telum* James Hall, in the Edwin Bradford Hall collection of Upper Devonian Reticulate Sponges. The specimen is from the Upper Devonian (Conneaut Group*) at Wellsville, Allegany County, New York. The Xiphosuran, together with the sponges, is preserved in an impure sandstone and shows little evidence of having been crushed or distorted. Other typical Upper Devonian marine forms are found in the adjacent strata. The specimen belongs to the genus *Belinurus* and is probably the oldest form known for America and perhaps antedates the European species *Belinurus kiltorkensis* Baily. Only one other species of the genus, *Belinurus grandævus* Jones and Woodward, from the Carboniferous, Riverdale formation of Nova Scotia, has so far been found or described from America.

The writer wishes to express his thanks, for their valuable suggestions in the study of this form, to Professor Carl O. Dunbar of Yale University and to Dr. I. P. Tolmachoff of the Carnegie Museum.

DESCRIPTION OF SPECIES

Belinurus alleganyensis sp. nov.

(Plate IX, figs. 1, 2)

The body is highly convex and similar in shape to the modern kingcrab or horseshoe crab, *Limulus*. The dimensions of the specimen, irrespective of the telson, are as follows: length 41.3 mm., width 46.4 mm., and height about 11 mm. The form, therefore, is rather

*Personal communication with Professor John G. Woodruff.

Issued, May 12, 1938.

large for *Belinurus*, being larger than any other specimen known to the writer.

The cephalothorax is semi-elliptical, except for the anterior margin which is more or less straight. The posterior margin is symmetrically waved with a backward curve to the rachial furrow of the abdomen where the margin curves forward and then backward to form a point opposite the middle of the rachis. The genal spines are stout and extend backward to a point opposite the fourth pleural segment of the abdomen.

The cardiac lobe is irregularly triangular in outline, elevated and rounded, thus having no distinct median line. Posteriorly the lateral

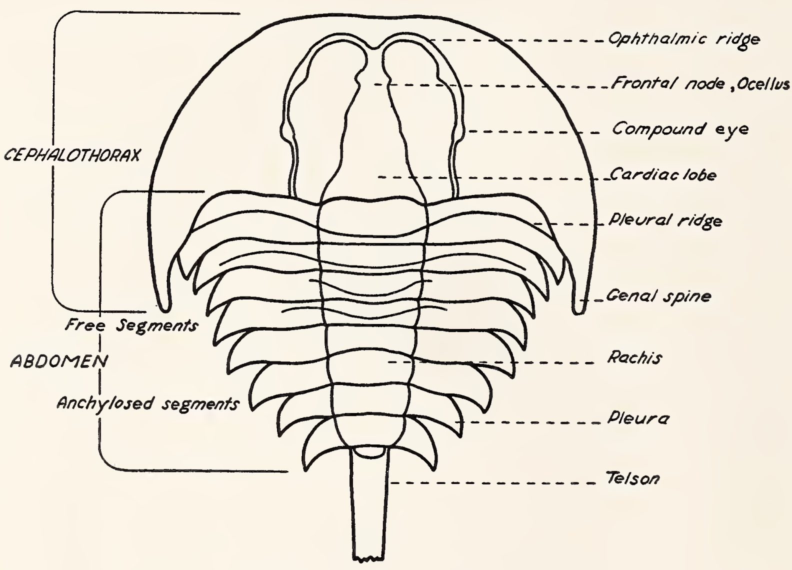


FIG. 1. Schematic representation of the Belinuridæ.

margins exhibit a wave-like outline to the apex. Slightly anterior to the middle, the lobe is crossed by a forward-curving furrow and there is also an indication of three other furrows on the lobe. On the anterior end the cardiac lobe bears a sharply defined frontal node, a trefoiled club-like structure from which extends the ophthalmic ridge. Perhaps this structure contained the ocelli. The ridges are strongly elevated and curve to the posterior margin of the cephalothorax. The furrows of the cardiac lobe, if they are not caused in the process of fossilization, would divide the cardiac lobe into five parts which, along with the frontal node, would suggest the presence of six limbs similar to those of the modern limulus. The ophthalmic ridges slope abruptly to the margins of the carapace but gradually to the cardiac lobe, except at the anterior part where a deeper area is found. At the lower end of this depressed area, the ophthalmic ridge has widened and forms a node-like structure which, together with the frontal node at the end of the cardiac lobe, nearly encloses, or better emphasizes this depression. An irregular impression, probably of the compound eye, is located posteriorly to the middle part of the ridge.

The abdomen is broadly convex and irregularly triangular in shape. There are eight segments well defined by deep grooves. The first six are probably movable and the remaining two anchylosed. On each side of the telson, which is, however, only partly preserved in the specimen, on the last segment are node-like projections which, perhaps, were functional in the articulation of the telson, or which may have been the bases of spines. On each of the first four segments near the posterior edge is a pleural ridge which in the first segment is highly elevated and extends the full length of the segment but which gradually becomes shorter and less pronounced in the remaining three. The first three articulated segments appear to be distinctly truncate and have large, round, and slightly raised areas at their ends. Perhaps these raised structures are for the articulation of movable spines. The rachis is highly elevated. The two, well defined, anchylosed segments, separated from the movable segments by a groove, are decidedly different in form from the proceeding ones. The first one is twice as wide as the last one and is crossed by a groove which gives a slight concavity to the segment. Whether this groove is actually a suture and constitutes true segmentation remains undecided. The last segment is small and is separated by a less well defined groove than that between the free and anchylosed segments.

DISCUSSION

Devonian Limuloids are usually found in marine deposits while Carboniferous and Permian forms are limited to fresh or brackish water deposits. During Jurassic times *Limulus*, as a form not unlike that living today, was again found in marine deposits. If the place of burial was also the habitat, it is interesting to note that the habitat of the *Limulida* changed from marine to fresh water and then back to a marine environment. Possibly these changes in habitat, whether forced by a changing environment or by migration, stimulated and then arrested their evolution, thus making forms of *Limulida* good examples of persistent types.

The Carnegie Museum has specimens of *Belinurus bellulus* König and another specimen labeled *Belinurus kœnigianus* Woodward, from the Carboniferous of England, which resemble *Belinurus alleganyensis* m. in certain details of the cephalothorax. The similarity is expressed mostly in the cardiac lobe, the frontal node, and the ophthalmic ridge. However, the general shape of the cephalothorax and the anchylosed segments of the abdomen are different. On cleaning *Belinurus kœnigianus* Woodward, which is figured on Plate IX, fig. 3, it was found that long spines were preserved. *Belinurus kœnigianus* Woodward does not bear genal spines in any of the illustrations (Plate XI, figs. 1, 2) seen by the writer but these show the genal angles to be rather obtuse. This bluntness of the genal angles is also mentioned in the descriptions of the species. In other respects, except for a wider rachis, the specimen, Plate XI, fig. 3, corresponds closely to *Belinurus kœnigianus* Woodward. Possibly the genal angles of some individuals were blunt while others developed spines or perhaps the spines were commonly broken off during life or in burial. Due to the lack of comparative material, the writer feels unable to decide if this form is a new species and thus, for the present, will consider it as *Belinurus kœnigianus* Woodward.

Belinurus grandævus Jones and Woodward, 1899,[1] Plate XII, figs. 7, 8, from the Carboniferous of Nova Scotia is similar in outline to *Belinurus alleganyensis* m. but the details of the Nova Scotia form are so little known that a comparison is difficult. *Belinurus kiltorkensis* Baily, Plate XIV, figs. 4-7, of the Upper Old Red Sandstone of Ireland is based on two extremely fragmentary specimens, one of which is badly distorted. Baily first described the specimens in 1869, Woodward, 1878, re-described and published figures, and Cole, 1901, also re-described and published new figures of the same specimens. These several figures do not agree very well and the descriptions are so general that there is some doubt in the mind of the writer as to their identification. For these reasons no comparisons will be attempted.

[1] All species attributed to Belinurus, known and available to the writer, are figured on Plates IX, X, XI, XII, XIII, and XIV.

Dix and Pringle, 1929, 1930, described five new species of *Belinurus*, Plate XI, figs. 7, 9, Plate XII, figs. 2, 5, 6, 9, from the Carboniferous of the South Wales Coal Field. These species resemble *Belinurus alleganyensis* m. in a general way. A fragment of the cephalothorax of *Belinurus pustulosus* Dix and Pringle, Plate XII, fig. 9, for which the authors have some doubt as to its true affinity, suggests segmentation of the cardiac lobe. Since there is perhaps a slight segmentation in the same area of *Belinurus alleganyensis* m. it would be interesting to make a closer comparison between these two forms.

Belinurus reginæ Baily, 1863, Plate X, figs. 1, 2, *Belinurus arcuatus* Baily, 1863, Plate XI, figs. 3-6, *Belinurus silesiacus* Roemer, 1883, Plate XII, figs. 3, 4, *Belinurus lunatus* Baldwin, 1907, Plate XIV, fig. 3, *Belinurus baldwini* Woodward, 1907, Plate XIV, fig. 1, and *Belinurus longicaudutus* Woodward, 1907, Plate XIV, fig. 2, are comparable to *Belinurus alleganyensis* m. in a general way.

The general shape of the cephalothorax, the cardiac lobe, and the ophthalmic ridge of *Paleolimulus avitus* Dunbar, 1923, compare rather favorably with *Belinurus alleganyensis* m. If the four, slightly raised structures in the depressed areas between the cardiac lobe and the ophthalmic ridge of *Belinurus alleganyensis* m. were actually nodes, and, if the node on each side of the frontal node at the apex of the cardiac lobe would be taken into consideration, the form would lack only one node of the necessary six to correspond with the six thoracic limbs of the modern *Limulus* and to be somewhat similar to the same structural detail of *Paleolimulus avitus* Dunbar.

Matthew, 1909, created a new genus, *Belinuropsis*, for a species *Belinuropsis wigodensis* Matthew, Plate XIV, fig. 9, from the Little River Group, at Duck Cove, Lancaster, N. B. This form is however so fragmentary that no good comparison can be made with *Belinurus alleganyensis* m.

In 1933, Chernyshev described from the Upper Devonian, Don River, U. S. S. R., *Bellinuroopsis rossicus* Chernyshev, a limuloid, new generically and specifically. Chernyshev's species, which is reproduced on Plate XIV, fig. 8, is well preserved but only comparable to *Belinurus alleganyensis* m. in a general way. The generic name used by Chernyshev was already pre-occupied by Matthews for an entirely different form and therefore should be replaced by a new one, for which the author suggests

Neobelinuropsis nom. nov.

The following diagnosis of the genus *Belinurus* König is a revision by Professor Dunbar, 1923, published in conjunction with his paper on a new genus of paleozoic *Xiphosura:*

Belinurus: "Body limuloid in shape. Abdomen triangular, distinctly trilobed, consisting of eight segments plus a slender ensiform telson. The first five segments movably articulare, the last three anchylosed."

Dix and Pringle, 1929, gave the following diagnosis for the genus:

Belinurus: "Body limuloid, head-shield or prosoma semi-circular with long genal spines from the posterior angles. Median part of prosoma (glabella) prominent and divided into two lobes, declining toward the circumference and surrounded by a narrow, flattened margin. Mesasoma, consisting of five free segments, each produced laterally into spines. Metasoma small, formed of three fused segments, and a long telson. Genoholotype, *Belinurus bellulus* König."

Several of the species described by Dix and Pringle, 1929, 1930, Plate XI, figs. 7, 9, Plate XII, figs. 2, 5, 6, 9, do not correspond with the above diagnosis of the genus in the number of abdominal segments. In the first paper *Belinurus truemanni* D. & P., in which the abdomen is poorly preserved, is thought to have four free and three anchylosed segments; in the second paper, where the species is described from a specimen in which the abdomen is better preserved, five free and two anchylosed segments are shown to be present. *Belinurus concinnus* D. & P., shows six free segments, the anchylosed segments being indiscernible. *Belinurus carnayensis* D. & P., has five free and two anchylosed segments, while *Belinurus morgani* D. & P., is shown to have seven free and two anchylosed.

B. alleganyensis m. likewise does not correspond in all details with the above qualifications of the genus in the abdominal region, since it apparently has six movable and two anchylosed segments. The writer is doubtful about the generic position of *Belinurus alleganyensis* m. but, for several reasons, the separation of it under a new generic name does not seem advisable at the present time. In making a general comparison of *Belinurus alleganyensis* m. with the known species of the genus *Belinurus*, it is evident that there is a common likeness or relationship between them. The fact that *Belinurus alleganyensis* m. is larger and older geologically than the Carboniferous species does not, at least in the mind of the writer, alone signify any valid reason for a generic difference. It would follow, then, that the diagnosis of the genus *Belinurus* should be made more elastic as to the number of segments of the abdomen.

Belinurus, Diagnosis: Body limuloid in shape. Cephalothorax semi-circular usually with post-lateral genal spines, prominent cardiac lobe, and paired ophthalmic ridges bearing compound eyes. Abdomen triangular, distinctly trilobed, consisting of seven or more segments bearing lateral spines, and a slender ensiform telson. The first four or more segments are movably articulated, the last two or more anchylosed.

List of Papers Consulted by the Author

Ami, H. M.

1899. Bellinurus grandaevus, A New Species of Paleozoic Limuloid Crustacean Recently Described by Prof. T. R. Jones and Dr. Henry Woodward, from the Eo-Carboniferous of Riverdale, Nova Scotia. The Ottawa Nat., Vol. 13, No. 8, pp. 207-209.

Baily, W. H.

1863. Remarks on some Coal-measure Crustacea belonging to the Genus *Belinurus*, Konig, with Description of Two New Species from Queen's County, Ireland. Ann. and Mag. Nat. Hist., 3rd Ser., Vol. 11, pp. 107-114.

1869. On Fossils Obtained at Kitorkan Quarry, Co. Kilkenny. Brit. Assoc. Rep., pp. 73-75.

Beecher, C. E.

1902. Note on a New Xiphosuran from the Upper Devonian of Pennsylvania. Amer. Geol., Vol. 29, No. 3, pp. 143-146.

Buckland, W.

1836. On Geology and Mineralogy. Bridgewater Treatise, Vol. 1, 299; Vol. 2, p. 77, pl. 46.

Chapman, F.

1932. Two New Australian Fossil King Crabs. Proc. Roy. Soc. Victoria, Vol. 44, pp. 100-102.

Chernyshev, B.

1927. Note sur les representants des Xiphosura du bassin du Donetz. Bull. du Comité Géologique, Vol. 46, No. 7, pp. 645-655.

1928. Nouvelles donnees sur les Xiphosura du bassin du Donetz. Bull. du Comité Géologique, Vol. 47, pp. 519-531.

1933. Arthropods from the Urals and Other Regions of the U.S.S.R. Materials of the Central Scientific Geological and Prospecting Institute. Paleont. & Stratigraphy Mag. Leningrad 1, pp. 15-24, 1 pl.

CLARKE, J. M. AND RUEDEMANN, R.

1912. The Eurypterida of New York. New York State Museum, Memoir 14.

COLE, G. A. J.

1901. On Belinurus Kiltorkensis Baily. Geol. Mag., Dec. 4, Vol. 7, No. 440, p. 52, figs. 1, 2.

DIX, E. AND PRINGLE, J.

1929. On the Fossil Xiphosura from the South Wales Coal Field with a Note on the Myriapod Euphoberia. Geological Survey of Great Britain Summary of Progress, Pt. 2, pp. 90-113.

1930. Some Coal Measure Arthropods from the South Wales Coal Field. Ann. and Mag. Nat. Hist., Ser. 10, Vol. 6, pp. 136-144.

DUNBAR, CARL O.

1923. Kansas Permian Insects. Part 2. Paleolimulus, A New Genus of Paleozoic Xiphosura, with Notes on other Genera. Am. Jour. Sci., 5th Ser., Vol. 5, Ser. 50, No. 30, pp. 443-454.

FRITEL, P. H.

1902. Crustaces Fossiles. Le Naturaliste, Annee 24, pp. 221-224.

FRITSCH, A.

1901. Fauna der Gaskohle und der Kalksteine der Permformation Bohmens. Prag. 4, p. 64.

JONES, T. R. AND WOODWARD, H.

1899. Contributions to Fossil Crustacea. Geol. Mag., Dec. 4, Vol. 6, No. 423, p. 388, pl. 15, figs. 2, 3.

KOBAYASHI, T.

1933. On the Occurrence of Xiphosuran Remains in Chosen (Korea). Japanese Jour. of Geol. and Geogr., Vol. 10, pp. 175-182.

MARTIN, W.

1809. Petrificata Derbiensia. Plate 45, fig. 4.

MATTHEWS, G. F.

1909. Remarkable Forms of the Little River Group. Trans. Roy. Soc. Canada, Ser. 3, Vol. 3, Sect. 4, pp. 115-125.

MEEK, F. B.

1867. Notes on a New Genus of Fossil Crustacea. Am. Jour. Sci., Ser. 2, Vol. 43, pp. 394-395.

MEEK, F. B. AND WORTHEN, A. H.

1865. Notice of Some New Types of Organic Remains, from the Coal Measures of Illinois. Proc. Acad. Nat. Sci., Vol. 17, pp. 41-45.

1866. Paleontology of Illinois. Geol. Sur. Ill., Vol. 2, pp. 395-398, pl. 32, fig. 2, 2a.

MILNE-EDWARDS, A.

1873. Etudes sur les Xiphosures et Crustaces de la region Mexicaine. Mission Scientifique au Mexique et dans L'Amerique Centrale, Zoologie, 5me Parte, pp. 1-48.

OWEN, R.

1872. On the Anatomy of the American King-crab. Trans. Linnaean Soc., Vol. 28, pp. 459-512.

PACKARD, A. S.

1872. The Development of Limulus Polyphemus. Memoirs Boston Soc. Nat. Hist., Vol. 2, pp. 155-202.

1880. The Anatomy, Histology and Embryology of Limulus Polyphemus. Anniv. Mem. Boston Soc. Nat. Hist., pp. 3-45.

1885. Types of Carboniferous Xiphosura New to North America. Am. Nat., Vol. 19, pp. 391-394.

1886. On the Carboniferous Xiphosurous Fauna of North America. Nat. Acad. Sci., Vol. 3, pp. 143-157.

1900. On Supposed Merostomatous and other Paleozoic Arthropod Trails with Notes on those of Limulus. Proc. Amer. Acad. Arts and Sci., Vol. 36, pp. 63-71.

PARKER, W. A.

1907. Belinurus lunatus Parker (Not read by writer). Lancashire Naturalist, p. 44.

1908. Fossil Arthropods and Pisces from the Middle Coal Measures of Sparth, Rochdale. Trans. Rochdale Lit. and Sci. Soc., Vol. 9, pp. 64-76.

PATTEN, W. AND REDENBAUGH, W. A.

1900. Studies on Limulus. Journ. Morph., Vol. 16.

POCOCK, R. I.

1902. The Taxonomy of Recent Species of Limulus. Ann. & Mag. Nat. Hist., Ser. 7, Vol. 9, pp. 256-266.

PORTLOCK, J. E.

1843. Rept. Geol. Londonderry. p. 316.

PRUVOST, PIERRE.

1911. Note sur quelques Crustaces (*Prestwichia*, *Belinurus* et *Eurypterus*) du terrain hoviller du Nord de la France. Ann. Soc. Geol. du Nord., Vol. 40, pp. 295-302.

RICHTER, R. AND E.

1929. *Weinbergina opitz* n. g. n. sp., ein Schwerttrager (Merost., Xiphos) aus dem Devon. (Rheinland). Senckenbergiana, Band 11, No. 3, pp. 193-209.

ROEMER, F.

1883. Ueber eine Art. d. Limuliden-Gattung Belinurus aus dem Steinkohlengebirge Oberschlesiens. Zeitschr. d. Deut. Geol. Gesell., Bd. 35, pp. 429-432.

RUEDEMANN, R.

1916. Paleontologic Contributions from the New York State Museum, N. Y. State Mus. Bull. No. 189, p. 105.

R. W. E.

1900. Notes. The Ottawa Naturalist, Vol. 13, No. 10, p. 256.

SCHUCHERT, CHARLES

1916. The Earliest Fresh-water Arthropods. Nat. Acad. Sci., Proc., Vol. 2, pp. 726-733.

SHIPLEY, A. E.

1920. Intro. to Arachnida and Xiphosura. The Cambridge Nat. Hist., Vol. 4, pp. 253-279.

STORMER, L.

1934. Downtonian Merostomata from Spitzbergen with remarks on the Suborder Syniziphosura. Skrifter utgitt av Det Norske Videnskaps-Akademi i Oslo I. Matem. Naturvid. Klasse. No. 3.

VAN STRAELEN, V.

1922. Sur la presence d'un Xiphosure dan le Westphalien des Environs de Liege. Ann. Soc. Géol. de Belgique, Tome 45, pp. 91, 92.

WILLIAMS, H. S.

1885. Notice of a New Limuloid Crustacean from the Devonian. Am. Journ. Sci., Vol. 30, Ser. 3, pp. 45-49.

1885. Notice of a New Limuloid Crustacean from the Devonian. Geol. Mag., Decade 3, Vol. 11, pp. 427-429.

Withers, R. B.

1933. A New Genus of Fossil King Crab. Proc. Roy. Soc. Victoria, Vol. 45, pp. 18-22.

Woodward, H.

1866. Structure and Classification of the Fossil Crustacea. Rept. Brit. Assoc. Adv. Sci., pp. 179-182.

1866-1878. British Fossil Crustacea. Paleontographical Soc. of London.

1867. The Structure of the Xiphosura. Quart. Journ. Geol. Soc. London, Vol. 23, pp. 28-37.

1868. On a New Limuloid Crustacean (*Neolimulus falcatus*) from the Upper Silurian of Lesmahagow, Lanarkshire. Geol. Mag., Vol. 5, pp. 1-3.

1907. Further Notes on the Arthropods of the British Coal-measures. Geol. Mag., Dec. 5, Vol. 8, pp. 540-541.

1918. Notes on Some Fossil Arthropods from the Carboniferous Rocks of Cape Brenton. Geol. Mag. Ser. 6, Vol. 5, pp. 462-471.

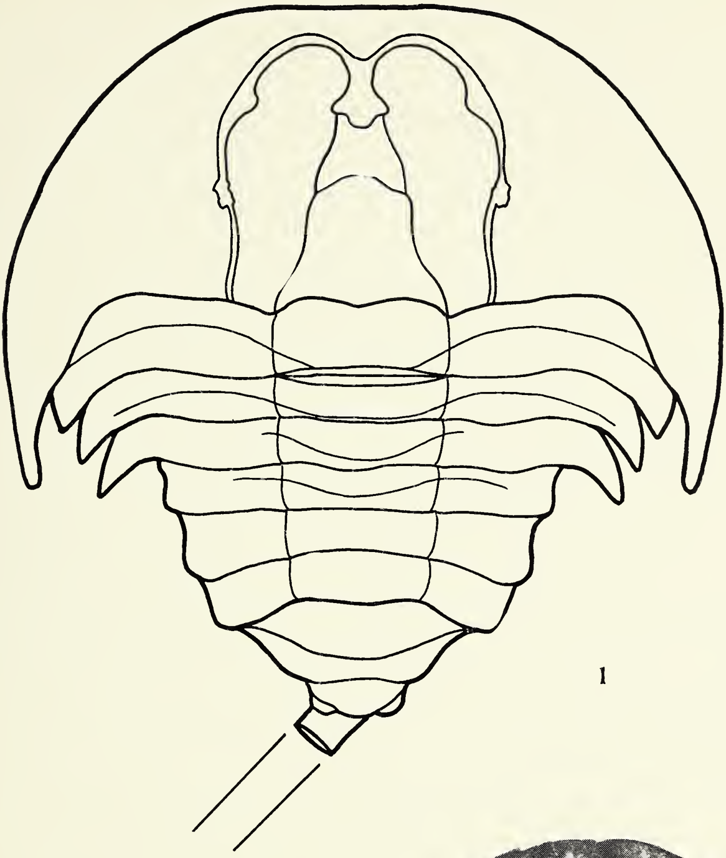
EXPLANATION OF PLATE IX

FIG. 1. *Belinurus alleganyensis* sp. nov. × 2. Drawing of fig. 2. Upper Devonian, Wellsville, N. Y.

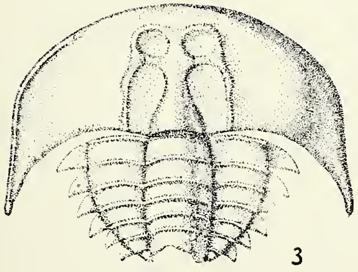
FIG. 2. *Belinurus alleganyensis* sp. nov. Natural size. Upper Devonian, Wellsville, N. Y.

The type is in the Carnegie Museum, Number 11065, Section of Invertebrate Paleontology.

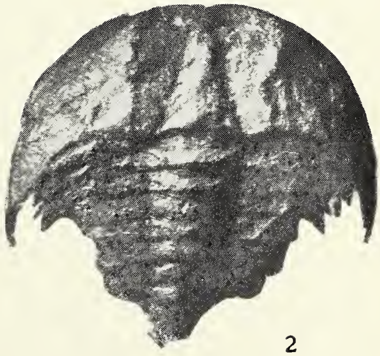
FIG. 3. *Belinurus kœnigianus* Woodward. Natural size. Coal Measures, Carboniferous, Caseley, England.



1



3



2

EXPLANATION OF PLATE X

FIG. 1. *Belinurus reginæ* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 16, 1866-1876.

FIG. 2. *Belinurus reginæ* Baily. Enlarged. From Quat. Jour. Geol. Soc., London, Vol. 23, pl. 1, fig. 1, 1867.

FIG. 3. *Belinurus bellulus* König, × 3. From Ann. Nat. Hist., Vol. 6, p. 140, fig. 3, 1930.

FIG. 4. *Belinurus bellulus* König. From Geol. of Londonderry, p. 316, pl. 24, fig. 11, 1843.

FIG. 5. *Belinurus bellulus* König. From British Fossil Crust., Paleon. Soc. pl. 31, fig. 3b. 1866-1878.

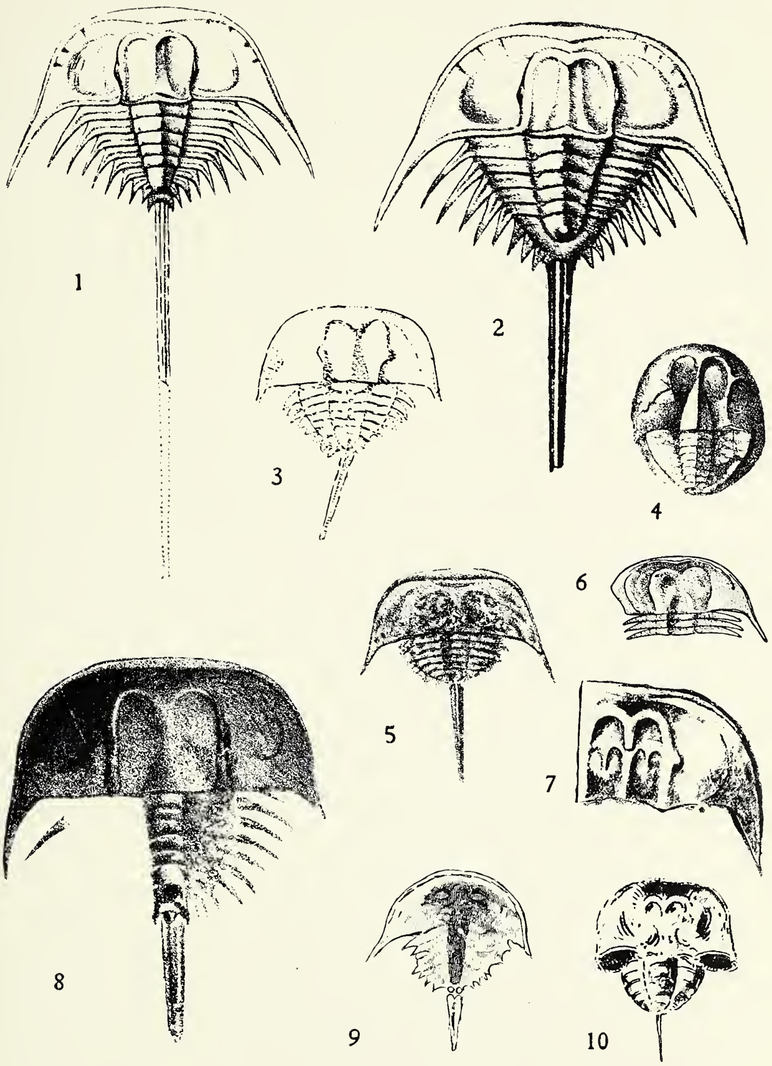
FIG. 6. *Belinurus bellulus* König, × ⅔. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 97, fig. 5. 1928.

FIG. 7. *Belinurus bellulus* König, × ⅔. From Trans. Manchester Geol. and Min. Soc., Vol. 28, pp. 198-202, 1903.

FIG. 8. *Belinurus bellulus* König, × 1½. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 3a, 1866-1878.

FIG. 9. *Belinurus bellulus* König. From Bridgewater Treatise, Vol. 2, pl. 46, 1836.

FIG. 10. *Belinurus bellulus* König. From Petrificata Derbiensia, pl. 45, fig. 4, 1809.


1
2
3
4
5
6
7
8
9
10

EXPLANATION OF PLATE XI

FIG. 1. *Belinurus kœnigianus* Woodward. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 3c, 1866-1878.

FIG. 2. *Belinurus kœnigianus* Woodward. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 4, 1866-1878.

FIG. 3. *Belinurus arcuatus* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 2b, 1866-1878.

FIG. 4. *Belinurus arcuatus* Baily. × 1¼. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 2a, 1866-1878.

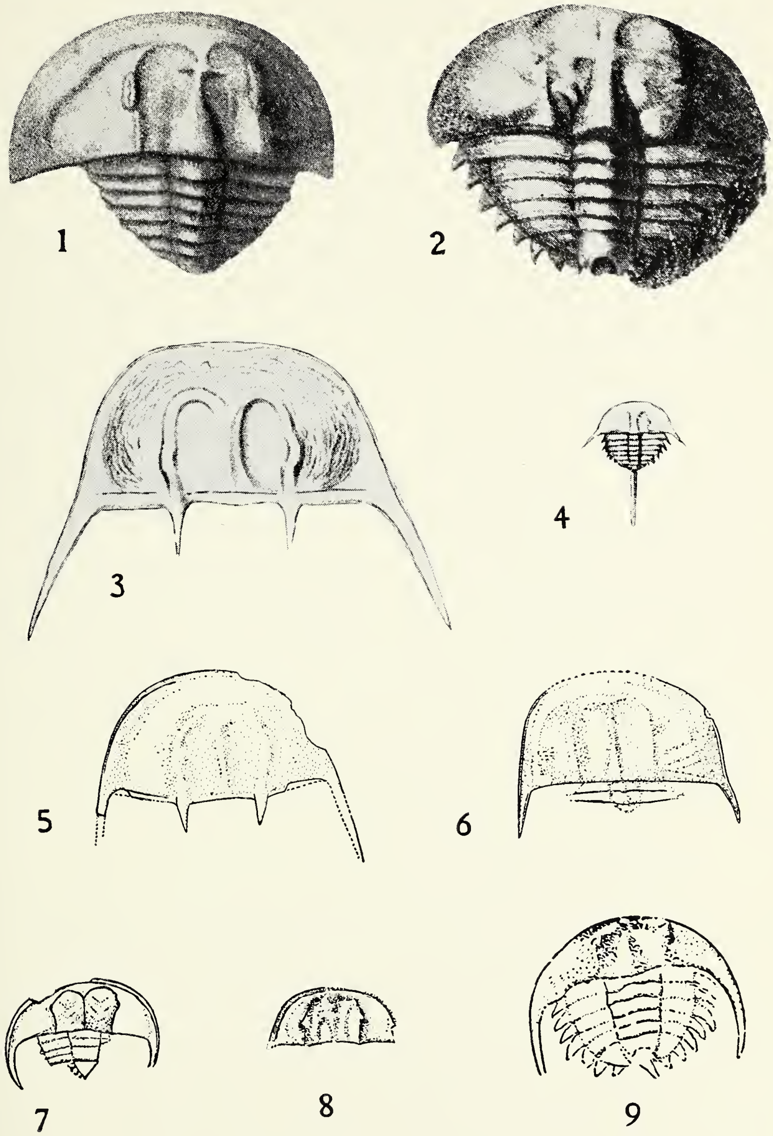
FIG. 5. *Belinurus* cf. *arcuatus* Baily. × 2½. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 99, fig. 7, 1928.

FIG. 6. *Belinurus arcuatus* Baily. × 2. From Summary of Progress. Gr. Britian, pt. 2, p. 98, fig. 6. 1928.

FIG. 7. *Belinurus truemani* Dix & Pringle. × 3¼. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 95, fig. 3. 1928.

FIG. 8. *Belinurus kœnigianus* Woodward. × 1½. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 100, fig. 8. 1928.

FIG. 9. *Belinurus* cf. *truemani* Dix & Pringle. × 3¼. From Ann. Nat. Hist., Ser. 10, Vol. 6, p. 139, fig. 2. 1930.


1
2
3
4
5
6
7
8
9

EXPLANATION OF PLATE XII

FIG. 1. *Belinurus trechmanni* Woodward. × 4. From Geol. Mag., Dec. 6, Vol. 5, pp. 462-471, fig. 5, 1918.

FIG. 2. *Belinurus morgani* Dix & Pringle. × 3. From Ann. Nat. Hist., Ser. 10, Vol. 6, p. 138, fig. 1, 1930.

FIG. 3. *Belinurus silesiacus* Roemer. × ¾. From Zeitschr. d. Deut. Geol. Gesell. Bd. 35, pp. 429-432, fig. 1, 1883.

FIG. 4. *Belinurus silesiacus* Roemer. Enlarged. From Zeitschr. d. Deut. Geol. Gesell. Bd. 35, pp. 429-432, fig. 2, 1883. Restoration of fig. 1.

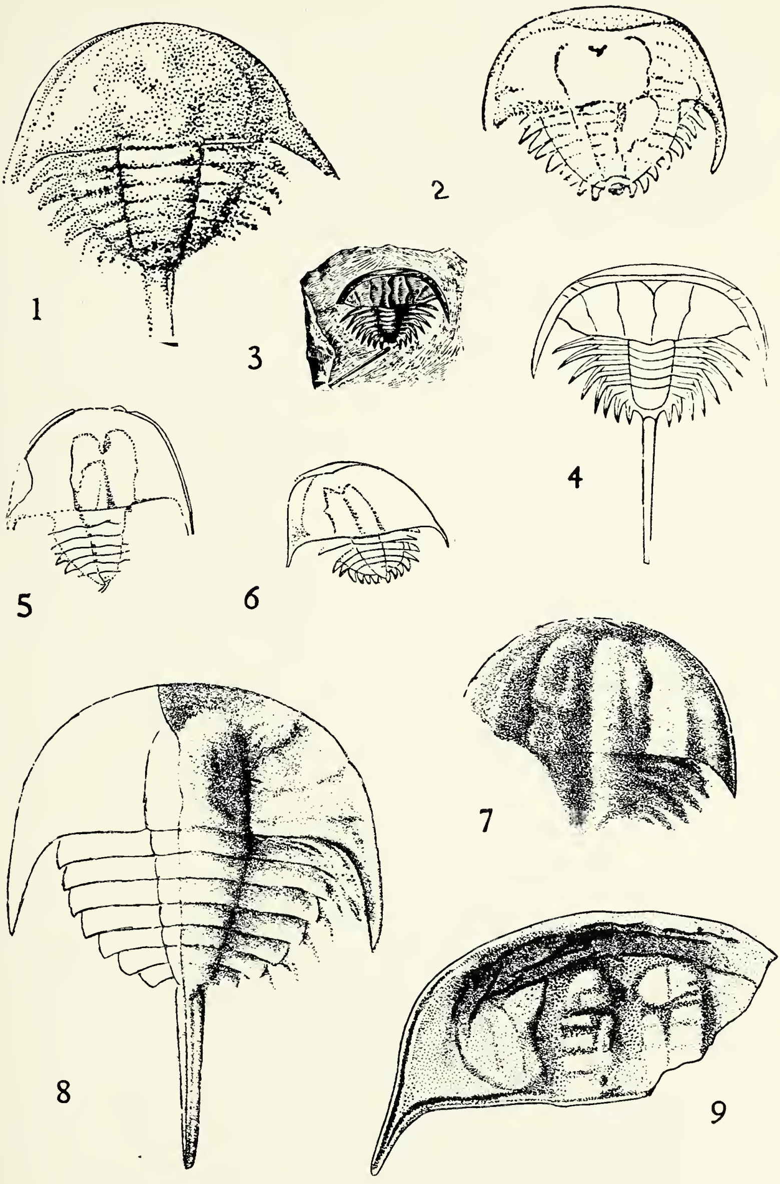
FIG. 5. *Belinurus concinnus* Dix & Pringle. × 1. From Summary of Progress. Surv. Gr. Britain, pt. 2, p. 92, fig. 1, 1929.

FIG. 6. *Belinurus carwayensis* Dix & Pringle. × 1. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 94, fig. 2, 1929.

FIG. 7. *Belinurus grandævus* Jones & Woodward. × 7. From Geol. Mag., Dec. 4, Vol. 6, pl. 15, fig. 3. 1899.

FIG. 8. *Belinurus grandævus* Jones & Woodward. × 7. From Geol. Mag., Dec. 4, Vol. 6, pl. 15, fig. 2, 1899.

FIG. 9. *Belinurus pustulosus* Dix & Pringle. × 2. From Summary of Progress. Geol. Gr. Britain, pt. 2, p. 96, fig. 4, 1928.


1
2
3
4
5
6
7
8
9

EXPLANATION OF PLATE XIII

FIG. 1. *Belinurus metschetnensis* Chernyshev. × 3½. From Bull. du Comité Géol., Vol. 46, p. 35, fig. 5, 1927.

FIG. 2. *Belinurus metschetnensis* Chernyshev. × 3½. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 4, 1927.

FIG. 3. *Belinurus iswarinensis* Chernyshev. × 2. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 10, 1927.

FIG. 4. *Belinurus stepanovi* Chernyshev. × 3¾. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 7, 1927.

FIG. 5. *Belinurus iswarinensis* Chernyshev. × 2½. From Bull. du Comité Géol., Vol. 47, pl. 37, fig. 16, 1928.

FIG. 6. *Belinurus stepanovi* Chernyshev. × 3½. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 6, 1927.

FIG. 7. *Belinurus iswarinensis* Chernyshev. From Bull. du Comité Géol., Vol. 46, p. 649, text fig. 1, 1927.

FIG. 8. *Belinurus iswarinensis* Chernyshev. × 3½. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 2, 1927.

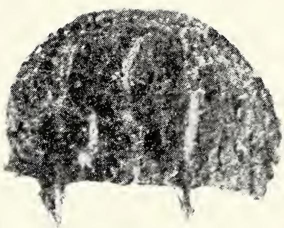

1

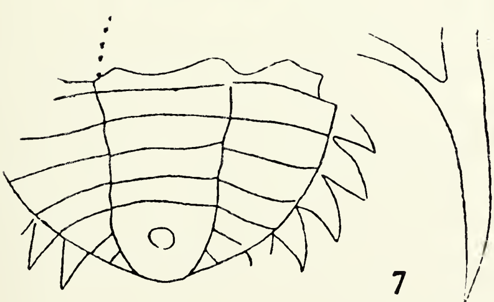

2


3


4


5


6


7


8

EXPLANATION OF PLATE XIV

FIG. 1. *Belinurus baldwini* Woodward. × 3. From Geol. Mag., Dec. 5, Vol. 8, pp. 540-541, fig. 1, 1908.

FIG. 2. *Belinurus longicaudatus* Woodward. × ¾. From Geol. Mag., Dec. 5, Vol. 8, pp. 540-541, fig. 2, 1907.

FIG. 3. *Belinurus lunatus* Baldwin. × 1. From Trans. Manchester Geol. and Min. Soc., Vol. 29, p. 126, fig. 2, 1904.

FIG. 4. *Belinurus kiltorkensis* Baily. From Geol. Mag., Dec. 4, No. 440, p. 52, fig. 2, 1901.

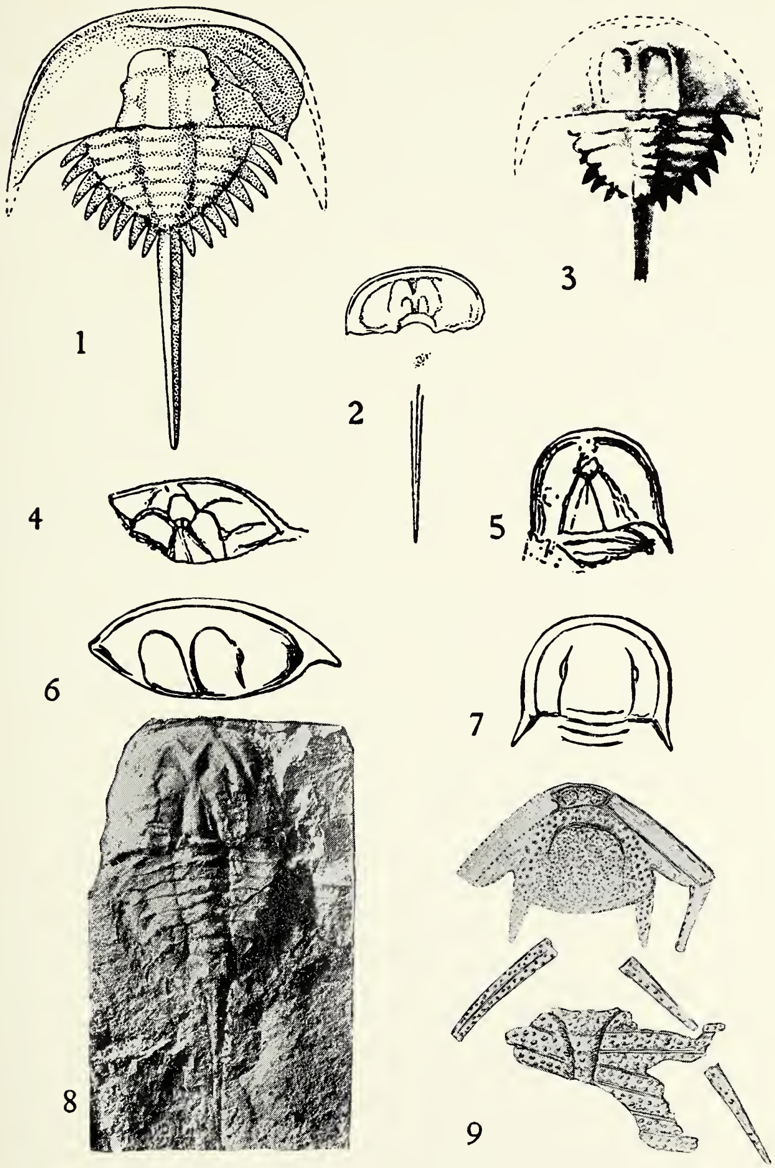
FIG. 5. *Belinurus kiltorkensis* Baily. From Geol. Mag., Dec. 4, No. 440, p. 52, fig. 1, 1901.

FIG. 6. *Belinurus kiltorkensis* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., p. 238, fig. 79b, 1866-1878.

FIG. 7. *Belinurus kiltorkensis* Baily. Enlarged. From British Fossil Crust. Paleon. Soc., p. 238, fig. 79a, 1866-1878.

FIG. 8. *Neobelinuropsis rossicus* (Chernyshev). × ¾. From Materials of the Centr. Geol. and Prospecting Inst., Paleon. and Strat., Mag. 1, pp. 15-24, 1 pl., fig. 1, 1933.

FIG. 9. *Belinuropsis wigodensis* Matthew. Enlarged. From Trans. Roy. Soc. Canada, Ser. 3, Vol. 3, Sect. 4, pp. 115-125, fig. 3, 1909.


1
2
3
4
5
6
7
8
9

ART. IX. A NEW XIPHOSURAN, *EUPROOPS MORANI*, FROM THE UPPER DEVONIAN OF PENNSYLVANIA.

By E. R. Eller

So few Xiphosurian remains have been described that any record of their occurrence is of interest. Mr. William Moran, during the collecting season of 1936, found part of an abdomen of a Limuloid, whose closest relationship is probably to the genus *Euproops*. This specimen was found along the road-cut north of North Warren, Pennsylvania, and is from the Salamanca sandstone, the former second Venango oil sand, of the Upper Devonian, and therefore one of the oldest "Euproops-like limuloids" so far found. Typical Salamancan marine forms were collected in the same stratum.

Three other species have been described from nearby localities in the Upper Devonian of New York and Pennsylvania. *Prestwichia randalli* Beecher, 1902, has been shown by Dunbar, 1923, to be probably a *Paleolimulus; Belinurus alleganyensis* Eller, 1938, cannot be compared with the specimen described in this paper; while the third species, *Protolimulus eriensis* Williams, 1885, has a general limuloid shape, but the condition of its preservation makes comparison impossible. The writer hesitates to erect a new genus for the Warren form since only the abdomen is known, even though the specimen is well preserved and differs in some respects from *Euproops* and *Prestwichianella.*

I am indebted to Mr. Sydney Prentice for the drawing which accompanies the description.

Euproops morani sp. nov.

The abdomen is semicircular in outline with probably one or two segments missing. The left side is slightly distorted by being compressed toward the rachis. Six segments of the rachis present are highly convex and taper gradually and become less convex and smaller, posteriorly, except for the last segment which is wider. The individual segments of the rachis have three large nodes, the middle one being the largest, and there is evidence that it is capped by an additional tubercle. The pleural region is highly convex, adjacent to

ssued, May 12, 1938.

the rachis, but becomes concave toward the flattened lateral margins. Margins of the pleural regions are serrated, and the serrations probably bore spines. From the lower half of the first three rachial segments, pleural ridges extend to the serratures on the lateral margins. Pleural ridges do not extend from the three posterior rachial segments and the opposite lateral margins are not serrated. The dimensions of the specimen are as follows: width of the abdomen 35.3 mm., length of the abdomen 20.8 mm., width of rachial segment 7.5 mm., length of rachis 14.1 mm., estimated height 8 mm.

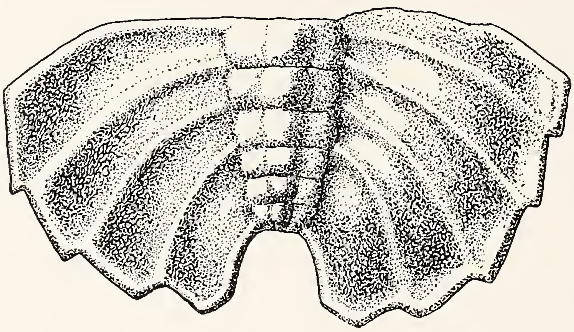


FIG. 1. *Euproops morani* Eller, × 2, from the Upper Devonian of Pennsylvania. The type is in the Carnegie Museum, no. 11574, Section of Invertebrate Paleontology.

Family EUPROOPIDAE fam. nov.

In the course of this study the writer has reviewed the forms belonging to the family *Limulidæ* and has concluded that the genera *Euproops* and *Prestwichianella* (which are closely related) are different from the other genera of the family in so many respects that they should be segregated to constitute a new family, with *Euproops* as the type of this family. In such a way the classification of the group will be as follows:

Order XIPHOSURA Gronovius

Suborder LIMULIDA Rud. and E. Richter

Family Belinuridae Packard

Genus *Belinurus* König
Neobelinuropsis Eller
Picombella Chapman

Family Limulidae Zittel

?Genus *Belinuropsis* Matthews
Prolimulus Fritsch
Protolimulus Packard
Psammolimulus Lange
Paleolimulus Dunbar
Limulus Miller
Kioeria Stormer

Family Euproopidae fam. nov.

Genus *Euproops* Meek
Prestwichianella Woodward

BIBLIOGRAPHY

BEECHER, C. E.
1902. Amer. Geol., vol. 29, no. 3, pp. 143-146.
DUNBAR, C. O.
1923. Amer. Jour. Sci. 5th series, vol. 5, no. 30, pp. 443-454.
ELLER, E. R.
1938. Ann. Carnegie Museum, vol. XXVII, pp. 129-150.
WILLIAMS, H. S.
1885. Amer. Jour. Sci. 3rd series, vol. 30, pp. 45-49.
1885. Geol. Mag., Decade 3, vol. 2, pp. 427-429.

ART. X. NOTE ON THE XIPHOSURAN, *PROTOLIMULUS ERIENSIS* WILLIAMS.

BY E. R. ELLER

(PLATE XV)

In examining various Xiphosuran forms in connection with some recent studies, [1, 2] an exact impression and plaster of Paris mold of the type specimen[3] of *Protolimulus eriensis* Williams[4] from the Chemung group, Upper Devonian, at LeBoeuf, Erie County, Pennsylvania, was studied in detail. The specimen, which is rather poorly preserved, was compared with the original figures and it was found that many important details on the specimen were not shown in Williams' figures, while other parts were emphasized.

The writer at first was doubtful of the limuloid nature of the specimen and even of its organic origin in general because it resembles some of the markings, mud slippings, or concretionary structures so common in the Upper Devonian of that area. It reminds one of a wax model that has started to melt or of an object that has been dipped in a coating.

However, one cannot disregard the general limuloid shape of the specimen, the symmetrical arrangement of the various parts[5] although of an indefinite nature, the paired genal spines, the telson, the pleural spines, and the nine parallel ridges in the posterior region.

Williams described the specimen as a limuloid seen from the underside. However, the rounded cephalic shield has the form of a regularly shaped limuloid shield, as seen from the dorsal side. For this reason the writer considers the specimen as a limuloid exposed from the

[1]Annals, Carnegie Museum, vol. XXVII, pp. 129-150, 1938.

[2]Annals, Carnegie Museum, vol. XXVII, pp. 151-154, 1938.

[3]The writer is indebted to Dr. R. S. Bassler of the U. S. National Museum, for the impression of *Protolimulus eriensis* Williams and the photograph for Plate XV, upper figure.

[4]Notice of a New Limuloid Crustacean from the Devonian: Amer. Journ. Sci., vol. 30, ser. 3, pp. 45-49. Geol. Mag. London, Dec. 3, vol. 11, pp. 427-429.

[5]Terminology in this paper is identical with that used by Williams.

Issued, May 12, 1938.

dorsal side. Owing to the fact that the upper surfaces of the thorax and abdomen were destroyed, the lower part of the specimen is exposed showing the different appendages which are, however, poorly preserved and partly destroyed. The presence of the appendages probably caused Williams to treat the specimen as if it were exposed from the underside.

There are several features which do not seem quite natural and which are not found in other limuloids. For example, the genal spines seem too close to the thorax; the tail spine is heavier than in other limuloids and appears twisted. Around the depressed area, marked M. in Williams' figure (Fig. 1), which may correspond to the mouth, are five, oval or suboval ridges which together form a crude star.

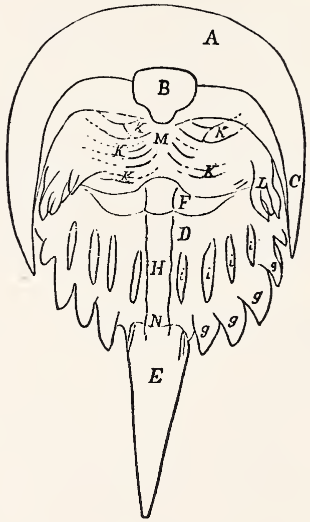


FIGURE 1

A. Cephalic shield. B. ? Hypostoma. C. Genal spines of the cephalic shield. D. Thoracico-abdominal buckler. E. Telson. F. First (and second ?) segments of thorax (? anchylosed). Gg. Marginal spines of buckler. H. Flat median depression extending across the buckler and upon the telson. ii. Longitudinal ridges of the buckler. KK. Portions of the gnathopods. L. ? Foliaceous terminations of the last gnathopods. M. Position of the mouth. N. Probable place of articulation of the telson.

The anterior ridge, figure 1, B, according to Williams, is located in the middle and is composed of one lobe and it may be the hypostoma.

The writer finds this ridge to be located to the right of the middle line with its length in the direction of the mouth. A second, distinct ridge adjoins it anteriorly on the right side. Three paired portions of the gnathopods are illustrated by Williams, figure 1, K, but the writer can only find one ridge on the right side and two, rather irregular in shape, on the left side, which could be interpreted as gnathopods. The foliaceous terminations of the last gnathopods, figure 1, L, may be distinguished also on other ridges although not very clearly. The parts called by Williams the "first (and second ?) segments of the Thorax (? anchylosed)" and the "Flat median depression extending across the buckler and upon the telson" marked F and H on figure 1, are only irregular spaces between the various ridges. The longitudinal ridges of the buckler are nine in number, five on the right side and four on the left. The ridges on the right side are partially bifid. There are three distinct marginal spines of the buckler on the left side and possibly four indistinct ones on the right side which seem, in some ways, to be a continuation of the longitudinal ridges of the buckler.

The actual total length of the specimen examined by the author is 10.7 cm., greatest width 6.3 cm., although Williams' measurements for the same specimen are given as 10 and 5.7 cm., respectively. Thus, in reality, his figure, supposedly natural size, is actually smaller than the specimen itself (Plate XV, lower figure). The dimensions of the telson and buckler are omitted because there are no definite lines of demarcation between the various parts.

It is obvious from Plate XV, middle and upper figures, that many of the ridges and other details of the specimen were left out and that other features were over-emphasized in the original figures of Williams. One of the important characters omitted from both figures and description is the sculpture, Plate XV, middle figure. There were, perhaps, some very fine tubercles present but the most important characters of the sculpture are rows of variously sized plates or scales. This type of ornamentation has not been described in other fossil limuloids. The raised parts, such as the longitudinal ridges of the buckler, the gnathopods, the foliaceous terminations of the last gnathopods, the other features around the mouth (?) and in the region of the thorax and abdomen, are made up of rows of scales or plate-like objects often distributed in zigzag form. Definite evidence of plates on the head shield and the posterior portion of the telson is lacking. This surface sculpture resembles perhaps that of the eurypterids more than that of any other form.[6] In the eurypterids the scales correspond to the attachment of the muscles of the innerside. The test of the modern, mature Limulus is too thick to show muscle impressions on the outside but, in the young stages, muscle scars can be detected on the surface. It is suggested that scales or plates in *Protolimulus eriensis* Williams corresponded to the attachment of muscles. The occurrence of more definite plates around the mouth and in the thorax and abdomen, indicates the natural position for the insertion of the more active muscles. If these observations on the sculpture are valid, then perhaps they constitute additional evidence that *Protolimulus eriensis* Williams is a lumuloid.

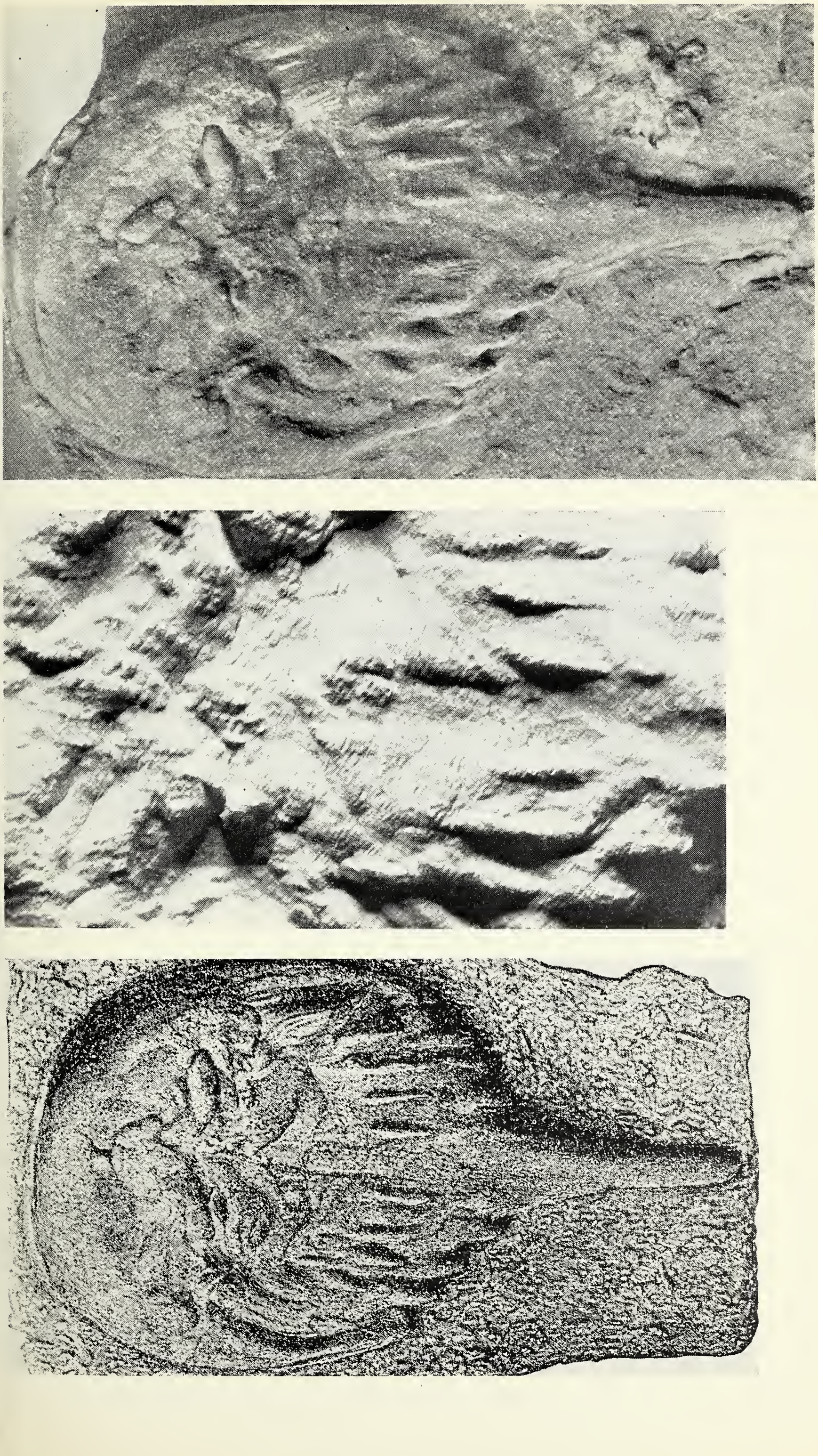
[6]Clarke, J. M., and Ruedemann, R., The Eurypterida of New York: N. Y. State Museum, Memoir 14, p. 26, 1912.

EXPLANATION OF PLATE XV

UPPER FIGURE. *Protolimulus eriensis* Williams. Natural size.

MIDDLE FIGURE. Surface of *Protolimulus eriensis* Williams showing sculpture. Enlarged.

LOWER FIGURE. *Protolimulus eriensis* Williams, after Williams.



Protolimulus eriensis Williams.

ART. XI. THE OCCURRENCE OF THE EASTERN TIGER SALAMANDER, *AMBYSTOMA TIGRINUM TIGRINUM* (GREEN), IN PENNSYLVANIA AND NEAR-BY STATES

By M. Graham Netting*

Several years ago the late Dr. D. A. Atkinson donated to the Carnegie Museum two large collections of amphibians and reptiles which he had secured in Western Pennsylvania between 1899 and 1912. Since many of the local streams were not polluted at that time, a number of species, now rare locally, are represented by excellent series of specimens. However, the most surprising find in the collections was a series of four specimens of *Ambystoma tigrinum tigrinum* (Green) collected at Wexford, McCandless Township, Allegheny County, Pennsylvania, on April 1, 1911, by Dr. Atkinson. These specimens constitute the first adults of the species ever collected in Pennsylvania, and they add a third locality for the species in the state.

The series consists of one adult male, CM 10431, which is 230 mm. in total length; two adult females, CM 10432-33, measuring 225 and 190 mm. respectively; and a subadult female, CM 10434, approximately 150 mm. in length. Six specimens of *Ambystoma jeffersonianum*, CM 10435-40, were taken at the same locality on the same date, and one specimen of *Ambystoma maculatum*, CM 10527, was secured at Wexford by Dr. Atkinson on March 31, 1908. Wexford is situated in the northern part of Allegheny County in the Pittsburgh Section of the Appalachian Plateaus Province. It lies in unglaciated territory, in a region of low hills; the highest point in the vicinity having an altitude of 1298 feet and the stream valleys an altitude of approximately 1100 feet. According to Dr. Atkinson's recollection, the specimens were taken in a small pond which was then surrounded by forest.

It is doubtful if *tigrinum* was ever widely distributed in southwestern Pennsylvania where suitable habitats for this species are not well represented. *A. maculatum*, on the other hand, is by no means

*I am indebted to Dr. Doris M. Cochran, Dr. E. R. Dunn, Mr. Arthur Loveridge, Dr. G. K. Noble, and Dr. Charles M. Walker for assistance in tracing specimens and localities mentioned in this paper.

Issued May 20, 1938.

rare even today, and was probably far more widespread when the area was forested. The reduction in the *maculatum* population may be attributed, in a large measure, to deforestation, but I wish to call attention to another factor which certainly affected the latter species, and possibly the former as well. During the latter decades of the nineteenth century and the early years of the twentieth, Pittsburgh boasted a very active Entomological Society. As early as 1888, Mr. Samuel Klages, an ardent coleopterist, discovered that *Ambystoma maculatum* fed upon three species of beetles of the genus *Cychrus*, now known as *Scaphinotus viduus* (Dejean), *Scaphinotus germari* Chaudoir, and *Sphaeroderus lecontei* Dejean. Since these species were not common in collections and were highly desirable for exchange purposes, Mr. Klages, and some of his fellow members, embarked upon a salamander extermination campaign which was eminently successful so far as beetle collecting in succeeding years was concerned. How long this killing of Ambystomas was continued, or how widespread the practice became in this region, it is now impossible to ascertain, but Mr. Klages alone is said to have killed as many as one hundred of the "yellow spotted" salamanders in a single day. It is doubtful if this attempted extermination was selective enough to stop with *maculatum*. If, as I assume, *tigrinum* was always rare and local in its distribution in the Pittsburgh area, this systematic killing may have led to its extermination at some of its stations.

Cope secured a salamander from Londongrove, Chester Co., Pa., which he considered a nondescript and which he described (1859: 123) as *Ambystoma conspersum*. This specimen, no. 10589 in the collection of the Academy of Natural Sciences of Philadelphia, and certain others from Carlisle, Pa., which have been considered conspecific with it, have complicated herpetological literature for years. Since *conspersum* has proved to be invalid, and later, expanded descriptions are unquestionably composite, it is necessary to review the principal references in order to allocate the Pennsylvania specimens, which have been recorded under this name, to their proper synonomies.

Cope (1867: 177-178) listed the ANS type, and four additional specimens; *i.e.* USNM 3934 (3) and USNM 3918 (1) collected at Carlisle, Cumberland Co., Pa., by Prof. S. F. Baird. Cope (1875: 25) gave the range of *conspersum* as "Pennsylvania to Georgia," but did not mention any specimens. Boulenger (1882: 42) listed several larvae from Carlisle presented by the Smithsonian Institution. Next Yarrow (1883: 148) listed USNM 7904 (30 larvae—probably a misprint of 300) also taken at Carlisle by Baird. However, Cope (1889: 61-62) again listed ANS 10589 and USNM 3918 and 3934 (the last appearing under both *conspersum* and *punctatum*!), but he failed to list the specimens cited by Yarrow. Dr. Cochran wrote to me, under date of Feb. 5, 1936: "Our U.S.N.M. 3918 is listed in the original record book as *Salamandra*, Carlisle, Pa., S. F. Baird, 1 specimen. We do not have it now, and there are no cards for it, so it evidently disappeared or was destroyed long before our present card-catalogue system was inaugurated." Since this specimen came from the same locality and same collector as USNM 3934, and since Cope twice listed it as being conspecific with the latter, it appears probable that the two numbers represented the same species, and that USNM 3918 may be subjected to the same taxonomic fate as USNM 3934. Stone (1906: 160), Fowler and Dunn (1917: 10), and Stejneger and Barbour (1917: 9), refer only to the type specimen or type locality.

Dr. E. R. Dunn has examined the existing specimens on which the above records are based. The type of *conspersum* proved to be a recently transformed individual of *tigrinum*. However, USNM 3934 (4 specimens were listed in the original record but there are now 3 young and 4 larvae in the jar) and USNM 7904 (the number of specimens is not stated in the record book but there are now 319 soft *Ambystoma* larvae and two specimens of *Desmognathus fuscus fuscus* in the jar) proved to be *opacum*. Therefore, it appears that all of the USNM specimens from Carlisle formerly referred to *conspersum* are actually larvae of *opacum*, and that all published records of *conspersum* at this locality should be referred to the synonomy of *opacum*.

Surface (1913: 50-51) included *tigrinum* in the herpetofauna of Pennsylvania on the basis of its range, but stated that his collection did not include any specimens from the state. Stewart (1926: 4) followed Surface in listing the species in the absence of specimens. Mohr (1930: 50) wrote as follows: "Professor E. R. Dunn, of Haverford College, supplied the following records of this rare salamander: one adult and two larvae collected at Carlisle by Baird, and now in the National Museum; an adult from Londonville, Chester County, now in the American Museum of Natural History, and a larva in the same museum from Pittsburgh. He also has a record of an adult from

Mountainville, Lehigh County." This statement contains a number of errors. There is no adult from Londonville, Chester County, in the American Museum collection and this is presumably a confused reference to the Academy type of *conspersum* from Londongrove. The record of an adult from Mountainville is apparently a bibliographic error since Mattern and Mattern, the only writers who have published *Ambystoma* records for Mountainville, list only *jeffersonianum* and *maculatum* in their Lehigh County list. The AMNH larva referred to by Mohr was collected by Maximillian, presumably in 1832. When Dunn examined this specimen some years ago, he determined it as a larva of *tigrinum*. Since the determination was open to question because the specimen was in a very poor state of preservation, and in the absence of other specimens from Western Pennsylvania, I have consistently omitted this record in several published lists of the local fauna. Dr. Noble informs me that the Maximillian specimen is now in such bad condition as to be absolutely unidentifiable. However, the adults secured by Dr. Atkinson increase the probability that Maximillian was the first collector to secure the species in Pennsylvania. Netting (1933: 102) states in reference to the species "it has been definitely recorded from Londongrove, Chester County, and there is, in addition, a questionable record for Cumberland County." As I have shown, the Carlisle, Cumberland County, records are referable to *opacum*.

Dr. Dunn spent a week at Londongrove in the spring of 1920 searching unsuccessfully for topotypes of *conspersum*. It is to be hoped that future collecting in the Wexford and Londongrove areas will yield additional specimens. All of the known specimens of *tigrinum* from Pennsylvania are listed below. The published records for the state are based on these specimens, on the general range of the species, or they refer to *opacum* as noted above.

PENNSYLVANIA SPECIMENS OF *TIGRINUM*

Allegheny County

AMNH 1846	1 larva	Pittsburgh	1832	Maximillian
CM 10431-34	4 adults	Wexford	Apr. 1, 1911	D. A. Atkinson

Chester County

ANS 10589 1 post-larva Londongrove (Type of *A. conspersum* Cope)

TIGRINUM RECORDS FOR NEAR-BY STATES

The following summary of the occurrence of *tigrinum* in states near Pennsylvania is believed to be accurate. I will be delighted to be informed of any existing specimens which I have overlooked. No attempt has been made to survey the literature for any of these states except West Virginia.

Delaware: No specimens are known from this state.

Maryland: The only known specimen is USNM 89904 which was collected at Vienna, Nanticoke River, Dorchester County. Dr. Cochran wrote to me, under date of May 12, 1936, that this specimen "was received in Feb. 1933 from a physician, Dr. E. E. Lamkin, who, as I recollect, said that there were lots of them near a waterworks at Vienna."

New Jersey: The species is not rare on the coastal plain.

New York: In addition to numerous Long Island records there is one specimen from the mainland in the American Museum of Natural History collection. This specimen, no. 2327, was collected at Suffern in 1896 by W. A. Chapman.

Ohio: Dr. Charles M. Walker informs me that he has taken *tigrinum* in Ohio in only a few scattered localities in the western half of the state, but that there is a specimen from "Rockport" in the Museum of Comparative Zoology. Since there is a "Rock Port" in Allen County in western Ohio as well as a "Rockport" in Cuyahoga County in eastern Ohio the exact derivation of this specimen may be open to question. Mr. Arthur Loveridge writes, under date of Apr. 28, 1938: "I have searched our register and there does not appear to have been any other J. P. Kirtland material catalogued. The specimen MCZ 169, *Ambystoma tigrinum*, Rockport, Ohio, was sent to Baird for identification on 22.I.1859, and formed part of Prof. Agassiz's collection (catalogued by species when the catalogue was commenced) on 20.II.1862. There is no date of collection nor further information available in the register or with the specimen." Since Kirtland lived in Cuyahoga County and since the spelling of the locality is in agreement I believe that this specimen may be accepted as having come from Rockport (approx. 1¼ mi. S. of Rocky River), Cuyahoga County, and that it represents, therefore, the easternmost record for *tigrinum* in Ohio.

Virginia: There is one specimen, USNM 9273, from "Virginia," collected in Sept. 1874.

West Virginia: No specimens are known from West Virginia. Bond's (1931: 53) record of the species as "Not uncommon" in Monongalia County was based upon a single specimen in his private collection which I examined later and found to be *maculatum*. Strader's (1936: 33) sight record for an adult "seen near an egg mass on Shenandoah River near Bloomery on March 18, 1933—at night" almost certainly refers to *jeffersonianum*. Since some of the rarer West Virginia species are represented in the collections of West Virginia University by specimens which are without definite locality data, but which are most probably from the state, I examined the entire salamander collection at Morgantown. The only specimens of *tigrinum* in this collection were two collected at Fort Whipple, Arizona, in 1920 by A. F. Vierheller.

REMARKS ON DISTRIBUTION

The definite locality records mentioned in this paper number three for Pennsylvania, one for Maryland, one for mainland New York, and one for eastern Ohio. Six localities scattered over four states do not provide an adequate basis for any statements regarding distribution. It is worth noting, however, that the altitudinal range represented by these records varies from twelve feet at Vienna, Md., to 1100 feet at Wexford, Pa. Pittsburgh, Vienna, and Suffern are located in river valleys, Rockport on a bluff overlooking a river, and both Wexford and Londongrove in regions drained by numerous creeks. In spite of active herpetological collecting during recent decades, only the Wexford and Vienna specimens were collected subsequent to 1900. Probably *tigrinum* had attained the status of a relict form, in the area treated here, by the mid-nineteenth century. The trend toward disappearance has apparently continued since then, but whether river pollution or other man-engendered factors have contributed to this trend it is impossible to say. A detailed study of the ecology of *tigrinum* on Long Island and the New Jersey Coastal Plain offers the only approach to an explanation of the erratic distribution of the form in the several near-by states.

LITERATURE CONSULTED

BOULENGER, G. A.

1882. Catalogue of the Batrachia Gradientia S. Caudata and Batrachia Apoda in the Collection of the British Museum. [2nd ed.] London: viii+128, pls. 1-9.

BOND, HARLEY D.

1931. Some Amphibians and Reptiles of Monongalia County, West Virginia. Copeia, **1931**, no. 2: 53-54.

COPE, E. D.

1859. On the Primary Divisions of the Salamandridæ, with Descriptions of Two New Species. Proc. Acad. Nat. Sci. Philadelphia, **11**: 122-128.

1867. A Review of the Species of the Amblystomidæ. Proc. Acad. Nat. Sci. Philadelphia, **19**: 166-211.

1875. Check-list of North American Batrachia and Reptilia; with a Systematic List of the Higher Groups, and an Essay on Geographical Distribution Based on the Specimens contained in the U. S. National Museum. Bull. U.S.N.M., no. **1**: 1-104.

1889. The Batrachia of North America. Bull. U.S.N.M., no. **34**: 1-525.

FOWLER, H. W. AND DUNN, E. R.

1917. Notes on Salamanders. Proc. Acad. Nat. Sci. Philadelphia, **69**: 7-28, pls. 3-4.

MATTERN, E. S. AND MATTERN, W. I.

1917. Amphibians and Reptiles of Lehigh County, Pennsylvania. Copeia, no. **46**: 64-66.

MOHR, CHARLES E.

1930. The Ambystomid Salamanders of Pennsylvania. Proc. Pa. Acad. Sci., **4**: 50-55.

NETTING, M. GRAHAM.

1933. The Amphibians of Pennsylvania. Proc. Pa. Acad. Sci., **7**: 100-110.

STEJNEGER, L. AND BARBOUR, T.

1917. A Check List of North American Amphibians and Reptiles. Harvard Univ. Press, Cambridge: 1-125.

STEWART, NORMAN H.

1926. The Amphibia of Pennsylvania. Lewisburg, Pa.: 1-16.

STONE, WITMER.
1906. Notes on the Reptiles and Batrachians of Pennsylvania, New Jersey, and Delaware. Amer. Nat., **40**, no. 471: 159-170.

STRADER, L. DOW.
1936. Herpetology of the Eastern Panhandle of West Virginia. (A Preliminary Survey). Proc. W. Va. Acad. Sci. for 1935, **9**: 32-35.

SURFACE, H. A.
1913. First Report on the Economic Features of the Amphibians of Pennsylvania. Bi-monthly Zool. Bull., Div. Zool., Pa. Dept. Agri., **3**, nos. 3-4: 65-152, pls. 1-11, figs. 1-25.

YARROW, H. C.
1883. Check List of North American Reptilia and Batrachia, with Catalogue of Specimens in U. S. National Museum. Bull. U.S.N.M., no. **24**: 1-249.

ART XII. *ANODONTA BROOKSIANA*, A NEW NAIAD FROM NEWFOUNDLAND

By Henry van der Schalie
University of Michigan

(Plate XVI)

A series of about four hundred specimens of *Anodonta* from Newfoundland, representing collections made by Dr. and Mrs. Stanley Truman Brooks, was recently sent to me for identification. These came from four localities, chiefly in the Ferryland district which is in the southeastern part of the island. With such a large collection it is possible to make comparative studies. One series of sixty-seven specimens from Junction Pond, at Whitbourne, obviously belong to what has been called *Anodonta marginata* Say. The remaining three hundred and fifty are definitely not that species but are more closely related to the *cataracta-implicata* complex. Since they cannot justly be classified as either *Anodonta cataracta* or *Anodonta implicata*, they are being described here as a new species.

Anodonta brooksiana sp. nov.

Description: Shell thin, of medium size, elliptical in outline, not compressed but generally somewhat swollen and well rounded. Posterior ridge low and inconspicuous. There is a low but not pronounced wing which tends to make the dorsal and ventral margins appear more or less parallel. Beaks low and not prominent, giving the shell a decided inequilateral appearance. Beak-sculpture consisting of numerous (8-12) more or less irregularly concentric, corrugated folds which extend well out on the disc; the first two or three folds somewhat double-looped while the others are irregular and often appear to anastomose. Anterior end of shell well rounded; ventral outline slightly bulging post-ventrally; posterior end somewhat biangular. Viewed from above the shell has an elliptical outline with the greatest diameter close to its center. The outer surface has a straw-yellow background crossed by numerous fine, radiating green rays which give it a greenish yellow appearance. Surface broken by minor growth-rests and well-defined annulations; two prominent green rays are usually evident on the posterior slope. Nacre thin, uniform in thickness, with a bluish silvery hue; often marred by yellowish waxy

Issued June 4, 1938.

blotches which are most likely due to trematode parasitism of the mantel.

Type locality: Spout Pond Arm, Ferryland District, Southern Shore, Newfoundland. Dr. and Mrs. Stanley Truman Brooks, collectors, September 17, 1937. Type, (Cat. No. 61.13137), Carnegie Museum; paratypes in the Museum of Zoology, University of Michigan; Museum of Comparative Zoology, Cambridge; Academy of Natural Sciences of Philadelphia; United States National Museum; and in the Museum of Natural History, University of Illinois.

DIMENSIONS IN MILLIMETERS

	Annulae	Length	Height	Diameter
TYPE	7	69.5	33.3	24.5
Paratypes	3	39.4	20.0	12.0
”	4	49.2	24.9	16.3
”	6	67.2	32.7	22.5
”	7	72.7	34.2	24.1
”	13	88.5	45.0	30.7
”	13	88.4	43.6	29.0

Distribution: At present this species has been taken from four localities in Newfoundland, as follows:

Spout Pond Arm, Ferryland District, 1937	35 specimens
Long Run Pond, Ferryland District, 1937	135 “
Spout Pond, Ferryland District, 1937	187 “
Well's Gully, Whitbourne, 1935	No definite count

The last locality was recorded in a paper by Dr. Brooks in 1936, when this species was referred to *Anodonta implicata* Say. After re-examining this material it is obvious that this was erroneously referred to *Anodonta implicata* Say and that it should be included under *Anodonta brooksiana.*

Discussion: The most distinguishing character of *Anodonta brooksiana* is its beak-sculpture which is not characteristically double-looped and nodular as is the case in *Anodonta marginata, implicata,* and *cataracta* (Marshall, 1890, figs. 16 and 17). The position and lack of prominence of the beaks is also distinctive. In this there is a strong indication of an apparent relationship with the European *Anodonta cygnea.* However, our knowledge at present does not warrant any positive statement as to whether this similarity to *cygnea* indicates a close relationship or whether it is due to parallel evolution.

There has been some question as to what specimens Lamarck used in his description of *Anodonta fragilis.* In Lamarck's original description (*Anim. sans vert.*, 1819, p. 85) the following locality data are given: "Habite les lacs de Terre-Neuve. M. Lapylaie. Mon Cabinet." Previous to 1900 such workers as Lea, Beauchamp, Walker, Mitchell, and Nylander repeatedly reported *A. fragilis* as occurring in northeastern North America. Between the years 1900 and 1916, Simpson, Whiteaves, Ortmann, and Maury have considered *fragilis* a synonym of *marginata,* which has priority since it was described by Say two years previous to Lamarck's description of *fragilis.* Since Lea (*Observations* . . ., vol. 1, p. 205) reports receiving a specimen of Lamarck's material which was collected by M. Lapylaie from Newfoundland and since Lea claims to have seen this species from Lake Skaneateles, Lamarck's *fragilis* is most likely a synonym of *marginata* Say. *Anodonta brooksiana* is consequently suggested as the new name for this hitherto undescribed species from Newfoundland. The fact that nothing resembling *A. brooksiana* has been seen from the North American mainland supports this contention.

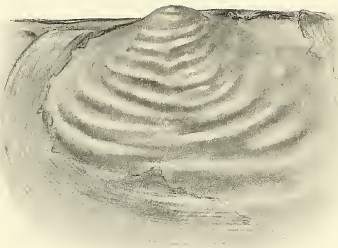
EXPLANATION OF PLATE XVI

FIG. 1. *Anodonta brooksiana*, type. (a) external view; (b) internal view; (c) dorsal view.

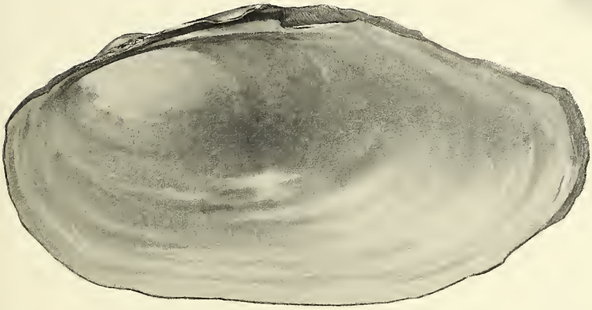
FIG. 2. Beak sculpture of a young specimen of *Anodonta brooksiana* collected at Long Run Pond, Ferryland District, Newfoundland.

FIG. 3. Beak sculpture of a young specimen of *Anodonta marginata* Say collected at Junction Pond, Whitbourne, Newfoundland.

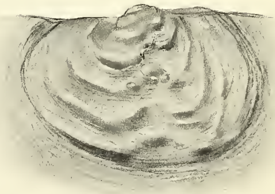
1a



2



1b



3

1c

Grace Eager

ART. XIII. THE BREEDING BIRDS OF TARRANT COUNTY, TEXAS

By George Miksch Sutton

Annals of the Carnegie Museum
Vol. XXVII, p. 171-206, 1938

Issued Sept. 24, 1938
Pittsburgh, Pa.

ART. XIII. THE BREEDING BIRDS OF TARRANT COUNTY, TEXAS.

By George Miksch Sutton.[1]
Cornell University.

From July, 1911, to latter June, 1914, my family lived at Fort Worth, Tarrant County, Texas. During the earlier part of this period we resided in the city proper; but during the latter two years we lived on what was called "T. C. U. Hill"—at that time a decidedly rural section about four miles southwest of the city, whereon had just been erected the first three buildings of Texas Christian University. Here I had abundant opportunity to observe birds; maintained a small aviary; and wrote bookfuls of notes upon the species I encountered. Many of these notes, particularly those relating to subspecific identification of transient forms, are now amusing rather than useful. Those relating to the activities of nesting species are for the most part accurate, however, and it is primarily upon these that the original portions of the present paper are based.

While in Fort Worth it was my good fortune to make the acquaintance of Mr. Ramon Graham, an enthusiastic oölogist and capable taxidermist, who knew the Tarrant County countryside well. Mr. Graham has published many notes upon the birds of this region in *The Oölogist.* Among his papers are three which list the species known or thought by him to breed in Tarrant County. The first of these, "Birds That Nest in Tarrent [Tarrant] Co. Texas and Notes," appeared in November, 1915.[2] The second list, which differed considerably from the first in some respects, and which was briefly annotated, was published in October, 1919. This list was entitled "Tarrant County, Texas Breeders."[3] The third list, which was published jointly by Mr. Graham and Mr. Jake Zeitlin, also of Fort Worth,

[1] The author is indebted to the following gentlemen, all of Fort Worth, Texas, for assistance in the amassing of data pertaining to the species listed in this paper: Mr. Ramon Graham, Mr. Jake Zeitlin, Mr. Charles McLendon, and Mr. Millard Chandler.

[2] *The Oölogist,* XXXII, No. 11, November, 1915, 191.

[3] *The Oölogist,* XXXVI, No. 10, October, 1919, 187.

Issued Sept. 24, 1938.

appeared in July, 1921. This list was called: "List of Breeding Birds of Tarrant County, Texas." Here appeared the names of such species as were "observed in summer during the years 1915-1919."[4]

These three lists include most of the species I encountered in summer during 1911-1914. They include some species that I did not record, but that doubtless were nesting in the region at the time of my sojourn there. They include also some species and subspecies that in my opinion do not nest, and never have nested, in the Fort Worth region. Inclusion of such forms was, I believe, the result of incorrect identification of specimens, or of misconception as to breeding range.

Drastic changes have come about during the past twenty years in the Fort Worth region. The wild prairies beyond Forest Park and the Texas Christian University campus are gone. In their place now stand row upon row of residences; churches; stores; golf links. Lake Worth, a vast artificial body of water northwest of the city, now covers what twenty years ago were the forested banks of the West Fork of the Trinity River. The well known smaller birds, such as the Scissor-tailed Flycatcher, Dickcissel, Orchard Oriole, Bell's Vireo, and Lark Sparrow probably are as common today as they ever were; perhaps commoner. But larger, less common species, such as the Road-runner, are gradually being crowded farther and farther into the wilds; the nesting hawks and owls are one by one paying toll to the farmer, poultry raiser, and gunner with their lives; and new species, such as the Pied-billed Grebe, Green Heron, Purple Gallinule, Prothonotary Warbler, and Yellow-throat (*Geothlypis*) are establishing themselves at Lake Worth.

The prairie country about Fort Worth is gently rolling. Patches of prickley pear and barrel cactus; mesquite trees; waxen-flowered yuccas; horned, scaly swift, and striped race-runner lizards; velvet-legged tarantulas; scorpions: all these xerophilous plant and animal forms live in the more desertlike areas. Along the Trinity River stand forests, some of them deep and shadowy; some thin and open; some bordered with tangles of black haw and cat's claw smilax, or stretch-berry. Much of the opener country is cattle range. Here and there lie broad cotton, corn, Johnson grass, sorghum, and peanut fields. In spring the countryside is gay with a variegated carpet of wild flowers.

In the ensuing annotated list, which follows the order and, for the

[4] *The Oölogist*, XXXVIII, No. 7, July, 1921, 93.

most part, the nomenclature of the American Ornithologists' Union's "Check-List of North American Birds" (1931), those species which are numbered are definitely known to breed in the Fort Worth region at the present time. Forms which are not numbered include some which are thought to have nested in former years; some whose presence in summer has been noted during recent years but whose nest, eggs, or young have not actually been discovered; and a few which have never, to the best of our knowledge, been seen nor taken in the Fort Worth region, but which have been listed as "breeders" in the literature at hand.

For some of the subspecific names used we are indebted to our friend Dr. Harry C. Oberholser, of the U. S. Biological Survey, who has been good enough to give the manuscript a critical reading and to assist us in our preparation of the Bibliography.

This list is not intended to be the last word upon the subject. It is, rather, a working list. I am convinced that one season's field-work in the Lake Worth region would lead to the adding of several forms that are not named here or that are included among our hypotheticals. Among such forms may be mentioned the Black Tern, Florida Gallinule, Coot, some species of rail (indeed perhaps two species), some small flycatcher, the Yellow Warbler, and perhaps one or two Fringilline species.

LIST OF SPECIES

Podilymbus podiceps podiceps (Linnaeus). PIED-BILLED GREBE.

Graham (1915e; 1919e) and Graham and Zeitlin (1921) do not include this species in their lists. Mr. Graham informs me that he and other observers have seen it about Lake Worth in summer, however, so it seems likely that it has by this time established itself as a summer resident. I am not aware that eggs or young have actually been taken. During 1911-1914 I noted it only as a transient.

1. **Butorides virescens virescens** (Linnaeus). EASTERN GREEN HERON.

Not named in Graham's first list (1915e); characterized in Graham's second list (1919e, 187) as "rare"; listed by Graham and Zeitlin (1921, 93). According to Graham (1917g, 187), the first eggs actually to be taken in the Fort Worth region were collected by "Mr. and Mrs. Gentry" at Lake Worth, during May, 1917. The species evidently established itself promptly, for Daniels (1921, 92) tells us of finding several nests with young on May 31, 1921. Graham (1916f, 137) tells us that he noted an arrival from the south on March 27, in 1916. I noted the species several times in late summer along the Clear Fork of the Trinity River in 1911-1914, but am of the opinion that these were individuals that had wandered into the vicinity from nesting grounds elsewhere.

Nycticorax nycticorax hoactli (Gmelin). BLACK-CROWNED NIGHT HERON.

Mr. Graham writes me that he and other observers have seen this bird in summer about Lake Worth in considerable numbers. By this time it probably has established itself in colonies on some of the wooded islands. I noted it frequently in summer along the Clear Fork of the Trinity River during 1911-1914, and examined several specimens that had been shot, but I think that all of these were mid-summer wanderers.

Spatula clypeata (Linnaeus). SHOVELLER.

Mr. Zeitlin, in a personal letter dated January 28, 1922, informs me that he saw a pair of Shovellers with their young "feeding off Todd Island [in Lake Worth] on April 27, 1919." This date is exceedingly early for young birds, and the fact that Graham and Zeitlin (1921) do not include the Shoveller in their list leads me to suppose that there must have been some mistake in Mr. Zeitlin's identification. This species will in time probably establish itself at Lake Worth as a summer resident, if it has not already done so.

Aix sponsa (Linnaeus). WOOD DUCK.

Graham calls this species "rare" in his second list (1919e, 187). Graham and Zeitlin (1921) do not list it. Graham (1918a, 29) tells us that he has noted Wood Ducks in the Lake Worth region in summer on several occasions. He and Mr. Zeitlin inform me that they have seen what they thought to be young birds; but that they have never actually taken the eggs nor found an occupied nest. The drowned forests at Lake Worth should furnish an admirable nesting site for this species as well as for the Hooded Merganser, *Lophodytes cucullatus* (Linnaeus).

2. **Cathartes aura teter** Friedmann.[5] WESTERN TURKEY VULTURE.

Common. Graham (1915e, 191; 1919e, 187) and Graham and Zeitlin (1921, 93) list it. Graham (1916b, 170; 1919a, 89, etc.); Graham and Maxon (1915, 118); Maxon (1916, 178; 1921, 177); and Moffat (1916d, 159) all tell us of eggs or young birds found in the region. According to available information eggs may be deposited as early as mid-March. Graham (1916f, 137) tells us of collecting a set of two eggs at Lake Worth on April 12, 1916. In another note (1916g, 170) he writes of finding eggs that were at the point of hatching, on June 20, 1916. I found several nests during 1911-1914, some with young birds. Concerning one of these I have written extensively (1929, 810). Eggs are usually laid in a hollow log, in a cave or niche in the rocks, or on the ground amid thick shrubbery. Mr. Graham tells me of finding two eggs "in bushes" on Vine Island, in Lake Worth, on May 1, 1916.

3. **Coragyps atratus atratus** (Bechstein).[6] BLACK VULTURE.

Graham lists the Black Vulture as "common" (1915e, 191; 1919e, 187). Graham and Zeitlin (1921, 93) name it. According to my observations in 1911-1914, the Black Vulture and Turkey Vulture are about equally abundant in the Fort Worth region. Maxon (1921, 177) discusses nests found by him, and tells of variation in the numbers of nesting pairs from year to year (1916b, 178). Graham and Maxon (1916, 118) tell us of finding a nest with two eggs near Jefferson Crossing as early as March 19, 1915. Graham (1914b, 139) tells us of a nest found April 12, 1914.

Accipiter cooperi (Bonaparte). COOPER'S HAWK.

Rare. Not included by Graham (1915e; 1919e), but listed by Graham and Zeitlin (1921, 93). Since we are not informed as to eggs actually collected in the region, and since there is some doubt concerning certain other species of hawks listed by various observers, we are obliged to include Cooper's Hawk among our hypotheticals for the present. I recorded the species twice in summer during 1911-1914.

[5] The Turkey Vulture of the western United States has been described as distinct from the eastern form by Friedmann, *Proc. Biol. Soc.* Wash., 46, 188.

[6] *C. a. atratus* (Meyer) of the A.O.U. Check-List (1931, 61) apparently is antedated by *C. a. atratus* (Bechstein). See Peters, J. L. Check-List of Birds of the World, I, 1931, 190.

4. **Buteo jamaicensis borealis.** (Gmelin).[7] EASTERN RED-TAILED HAWK.

Red-tailed Hawks of one subspecies or another are to be found throughout the year at Fort Worth. As a rule they are commoner in winter than in summer. The nesting race, so Dr. Oberholser informs me, is eastern *borealis*. The listing of "Krider's Hawk" by Graham (1915e, 191; 1919e, 187) and Graham and Zeitlin (1921, 93) among the breeding birds of Tarrant County must therefore he considered an error and, since these observers do not list Swainson's Hawk anywhere, it is quite possible that their "Krider's Hawk" was this smaller species.

Mr. Graham tells me that he encountered a nesting pair of "light-colored red-tails at Jefferson Crossing" throughout the spring of 1914; and young birds with their parents during the following summer. Graham and Maxon (1915, 118) write of a nest and two eggs found at Jefferson Crossing on March 19, 1915, and Graham (1916e, 82) tells us of finding a nest with three eggs in an elm "fifteen feet up" on May 5, 1915.

Three species of the genus *Buteo* nest regularly about Fort Worth. Judging from my experience in 1911-1914, I should call *jamaicensis* the commonest of the three, *lineatus* considerably rarer and more local, and *swainsoni* decidedly rare. The drowned forests about Lake Worth should furnish an admirable nesting-ground for the Red-shouldered Hawk, so *lineatus* may quite possibly be the commonest *Buteo* of the region today.

5. **Buteo lineatus alleni** Ridgway. FLORIDA RED-SHOULDERED HAWK.

Graham (1915e, 191; 1919e, 187) lists this species as "rare." Graham and Zeitlin (1921, 93) list it; but we find few other references to the Red-shouldered Hawk in the literature at hand. Graham (1916f, 137) tells us of collecting a set of three eggs on March 12 and a set of two eggs on April 9, in 1916, at Lake Worth. Concerning the former set Mr. Graham has written me: "The bark-lined nest was thirty feet up in a Spanish oak that stood in the water a quarter of a mile from shore. The eggs were fresh."

Mr. Graham informs me, too, that on June 5, 1918, he observed two

[7] *Buteo borealis borealis* of the Check-List. For change of name see A.O.U. Check-List, 1931, 65 (footnote), and Peters, J. L. Check-List of Birds of the World, I, 1931, 231.

nesting pairs of Red-shouldered Hawks at Lake Worth. During 1911-1914 I recorded the species several times during spring and summer and knew of one nesting pair along the Clear Fork of the Trinity River not far from Texas Christian University Hill.

6. **Buteo swainsoni** (Bonaparte). SWAINSON'S HAWK.

Graham does not mention this species in either of his lists (1915e; 1919e); Graham and Zeitlin (1921) do not list it; nor is there specific reference to it anywhere in the literature at hand. That the Swainson's Hawk occasionally nests in Tarrant County there can be no doubt, however. An adult female shot by Mr. Andy Elam on May 4, 1914, not far from Texas Christian University Hill, was incubating eggs.[8]

A pair of Swainson's Hawks nested in the southern part of the County not far from Mansfield in a big cottonwood tree on a farm owned by my father. The nest held half-grown young at the time of our visit there on June 26, 1914.

Parabuteo unicinctus harrisi (Audubon). HARRIS'S HAWK.

Graham names this species in both his lists, calling it "rare" (1915e, 191; 1919e, 187). Graham and Zeitlin (1921, 93) also list it. To the best of my knowledge no specimen has ever been taken in the Fort Worth region, however, so I suspect that Mr. Graham and Mr. Zeitlin may have confused the present with some other species. During 1911-1914 I heard about "Harris's Hawks" several times, but never saw one. I did record Audubon's Caracara, *Polyborus cheriway auduboni* Cassin, upon one occasion,[9] however, so am inclined to think that Harris's Hawk may occasionally wander into Tarrant County from its nesting ground in the south.

Pandion haliaëtus carolinensis (Gmelin). AMERICAN OSPREY.

So far as I know this species has never been found nesting in the Fort Worth region. It has been seen several times in mid-summer, however, and Moffat (1916a, 13) calls attention to the fact that Lake Worth lies within its breeding range.

[8] This specimen was presented, in 1915, to Bethany College, Bethany, West Virginia, where it may now be seen. It is in what often is called the "normal phase" of plumage.

[9] In early October, 1913. Mr. Graham writes me that he has recorded Audubon's Caracara at least once in the Fort Worth region. In late March, 1910, he shot one while collecting hawk eggs.

7. **Falco sparverius sparverius** Linnaeus. EASTERN SPARROW HAWK.

Graham (1919e, 188) lists this species, calling it "rare." Graham and Zeitlin (1921) do not include it, however. During 1911-1914 I saw it frequently in winter, and observed, throughout the spring of 1913, a pair which had a nest in a dead oak about two miles west of the Texas Christian University campus. We saw the young birds on several occasions, collecting a male on June 6.

Tympanuchus cupido americanus (Reichenbach). GREATER PRAIRIE CHICKEN.

The Prairie Chicken is not found about Fort Worth today. According to Rowe (1885, 243) it must have been present in considerable numbers fifty years ago. While I have not examined any specimen taken in past years it is reasonable to suppose that the present species, rather than *T. pallidicinctus* (Ridgway), ranged the open country of north central Texas in frontier days.

8. **Colinus virginianus virginianus** (Linnaeus). EASTERN BOB-WHITE.

Uncommon and local permanent resident. Listed by Graham (1915e, 191) as the "Texas Bob-white," who characterizes it as "scarce" (1919e, 188). Listed by Graham and Zeitlin (1921, 93). I noted it infrequently during 1911-1914, but did not find a nest. Mr. Graham tells me that he encountered four nesting pairs about Lake Worth during June, 1918.

Meleagris gallopavo intermedia Sennett. RIO GRANDE WILD TURKEY.

I have been told by several persons that Wild Turkeys were formerly to be found in the wooded country about Fort Worth. In substantiation of such reports we find a note in an early issue of *American Field* concerning "Christmas Turkeys and Other Turkeys."[10] I do not know of any specimen actually taken in Tarrant County that is extant today.

9. **Ionornis martinica** (Linnaeus). PURPLE GALLINULE.

This species, which I did not once record during 1911-1914, and which is not listed by Graham (1915e; 1919e) nor by Graham and Zeitlin (1921), now nests at Lake Worth. A nest and five eggs were found on July 12, 1925, by Mr. Verlain Daniels, who has published a

[10] Christmas Turkeys and Other Turkeys. Jordan, *American Field*, 50, No. 26, December 26, 1898.

note upon the discovery (1926, 16). The Purple Gallinule is probably rare and decidedly local in Tarrant County, Texas.

Gallinula chloropus cachinnans (Bangs). FLORIDA GALLINULE.

This gallinule quite possibly has established itself as a summer resident at Lake Worth by this time, though I have not been told of any recent midsummer records, and there is no reference to the species in the literature at hand.

Fulica americana americana Gmelin. AMERICAN COOT.

Not listed by Graham (1915e; 1919e) nor by Graham and Zeitlin (1921). Both Mr. Graham and Mr. Zeitlin write me, however, that Coots are to be seen at Lake Worth in midsummer, so it is highly probable that the species nests regularly in Tarrant County today.

10. **Oxyechus vociferus vociferus** (Linnaeus). NORTHERN KILLDEER.

Common permanent resident, often more abundant in winter than in summer. Listed as "common" by Graham (1919e, 188), who writes of finding a nest with four eggs on April 21, 1915; and of a nest "sunk in the ground" and "lined with small gravel" found on May 4, 1915 (1916e, 81). Mr. Graham informs me that the former of these was found near Frisco, the latter at Jefferson Crossing; and that during the summer of 1918 he observed one nesting pair of Killdeers near his camp at Lake Worth.

11. **Zenaidura macroura marginella** (Woodhouse). WESTERN MOURNING DOVE.

The Mourning Dove is abundant the year round. Whether some winter birds are subspecifically different from summer birds I cannot say. Listed by Graham (1919e, 188) as "common." During 1911-1914 I found many nests, most of them on low, horizontal branches; several on the ground; and three in old Mockingbird nests. Several sets of fresh eggs were discovered in early or mid-April. Two fresh eggs found August 10, 1912, were probably of a second brood.

Mr. Graham, who informs me that he has found small young in the nest as late as mid-September, has published an interesting note on a set of three Mourning Dove eggs found June 11, 1910, in a deserted grackle nest; and of another grackle nest that held two dove eggs and three grackle eggs, found June 12, 1910 (1915h, 211). He has published notes also upon nests found April 14, 1915 (1916e, 81).

12. **Coccyzus americanus americanus** (Linnaeus). EASTERN YELLOW-BILLED CUCKOO.

Listed by Graham (1915e, 191), who characterizes it as "common" (1919e, 187). Listed also by Graham and Zeitlin (1921, 93). During 1911-1914 I found it common both as a summer resident and as a transient. In 1914 I recorded it first on May 23, when many were heard calling; and found a nest with three fresh eggs (perhaps an incomplete set) on June 7. Mr. Graham writes me of finding a nest with four slightly incubated eggs on May 21, 1916; another with three fresh eggs on June 3, 1916; and another with three heavily incubated eggs on July 8, 1916.

13. **Geococcyx californianus** (Lesson). ROAD-RUNNER.

Fairly common permanent resident, probably not so common as formerly. Listed by Graham (1915e, 191), who characterizes it as "not common" (1919e, 187). Listed also by Graham and Zeitlin (1921, 93). During 1911-1914 I found several nests, concerning some of which I have written at considerable length (1914, 141; 1922, 6). Mr. Graham informs me that he found a nest with five somewhat incubated eggs on April 15, 1916; one with four fresh eggs on April 16, 1916; and one with four fresh eggs on April 27, 1915. He is of the opinion, as am I also, that unusually large sets of eggs are the product of two or more females (1915d, 182).

14. **Tyto alba pratincola** (Bonaparte.) AMERICAN BARN OWL.

Graham (1915e, 191) lists this species, calling it "common" (1919e, 187). Graham and Zeitlin (1921, 93) list it. During 1911-1914 I found it only fairly common, recording it at all seasons of the year, and discovering a nest with five small young in the "first woods" beyond Texas Christian University Hill on April 25, 1914. Graham and Maxon (1915, 118) tell us of early spring expeditions after the eggs of this and other species. Graham (1914b, 138) tells of a set of five eggs taken in early April, 1914, from a "large hole" near a spring, and writes entertainingly of "fishing" for Barn Owls at Lake Worth (1917a, 18). Mr. Graham informs me that he found a nest with two heavily incubated eggs on April 9, 1916, at Lake Worth.

15. **Otus asio hasbroucki** (Ridgway). HASBROUCK'S SCREECH OWL.

Common permanent resident, especially about Lake Worth; listed as "Texas Screech Owl" (1915, 191) and as "Screech Owl" (1919e,

188) by Graham, who calls it "common." Listed as "Screech Owl" by Graham and Zeitlin (1921, 93). The breeding Screech Owl of the Fort Worth region has been definitely identified as *hasbroucki*.[11]

During 1911-1914 I found several nests about Forest Park and in the woodlands south of Texas Christian University, among these one with four fresh eggs in a high stub not far from the Clear Fork of the Trinity River, on April 21, 1914; and one with two small young, on June 2, 1914. In this nest were the remains of a male Cardinal.

Graham describes several nests found by him. In the first of these notes (1914b, 138) he tells of a set of four fresh eggs found in early April, 1914. In another (1916e, 81) he writes of a nest with four fresh eggs [along Sycamore Creek] found on April 20, 1915; of a nest with four eggs found the following day; and of nests with three eggs found April 27 and April 30, 1915. In another (1916f, 137; 1916g, 170) he relates of finding a nest which held one egg on March 24 and four eggs on April 3, 1916. In another (1919a, 89) he tells of sets collected March 30, 1919. In another he describes a set of five heavily incubated eggs found April 7, 1919 (1919b, 97).

I reared two young Hasbrouck's Screech Owls during the spring of 1914, taking them with me to West Virginia where one was liberated near Bethany, Brooke County, in late September of the same year.

16. **Bubo virginianus virginianus** (Gmelin). EASTERN HORNED OWL.

Rare permanent resident. Listed by Graham (1915e, 191), who calls it "rare" (1919e, 188); and by Graham and Zeitlin (1921, 93). A pair nested along the Clear Fork of the Trinity River about three miles from our house during the early spring of 1913. Graham and Maxon (1915, 118) tell us of finding two half-grown young in an old hawk's nest at Jefferson Crossing on March 18, 1915. These observers found another nest on the following day, this one containing three heavily incubated eggs. Graham (1916e, 81) writes of these same nests in a separate note, and mentions "half-grown Horned Owls" seen on February 15, 1920.[12] Mr. Graham informs me that he noted one pair of Horned Owls at Lake Worth on June 5, 1918.

[11] See original description, *Bull. U. S. Nat. Mus.*, No. 50, Pt. IV, 1914, 694. The type locality of the form is Palo Pinto County, Texas.

[12] Graham, Ramon. Texas Migration Notes. *Oölogist*, XXXVII, No. 3 March, 1920, 34.

17. **Speotyto cunicularia hypugaea** (Bonaparte). WESTERN BURROWING OWL.

Not common anywhere about Fort Worth, but to be observed at all seasons and undoubtedly nests occasionally. Both Mr. Graham and myself have seen mated pairs at their burrows, though neither of us has actually taken the eggs or young. Graham (1915e, 191; 1919e, 188) lists the Burrowing Owl, calling it "rare." Graham and Zeitlin (1921, 93), however, do not include it. I have published a note upon an albinistic specimen collected during my sojourn in the region (1912b, 184).

18. **Strix varia georgica** Latham.[13] FLORIDA BARRED OWL.

Permanent resident, somewhat commoner than the Horned Owl. Listed as "Texas Barred Owl" by Graham (1915e, 191), who calls it "rare" (1919e, 188). Moffat (1916, 147) and Graham (1916f, 137) tell us of finding a nest with three slightly incubated eggs at Lake Worth on March 12, 1916. Graham and Maxon (1915, 118) tell us of finding a nest with two eggs at Jefferson Crossing on March 19, 1915. Graham (1916e, 81) writes of this same nest in a separate account. During 1911-1914 I kept an adult Barred Owl in captivity for several months.

19. **Asio otus wilsonianus** (Lesson).[14] AMERICAN LONG-EARED OWL.

I never saw this bird alive about Fort Worth, but my friend Mr. Millard Chandler shot one during the late autumn of 1912, and Mr. Graham informs me that he found a nest near Jefferson Crossing bridge along the West Fork of the Trinity River in the spring of 1910 "in a hole in a washed-out sand bank." Graham (1915e, 191; 1919e, 188) lists the species, calling it "rare." Graham and Zeitlin (1921, 93) also include it. It is doubtless very local in distribution.

Asio flammeus flammeus (Pontoppidan). NORTHERN SHORT-EARED OWL.

Graham (1915e, 191) names this owl in his first list of the breeding birds of Tarrant County, and speaks of Short-eared Owls observed to be occupying "dark holes and caves" (1914a, 31). He does not name it in his second list (1919e), however; nor do Graham and Zeitlin

[13] *Strix varia alleni* Ridgway of the Check-List. For change of name see Kelso, Leon. The Forgotten Georgian Owl. *Auk*, 1933, 106, 107.

[14] *Asio wilsonianus* of the Check-List. For *A. o. wilsonianus* see Oberholser, H. C. *Auk*, 1922, 72-78.

(1921) include it. I observed the species several times in winter during 1911-1914, but never in summer. Graham probably assumed that Short-eared Owls nested in the region because he observed transient individuals late in spring.

20. **Antrostomus carolinensis** (Gmelin). CHUCK-WILL'S-WIDOW.

Not listed by Graham (1915e; 1919e) nor by Graham and Zeitlin (1921). I never saw the species in the immediate vicinity of Fort Worth, though I found it nesting in some numbers, and collected one specimen, north of Aquilla, Hill County, about fifty miles south of Fort Worth, during the summer of 1913. Mr. Graham writes me that it now summers about Lake Worth; that he recorded a spring arrival from the South on April 16, 1916; and that on June 5, 1918, he noted four individuals, thought to be two mated pairs, in the vicinity of his encampment at Lake Worth.

Antrostomus vociferus vociferus (Wilson). EASTERN WHIP-POOR-WILL.

Graham (1915e, 191) names this in his first list of the breeding birds of Tarrant County. He does not include it in his second list (1919e), however; and the fact that he and Zeitlin (1921, 93) include it but do not include the Chuck-will's-widow, causes me to wonder if these observers may not have confused the two species to some extent. Graham (1914b, 138; 1919b, 97) tells us of hearing Whip-poor-wills about his camp during April and May. I recall examining a Whip-poor-will that had been shot by a negro south of Fort Worth in May, 1913. Nevertheless I prefer not to give the species full ranking here until definite data upon eggs or young birds have been obtained.

Phalaenoptilus nuttalli nuttalli (Audubon). NUTTALL'S POOR-WILL.

I did not record this species during the period of my residence at Fort Worth; nor does Graham (1915e; 1919e) include it in his earlier lists. That the species is sometimes found in Tarrant County there can be no doubt, however. Graham (1914b, 139) tells us of collecting a specimen on April 14, 1914. Graham and Zeitlin (1921, 93) include the species in their list. Mr. Graham writes me that he has noted Poor-wills in the northeastern corner of the County on several occasions; and Mr. Zeitlin informs me that he has recorded the species in midsummer.

21. **Chordeiles minor howelli** Oberholser. HOWELL'S NIGHTHAWK.

The Nighthawk is sometimes exceedingly abundant as a transient about Fort Worth. As a summer resident it is not nearly so common, however, and it is decidedly local. Two or more subspecies probably are to be encountered during the course of the year.

Graham (1915e, 191) names the "Texas Nighthawk" in his first list. In his second list (1919e, 187) he names the "Nighthawk," calling it "common." Graham and Zeitlin (1921, 93) list the species. Mr. Graham informs me that he found two heavily incubated eggs along a road west of Fort Worth on June 27, 1916; observed two half-grown young on a gravel hill east of Katy Lake on June 28, 1916; and encountered what he thought to be about ten nesting pairs about Lake Worth on June 5, 1918. During 1911-1914 I noted the Nighthawk in summer on several occasions but did not discover either eggs or young.

Chordeiles acutipennis texensis Lawrence. TEXAS NIGHTHAWK.

Graham (1915e, 191) names this form in his first list of the breeding birds of Tarrant County, and writes of "Texas Night-hawk or Bull Bat" nests (1914a, 30). He probably did not, at the time of writing these notes, realize that Nighthawks found in Texas were not necessarily *Texas* Nighthawks. My own notes in those days were full of similar mistakes. Maxon (1916, 178) also writes of the "Texan Nighthawk," and his remarks also obviously apply to *C. minor* and not to *C. acutipennis*.

22. **Archilochus colubris** (Linnaeus). RUBY-THROATED HUMMINGBIRD.

Uncommon as a nesting species; commoner as a transient. I took specimens in midsummer at Fort Worth and in the vicinity of Aquilla, Hill County, during 1911-1914. Graham (1915e; 1919e) does not include any hummingbird in his earlier lists; but Graham and Zeitlin (1921, 93) name the present species, and Graham has published several notes upon hummingbird nests. What appears to be the first of these relates of a "Black-chinned Hummer's" nest containing one young bird, discovered June 27, 1915, at Lake Worth (1916e, 82). Although the parent birds were not obtained, this may indeed be a breeding record for *A. alexandri*, a western species which ranges eastward in summer, so Dr. Oberholser informs me, occasionally as far as east central Texas. Another note tells us of a nest with two eggs built on a pendant dead branch, found June 19, 1916 (1916g, 170). Another informs us that hummingbirds were "laying in full blast" on May 15, 1919 (1919b, 97). These comments pertain, we believe, to *A. colubris.*

Mr. Graham writes me that he found a hummingbird nest containing an egg and young bird at Ten Mile Bridge on June 22, 1915; and a nest just ready for eggs on June 23, 1916.

Archilochus alexandri (Bourcier and Mulsant). BLACK-CHINNED HUMMINGBIRD.

I did not record this species during 1911-1914. Graham (1915e; 1919e) does not mention it; nor do Graham and Zeitlin (1921) list it. As stated above, however, Graham (1916e, 82) writes of a "Black Chinned Hummer" nest found June 27, 1915, at Lake Worth. This record we are obliged to question in view of the fact that specimens of the parent birds were not obtained.

23. **Megaceryle alcyon alcyon** (Linnaeus). BELTED KINGFISHER.

Graham (1915e, 191) lists this species, calling it "not plentiful" (1919e, 187). Graham and Zeitlin (1921, 93) include it in their list. Graham tells us of unsuccessful attempts to collect eggs during the spring of 1915 (1915f, 191); of a nest in process of construction found by Mr. Earl Moffat at Lake Worth in mid-March, 1919 (1919a, 89); of five burrows observed about Lake Worth in March, April, and May, 1919; and of a set of seven heavily incubated eggs collected at Goat Island, Lake Worth, on May 16, 1919 (1919b, 97). I saw Belted Kingfishers along the Clear Fork of the Trinity River repeatedly in midsummer during 1911-1914, but did not discover a nest.

24. **Colaptes auratus luteus** Bangs. NORTHERN FLICKER.

The Flicker is common as a transient and winter resident at Fort Worth. *Colaptes auratus* × *Colaptes cafer* hybrids are not infrequently to be encountered during fall, winter and spring. Breeding birds are not, so far as we have observed, hybrids, however, and the species found in summer is *auratus*, not *cafer*. Graham (1915e) does not include the Flicker in his first list. In his second list (1919e, 187) he calls it "rare." Graham and Zeitlin (1921, 93) list it. The only nesting birds I observed during 1911-1914 were a pair that frequented a rocky ridge about two miles west of Texas Christian University Hill. These I saw repeatedly during May and June, 1914.

25. **Ceophloeus pileatus pileatus** (Linnaeus). SOUTHERN PILEATED WOODPECKER.

Rare. Graham (1915e) does not include it in his first list; in his second list (1919e, 187) he calls it "nearly all gone"; Graham and Zeitlin (1921, 93) include it. I did not find a nest in the immediate vicinity of Fort Worth during 1911-1914, but observed a pair along the Clear Fork of the Trinity River several times during the summer of 1913, and found the species fairly common just to the northward of Aquilla, Hill County, in a region about fifty miles south of Fort Worth. Mr. Graham tells me that in an earlier year (probably about 1910) he had knowledge of six nesting pairs in the vicinity of Jefferson Crossing.

26. **Centurus carolinus** (Linnaeus). RED-BELLIED WOODPECKER.

Not common. Graham does not include it in his earlier lists (1915e; 1919e). Graham and Zeitlin (1921, 93) name it, however. Graham (1916f, 137) tells us of a nest with four fresh eggs found April 9, 1916, at Lake Worth. I did not find the species actually nesting at Forest Park or near Texas Christian University, but collected a nest and three heavily incubated eggs at Mansfield, in the southeastern corner of the County, on June 26, 1914.

27. **Melanerpes erythrocephalus erythrocephalus** (Linnaeus). EASTERN RED-HEADED WOODPECKER.

Sometimes abundant as a transient, and in winter; usually much less common in summer. Graham (1915e, 191) lists it, characterizing it as "common" (1919e, 187). Graham and Zeitlin (1921, 93) list it. Graham (1919b, 97) tells us of finding a nest with one egg on May 16, 1919. Several pairs nested during 1913 and 1914 in the vicinity of Forest Park and Texas Christian University; and during the summer of 1912 I saw parent birds feeding their young at the edge of the city of Fort Worth, not far from the corner of Sixth and Magnolia Avenues.

28. **Dryobates villosus villosus** (Linnaeus). EASTERN HAIRY WOODPECKER.

This widely ranging species, which is not listed by Graham (1915e; 1919e) nor by Graham and Zeitlin (1921), I considered quite rare in the Fort Worth region, although I recorded it several times in mid-summer during 1911-1914, and collected a male in the red-crowned plumage of the juvenal on July 8, 1913. It is interesting to note that Isely and his fellow observers have recently been recording this species in winter with considerable regularity (See *Bird-Lore*, Christmas Bird Census, 1926, etc.)

29. **Dryobates pubescens pubescens** (Linnaeus). SOUTHERN DOWNY WOODPECKER.

Graham (1915e, 191) lists this species, calling it "not plentiful" (1919e, 187); Graham and Zeitlin (1921, 93) list it. I considered the Downy Woodpecker rare about Forest Park and Texas Christian University during 1911-1914. Graham (1916f, 137) writes of a nest containing small young, found at Lake Worth on April 16, 1916.

30. **Dryobates scalaris symplectus** Oberholser. TEXAS LADDER-BACKED WOODPECKER.

This species is rare at Fort Worth. Graham (1915e; 1919e) does not mention it, nor is it listed by Graham and Zeitlin (1921). I recorded it several times during 1911-1914, and found a nest along a stream known as Howard's Branch, west of Texas Christian University, during the summer of 1913. I saw the parent birds performing strange courtship antics during the spring of that year, and watched them feeding young in the nest. The cavity was about twenty feet from the ground, the entrance on the under side of a strongly leaning stub. Mr. Zeitlin informs me that he has noted the species several times. Isely and his fellow observers (1926, etc.) include it in their Bird-Lore Christmas-census list from the Fort Worth region as a rule.

Dryobates borealis (Vieillot). RED-COCKADED WOODPECKER.

I took this species once, a male, on January 30, 1914, in a dense patch of woods about three miles south of Texas Christian University, along the Clear Fork of the Trinity River. Since the Red-cockaded Woodpecker is thought to be relatively non-migratory its presence at any season of the year in a given region suggests the possibility that it may occasionally nest.

31. **Tyrannus tyrannus tyrannus** (Linnaeus). EASTERN KINGBIRD.

Graham (1915e) does not include this species in his earliest list. In his second list he names it, calling it "rare" (1919e, 187). Graham and Zeitlin (1921, 93) list it. I noted it several times in 1911-1914, most frequently during the period of migration. A pair nested in a bois d'arc hedge near Handley during the summer of 1912. Mr. Graham tells me that he noted arrivals from the South on May 2, in 1916. In 1914 I saw Kingbirds repeatedly from May 4 to 10, but encountered no nesting pairs that season. Mr. Zeitlin informs me that the species is gradually establishing itself at Lake Worth, where it nests in the tops of dead trees sometimes at considerable distance from the shore.

32. **Tyrannus verticalis** Say. ARKANSAS KINGBIRD.

Rare; not listed by Graham (1915e; 1919e) nor by Graham and Zeitlin (1921). Its inclusion here is based upon a nest found during the summer of 1911 in a small sycamore tree in a residential part of the city and reported to me by my friend Mr. Charles McLendon, who described the yellow breasts of the parent birds. I took the species near Forest Park twice during the period of migration (one of these a male, May 1, 1914), but did not encounter a nesting pair.

33. **Muscivora forficata** (Gmelin). SCISSOR-TAILED FLYCATCHER.

Common. All ornithologists who have written of the region include it in their lists, and several, notably Litsey (1911, 106) and Graham (1916b, 33), have devoted papers especially to it. During the spring of 1915 Mr. Graham and his friend Mr. Emmett Maxon found a full set of eggs (four) first on May 16, and examined another nest containing four eggs on May 23 (Graham, 1916e, 82). Graham (1919b, 97) tells us of recording an arrival from the South on March 30, 1919; and of finding a pair and their partly finished nest on May 16 of that year. This observer tells us too of a nest that was built in seven days (1924a, 88).

During 1911-1914 I observed the species repeatedly in summer, my earliest date for nesting operations being May 13, 1914 (partly finished nest). Most of the nests I found were in mesquite, hackberry, or sycamore trees; but several were on telegraph poles, and one was built upon an English Sparrow's nest in a shade tree on the Texas Christian University campus. Mr. Graham has written me of finding several nests with fresh eggs on June 3, 1916; and of seeing a flock of transient birds on September 7 of the same year.

During the spring of 1914 I kept a young Scissor-tail in captivity for several weeks, finding that it ate small fruits, lizards, and spiders as readily as it did insects.

34. **Myiarchus crinitus boreus** Bangs. NORTHERN CRESTED FLYCATCHER.

Fairly common in wooded sections. Listed by Graham (1915e, 191), who characterizes it as "common" (1919e, 187); and by Graham and Zeitlin (1921, 93). Graham (1919b, 97) tells us of a pair that were mating on May 7, 1919. Mr. Graham informs me that he noted arrivals from the South on April 16, 1916; and that on June 5, 1918 he encountered two nesting pairs at Lake Worth. During 1911-1914 I discovered two nests—one in a pecan tree at Forest Park, June 10, 1913; the other at Mansfield, in the southeastern corner of Tarrant County, with four young birds, June 26, 1914.

35. **Sayornis phoebe** (Latham). EASTERN PHOEBE.

Graham (1915e) does not include the Phoebe in his first list, but characterizes it as "rare" in his second list (1919e, 187); and Graham and Zeitlin (1921, 93) name it. Inclusion of the species here is based primarily upon a set of four eggs taken April 12, 1915 by Graham, who has published two notes upon the discovery (1916c, 34; 1916e, 81). Mr. Zeitlin informs me that he found a nest near a spring at Jefferson Crossing, on April 16, 1922. Mr. Graham writes me that nowadays one or two nesting pairs are customarily to be found about Lake Worth. I did not record the Phoebe in midsummer during 1911-1914, but noted it several times as a transient.

36. **Stelgidopteryx ruficollis serripennis** (Audubon). ROUGH-WINGED SWALLOW.

Not common, and very local; not included in Graham's earlier lists (1915e; 1919e), but listed by Graham and Zeitlin (1921, 93). I noted it in summer along the Clear Fork of the Trinity River, seeing young birds with their parents on two occasions in July, 1913; but did not discover a nest containing eggs.

37. **Progne subis subis** (Linnaeus). EASTERN PURPLE MARTIN.

Fairly common, but local; named by Graham (1915e, 191) in his first list, but not in his second (1919e); included by Graham and Zeitlin (1921, 93). During the spring of 1914 two pairs of Martins lingered for some time about a crude house I had hastily erected for them. They finally built bulky nests, but did not, for some reason, lay any eggs. I think the supports of the house may have been insecure.

I saw several Martins feeding their young about farms near Aquilla, Hill County, about fifty miles south of Fort Worth, during the summer of 1913.

38. **Cyanocitta cristata cyanotephra** Sutton.[15] SOUTHWESTERN BLUE JAY.

The Blue Jay is listed by Graham (1915e, 191; 1919e, 187) and by Graham and Zeitlin (1921, 93). I noted it in summer at several points in the region, notably at Forest Park where, on June 14, 1914, I observed a pair building their nest; and at Mansfield where, on June 26, 1914, I found a nest with three young in a shade tree in the heart of town. Mr. Graham tells me that he noted two pairs of Blue Jays about his camp at Lake Worth during the spring of 1918. He has published an interesting note on destruction of Summer Tanager nests by jays (1924a, 88).

39. **Corvus brachyrhynchos brachyrhynchos** Brehm. EASTERN CROW.

Common; listed by Graham (1915e, 191; 1919e, 187) and by Graham and Zeitlin (1921, 93). Graham and Maxon (1915, 118) tell us of "six fresh crow nests" found along the Trinity River on March 10, 1915. Graham (1916e, 81) tells us of many nests found during the spring of 1915, the first with six fresh eggs on March 6, the last with heavily incubated eggs (four in one nest, five in another) on April 27. During 1911-1914 I found scores of nests, most of them in live oaks. One found April 20, 1914, held six heavily incubated eggs. On June 5, 1914 I found a blue-eyed young Crow, barely able to fly.

40. **Penthestes carolinensis agilis** (Sennett). PLUMBEOUS CHICKADEE.

The "Chickadee" is listed by Graham (1915e, 191), who characterizes it as "common" (1919e, 188); and by Graham and Zeitlin (1921, 93). During 1911-1914 I found many nests, notably one with six fresh eggs, April 16, 1914, near Forest Park. Graham has published several notes upon the species, one telling of a nest with eight eggs found April 3, 1916 (1916h, 189); one calling attention to the fearlessness of parent birds at the nest (1917d, 84); one concerning nests found near Camp Graham at Lake Worth (1919a, 89); one describing a nest in detail (1919d, 127); and one telling of a nest and seven eggs found

[15] The Blue Jay of western Oklahoma, eastern Colorado, etc., has been found to be distinct from more easterly races. See Sutton, G. M. *Auk*, 1935, 176.

at Lake Worth on March 25, 1923 (1923a, 58). The Plumbeous Chickadee is one of the noticeable birds of the winter woodlands; it is less noticeable during the nesting season.

41. **Baeolophus bicolor** (Linnaeus). TUFTED TITMOUSE.

Common. Listed by Graham (1915e, 191; 1919e, 188) and by Graham and Zeitlin (1921, 93). Graham tells us of a nest containing "six well incubated eggs" in a hollow "a foot deep and facing the sky," found April 16, 1916 at Lake Worth (1916f, 137); of nests with five and four eggs found respectively on April 12 and May 5, 1915 (1916e, 81, 82); and of an incubating parent bird that hissed in the manner of a snake (1917e, 58). I found several nests during 1911-1914, among them one with young just leaving, at Mansfield, on June 26, 1914.

42. **Thryomanes bewicki cryptus** Oberholser. TEXAS BEWICK'S WREN.

Fairly common. Graham (1915e, 191) names both the "Bewick's Wren" and the "Texas Bewick's Wren" in his first list; in his second list he names only the latter form, calling it "common" (1919e, 187). Graham and Zeitlin include "Bewick's Wren." Graham (1914b, 139) tells us of a nest containing four eggs found April 14, 1914. In another note (1917g, 187) he tells us of a "wren nest" with five young (date?) in a coffee can at his encampment at Lake Worth. Again (1919b, 97), he tells of an occupied nest in a birdhouse at his camp, May 10, 1919. Mr. Graham writes me of a nest with six young found June 26, 1916 in a hollow branch, nine feet up, in a dead elm standing in the water at Lake Worth. During 1911-1914 I found the Texas Bewick's Wren not very common about Forest Park and Texas Christian University.

43. **Thryothorus ludovicianus ludovicianus** (Latham). CAROLINA WREN.

Calling it "Lomita Wren," Graham (1915e, 191) includes this species in his earliest list. In his second list (1919e, 187) he names the "Carolina Wren," characterizing it as "common." Graham and Zeitlin (1921, 93) include the species. On April 18, 1912, I found a nest with five fresh eggs among the vine covered branches of a fallen tree along the east bank of the Clear Fork of the Trinity River. Mr. Graham tells me that he found a nest which held three eggs on April 9 and five eggs on April 16, 1916, at Lake Worth; and that he encountered three nesting pairs about his camp there in June, 1918. He has published an entertaining note concerning the materials composing a Carolina Wren's nest (1922b, 175).

Thryothorus ludovicianus lomitensis (Sennett). LOMITA WREN.

Inclusion of the Lomita Wren by Graham (1915e, 191), as noted above, is obviously a mistake. This subspecies ranges only far south of Fort Worth (see A. O. U. Check-List, 1931, 247).

44. **Mimus polyglottos polyglottos** (Linnaeus). EASTERN MOCKINGBIRD.

Common permanent resident. Listed by Graham (1915e, 191; 1919e, 187) and by Graham and Zeitlin (1921, 93). Graham (1916e, 81, 82) tells us of several nests, each with a set of four eggs, found April 20, 21, and 30 and May 5 and 13, 1915; and of observing on May 21, 1916, a young Mockingbird that was being swallowed by a green snake (1917b, 33 and 54). During 1911-1914 I found many Mockingbird nests, among them one with four fresh eggs, June 15, 1914; and one with six rather heavily incubated eggs, May 18, 1914. Mr. Graham tells me that on June 26, 1916, along a bois d'arc hedge west of the city, he found five Mockingbird nests all with well developed young.

45. **Turdus migratorius achrusterus** (Batchelder). SOUTHERN ROBIN.

Graham (1915e; 1919e) and Graham and Zeitlin (1921) do not include this species in their lists. Daniels (1926, 16) tells us of finding a nest with four eggs during the spring of 1925, however, and of seeing young thought to be of the second brood, and possibly of the same parentage, later in the season. I did not encounter the Robin in summer during 1911-1914, but noted it repeatedly in winter.

46. **Sialia sialis sialis** (Linnaeus). EASTERN BLUEBIRD.

Fairly common in summer. Graham (1915e, 191) lists it, calling it "common" (1919e, 188). Graham and Zeitlin (1921, 93) list it. Graham (1916e, 81) tells us of a nest and four eggs found April 9, 1915, in a hole in a dead tree "eight feet up." During the spring of 1913 a pair nested not far from the Texas Christian University campus. The male of this pair was accidentally killed on April 3, on which date there were small young in the nest. Mr. Graham informs me that he encountered two nesting pairs of Bluebirds at Lake Worth during early June, 1918.

47. **Polioptila caerulea caerulea** (Linnaeus). EASTERN BLUE-GRAY GNATCATCHER.

Not named by Graham (1915e) in his first list; listed subsequently as "rare" (1919e, 188); and listed by Graham and Zeitlin (1921, 93). Moffat (1919c, 152) tells us of collecting a nest and five fresh eggs on May 23, 1916. Graham (1919b, 97) tells us of finding a nest containing one Gnatcatcher's and one Cowbird's egg on April 20, 1919. This nest was deserted when the young Cowbird hatched. Mr. Graham writes me that he observed one nesting pair near his camp at Lake Worth in early June, 1918. During 1911-1914 I noted Gnatcatchers frequently in midsummer, and took two specimens in juvenal feather in July, 1913.

Lanius ludovicianus Linnaeus. LOGGERHEAD SHRIKE.

Lanius ludovicianus is common, if not downright abundant, about Fort Worth during winter, and it may occasionally remain to nest. I did not record the species in midsummer in 1911-1914, however.

Vireo atricapillus (Woodhouse). BLACK-CAPPED VIREO.

Graham (1915e, 191) includes this species in his first list. It is not mentioned elsewhere in the literature at hand. I did not see it during 1911-1914 and, since neither breeding birds nor nest and eggs appear to have been taken we are obliged to accord it hypothetical ranking for the present.

48. **Vireo griseus noveboracensis** (Gmelin).[16] NORTHERN WHITE-EYED VIREO.

Fairly common as a transient; less common as a summer resident; occasional in winter. Graham (1915e, 191) lists it, calling it "rare" (1919e, 187). Graham and Zeitlin (1921, 93) list it. During the spring of 1913 two pairs nested on a brushy hillside south of Forest Park in a district that is now residential. Graham (1915b, 104; 1916e, 81) writes of finding a nest with one egg on April 19, 1915, in which

[16] As pointed out by Todd (*Auk*, 1933, 115 and *Wilson Bulletin*, 1926, 122) White-eyed Vireos from northern parts of the species' range are readily separable from southern birds. The northern form bears, therefore, the name bestowed by Gmelin when he described *Muscicapa noveboracensis*, Syst. Nat., i, 1788, 947.

a Cowbird later laid two eggs thereby causing the Vireos to desert. Mr. Graham informs me that he observed three nesting pairs in the vicinity of his encampment at Lake Worth during June, 1918.

49. **Vireo belli belli** (Audubon). BELL'S VIREO.

Abundant. Many nests found during 1911-1914, most of them in bois d'arc hedges or at the heads of wooded gullies. During the spring of 1914 eleven nests were discovered, the first—in process of construction—on May 4, the last (with three fresh eggs) on May 30. The Cowbird was found to parasitize this species frequently.

Mr. Graham has found many nests during the course of his field-work. He writes me specifically of one with four eggs found along Wright's hedge, west of Fort Worth, May 17, 1916; of one with three young Vireos and a young Cowbird found June 27, 1916; and of one with four fresh eggs found July 8, 1916. He has published notes upon nests found May 13 to June 7, 1915 at Ben Brook (1916e, 82).

Vireo olivaceus (Linnaeus). RED-EYED VIREO.

Graham (1914b, 139) tells us of a "fresh nest of Red-eyed Vireo" found April 14, 1914, and includes the species in his first list (1915e, 191). He does not name it in his second list (1919e), however; nor do Graham and Zeitlin (1921) list it. Strecker (1912, 55) calls it a summer resident in eastern Texas "in the wooded regions." During 1911-1914 I recorded it at least twice as a transient, but did not note it in midsummer.

50. **Protonotaria citrea** (Boddaert). PROTHONOTARY WARBLER.

Mr. Graham informs me that Mr. Robert Carnihan of Fort Worth saw a pair of Prothonotary Warblers repeatedly at Lake Worth during the spring and summer of 1916. Mr. Carnihan watched the female go to her nest on several occasions. By this time the species probably has established itself in the drowned woodlands about Lake Worth.

Vermivora pinus (Linnaeus). BLUE-WINGED WARBLER.

Graham (1919e, 187) names this species in his second list, calling it "rare." Graham and Zeitlin (1921, 93) also list it. So far as I have been able to determine the nest and eggs have never actually been found, and I am not convinced that the bird has been seen in midsummer. Mr. Graham informs me that a female, carrying bark-strips, was noted during the summer of 1920, on Todd Island, in Lake

Worth. But since the female Blue-wing bears superficial resemblance to the female Prothonotary Warbler, I am inclined to wonder if the two species may not have been confused. At any rate we cannot give the present species full ranking here until more conclusive evidence of its nesting has been obtained.

51. **Geothlypis trichas trichas** (Linnaeus). MARYLAND YELLOW-THROAT.

Dr. Oberholser informs me that this race of Yellowthroat nests at Lake Worth at the present time. Messrs. Graham and Zeitlin inform me that they have seen it thereabouts repeatedly in summer. There is no specific reference to it in the literature before us. During 1911-1914 I noted it only as a transient.

52. **Icteria virens virens** (Linnaeus). YELLOW-BREASTED CHAT.

Rare. Not named in Graham's first list (1915e); called "rare" in Graham's second list (1919e, 187); listed by Graham and Zeitlin (1921, 93). I noted the species twice in summer during 1911-1914, but did not find a nest. It is very local in distribution. Strecker (1912, 60) accords *Icteria virens* practically State-wide distribution in summer, restricting *I. v. virens* to the eastern part, *I. v. auricollis* (Lichtenstein)[17] to the western part. I have not examined breeding specimens from the Fort Worth region, but Dr. Oberholser assures me that the eastern race is the one found here.

53. **Passer domesticus domesticus** (Linnaeus). ENGLISH SPARROW.

Common in the city as well as in the rural areas. Most of the nests I found during 1911-1914 were built in relatively open situations in shade trees and not in crevices about buildings and bridges.

54. **Sturnella magna magna** (Linnaeus). EASTERN MEADOWLARK.

Dr. George B. Saunders, who has studied the distribution of the genus *Sturnella* exhaustively, informs me that "at about dusk on July 8, 1932" he "saw and heard four *magna* males singing about five miles west of the city [of Fort Worth] and collected one of these. . ." Continuing, he says: "*Neglecta* were probably present in this area, but

[17] *Icteria virens longicauda* Lawrence of the Check-List. For change of name see van Rossem, *Auk*, 1934, 549; and *Trans.* San Diego *Soc. Nat. Hist.*, VII, No. 30, May 31, 1934.

as it happened I neither saw nor heard any. It is possible that in earlier times this entire district was held by *neglecta* but such is not the case now. I believe the history of *Sturnella* distribution in Tarrant County may be somewhat similar to that of the Fort Reno prairies of central Oklahoma where *magna* has gradually replaced *neglecta*." Dr. Saunders tells me there are breeding specimens of *magna* in the old Texas Geological collection which were taken north of Fort Worth, however.

Mr. Graham tells me that in early June, 1918, he recorded four nesting pairs of "Meadowlarks" about Lake Worth. These may well have been *magna*, particularly in view of the fact that the creation of Lake Worth may by that time have set up a distinctly new sum-total of ecological factors in the vicinity.

55. **Sturnella neglecta neglecta** Audubon. WESTERN MEADOWLARK.

Graham (1915e, 191; 1919e, 187) lists the "Meadowlark," calling it "common." Graham and Zeitlin (1921, 93) also list the "Meadowlark." The present species, *neglecta*, is not mentioned in these lists. Graham's description of the "Tickle my craw with a straw" song heard south of Fort Worth in May shows these individuals clearly to have been *neglecta*, however; and these birds had young in the nest at the time of his visit.

Since the parent birds were not collected we now have no way of knowing whether the nest found by Graham (1916e, 81) on April 27, 1915 (four eggs) was of *neglecta* or of *magna*. During 1911-1914 I collected no Meadowlark specimen in midsummer, though I saw a nesting pair of *neglecta* in the vicinity of Handley in July, 1913.

In my bewilderment over the distribution of *neglecta* and *magna* I consulted Dr. Saunders who, in a personal letter dated December 28, 1934, says: "In summarizing the brief data I have on Tarrant County I should say that both *magna* and *neglecta* nest . . . , *magna* being the more common of the two in the northern, eastern, and southern sections, *neglecta* being dominant in the western section."

Strecker (1912, 43) gives us the impression that he considers all Meadowlarks nesting west of the "counties bordering on the State of Louisiana" to be *neglecta*. Obviously such a distribution does not obtain at the present time, for breeding *magna* has been taken near Fort Worth by Saunders (see above).

The distribution of *Sturnella* in the Fort Worth region is a problem that needs to be worked out in detail. The literature pertaining to the two species is in a state of confusion, the more so perhaps because the status of the two species may be changing as a result of destruction of the original prairie-lands in the interests of agricultural development.

56. **Agelaius phoeniceus phoeniceus** (Linnaeus). EASTERN REDWING.

Local, and not common. Graham (1915e, 191) includes it, calling it "common" (1919e, 187). Graham and Zeitlin (1921, 93) list it. During the spring of 1913 I found several pairs nesting about a small pond near the old bolt works near Handley. Graham (1916e, 82) tells us of finding a nest with four eggs in "tall grass" along a creek on May 17, 1915. He informs me that he found nests holding three and four eggs respectively on May 20 (in "snake weeds"), and on May 25, 1916.

57. **Icterus spurius** (Linnaeus). ORCHARD ORIOLE.

Common. Listed by Graham (1915e, 191; 1919e, 187) and by Graham and Zeitlin (1921, 93). Nests principally in mesquite, hackberry, bois d'arc, and sycamore. I found nests on May 28, 1913 (three fresh eggs); May 20, 1914 (four fresh eggs); and June 6, 1914 (four somewhat incubated eggs). Graham (1916e, 82) tells us of finding a nest with five eggs on May 23, 1915. He informs me that he found three occupied nests in mesquite trees on June 3, 1916, two of them with four slightly incubated eggs, one with five fresh eggs. I noted the species frequently about shade trees in the city during midsummer of 1911 and 1912.

Cassidix mexicanus major (Vieillot). BOAT-TAILED GRACKLE.

Graham (1915e, 191; 1919e, 187) includes the Boat-tailed Grackle in his lists. Graham and Zeitlin (1921, 93) also list it. This is a scarcely explainable mistake. I observed grackles closely while in the Fort Worth region and am convinced that the Bronzed Grackle is the only form that occurs there. The so-called Great-tailed Grackle, *C. m. mexicanus* (Gmelin), is known to nest at San Antonio, considerably to the southward of Fort Worth, and Graham[18] himself describes this form as "twice the size of Purple and Boat-tailed Grackles." From this statement we realize that Mr. Graham could

[18] Graham, Ramon. Great Tailed Grackle Very Tame. *Oölogist*, XXXVIII, No. 4, April, 1921, 42.

not have had a correct concept of the size of the Boat-tailed Grackle at the time he included it in his lists.

Quiscalus quiscula quiscula (Linnaeus). PURPLE GRACKLE.

Graham (1915e, 191; 1919e, 187) and Graham and Zeitlin (1921, 93) list this subspecies, Graham calling it "rare" in his second list. The only grackles I saw or took about Fort Worth were Bronzed Grackles. It is my belief that the Purple Grackle never occurs in the region save possibly as a straggler from the East.

58. **Quiscalus quiscula aeneus** (Ridgway). BRONZED GRACKLE.

This subspecies, which is not mentioned by Graham (1915e; 1919e) nor by Graham and Zeitlin (1921) is fairly common, but local, at Fort Worth. Graham's several comments concerning "Boat-tailed," "Bob-tailed," and "Purple" Grackles all doubtless refer to this form (1915h, 211; 1919d, 188; etc.). I found a small colony nesting in a bois d'arc hedge near Handley during the summer of 1913, and had in my collection for years a set of four eggs collected by Mr. Graham on May 2, 1913 "seven miles east of Fort Worth." Mr. Zeitlin informs me that on July 6, 1916, he found a grackle nest twelve feet up in a mesquite tree "composed entirely of binder cord," and containing two newly hatched young. This nest was not part of a colony. The tree in which it had been built stood not far from Ellis Lake.

59. **Molothrus ater ater** (Boddaert). EASTERN COWBIRD.

Common. Listed by Graham (1919e, 187) and by Graham and Zeitlin (1921, 93). The species most commonly parasitized by it apparently are the Bell's Vireo, Lark Sparrow, Cardinal, and Painted Bunting. In the literature at hand we find reference to Cowbird eggs in nests of the White-eyed Vireo (Graham, 1915b, 104; 1916e, 81), Blue-gray Gnatcatcher (Graham, 1924a, 88), Blue Grosbeak (Graham, 1922a, 25), and Summer Tanager (Graham, 1919b, 197).

60. **Piranga rubra rubra** (Linnaeus). SUMMER TANAGER.

Graham (1915e) does not include this species in his first list. In his second list he calls it "rare" (1919e, 187). Graham and Zeitlin (1921, 93) include it. I recorded a nesting pair at Forest Park several times during the spring of 1912 and 1913. Graham (1918b, 140) tells us of a nest with eggshells found by Mr. Verlain Daniels on July 23, 1918 at Williams's Spring, Lake Worth. Again (1919b, 97), he writes of finding a pair building their nest on April 30, 1919. In this nest, on May 13, there were three Tanager eggs and one Cowbird egg.

Mr. Graham informs me that he has within recent years taken several sets of Summer Tanager eggs near Williams's Spring, most of the nests being in elm and sycamore trees; that he noted springtime arrivals from the South on April 18, 1916; and that the Blue Jay is the principal natural enemy of the Summer Tanager in the vicinity of Lake Worth.

61. **Richmondena cardinalis magnirostris** (Bangs). LOUISIANA CARDINAL.

Abundant. Many nests found in 1911-1914: one with three young and an infertile egg on April 21, 1914; one with two small young on May 9, 1914; and one with three fresh eggs on May 28, 1914. I think three broods may regularly be reared in the region. Graham (1914b, 138) tells us of finding a nest with four eggs on April 13, 1915, a set of four eggs on April 19, and a set of four eggs on April 27, 1915 (1916e, 81); of discovering a "freak set" in which one egg was "solid brown" (1915c, 153); and of observing fully fledged young that were being fed by their parents (1924a, 88).

62. **Guiraca caerulea caerulea** (Linnaeus). EASTERN BLUE GROSBEAK.

Rare. Not included in Graham's first list (1915e); listed subsequently by this author as "rare" (1919e, 187); named by Graham and Zeitlin (1921, 93) in their list. Graham (1922a, 25) tells us of nests found on May 21, 1919 (two Grosbeak eggs and one Cowbird egg) and on June 15, 1919 (four Grosbeak eggs) that probably were built by the same pair of birds. Mr. Graham informs me that the species has nested regularly in the Lake Worth region in recent years. I did not record it during 1911-1914.

63. **Passerina ciris pallidior** Mearns. WESTERN PAINTED BUNTING.

Common. Listed by Graham (1915e, 191; 1919e, 187) and by Graham and Zeitlin (1921, 93). A pair nested in a small hackberry tree near the corner of Magnolia and Sixth Avenues in the city during the summer of 1912. On May 20 and 28, 1913, respectively, I found a nest, each with four eggs. In 1914 the species returned from the

South on about April 19; was "not yet common" by April 26; began nest-building toward the middle of May; and was laying eggs in latter May (four fresh eggs collected May 21). Another nest, with four slightly incubated eggs, was found June 5.

Mr. Graham writes me that he found a nest with three eggs on June 3, 1916; nests with one and four fresh eggs on June 27, 1916; and a nest with four fresh eggs on July 8, 1916. He has published an interesting account of the species as he has observed it in the Fort Worth region (1916d, 76); and of nests found May 5 and June 7, 1915 (1916e, 82).

64. **Spiza americana** (Gmelin). DICKCISSEL.

One of the commonest nesting species; abundant also as a transient. In 1914 I noted it first on April 23; recorded it as "very common" on April 30; and found a nest with six fresh eggs on May 9. Thereafter many nests were found, some in weeds but most of them near the ground in low shrubs. On May 23 I discovered eleven nests, most of them with five eggs. A nest with five perfectly fresh eggs was found June 1. Young just out of the nest were seen June 5.

Mr. Graham writes me that on June 3, 1916, he found a nest on the ground "under a thistle," that held four heavily incubated eggs. He has published notes upon eggs "spotted" with red-brown (1919b, 97; 1924a, 88); and upon nests found May 13 and 17, 1915, by Mr. Emmett Maxon and himself (1916e, 82).

65. **Ammodramus savannarum perpallidus** Coues.[19] WESTERN GRASSHOPPER SPARROW.

Listed as "common" by Graham (1915e, 191; 1919e, 187); listed also by Graham and Zeitlin (1921, 93). During 1911-1914 it was very common on the prairies about the Texas Christian University campus. In 1914, I noted it first on April 21, saw many the following day, and discovered the first nest (one egg) on May 5. On May 10 I found a nest containing seven fresh eggs, possibly the product of two females. Graham (1916e, 82) tells us of nests found May 5 (four eggs), May 13 (four eggs), and June 7 (five eggs), 1915, by himself and his friend Mr. Emmett Maxon.

[19] *Ammodramus savannarum bimaculatus* Swainson of the Check-List. For change of name see van Rossem, *Auk*, 1934, 549; and *Trans.* San Diego *Soc. Nat. Hist.*, VII, No. 30, May 31, 1934.

66. **Chondestes grammacus strigatus** (Swainson). WESTERN LARK SPARROW.

Abundant. Graham has published several notes upon it, among these one concerning a seven-day period of incubation which I think must be in the nature of a typographical mistake. Discussing this period he says (1924a, 88): "It takes a Lark Sparrow seven days to hatch a set of eggs and in twelve days after incubation starts the young are feathered." According to my own experience the period of incubation is twelve or thirteen days and the stub-tailed young leave the nest about eight or nine days after they have hatched.

During 1911-1914 I found scores of nests. In 1914, springtime arrivals from the South were noted on April 19, and several nests just ready for eggs were found on May 4. Many nests that I examined were on the ground under small bushes, bull nettles, or other weeds. A nest found June 4, 1914, held two runt eggs only.[20] Lark Sparrows were heard singing at night almost as frequently as were Mockingbirds during the height of the courtship period.

Graham (1916f, 137) writes of finding a nest with three Lark Sparrow and two Cowbird eggs on May 13, 1916. Mr. Graham tells me that he found three nests on June 26, 1916—two with four eggs and one with three eggs.

67. **Aimophila cassini** (Woodhouse). CASSIN'S SPARROW.

Not common, and decidedly local; listed as "rare" by Graham (1915e, 191; 1919e, 187); listed also by Graham and Zeitlin (1921, 93). During 1913 and 1914 I found it nesting in a restricted section of rocky prairie southwest of Texas Christian University. Here I watched the males giving their flight-songs day after day, took two specimens by way of identification, and found two nests—one with five fresh eggs on May 16, and one with four fresh eggs on May 20. Graham (1915g, 191) writes entertainingly of two nests found by him while he was searching for Black Vulture eggs. These nests, each of which contained four "incubated eggs," were found on April 12 and 13, 1915, in the "rugged hills northwest" of Fort Worth. Graham writes, too, of a nest with four eggs found on the "unusually late date" of May 5, 1915 (1916e, 82). In an early note from the Fort Worth region (1914b, 136) he tells of a nest with white eggs found

[20] These eggs are thought to be in the collection of Mr. J. Warren Jacobs, of Waynesburg, Pennsylvania, at the present time.

in early April, 1914, which may well have been of the present species though the eggs are said to have been "about the size of a Catbird's."

68. **Spizella pusilla pusilla** (Wilson). EASTERN FIELD SPARROW.

Uncommon and local; listed by Graham (1915e, 191; 1919e, 187) as "rare"; listed also by Graham and Zeitlin (1921, 93); not noted by me during the summer, 1911-1914. According to Graham (1914b, 139; 1916c, 34) the species returns from the South in March and nests in the "dry, hilly country" north or northwest of Fort Worth, where he found eggs as early as April 12 (two sets of four eggs; two sets of five eggs), April 13 (a set of five eggs), and April 14 (a set of four eggs) during the spring of 1914.

Mr. Graham informs me that he encountered two nesting pairs in the vicinity of his encampment at Lake Worth during early June, 1918.

BIBLIOGRAPHY

DANIELS, VERLAIN.

1921. Texas Notes. *Oölogist*, XXXVIII, No. 7, July, 1921, 92. Notes on Green Heron nests with young found May 31, 1921.

1926. Texas Notes. *Oölogist*, XLIII, No. 2, February, 1926, 16. Notes on Robin and Purple Gallinule nests found at Fort Worth.

GRAHAM, RAMON.

1912. The Black and Turkey Vulture. *Oölogist*, XXIX, No. 3, August, 1912, 334.

1914a. Hints on Hawk, Owl and Vulture. *Oölogist*, XXXI, No. 2, February, 1914, 30-31.

1914b. First Sets Taken This Season, 1914. *Oölogist*, XXXII, No. 7, July, 1914, 138-9. Notes concerning nests of several well known species; a "red-eyed" vireo's nest; and a Poor-will collected on April 14.

1915a. North Texas Bird Notes. *Oölogist*, XXXII, No. 6, June, 1915, 102-3. Notes concerning the Mockingbird, Lark Sparrow, Field Sparrow, Grasshopper Sparrow, and Dickcissel.

1915b. A White-eyed Vireo's Misfortune. *Oölogist*, XXXII, No. 6, June, 1915. 104.

1915c. A Freak Set of Cardinals. *Oölogist*, XXXII, No. 9, September, 1915, 153.

1915d. Road Runner. *Oölogist,* XXXII, No. 11, November, 1915, 182.

1915e. Birds That Nest in Tarrent [Tarrant] Co. Texas and Notes. *Oölogist,* XXXII, No. 11, November, 1915, 191.

1915f. Belted Kingfisher. *Oölogist,* XXXII, No. 11, November, 1915, 191.

1915g. Two Accidental Finds of Cassin's Sparrows. *Oölogist,* XXXII, No. 11, November, 1915, 191.

1915h. Mourning Dove Notes. *Oölogist,* XXXII, No. 12, December, 1915, 211. Notes concerning dove eggs in "Boat-tailed" Grackle nests.

1916a. A Krider's Hawk Trick. *Oölogist,* XXXIII, No. 2, February, 1916, 31-2.

1916b. The Scissor-tailed Flycatcher. *Oölogist,* XXXIII, No. 2, February, 1916, 33-4.

1916c. Notes. *Oölogist,* XXXIII, No. 2, February, 1916, 34. Notes on Field Sparrow and Phoebe nests found near Fort Worth.

1916d. Painted Bunting. *Oölogist,* XXXIII, No. 4, April, 1916, 76.

1916e. Nesting Dates of Texas Birds. *Oölogist,* XXXIII, No. 4, April, 1916, 81-2. Notes on many well known species; also on a nest of "Black-chinned" Hummingbird.

1916f. Notes from Camp Graham at Lake Worth, Nine Miles Northwest of Ft. Worth, Texas. *Oölogist,* XXXIII, No. 7, July, 1916, 137-9. Notes on nests of several species.

1916g. Texas Bird Notes. *Oölogist,* XXXIII, No. 10, October, 1916, 170-1. Notes on the Screech Owl, Ruby-throated Hummingbird, Turkey Vulture, and other species.

1916h. The Water Bound Chickadee. *Oölogist,* XXXIII, No. 11, November, 1916, 189.

1917a. Fishing for Barn Owls in Lake Worth. *Oölogist,* XXXIV, No. 1, January, 1917, 18.

1917b. Mockingbird and Green Snake. *Oölogist,* XXXIV, No. 2, February, 1917, 33. This note appears also in the March issue, No. 3, 1917, 58.

1917c. Tufted Titmouse Found at Night. *Oölogist,* No. 3, March, 1917, 58.

1917d. Plumbeous Chickadees are not Afraid. *Oölogist*, XXXIV, No. 5, May, 1917, 84.

1917e. Horned Owls not Collected. *Oölogist*, XXXIV, No. 5, May, 1917, 90.

1917f. Eagles. *Oölogist*, XXXIV, No. 5, May, 1917, 94. Included here are notes on Barn Owl nests discovered March 26 and April 2, 1916.

1917g. Notes from Camp Graham, Ft. Worth, Texas. *Oölogist*, XXXIV, No. 11, November, 1917, 187-9. Notes on the nesting of the Green Heron at Lake Worth and on a "wren," probably *Thryomanes bewicki*.

1918a. Ducks and Other Water Birds of Lake Worth, Texas. *Oölogist*, XXV, No. 2, February, 1918, 29-30. Includes a note on the occurrence of the Wood Duck in summer.

1918b. [Nesting of the Summer Tanager at Lake Worth, Tarrant County, Texas.] *Oölogist*, XXXV, No. 10, October, 1918, 140-1. Note on a Summer Tanager nest with egg-shells found by Mr. Verlain Damals [Daniels] on July 23, 1918, at Williams' Spring, Lake Worth.

1919a. Notes from Camp Graham. *Oölogist*, XXXVI, No. 5, May, 1919, 89-90. Notes on nests of Screech Owl, Belted Kingfisher, Plumbeous Chickadee, Tufted Titmouse, and Turkey Vulture.

1919b. Bird Notes from Lake Worth, Tarrant County, Texas. *Oölogist*, XXXVI, No. 6, June, 1919, 97. Notes on the following species: Belted Kingfisher, Scissor-tailed Flycatcher, Blue-gray Gnatcatcher, Summer Tanager, Whip-poor-will, Bewick's Wren, Ruby-throated Hummingbird, Red-headed Woodpecker, Crested Flycatcher, Dickcissel, and others.

1919c. The Plumbeous Chickadee. *Oölogist*, XXXVI, No. 6 [No. 7], July, 1919, 127-8.

1919d. My First Find of Blue Grosbeaks. *Oölogist*, XXXVI, No. 8, August, 1919, 133.

1919e. Tarrant County, Texas Breeders. *Oölogist*, XXXVI, No. 10, October, 1919, 187-8. With brief annotations.

1919f. Bird Notes. *Oölogist*, XXXVI, No. 10, October, 1919, 188. Notes on the Boat-tailed [Bronzed] Grackle.

1920. Vulture Times. *Oölogist*, XXXVII, No. 6, June, 1920, 68.

1922a. The Blue Grosbeak in Terrant [Tarrant] County, Texas. *Oölogist*, XXXIX, No. 2, February, 1922, 25.

1922b. Carolina Wren Building Material. *Oölogist*, XXXIX, No. 12, December, 1922, 175-6.

1923a. Plumbeous Chickadee. *Oölogist*, XL, No. 4, April, 1923, 58. Note on a nest and seven eggs found March 25, 1923.

1923b. Timing a Screech Owl. *Oölogist*, XL, No. 5, May, 1923, 79. Note on a Screech Owl nest that contained one egg on March 24, three eggs on March 31, 1923.

1924a. Nature Studies. *Oölogist*, XLI, No. 7, July, 1924, 88. Notes on the following species: Cardinal, Blue-gray Gnatcatcher, Cowbird, Scissor-tailed Flycatcher, and Lark Sparrow.

1924b. A 1909 Wonder. *Oölogist*, XLI. No. 7, July, 1924, 89. Notes on [Western] Meadowlarks nesting south of Fort Worth.

GRAHAM, MRS. RAMON.

1922. A Devoted Father. *Oölogist*, XXXIX, No. 11, November, 1922, 155. Notes on the Scissor-tailed Flycatcher.

GRAHAM, RAMON AND MAXON, GEORGE EMMETT.

1915. First Eggs of the Season in Texas. *Oölogist*, XXXII, No. 7, July, 1915, 118. Notes on the Crow, Screech Owl, Barn Owl, Black and Turkey Vultures, Krider's Hawk, and Great Horned Owl.

GRAHAM, RAMON AND ZEITLIN, JAKE.

1921. List of Breeding Birds of Tarrant County, Texas. *Oölogist*, XXXVIII, No. 7, July, 1921, 93. List of the birds observed in summer during the years 1915-1919.

LITSEY, JOHN B., JR.

1911. Scissor-tailed Flycatcher (Milvulus forficatus [sic.]). *Oölogist*, XXVIII, No. 6, June, 1911, 106-7.

MAXON, GEORGE EMMETT.

1916a. The Texan Nighthawk, *Oölogist*, XXXIII, No. 10, October, 1916, 178. These notes, which pertain to *C. minor* and not to *C. acutipennis*, obviously apply to the Fort Worth region, though this fact is not stated.

1916b. Black and Turkey Vultures. *Oölogist*, XXXIII, No. 10, October, 1916, 178. These notes apparently pertain to the Fort Worth region.

1921. The Turkey and the Black Vulture. *Oölogist*, XXXVIII, No. 12, December, 1921, 177.

MOFFAT, EARL E.

1916a. American Osprey at Fort Worth, Texas. *Oölogist,* XXXIII, No. 1, January, 1916, 13.

1916b. Hunting Owl Eggs from a Boat. *Oölogist,* XXXIH, No. 8, August, 1916, 147-9. Notes concerning a Barred Owl nest.

1916c. An Expensive Set of Blue Gray Gnat Catchers. *Oölogist,* XXXIII, No. 8, August, 1916, 152-3.

1916d. Turkey Vulture Eggs. *Oölogist,* XXXIII, No. 9, September, 1916, 159.

[ROWE, N., Editor]

1885. How the Quails Fared. *American Field,* XXIII, No. 11, March 14, 243. A note concerning Bob-whites and Prairie Chickens in winter in the Fort Worth region.

STRECKER, JOHN K. JR.

1912. The Birds of Texas. *Baylor University Bulletin,* Vol. XV, No. 1, January, 1912, 69 pp.

SUTTON, GEORGE MIKSCH.

1912a. The Bravery of the Nonpareil. *Bird-Lore,* XIV, No. 1, January-February, 1912, 61.

1912b. An Albinic Burrowing Owl. *Bird-Lore,* XIV, No. 3, May-June, 1912, 194.

1913. A Pet Road-Runner. *Bird-Lore,* XV, No. 5, September-October, 1913, 324-326.

1915. Suggestive Methods of Bird-Study: Pet Road-Runners. *Bird-Lore,* XVII, No. 1, January-February, 1915, 57-61.

1922. Notes on the Road-Runner at Fort Worth, Texas. *Wilson Bulletin,* XXXIV, No. 1, March, 1922, 1-20.

1929. Birdnesting under Difficulties. An Adventure with a Turkey Vulture. *Atlantic Monthly,* 143, No. 6, June, 1928, 810-814.

ART. XIV. HELIOPHYLLUM AND "CYSTIPHYLLUM," CORALS OF HALL'S "ILLUSTRATIONS OF DEVONIAN CORALS."

By Carroll Lane Fenton and Mildred Adams Fenton

Annals of the Carnegie Museum
Vol. XXVII, p. 207-250, 1938

Issued Oct. 22, 1938
Pittsburgh, Pa.

ART. XIV. HELIOPHYLLUM AND "CYSTIPHYLLUM," CORALS OF HALL'S "ILLUSTRATIONS OF DEVONIAN CORALS."

By Carroll Lane Fenton and Mildred Adams Fenton

(Plates XVII-XXIV)

Introduction

In an earlier paper[1] we reviewed the circumstances attending publication of Hall's "Illustrations of Devonian Fossils" and its separate brochure on corals. We assigned both publications to the year 1876, partly because of the date on title pages, and partly because a letter from Rominger, which was found in Hall's personal copy of the coral brochure, indicated that its plates were published before Rominger's paper on fossil corals. That letter, dated by month and day but not year, was handed to the late Dr. Stuart Weller for preservation in the University of Chicago Library, but cannot now be found.

At Dr. Stanley Smith's request, Dr. Rudolf Ruedemann has investigated the date of Hall's "Illustrations." He finds that manuscript for its plate legends was not received until December 21, 1876, indicating that the book itself did not appear before 1877. Dates in our paper should be changed accordingly. The date on which Rominger's work actually was published still is undetermined.

Our first paper on corals of Hall's "Illustrations" described the tabulates. This study is devoted to the rugose genus, *Heliophyllum* and to Cystimorphs currently termed *Cystiphyllum*, of which Hall figured several new species and subspecies, as well as others described before 1877. We have added a few forms which are associated with and are closely related to the species of *Heliophyllum* mentioned by Hall.

The form of description agrees with that of our paper on tabulates, making this paper a text to Hall's plates. Illustrations have been

[1] Annals Carnegie Mus., vol. XXV, art. 5, pp. 17-58, 1936.

Issued October 22, 1938.

limited to sections and a few figures showing the shape or growth of new or debatable groups. Prospective republication of Hall's original figures in the "Type Invertebrate Fossils of North America (Devonian)" makes detailed illustration of external characters unnecessary. They have been discussed in detail, partly because they aid in identification of some species and subspecies; partly because such discussion may help clarify the uncertain relationships of external and internal characters in rugose corals. It is especially appropriate because we sometimes were forced to identify some sectioned hypotypes by comparing them externally with Hall's holotypes and syntypes.

While this paper was in press, Dr. J. W. Wells published his study of "Individual Variation in the Rugose Coral Species Heliophyllum halli E. & H."[2] Dr. Wells reduced Hall's species and subspecies to *formæ* of *H. halli* which supposedly represent only individual, or fluctuating variation. He applied Hall's names to these *formæ* and names several new ones, supposedly of the same sort.

While we do not deny that *H. halli s. s.* may contain individual variants which resemble his named species and subspecies, we have not found them. More important, Dr. Wells' five figures of internal structures are indistinct and do not enable us to identify his *formæ* from the Ludlowville of Skaneateles Lake with our own hypotypes, which dominantly are from the Moscow of western New York. Lacking sections of Wells' specimens, we prefer to retain the interpretations advanced in this paper and to suggest that if fluctuating *formæ* of *H. halli* are named, they should have designations other than those of Hall's species and subspecies.

ACKNOWLEDGMENTS

Grants from the American Association for the Advancement of Science and the American Academy of Arts and Science financed this study. Mr. E. R. Eller collected some of the specimens used as hypotypes, while Drs. Charles C. Adams and Rudolf Ruedemann, of the New York State Museum, lent those of Hall's types which are in that institution. Dr. Wells has answered many questions regarding his interpretations of *Heliophyllum*.

[2] Palæontographica Americana, vol. 2, no. 6 (1937).

SYSTEMATIC REVISION

Generic Descriptions

Genus Heliophyllum Hall

Genotype *H. halli* Milne-Edwards and Haime, by subsequent monotypy.

Heliophyllum Hall, in J. D. Dana, U. S. Explor. Exped. during years 1838-1842, under command Charles Wilkes, U. S. N., vol. 7, Zoophytes, p. 356, Philadelphia 1848 or 1849 (?); Milne-Edwards and Haime, Mon. Polyp. Foss. Terr. Pal., Arch. Mus. d'Hist. Nat., vol. 5, p. 408, 1851; Nicholson, On the Structure and Affinities of the Genera *Heliophyllum* and *Crepidophyllum*, Ann. Mag. Nat. Hist., ser. 5, vol. 1, pp. 44-54, 1878.

Original Description: "There are others in which these dissepiments run *upward* and inward, as represented in plate 26, figures 3, 4, 4*a;* and as the species have also some difference of habit [from *Cyathophyllum*] they constitute at least a subgenus, if not a wholly distinct group. The name HELIOPHYLLUM, has been applied by Mr. James Hall to a specimen of this kind in his cabinet and may well be retained. It is represented in his N. Y. Geological Report, fig. 3, p. 209, and is probably near the Cyathophyllum Helianthoides of Goldfuss, plate 20, fig. 2.

"The subgenus *Heliophyllum* will then contain species having generally the transverse septa of the Cyathophylla, but with the intermediate dissepiments running oblique *upward* and inward. Plate 26, figure 3, is a section of the same turbinate species, figured by Mr. Hall; and figs. 4, 4*a*, are views of sections of a massive Astræoid species."

Milne-Edwards and Haime's Description (*Translation*)*:* "Polyp simple, subturbinate. Septa well developed, giving rise laterally to lamellar prolongations which advance from the wall to the center, pursuing an arched and ascending direction, in this way forming irregular tabulæ on the vertical axis; these lamellar prolongations are united, near the periphery of the corallum, by vertical dissepiments.

"*Heliophyllum* very clearly is distinguished from other Cyathophyllids by the very remarkable structure of its interseptal spaces." (Authors' translation.)

Revised Description: Corallum simple, proliferating or massively compound with calycinal or marginal calycinal gemmation. Septa long, straight or flexuous, in two distinct series; they may stop short of the axis, ending freely or turning to form phyllothecal plates or tubes; may reach the axis and join in fascicles; may twist into a rudimentary, irregular or reticulate streptocolumella, or even may form a heavy streptocolumella reënforced by stereoplasm.

In some species the septa disintegrate marginally into radial series of cysts. Carinæ opposite: present on septa in all but early neanic stages. Tabulæ incomplete or complete, differentiated into a central and outer series. In the former they are horizontal or convex; in the latter they generally are concave. Dissepiments small, numerous and cystose; in some species they lie between or cross irregularly radial structures here termed interseptal plates. Stereozones well developed in some species, forming structures which vary both specifically and with growth stages.

Remarks: Heliophyllum probably finds its closest relative in *Eridophyllum* Milne-Edwards and Haime[3] (= *Crepidophyllum* Nicholson and Thompson and *Craspedophyllum* Dybowski, *fide* Smith)[4]. In this genus of compound—and probably solitary—corals, the carinæ are opposite and at right angles to the septa, which bend and form a continuous axial tube or aulos. A similar structure appears in neanic stages of *H. obconicum teres,* and elongate, flexed and united septa (phyllothecæ) are present in *H. halli,* with development of an indistinct periaxial zone. Yet the structures are so much inferior to those of *Eridophyllum* that there seems little danger of confusion.

Longitudinal sections of *Heliophyllum* are, in some species, virtually identical with those of *Xylodes* Lang and Smith, of the Silurian. *Xylodes,* however, lacks a stereozone and, in transverse section, shows septa which either are non-carinate or have carinæ arranged alternately at the angles of zigzag septa, while septa of *Heliophyllum* are straight or flexuous and carinæ are opposite. Thus the character of the carinæ, not their mere presence, serves to distinguish the genera.

Genus CYSTIPHYLLUM Lonsdale

Genolectotype *C. siluriense* Lonsdale, selected by Lang and Smith.

Cystiphyllum Lonsdale, in Murchison, Silurian System, p. 691, 1839; Milne-Edwards and Haime, Mon. Brit. Foss. Corals, p. lxxii, 1850; Mon. Polyp. Foss. Terr. Pal., Arch. Mus. d'Hist. Nat., vol. 5, p. 464, 1851; Lang and Smith, Proc. Geol. Soc. London, vol. 83, p. 455 ff., 1927.

Remarks: Lang and Smith, and Smith, have found that *Cystiphyllum siluriense* is a Tryplasmid coral whose septal rays are derived from primarily acanthine septa. Devonian Cystimorphs, on the other hand, are derived from ancestors with lamellar septa, and therefore are not congeneric with *C. siluriense.* No new generic term may be applied to them, however, because Wedekind has distinguished

[3] Mon. Brit. Foss. Corals, p. lxxi, 1850.

[4] Am. Jour. Sci., vol. 26, p. 520, 1933. See p. 518 for a revised diagnosis of *Eridophyllum* and p. 519 for description of the genotype, *E. seriale* Milne-Edwards and Haime.

genera of Devonian Cystimorphs whose essential structure cannot be determined from his descriptions and figures.

Under these conditions, we are forced to use *Cystiphyllum* as a generic name for some of the corals described in this paper, even though it is inappropriate. To indicate this fact, we have placed the name in quotation marks. Fortunately, uncertainty as to generic identity apparently does not affect the relationships and differences between Hall's species, with which this study is concerned.

SPECIFIC DESCRIPTIONS

To facilitate reference to the "Illustrations of Devonian Corals," each species or variety is given a separate heading conforming to that publication, changes or corrections being given in the bibliography, description or remarks.

HELIOPHYLLUM HALLI Milne-Edwards and Haime; Hall, Ill. Dev. Foss. Corals, pl. 23, figs. 1-5, 12; pl. 25, figs. 1-7, 1877.

Heliophyllum halli Milne-Edwards and Haime (Fig. 6; plate XVII, figs. 1-5; plate XVIII, fig. 1.)

?Strombodes helianthoides Hall, Geol. N. Y., pt. 4, p. 209, no. 48, fig. 3, 1843, (*not Cyathophyllum helianthoides* Goldfuss).

Heliophyllum halli Milne-Edwards and Haime, Mon. Brit. Foss. Corals, p. lxix, 1850; Mon. Polyp. Foss. Terr. Pal., Arch. Mus. d'Hist. Nat., vol. 5, p. 408, pl. 7, figs. 6-6b, 1851; Hall, Ill. Dev. Foss. Corals, pl. 25, figs. 2-3, 5-7, (*probably not* pl. 23, figs. 1-4; *not* pl. 23, figs. 5, 12 and pl. 25, fig. 4 = *H. obconicum*), 1877; Shimer and Grabau, Bull. Geol. Soc. Am., vol. 13, p. 167, 1902.

Not *Heliophyllum halli* Stewart, Geol. Soc. Am. Spec. Pap. 8, p. 37, pl. 6, figs. 7-8, 1938.

Cyathophyllum halli Rominger, Geol. Surv. Mich., vol. 3, p. 98, pl. 25 (part?), 1876(?); Lambe, Contrib. Can. Pal., vol. 4, p. 148 (part), 1901.

Original Description (*Translation*): "Corallum turbinate or cylindro-conical, in general rather elongate and slightly curved at the base; surrounded by an epitheca and presenting slight expansions. Calyx circular and moderately deep; septal fossette small; septa very thin, crowded, rather large at the top or increasing in size upward and denticulate on their free margins, slightly unequal in alternating series, somewhat twisted in the center; they number more or less than 80. In a vertical section one sees that the lateral prolongations of the septa are arched and ascending; those that occupy the upper part of the interspaces (*loges*) terminate on the free border of the septa but those which lie lower unite centrally to form irregular tabulæ; these prolongations, which incompletely close the interseptal spaces, are spaced more or less than one millimeter apart and are united by simple, crowded dissepiments which cut them at right angles. Height 5 or 6 cm.; diameter of the calyx 4 cm."

Revised Description: Corallum solitary, thickly subturbinate, moderately and generally uniformly curved; constrictions numerous but amounting to 20 per cent. or more of the diameter only in gerontic stages. Epitheca thin but generally continuous; costæ prominent; symmetry and insertion of septa well displayed by costæ and septal grooves. Fossa occupies 60 to 80 per cent. of the calyx; marginal zone convex and undefined. Fossula indistinct. Septa discernibly in two series, but subequal in thickness and height; denticulations marked but not coarse. Diameter of largest hypotype (gerontic) 62.5 mm.; of two ephebic hypotypes, 36 and 38 mm.

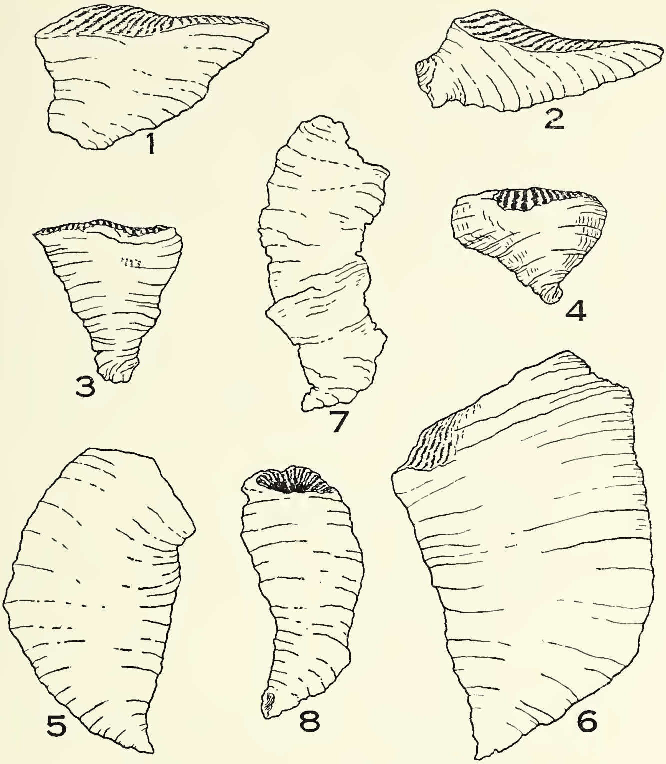
Transverse sections slightly less than 20 mm. in diameter show 48 to 52 septa in two sharply distinguished series. Primaries reach the central region or even the axis, bending and fusing with others; in some cases they show junction of cardinal and counter septa with closure of the fossula by the third pair of septa in the cardinal quadrants. More commonly, there is indiscriminate flexuous union, as in plate XVII, figure 5, the primaries occupying a rhomboidal or rhombo-ovoid region in which secondary calcification gives them thicknesses reaching 1.3 mm. Dissepiments are marginal, carinæ lacking or incipient; interseptal plates are lacking.

One section 28 mm. in diameter shows 72 septa; primaries and ends of a few secondaries are heavily calcified; primaries deflect and join (or end) 0.5 to 2 mm. from the axis. Carinæ well developed; dissepiments numerous and closely spaced marginally; interseptal plates incipient or lacking. Other ephebic sections show 64 to 68 septa which generally lack secondary thickening; a few are united by phyllothecal extensions.

In gerontic sections (plate XVII, figures 1 and 4) the septa number 80 to 94 and phyllothecæ become well developed. The fossula persists, but is very indistinct. Septa remain continuous, and in neither gerontic hypotype is there trace of interseptal plates. Dissepiments apparently more numerous, but definitely thinner than at lower levels; thickness of carinæ somewhat reduced.

Longitudinal sections show few ontogenetic changes except the development of carinæ and thinning and crowding of dissepiments. Tabulæ are markedly incomplete, convex and cystose; differentiation into inner and outer series definite but not complete in all coralla, and clearly distinguishable only where the outer series is set apart by phyllothecæ, which appear not to form a true aulos.

Remarks: Milne-Edwards and Haime's description mentions no characters which distinguish *Heliophyllum halli* from several other



FIGURES 1-8. Lateral views of specimens of *Heliophyllum*, showing characteristic differences in shape. All figures × 0.5.

FIG. 1. *H. arachne* Hall. A hypotype showing typically oblique growth. Hamilton (Moscow), D.L. and W. R.R., 1.5 miles east of East Alexander, N. Y. (6776 Carnegie Museum.)

FIG. 2. *H. arachne* Hall. A hypotype with exceptionally oblique growth. Position in life doubtful. Hamilton (Moscow), D.L. and W. R.R., 1.5 miles west of East Bethany, N. Y. (6775 Carnegie Museum.)

FIGS. 3-4. *H. reflexum* Hall. Two hypotypes. Hamilton (Moscow), D.L. and W. R.R., 1.5 miles east of East Alexander, N. Y. (6784-6785 and 6777 Carnegie Museum.)

FIG. 5. *H. decorosum* sp. nov. Holotype. Hamilton (Moscow), Leicester (= Moscow), N. Y. (6751-6753 Carnegie Museum.)

FIG. 6. *H. halli* Milne-Edwards and Haime. A large but otherwise typical specimen. Hamilton (Moscow), Leicester, N. Y. (7348-7350 Carnegie Museum.)

FIG. 7. *H. asperum* sp. nov. A paratype of moderate diameter and greater than average height. Hamilton (Moscow), D.L. and W. R.R., 1.5 miles east of East Alexander, N. Y. (7335-7336 Carnegie Museum.)

FIG. 8. *H. halli irregulare* Hall. A typical, irregular specimen. Hamilton (Moscow), western N. Y. (37722 Walker Museum.)

subturbinate and turbinate members of the genus. Chief reliance is placed on their figure 6, which shows a longitudinal section in which tabulæ seem to constitute one series and are highly convex. These characters rule out the externally similar *H. decorosum* n.sp., while they join with shape to eliminate *H. obconicum* Hall. The specimens selected as hypotypes agree with this section more closely than do any others that we have found, and also compare well with Hall's plate 25, figures 2 to 3 and 5 to 7.

No attempt has been made to solve the doubtless complicated synonymy of this species. Lambe[5] considers *H. eriense* Billings, *H. cayugœnse* Billings, *H. canadense* Billings, *H. colbornense* Nicholson, *H. proliferum* Nicholson and *H. proliferum* Hall as synonyms of "*Cyathophyllum*" *halli;* but the last two definitely may be eliminated from that category, while the first four are without descriptions or figures on which conclusions may be based.

Occurrence: Hamilton (especially Moscow), western and central-western New York, Thedford regions of Ontario, and probably in the Ohio Valley. Specimens on which redescription is based are from the Hamilton of western New York.

Hypotypes: 3778, 3779 Walker Museum; 6706-6719 and 7348-7353 Carnegie Museum.

HELIOPHYLLUM DEGENER Hall,
Ill. Dev. Foss. Corals, pl. 25, figs. 8-11, 1877.

Heliophyllum halli degener Hall (Plate XVII, figs. 6-8; plate XVIII, fig. 2.)

Heliophyllum degener Hall, Ill. Dev. Foss. Corals, pl. 25, figs. 8-11, 1877.

Description: Corallum irregularly subturbinate, with more moderate rate of expansion than that of *H. halli.* This expansion persists into ephebic stages, at heights of 30 to 55 mm. above the base. Beyond this it is replaced by periodic but persistent constriction which reduces the diameter by one-fourth to one-half in gerontic stages. Epitheca thin, discontinuous or gerontically absent; calyx shallow to deep. Fossa generally indistinct externally though well marked in sections. Septa fine to coarse, subequal marginally.

Internal characters are shown by plate XVII, figures 6 to 8. Septa number 70 throughout and, especially in ephebic stages, commonly show union at the edge of the tabular zone and thickening of the

[5] Contrib. Can. Pal., vol. 4, p. 148, 1901.

primaries within it. The primaries unite by phyllothecæ and the fossa is enclosed. Dissepiments are closely spaced; carinæ are thicker than those of *H. halli.* Highly convex, outwardly downcurved tabulæ are pronounced through ephebic stages.

Remarks: While this may be a physiologic variant, the association of internal characters with defective epitheca and gerontic constriction is so constant as to indicate at least subspecific rank. Hall himself questioned the value of the form, designating it as "n. sp.?" Similarity between the axial region of *H. halli degener* and that of *H. halli* indicates close relationship with the latter species.

Occurrence: Hamilton, Skaneateles Lake (type locality), East Alexander and other localities in western New York.

Syntypes: $\frac{4456}{1}$ Am. Museum of Natural History; *Hypotypes:* 37758 Walker Museum and 6729-6735 Carnegie Museum.

HELIOPHYLLUM IRREGULARE Hall,
Ill. Dev. Foss. Corals, pl. 24, figs. 1-7, 13, 1877.

Heliophyllum halli irregulare Hall (Fig. 8; plate XVIII, figs. 3-6.)

Heliophyllum irregulare Hall, Ill. Dev. Foss. Corals, pl. 24, figs. 1-6; (*not* pl. 24, figs. 7, 13), 1877.

Description: Corallum irregularly subturbinate, with moderate rate of expansion and numerous constrictions which, in some cases, amount to .35 or .40 of the diameter preceding them. Epitheca comparatively thick and heavily wrinkled; costæ generally indistinct in wrinkled specimens. Calyx generally constricted in specimens more than 30 mm. long; fossa deep and steep-sided; marginal zone narrow, poorly defined, and steeply inclined. Primary septa generally very coarse, numbering 30 to 38 in calyces 27 to 30 mm. in diameter; commonly they visibly fail to reach the axial region. In such specimens, the secondaries appear as weak ridges or are indistinguishable even in the marginal zone. In some, however, the septa are subequal marginally and the primaries approach the axis and unite in fascicles as shown in Hall's figure 3.

A transverse section 8.8 mm. in diameter shows 21 short marginal septa without carinæ and with few dissepiments. One measuring 17.5 mm. shows 58 thin, continuous carinate septa whose primaries stop short of an axial region 4.5 to 5.3 mm. in diameter. Another, 28 mm. in diameter, has similar septa, with carinæ numerous and relatively thick.

Primaries are 9.5 to 11 mm. long, the secondaries 5 mm. or less. All end freely, structures which in sections appear as phyllothecal plates actually being highly convex, incomplete tabulæ. Carinæ well developed but not thick; dissepiments widely spaced. There is no perceptible sclerotheca and virtually no stereozone.

Remarks: Externally, this subspecies may be distinguished from *H. asperum* sp. nov. by its more nearly continuous epitheca, by its narrow, convex marginal zone and its failure to develop two sharply marked series of septa, secondaries being either obscure or virtually as strong as the primaries. The principal hypotype shows the former condition, with septa stopping short of the center, and therefore closely resembles the specimen of Hall's figures 1 to 2. Another (37722 Walker Museum) has subequal septa reaching almost to the axis, and corresponds to Hall's figure 3. It is doubtful, however, that reliable identifications can be made without sections.

Occurrence: Hamilton (Moscow), Darien (type locality), East Alexander, Leicester and elsewhere in western New York.

Syntypes: $\frac{3440}{1}$ N. Y. State Museum and $\frac{4460}{1}$ Am. Museum of Natural History; *Hypotypes:* 37722 Walker Museum and 6742-6750 Carnegie Museum.

Heliophyllum decorosum sp. nov. (Fig. 5; plate XVIII, figs. 7-9.)

Heliophyllum irregulare Hall, Ill. Dev. Foss. Corals, pl. 24, figs. 7, 13 (?), 1877.
Heliophyllum halli Hall, op. cit., pl. 23, figs. 1-3 (?).
Heliophyllum proliferum (?) Hall, op. cit., pl. 26, fig. 5 (?).

Description: Corallum generally solitary, though some specimens show parricidal calycinal gemmation; subturbinate though considerably and commonly irregularly curved. Constrictions more pronounced than those of *H. halli*, but less than those of *H. halli degener;* epitheca thicker than that of *H. halli*, with low costæ. Width of fossa less than half its depth, its sides steep, its floor concave from presence of a wide false columella. Fossula indistinct. Septa number 4 to 5 in 5 mm. at periphery of holotype, which is constricted, 3 at periphery of an expanded, gerontic paratype; they are equal except within the fossa.

A transverse section 14 mm. in diameter shows 56 septa, of which 9 reach the axial region and twist, uniting most of the remaining 19 primaries. Secondaries are 4 to 5 mm. long; some of them join and fuse with adjoining primaries. Carinæ well developed. Fossula pronounced but asymmetrical. There is a sharply bounded stereotheca, ovo-rhomboidal, within which the septa are secondarily thickened until they form a compact mass. Interseptal plates rudimentary.

Transverse sections 36 to 38 mm. in diameter show 64 to 66 thin, continuous septa in two series. The secondaries reach more than half the distance to the axis; some primaries stop 1 to 4.5 mm. from it while others, 6 to 10 in number, reach the axial region and twist, uniting many of the shorter primaries. There is no discernible secondary thickening in the holotype; interseptal plates are lacking.

A longitudinal section shows the tabulæ of the inner series to be flat or moderately concave and partially continuous. Those of the outer series are convex, the two series being bounded by incipient stereothecal plates and calcareous deposits on the septa themselves which are more prominent than the stereothecæ. Each of these might be termed a false aulos; their development is well shown in plate XVIII, figure 7.

Remarks: Identification of Hall's large syntypes of *H. irregulare* with this species is based upon the published section, which closely resembles two gerontic paratypes (6756 and 6766-6767 Carnegie Museum). The hypotype of *H. "halli"* illustrated in Hall's plate 23, figure 1 was compared externally with the small paratype of *H. decorosum;* specimens of figures 2 to 3 have not been traced, but are tentatively identified from illustrations.

Two specimens showing parricidal calycinal gemmation compare closely with the syntype of *H. proliferum* Hall illustrated, with query as to species, in Hall's plate 26, figure 5. Since sections show typical *decorosum* structure with only a few rudimentary interseptal plates, they, and Hall's specimen, are referred to this species.

Occurrence: Hamilton (Moscow), Leicester, East Alexander, East Bethany and Reserve, N. Y.

Holotype: 6751-6755; *Paratypes:* 6756-6770 Carnegie Museum.

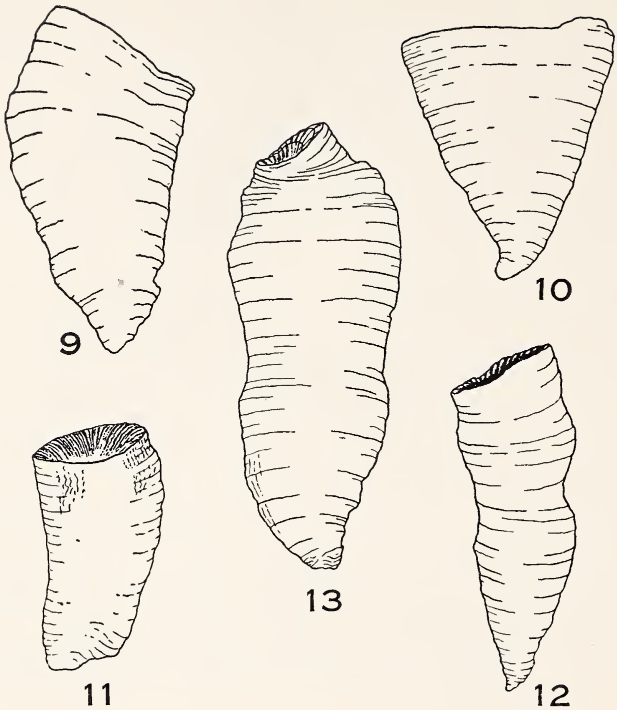
HELIOPHYLLUM ARACHNE Hall,
Ill. Dev. Foss. Corals, pl. 24, figs. 8-12, 14, 1877.

Heliophyllum arachne Hall (Figs. 1-2; plate XXII, figs. 1-2.)

Heliophyllum arachne Hall, Ill. Dev. Foss. Corals, pl. 24, figs. 8-12, 14, 1877.
?Heliophyllum reflexum Hall, op. cit., pl. 23, figs. 7-11.

Description: Corallum broadly subturbinate; generally oblique rather than curved, though a few large corals are curved in the manner of *H. halli* and show parricidal calycinal gemmation. Epitheca relatively thick; costæ low, rounded and indistinct except near the base. Calyx generally greater in diameter than is the corallum, because of oblique growth; fossa less than half its diameter; marginal zones flat or convex but well defined. Septa subequal or in two series; they are coarse with thick denticulations. Fossula rarely distinguishable externally.

A transverse section 27 to 30 mm. in diameter shows 62 septa; a



FIGURES 9-13. Lateral views of *Heliophyllum obconicum* Hall and its new subspecies, *teres*. All figures × 0.5.

FIG. 9. *H. obconicum* Hall. A hypotype of average diameter, showing gerontic change in direction of growth. Hamilton (Moscow), D.L. and W. R.R., 1.5 miles East of East Alexander, N. Y. (6822-6823 Carnegie Museum.)

FIG. 10. *H. obconicum* Hall. A hypotype showing more rapid expansion and basal curvature. The epitheca is very thin. Hamilton (Moscow), Leicester, N. Y. (6811-6812 Carnegie Museum.)

FIG. 11. *H. obconicum teres* subsp. nov. A paratype of moderate and nearly uniform diameter. Hamilton (Moscow), Livingston Co., N. Y. (20793 Walker Museum.)

FIG. 12. *H. obconicum teres* subsp. nov. The holotype, showing constrictions in growth. Hamilton (Moscow), LeRoy, N. Y. (6835-6840 Carnegie Museum.)

FIG. 13. *H. obconicum teres* subsp. nov. A gerontic paratype with extreme constriction of growth. Hamilton (Moscow), Genesee County, N. Y. (33393 Walker Museum.)

calyx reaching 49.5 mm. shows 78. Secondaries are 5 to 7 mm. long; primaries stop or fuse at distances of 2 to 4.5 mm. from the axis. Fossula pronounced. Stereozone subrhomboidal with greatly thickened septa. Interseptal plates are well developed in the fossular region, where they reach lengths to 4.5 mm.; elsewhere they are few and small. In late ephebic stages there is some disintegration of septa, also in the alar quadrants adjoining the fossula, but septa of the counter quadrants are continuous to the margins and so link the species with *H. decorosum.*

Remarks: The large syntype of *H. reflexum* Hall (his plate 23, figures 8 to 11) resembles this species more closely than it does the associated syntypes of *H. reflexum.* The specimen of Hall's figure 7 also may be a young corallum of *H. arachne.*

Occurrence: Hamilton (Moscow), Genesee valley (type locality), East Alexander and cuts 1.5 miles west of East Bethany, N. Y.

Syntypes: $\frac{4454}{1}$ Am. Museum of Natural History; *Hypotypes:* 6771-6776 Carnegie Museum.

HELIOPHYLLUM HALLI (?) var. OBCONICUM Hall,
Ill. Dev. Foss. Corals, pl. 25, figs. 12-13, 1877.

Heliophyllum obconicum Hall (Figs. 9-10; plate XIX, figs. 1-5; plate XX, figs. 8-10.)

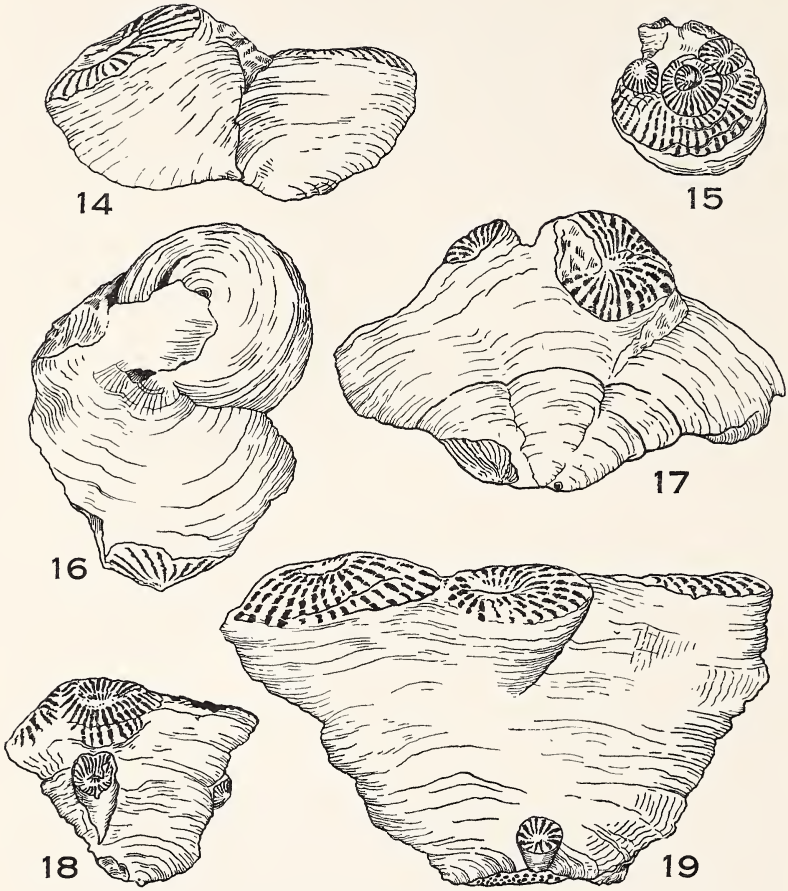
Heliophyllum halli (?) var. *obconicum* Hall, Ill. Dev. Foss. Corals, pl. 25, figs. 12-13, 1877.

Heliophyllum halli Hall, op. cit., pl. 23, figs. 5, 12; pl. 25, fig. 4.

Description: Corallum conical or conico-turbinate; slightly and regularly curved; constrictions of very slight magnitude. Epitheca thicker than that of *H. halli,* but the low rounded costæ show septal insertion clearly. On the theca, dissepiments describe lines which are concave upward or describe "saddles" less pronounced than those of *H. halli.* Fossa, in expanded specimens, is less than half the calycinal diameter; the marginal zone is gently convex or even flattened and is abruptly defined. In constricted specimens its character prevails but the fossa may occupy but one-third the diameter. Fossula distinguishable in the fossa only. Septa sharply and coarsely denticulate, equal only marginally; false columella but slightly elevated.

Transverse sections 8 mm. or less in diameter show 46 to 48 septa, with an enclosed fossula. Secondaries are 0.6 to 1 mm. long; primaries reach the central region, become flexuous, and either end freely or are united in fascicles of 2 to 4. Carinæ and interseptal plates lacking. Stereotheca ovoid and within 1 mm. of the periphery.

Sections 32 and 34 mm. in diameter (maxima, for these specimens,



FIGURES 14-19. *Heliophyllum obconicum* form *confluens* Hall. A series of specimens showing gemmation and fusion of corallites to form colonial coralla. Hamilton (Moscow), D.L. and W. R.R., 1.5 miles west of East Bethany, N. Y. (37762, 37767, 37763, 37760, 37764 and 37759 Walker Museum.) All figures × 0.5.

46 and 53.5 mm.) bear 79 and 78 septa. Secondaries 9 to 11 mm. long; they end freely or join adjacent primaries. The latter reach the axis or stop within 2.5 mm. of it; they turn, join and send out phyllothecal plates, the whole forming a variably complex network.

Carinæ prominent; dissepiments weak and irregular in direction. In some specimens, they hardly are distinguishable from the interseptal plates. These are abundant and well developed in the marginal zone, obscuring some of the weaker secondary septa and even giving rise to pseudosepta. The stereotheca is pronounced, and septa within it are considerably thickened.

Late ephebic and gerontic sections differ in the greater number of septa (84, 84 and 87 in three typical specimens), in the lengthening of secondaries (to 17 mm. in a diameter of 48 mm.), in the extreme development of interseptal plates, and in division of the septa themselves. In many cases these divide into series of 3 flexuous plates which become cystose and are linked by the carinæ. In others, the septa degenerate into a network of cysts and plates in which no order can be discerned, though the carinæ may remain solid and distinct.

Tabulæ are incomplete, convex and cystose throughout, though divided into two series. Their irregularity increases with growth.

Remarks: This species is externally distinguished from *H. decorosum* by its conical shape, small fossa and flattened marginal zone. Internally, the heavy stereotheca, abundant interseptal plates, and degeneration of septa themselves distinguish it.

Occurrence: Hamilton (Moscow), Skaneateles Lake (type locality), East Alexander, East Bethany, Leicester and other localities in western New York.

Holotype: $\frac{4458}{1}$ Am. Museum of Natural History; *Hypotypes:* 23429, 37755-37757 Walker Museum and 6811-6834 Carnegie Museum.

HELIOPHYLLUM CONFLUENS Hall,
Ill. Dev. Foss. Corals, pl. 26, figs. 3-4; pl. 27, 1877.

Heliophyllum obconicum form **confluens** Hall (Figs. 14-19; plate XXI, fig. 1.)

?Cyathophyllum (*Strombodes?*) *turbinatum?* Hall (*not* Goldfuss), Geol. N. Y., pt. 4, no. 49, fig. 1, 1843.

Heliophyllum confluens Hall, Ill. Dev. Foss. Corals, pl. 27; (*not* pl. 26, figs. 3-4), 1877; Grabau and Shimer, N.A. Index Foss., vol. 1, p. 68, fig. 103, 1909.

?Cyathophyllum multigemmatum Davis, Kentucky Foss. Corals, pl. 80, fig. 17; *probably* pl. 89, fig. 2 and pl. 92, fig. 4, (*not* pl. 87 and pl. 88, fig. 1), 1887.

Description: Corallum compound, originating by basal or marginal gemmation, by fusion of adjoining corallites, or by a combination of both methods. Peritheca formed by fusion of heavily wrinkled epithecæ. External characters much like those of *H. obconicum* except that some corallites are more widely expanded. Internal characters differ from those of that species only in moderate shortening of secondary septa, general absence of secondary thickening, and development of a more pronounced axial network. Both theca and epitheca commonly disappear within the corallum; septa join at low angles or even achieve moderate degrees of confluence. Dissepiments commonly fuse to unite corallites.

Remarks: Strict application of priority would apply the name *confluens* to the specimen of Hall's plate 26, figures 3 to 4. That specimen, however, was not available for study, and it departs from the obvious intention of the name in having corallites which are not confluent but are separated by ridges which appear to be thecæ. Thecæ are not present in the specimen of plate 27 and many septa are confluent. For these reasons, and its availability, this specimen is made lectoholotype, but since its fractured condition forbids sectioning, description is based on hypotypes from the Hall collection which were compared with it. No opinion on the identity of the specimen of plate 26, figures 3 to 4 can be given.

Resemblance in structure between these and *H. obconicum* is close. Some of them join the lectoholotype in showing fusion of originally distinct corallites, which give force to the structural evidence that *confluens* is a physiologic form of *H. obconicum* rather than a subspecies. The name thus is retained as a matter of convenience; those who wish names to have taxonomic significance, or who elevate all subspecific groups to species, may wish to discard it.

Occurrence: Hamilton (Moscow), York (type locality), East Bethany and other localities in western New York.

Lectoholotype: 18974; *Hypotypes:* 37759-37760, 37762-37765, 37767 Walker Museum and 6881-6883 Carnegie Museum.

Heliophyllum obconicum teres subsp. nov. (Figs. 11-13; plate XIX, fig. 6; plate XX, figs. 1-7; plate XXI, figs. 2-3; plate XXII, fig. 3.)

Description: Corallum elongate-conical to columnar, very slightly curved. Epitheca comparatively thick; costæ indistinct. Fossa deep (9.7 mm. in a specimen whose diameter is 27.5 mm.) and steepsided; marginal zones flattened, steeply inclined and sharply bounded internally. Septa equal in the marginal area; they number about 4.3 in 5 mm. on ephebic margins.

Transverse sections 12 to 13 mm. in diameter show 52 to 56 septa;

though but 11 and 12 mm. from the bases, they show interseptal plates and splitting of some septa. Secondaries are about 3 mm. long; primaries 1 to 1.6 mm. from the axis and bend into open phyllothecal tubes like those made diagnostic of *Crepidophyllum* (=*Eridophyllum*) by Nicholson.[6] Sclerotheca pronounced; septa thickened within it. Carinæ thick. Fossula well developed.

Sections measuring 15.3 and 14 mm., respectively, show the central tube almost closed and beginning to disappear; at 23 and 24 mm. it is lacking, though twisting and fusion of septa leaves an open axial area. Septa in these stages number 64 and 70; they are thickened within the now indefinite stereotheca, while the carinæ show secondary thickening to the periphery.

In late ephebic and gerontic growth, septa are added to a final number of 76 to 80. Interseptal plates are further developed, in some cases becoming thicker than the septa themselves, causing the latter to appear more degenerate than they really are.

Longitudinal sections show strong but discontinuous bands of carinæ ascending at angles of 65 to 80 degrees. There also are downward-curving bands of stereoplasm, most marked in the zones where dissepiments are finest, most abruptly downcurved, and most cystose. Tabulæ of the inner series are incomplete and cystose; those of the outer series are demarked by stereoplasmic bands and range from concave to convex on upward surfaces.

Remarks: The most obvious peculiarities of this subspecies are its almost columnar shape, the phyllothecal tube in neanic stages, and the greater persistence of septa as compared with *H. obconicum.* Their partial degeneration and the great development of interseptal plates effectively link it with that species.

In transverse section, the phyllothecal tube (aulos) of neanic stages almost duplicates that of *Heliophyllum subcæspitosum* Nicholson, genosyntype of *Crepidophyllum* Nicholson and Thomson,[7] now referred to *Eridophyllum* Milne-Edwards and Haime, though its aulos is less nearly perfect than that of *E. archiaci* (Billings) and *E. seriale* Milne-Edwards and Haime.

Though not represented among Hall's illustrations, this subspecies must be included here for contrast with the true *H. obconicum.*

Occurrence: Hamilton (Moscow), LeRoy (type locality), East Alexander and other localities in western New York.

Holotype: 6835-6848; *Paratypes:* 6849-6880 Carnegie Museum; 20793, 33393 and 33394 Walker Museum.

[6] Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 51, 1887.

[7] Proc. Royal Soc. Edinburgh, vol. 9, p. 149, 1877.

HELIOPHYLLUM HALLI REFLEXUM Hall,
Ill. Dev. Foss. Corals, pl. 23, figs. 6-11, 1877.

Heliophyllum reflexum Hall (Figs. 3-4; plate XXII, figs. 4-5, plate XXIII, fig. 1.)

Heliophyllum halli reflexum Hall, Ill. Dev. Foss. Corals, pl. 23, fig. 6, (*not* figs. 8-11 = *H. arachne?; probably not* fig. 7), 1877.

Description: Corallum subconical or irregularly conical, generally with great expansion in ephebic and gerontic stages; constrictions commonly of minor magnitude. Epitheca complete, thick, wrinkled. Calyx expanded; fossa deep, with convex streptocolumella and sloping sides; marginal zone convex and poorly defined. Septa subequal marginally, but secondaries stop on sides of fossa.

A transverse section 15 mm. in diameter shows thin continuous septa, the secondaries 3.5 mm. or less in length. Primaries enter a stereozone in which they twist into a streptocolumella, though all are united by deposits of calcite so that the whole zone forms a solid mass in which structures are indistinct.

A transverse section 22 mm. in greatest diameter shows 64 continuous septa, the secondaries 5 mm. or less in length. There are incipient interseptal plates; carinæ are well marked. The stereozone is ovo-rhomboidal, with septa well distinguished though united and a streptocolumella 5 mm. in diameter. In addition to the twisted ends of the septa, it includes stereoplasmic material which forms a solid mass. The fossula is distinctly present, though not fully closed.

A longitudinal section shows the greatest depth of the calyx to be about half the height of the corallum. Tabulæ are divided into two series; the inner bounded by a false inner wall (pseudotheca) formed by downbending of tabulæ (cyathotheca) reenforced by sclerothecal deposits, the outer by a broken sclerotheca from which obconical sclerothecal lamellæ extend upward and outward to the margins. Carinæ few and nearly vertical; dissepiments unequal in size, cystose. Streptocolumella not well shown.

Remarks: This description is based on specimens compared with the small, reflexed corallum of Hall's figure 6, here designated the lectoholotype. The figure itself errs only in showing the septa somewhat too coarse and too clearly divided into two series on the marginal zone.

The large specimen of Hall's figures 8 to 11 is questionably assigned to *H. arachne*. Identity of that of figure 7 is uncertain, though it also resembles *arachne* more closely than it does the lectoholotype and hypotypes of *reflexum*.

Continuous septa and paucity of interseptal plates link this species with *H. decorosum*, from which, however, it is clearly separated by the streptocolumella with its initially reticulate and finally massive stereoplasmic reenforcements.

Occurrence: Hamilton (Moscow), Darien and Livingston County (type localities), East Alexander and elsewhere in western New York.

Lectoholotype: $\frac{3441}{1}$ N. Y. State Museum; *Syntypes:* $\frac{4459}{1}$ Am. Museum of Natural History (=*H. arachne?*) and $\frac{3441}{2}$ N. Y. State Museum (=*H. arachne?*); *Hypotypes:* 6777-6787 Carnegie Museum.

Heliophyllum (?) asperum sp. nov. (Fig. 7; plate XXI, figs. 4-6.)

Description: Corallum irregularly subturbinate, with numerous expansions, contractions and changes of axial direction. Epitheca thick, continuous or discontinuous; costæ indistinct. Fossa generally more than half the diameter of the calyx, deep to shallow. Marginal zone commonly flattened and inclined; in a few cases it is so steeply inclined as to be continuous with the fossal sides. Septa in two very distinct series, secondaries being low and narrow while primaries are high, coarse and sharply denticulate. Fossula not distinguishable externally.

A transverse section 13 mm. in diameter shows only primary septa, 26 in number. They are flexuous; some are barely 2 mm. long while others reach the axial region and end freely or fuse. Dissepiments are present, but carinæ are not. Another specimen, at 12.4 mm., shows a few secondaries, though primaries are but 2 to 5.5 mm. long and end freely. At 15 mm. this same specimen shows 29 primaries, most of which reach the axial region; secondaries are very thin and but 1.6 mm. or less in length. Dissepiments have the V-shape characteristic of the species; carinæ are present but are few and commonly indistinct.

A section 33 mm. in diameter cuts 80 septa, the secondaries reaching lengths of 11 mm. and ending freely. Primaries twist slightly, end freely or in fascicles in a manner resembling those of *H. obconicum* and are complicated by a stereocolumella which becomes reticulate in section. There is a subrhomboidal, broken sclerotheca, with stereothecal elements; thickening of septa and dissepiments extends beyond this false inner wall and results in an indistinct stereothecal band about 8.5 mm. from the axis. Dissepiments are subangular to V-shaped, crowded in some zones and sparsely spaced in others; there are many interseptal plates though few septa disintegrate. The fossula is distinct.

A gerontic section, just beneath the fossa, shows further development of V-shaped dissepiments and interseptal plates. The pseudocolumella is eccentric, and involves both stereoplasm and twisted septa, especially of the cardinal quadrants.

Paratypes differ chiefly in details of the stereotheca and sclerotheca.

A longitudinal section shows the tabulæ incomplete and cystose, with the outer series poorly defined or absent. Carinæ are steeply inclined. Dissepiments crowded, varying in direction of inclination.

Remarks: The most distinctive features of this species are its abundant, V-shaped dissepiments, its long interseptal plates, and its stereocolumella. It is included here because of its external resemblance to *H. halli irregulare* Hall, though its real relationships appear to be with *H. obconicum teres.* In fact, one specimen assigned to this species because of its coarse primary septa, V-shaped dissepiments, streptocolumella and combined stereosclerotheca, shows close resemblance to *teres* even though it lacks the neanic phyllothecal tube.

Occurrence: Hamilton (Moscow), Near East Alexander (type locality) and Leicester, New York.

Holotype: 6884-6887; *Paratypes:* 6888-6893 and 7335-7347 Carnegie Museum.

HELIOPHYLLUM PROLIFERUM Hall,
Ill. Dev. Foss. Corals, pl. 26, figs. 1-2, 5(?), 1877.

Heliophyllum proliferum Hall (Homonym; invalid)

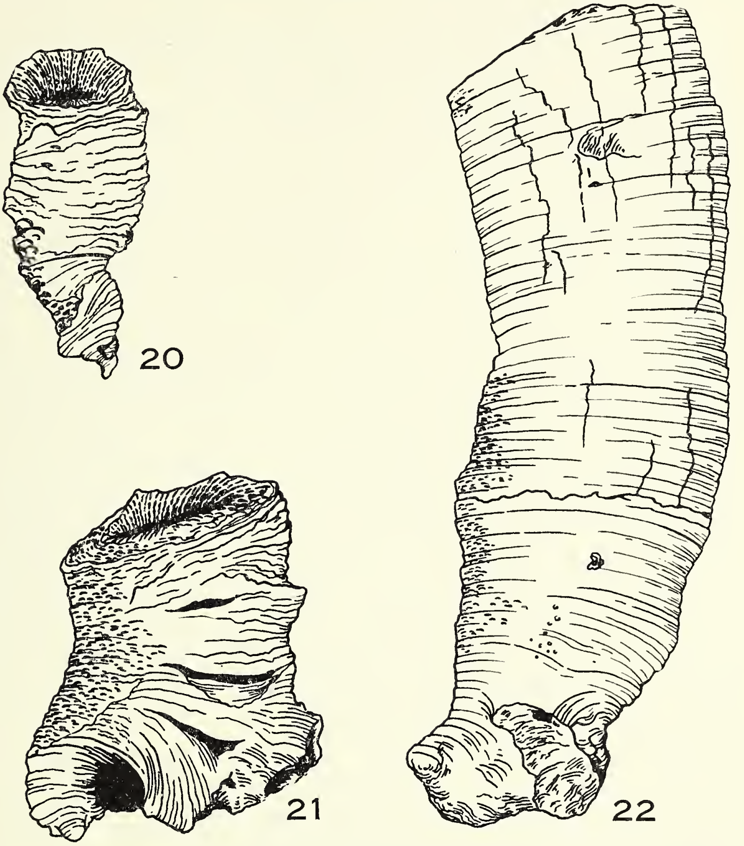
Not Heliophyllum proliferum Nicholson, Geol. Mag., dec. 2, vol. 1, p. 59, 1874; Nicholson, Rep. Pal. Province Ontario, p. 27, 1874.

Remarks: Heliophyllum proliferum Hall 1877 is preoccupied by *H. proliferum* Nicholson 1874, of the Onondaga. The two do not seem to be synonyms.

Hall's *H. proliferum* includes two species. The coral of his figure 5 has been doubtfully assigned to *H. decorosum* sp. nov. That of his figures 1 to 2 closely resembles, in external characters and proliferation, the syntype of *H. confluens* shown in plate 26, figures 3 to 4. Both, in turn, resemble an elongate, constricted, compound species of *Heliophyllum* found rarely in western New York. Without sections, however, identification is impossible, for there are other (doubtfully compound) species whose external characters—chiefly expansion rate, angularity of expansions and epithecal smoothness—also resemble the figures. *Heliophyllum proliferum* Hall thus is a homonym, lacks description and is not recognizably illustrated. Though types exist they were not available for study, and the species must be abandoned.

Occurrence: Hamilton (Moscow), Darien and Livingston County, New York (type localities).

Syntypes: $\frac{4461}{1}$ and $\frac{4161}{2}$ Am. Museum of Natural History. The second is referable to *H. decorosum* sp. nov.



FIGURES 20-22. Lateral views of three specimens of "*Cystiphyllum*." All figures × 0.5.

FIG. 20. "*C.*" *conifollis* Hall. A hypotype showing typical form, septal ridges and thick growth lines. The epitheca is exceptionally well developed. Hamilton (Moscow), Leicester, N. Y. (7411-7412 Carnegie Museum.)

FIG. 21. "*C.*" *americanum* Milne-Edwards and Haime. A hypotype, typical of the invalid species, "*C.*" *varians* Hall. Hamilton (Moscow), Leicester, N. Y. (20800 Walker Museum.)

FIG. 22. "*C.*" *americanum* Milne-Edwards and Haime. A columnar specimen of large size, comparable to the figured types. Hamilton (Moscow), Leicester, N. Y. (7354-7357 Carnegie Museum.)

HELIOPHYLLUM (ZAPHRENTIS) EXIGUUM Billings; Hall,
Ill. Dev. Foss. Corals, pl. 32, figs. 1-4, 1877.

HELIOPHYLLUM ? EXIGUUM var. Hall,
Ill. Dev. Foss. Corals, pl. 32, figs. 5-7, 1877.

Zaphrentis? exiguum (Billings)

Heliophyllum exiguum Billings, Can. Jour. Ind. Sci. Arts, n. s., vol. 5, p. 261, figs. 9-10, 1860.

Heliophyllum (*Zaphrentis*) *exiguum* Hall, Ill. Dev. Foss. Corals, pl. 32, figs. 1-4, 1877.

Heliophyllum? exiguum var. Hall, op. cit., pl. 32, figs. 5-7.

Zaphrentis exigua Rominger, Geol. Surv. Mich., vol. 3, pt. 2, p. 150, pl. 53, 7 figures, 1876(?).

Cyathophyllum exiguum Lambe, Contrib. Can. Pal., vol. 4, p. 150, 1901.

Remarks: Examination of the syntypes and other specimens, none of which is suited to sectioning, fails to add much to Billings' original description or to give validity to Hall's unnamed variety. A few specimens show clearly the "arched striæ" on septa which account for the original reference of the species to *Heliophyllum*. They are comparable, however, to structures found on the septa of several Zaphrentids and in the genotype of *Zaphrentis* itself as interpreted by O'Connell,[8] and are associated with the deep fossula and abortive cardinal septum found in that genus. To it the species is tentatively assigned as an indication of apparent general relationship. More cannot be done without specimens both more numerous and better suited to sectioning than any now at hand.

Occurrence: Onondagan of Ontario, New York and probably of Ohio and Kentucky; Rominger adds Onondagan at Mackinac and Hamilton at Broadwell's Mills, on Thunder Bay River, Michigan.

Syntypes: 3424 National Museum of Canada.

CYSTIPHYLLUM AMERICANUM Milne-Edwards and Haime; Hall,
Ill. Dev. Foss. Corals, pl. 28, figs. 1-7, 1877.

"Cystiphyllum" americanum Milne-Edwards and Haime (Figs. 21-22; plate XXII, figs. 6-7; plate XXIII, figs. 2-8; plate XXIV, figs. 1-3.)

Cystiphyllum cylindricum Hall (*not* Lonsdale), Geol. New-York, pt. 4, p. 209, figs. 1-2, 1843.

[8] Ann. N. Y. Acad. Sci., vol. 23, p. 189, 1914.

Cystiphyllum americanum Milne-Edwards and Haime, Mon. Polyp. Foss. Terr. Pal., Arch. Mus. d'Hist. Nat., vol. 5, p. 464, pl. 13, figs. 4-4a, 1851; Nicholson, Rep. Pal. Province Ontario, p. 36, pl. 6, fig. 8, 1874; Hall, Ill. Dev. Foss. Corals, pl. 28, figs. 1-7, 1877.

Cystiphyllum corrugatum Hall, op. cit., pl. 29, figs. 14-16.

Cystiphyllum varians Hall, op. cit., pl. 29, figs. 1-13; Grabau, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 127, fig. 10 A, 1899.

(?)*Cystiphyllum vesiculosum* Nicholson, Rep. Pal. Province Ontario, p. 37, fig. 8, 1874; Lambe, Contrib. Can. Pal., vol. 4, p. 192, 1901; Stewart, Geol. Soc. Am. Spec. Pap. 8, p. 57, pl. 11, figs. 3-5, 1938.

Original Description (*Translation*): "Corallum elongate, cylindro-turbinate, straight or slightly curved, covered with a thin epitheca and presenting more or less marked growth wrinkles. When the epitheca is removed one perceives, now and then, very fine costal striæ which are equal, uniformly distributed, and straight. Calyx circular, with weak boundaries, concave; septal rays distinct, extending to the center in the form of fine ridges which number about 100. Height 8 or 9 centimeters; diameter of the calyx, 4 or 5. A vertical section shows a texture wholly vesicular but very dense in the outer region; vesicles which occupy the periphery of the corallum are, in general, small and oblique downward and inward; those at the center are larger, unequal, somewhat horizontal, and larger above; the strongest are 3 mm. in length and 1 or 1.5 high while the small ones are not more than 1 mm. in width."

Revised Description: Corallum cylindro-turbinate with moderate rate of expansion and varied yet rather regular curvature. Constrictions numerous, angular, and commonly of magnitude exceeding 0.3 of the diameter. Epitheca thin, complete or incomplete, commonly removed by corrosion or erosion before fossilization or after it. Fossa shallow to deep; marginal zone concave to convex, undefined. Septal rays poorly developed in some specimens; in others they number 90 to 100 and cross the dissepiments to the axial region.

Transverse sections show a marginal band of cysts 1 to 3 mm. in greatest diameter and oval to concentric in shape; the dissepiments enclosing them are thin and generally lack septal rays. The size of dissepiments and cysts decreases centrally; thickness of the former increases; septal rays form prominent "teeth" on their inward faces, and cysts become irregularly oval or even round. At 5 to 12 mm. from the periphery (in sections 17 to 43 mm. in diameter) there is an irregular but commonly heavy sclerotheca formed partly by crowding together of small dissepiments and partly by deposition of stereoplasm upon and within them (plate XXIII, figures 6 to 8). Inside this wall, cysts and dissepiments enlarge—or more properly, merge with incomplete, highly convex, cyst-forming tabulæ 1.5 to 12 mm. in width, whose outermost members bear septal rays. Constriction is accomplished primarily by reduction of the dissepimental zone; except in extreme cases the tabulæ retain normal size and cover almost normal areas.

Longitudinal sections show the dissepiments arranged in broadly funnel-shaped series approximating the "cystosepiments" of Grabau. The false inner wall is either cylindrical though broken (plate XXIV, figure 1), or is resolved into another series of funnels variably spaced and either distinct or connected; their individual deposits are as much as 2.6 mm. thick. Tabulæ merge with dissepiments on levels between these funnels and (apparently) in them. Some tabulæ are concave; others reach convexities of about 200 degrees, forming cysts that are circular in transverse section.

Remarks: Some American identifications of this species are limited to specimens which lack the calyx, or in whose calyces the septal rays are indistinct, and apply Hall's names *corrugatum* and *varians* to those in which the septal rays are prominent. Milne-Edwards and Haime, however, both specify and illustrate septal rays, so that such distinction is invalid. Since no other characters have been found which distinguish "*C.*" *corrugatum* and the bulk of "*C.*" *varians*, both (with the exception noted under "*C.*" *varians*) are reduced to synonymy with "*C.*" *americanum*.

In tentatively reassigning to this species Hamilton material from Ontario, Ohio and New York identified as *C. vesiculosum* Goldfuss by Nicholson, Stewart and Lambe we do not imply that the latter species is lacking from the American Devonian. So far as published figures go, "*C.*" *americanum* may be (as Lambe and Stewart maintain) a synonym of "*C.*" *vesiculosum*. The question cannot be decided without cutting authentic specimens of Goldfuss's species and a large series of Hamilton and Onondagan Cystimorphs of the general *americanum-vesiculosum* type. Until that can be done, it is unwise to attempt further amalgamation of species.

Occurrence: Hamilton (especially Moscow), Lake Skaneateles (type locality), Leicester (=Moscow), York, Eighteen Mile Creek, East Bethany, East Alexander and many other localities in western New York.

Hypotypes: (Hall's) 11819 Walker Museum and $\frac{4449}{1\text{-}2}$ Am. Museum of Natural History; (Fenton and Fenton's) $\frac{3280}{1\text{-}4}$ N. Y. State Museum (Hall's syntypes of *C. varians*); 20800 Walker Museum, 7354-7380 and 7393-7395 Carnegie Museum.

CYSTIPHYLLUM VARIANS Hall,
Ill. Dev. Foss. Corals, pl. 28, fig. 8; pl. 29, figs. 1-13, 1877.

"Cystiphyllum" varians Hall (Invalid)

Cystiphyllum varians Hall, Ill. Dev. Foss. Corals, pl. 28, fig. 8; (*not* pl. 29, figs. 1-13 = *C. americanum*), 1877; *not Cystiphyllum varians* Grabau, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 127, fig. 10 A, 1899.

Remarks: The existing types of this species include six specimens: a transverse section, figured on plate 28; a longitudinal section shown on plate 29, figure 13; and four coralla—figures 1 to 5 and 10 to 12, plate 29. Specimens of figure 6 and 7 to 9 have not been traced.

All complete coralla are characterized by septal rays which, for Cystimorphs, are unusually prominent. Hall evidently placed emphasis on this character, and in the explanation of plate 28, figure 8, he remarks that it shows "the cysts arranged in concentric circles, forming cups as in Chonophyllum, and also . . . that the incipient rays are developed into continuous lines in the interior." Since this is all there is of description, this specimen ($\frac{4452}{1}$ Am. Museum of Natural History) probably must be held to determine the species, becoming the lectoholotype on which "*C.*" *varians* must, if possible, be accepted.

That it can be is doubtful. The specimen is a small fragment, polished at one end; the section as published suggests a poorly preserved specimen of *Heliophyllum.* It at least is a cyathophylloid, with true septa and dissepiments that are convex inwardly. The name may be held in abeyance pending adequate study of this fragment; but since it appears inadequate for reliable determination, we recommend that the species *varians* be dropped as without recognizable description or figure: a virtual *nomen nudum* of fifty years' standing.

The remaining syntypes, properly referable to "*Cystiphyllum,*" show all essential characters of "*C.*" *americanum* and no peculiarities other than exceptionally irregular growth. They therefore are assigned to that species.

Occurrence: Hamilton (Moscow), York, Leicester and other localities in western New York.

Lectoholotype: $\frac{4452}{1}$ Am. Museum of Natural History (undeterminable?); *Syntypes:* (= "*C.*" *americanum*), $\frac{4452}{2}$ Am. Museum of Natural History and $\frac{3280}{4}$ N. Y. State Museum.

CYSTIPHYLLUM CORRUGATUM Hall,
Ill. Dev. Foss. Corals, pl. 29, figs. 14-16, 1877.

"Cystiphyllum" americanum Milne-Edwards and Haime.

Cystiphyllum corrugatum Hall, Ill. Dev. Foss. Corals, pl. 29, figs. 14-16, 1877.

Remarks: Since specimens closely resembling Hall's figures show the characters of "*C.*" *americanum* and are distinguished only by obconical shape and strong septal striæ (both variable characters), *corrugatum* is considered a synonym of Milne-Edwards and Haime's species.

Occurrence: Hamilton, Skaneateles Lake, New York, (type locality).

Syntypes: $\frac{4451}{1}$ Am. Museum of Natural History.

CYSTIPHYLLUM CONIFOLLIS Hall,
Ill. Dev. Foss. Corals, p. 30, figs. 3-9, 1877.

"Cystiphyllum" conifollis Hall (Fig. 20; pl. XXIII, figs. 9-10; plate XXIV, figs. 4-7.)

Cyathophyllum conifollis Hall, Ill. Dev. Foss. Corals, pl. 30, figs. 3-9, 1877; Grabau, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 126, fig. 9, 1899.

Description: Corallum irregularly subcylindrical, with many constrictions of considerable magnitude and erratic curvature. Epitheca thick, wrinkled, complete or incomplete. Fossa shallow to moderately deep; septal rays prominent and coarse, numbering 5 in 5 mm.

Transverse sections show an outer zone of large dissepiments and cysts terminated by an irregular, heavily stereoplasmic false inner wall in which dissepiments are more closely spaced. Cysts formed by the dissepiment-like tabulæ range to 6 mm. wide in a corallite whose diameter is 16 mm. Septal rays are absent to thick, as many as 3 being noted on one dissepiment.

Longitudinal sections range from compact structures like that of plate XXIII, figure 10 to open, massive ones of plate XXIV, figure 6. Both show secondary thickening of dissepiments and tabulæ; the latter shows vertical stereothecal deposits in addition to the thickened funnels, perhaps characteristic of gerontic development.

Remarks: This species is readily distinguished by its coarse structure, columnar form and irregular growth. It appears to have no close relatives among Hamilton species of "*Cystiphyllum*" in the New York region, but is much closer to certain Onondaga species whose identity is undetermined.

Occurrence: Hamilton (chiefly lower Moscow), Eighteen Mile Creek, Leicester, East Alexander and other localities in western New York; Hamilton of Thedford region and Bosanquet, Ontario. Type localities are Leicester (=Moscow) and Bosanquet.

Syntypes: $\frac{4450}{1\text{-}2}$ Am. Museum of Natural History; *Hypotypes:* 7396-7417 Carnegie Museum.

CYSTIPHYLLUM (CHONOPHYLLUM) SULCATUM Billings; Hall, Ill. Dev. Foss. Corals, pl. 32, figs. 16-20, 1877.

Chonophyllum(?) sulcatum (Billings) (Plate XXII, fig. 8; plate XXIV, figs. 8-9.)

Cystiphyllum sulcatum Billings, Geol. Surv. Canada, Rep. Prog. for 1857, p. 178, 1858; Billings, Can. Jour. Ind. Sci. Arts, n.s., vol. 4, p. 136, 1859; Nicholson, Rep. Pal. Province Ontario, p. 38, pl. 6, fig. 7, 1874; Rominger, Geol. Surv. Mich., vol. 3, pt. 2, p. 139, pl. 50, fig. 3, 1876(?)

Not Cystiphyllum sulcatum Davis, Kentucky Foss. Corals, pl. 125, figs. 1-3, 1889.

Cystiphyllum (Chonophyllum) sulcatum Hall, Ill. Dev. Foss. Corals, pl. 32, figs. 16-20, 1877.

Description: Corallum short, obliquely turbinate, expanding without marked constriction from an acutely pointed base that furnished attachment only during neanic stages. Beyond that, rapid growth on the fossular side must have caused the corallum to sink to the position indicated on plate XXIV, figure 9. Epitheca thick and continuous, with distinct costæ. Calyx oval, shallow, floored by a continuous lamina which is either vesicular or smooth. Over much of this surface, in most specimens, there are pronounced septal ridges and grooves and one to four fossulæ, of which one predominates in length and depth. These fossulæ and ridges persist in all laminæ; dissepiments distinguishable throughout.

Remarks: Silicified specimens available are unsuited to sectioning, but are sufficient to confirm Hall's illustration of a series of eccentric, subconical laminæ which seem to equal the "série de planchers infundibuliformes superposés et invaginés, dont la surfase présente un grand nombre de rayons cloisonnaires" specified by Milne-Edwards and Haime[9] as the essential character of *Chonophyllum.* They do not give sections of the genoholotype, *C. perfoliatum* Goldfuss, nor does Wedekind,[10] whose figures of *C. planum* Wedekind and *C. patellatum*

[9] Mon. Polyp. Foss. Terr. Pal., Arch. Mus. d'Hist. Nat., vol. 5, p. 405, 1851.

[10] Zoantharia Rugosa Gotland etc., Sveriges Geol. Undersök., ser. Ca, no. 19, p. 42, pl. 7, figs. 1-3, 1927.

(Schlotheim) do not show the dissepimental area. The reference of *sulcatum* (Billings) to *Chonophyllum* therefore must be provisional.

Occurrence: Onondagan, Port Colburne and elsewhere, Ontario, Clarence and perhaps Mendon, New York. Rominger adds Falls of the Ohio and Mackinac Island, Michigan.

Syntypes: 3439a National Museum Canada; *Hypotypes:* $\frac{4140}{1}$ Am. Museum of Natural History.

NOTE

In the explanations of plates, localities on the Delaware, Lackawanna and Western Railway, which are 1.5 miles east of East Alexander and 1.5 miles west of East Bethany, New York, have been given as East Alexander and East Bethany respectively.

EXPLANATION OF PLATE XVII.

All figures × 1.6.

FIGS. 1-5. *Heliophyllum halli* Milne-Edwards and Haime.

FIG. 1. Transverse (gerontic) section of a hypotype in which phyllothecal extensions are poorly developed. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (6714 Carnegie Museum.)

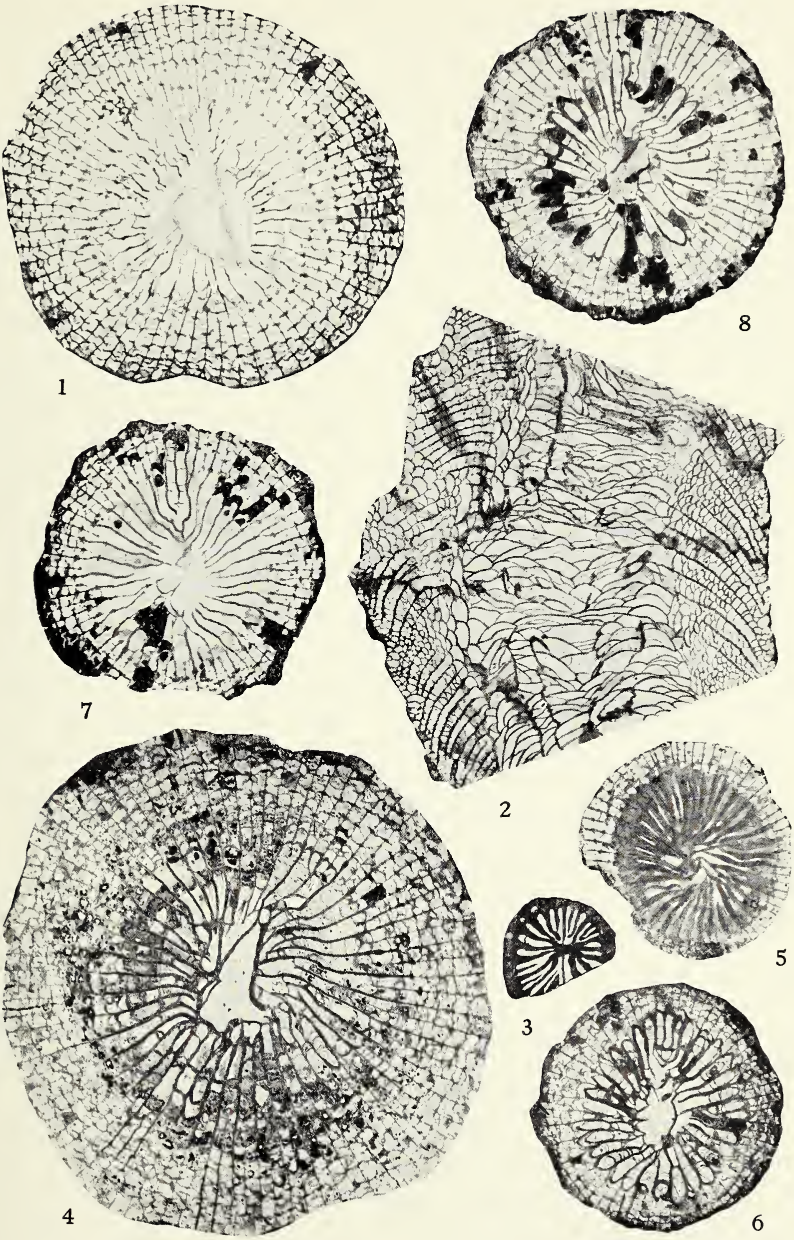
FIG. 2. Longitudinal (ephebic to gerontic) section of the same hypotype. Note the incomplete periaxial zone. (6713 Carnegie Museum.)

FIG. 3. Transverse (neanic) section of the same specimen. (Drawn from 6709 Carnegie Museum.)

FIG. 4. Transverse (gerontic) section of a rapidly expanding specimen with both curved septa and phyllothecæ. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (6708 Carnegie Museum.)

FIG. 5. Transverse neanic section of the same specimen. (6707 Carnegie Museum.)

FIGS. 6-8. *Heliophyllum halli degener* Hall. Transverse sections (early ephebic, ephebic and late ephebic stages) of a typical hypotype with very thin epitheca and constricted gerontic growth. Note pronounced fossular complex, thickened primary septa and ephebic development of the periaxial zone. Hamilton (Moscow), East Alexander, N. Y. (6734, 6732, 6735 Carnegie Museum.)


1
2
3
4
5
6
7
8

EXPLANATION OF PLATE XVIII.

All figures × 1.6, except fig. 2 which is × 0.8.

FIG. 1. *Heliophyllum halli* Milne-Edwards and Haime. Transverse (neanic) section of the large specimen shown in text figure 6. Like figure 5 of the preceding plate, it shows heavy calcification in the tabular region. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (7351 Carnegie Museum.)

FIG. 2. *Heliophyllum halli degener* Hall. Hall's figure 8 of plate 25, showing absence of epitheca and gerontic constriction. Hamilton, Skaneateles Lake, N. Y. ($\frac{4456}{1}$ Am. Museum of Natural History.)

FIGS. 3-6. *Heliophyllum halli irregulare* Hall.

FIG. 3. Transverse (ephebic) section of the hypotype shown in text figure 8. Hamilton (Moscow), western N. Y. (37722 Walker Museum; section 6747 Carnegie Museum.)

FIG. 4. Transverse ephebic section of a specimen with more rapid rate of expansion. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (6744 Carnegie Museum.)

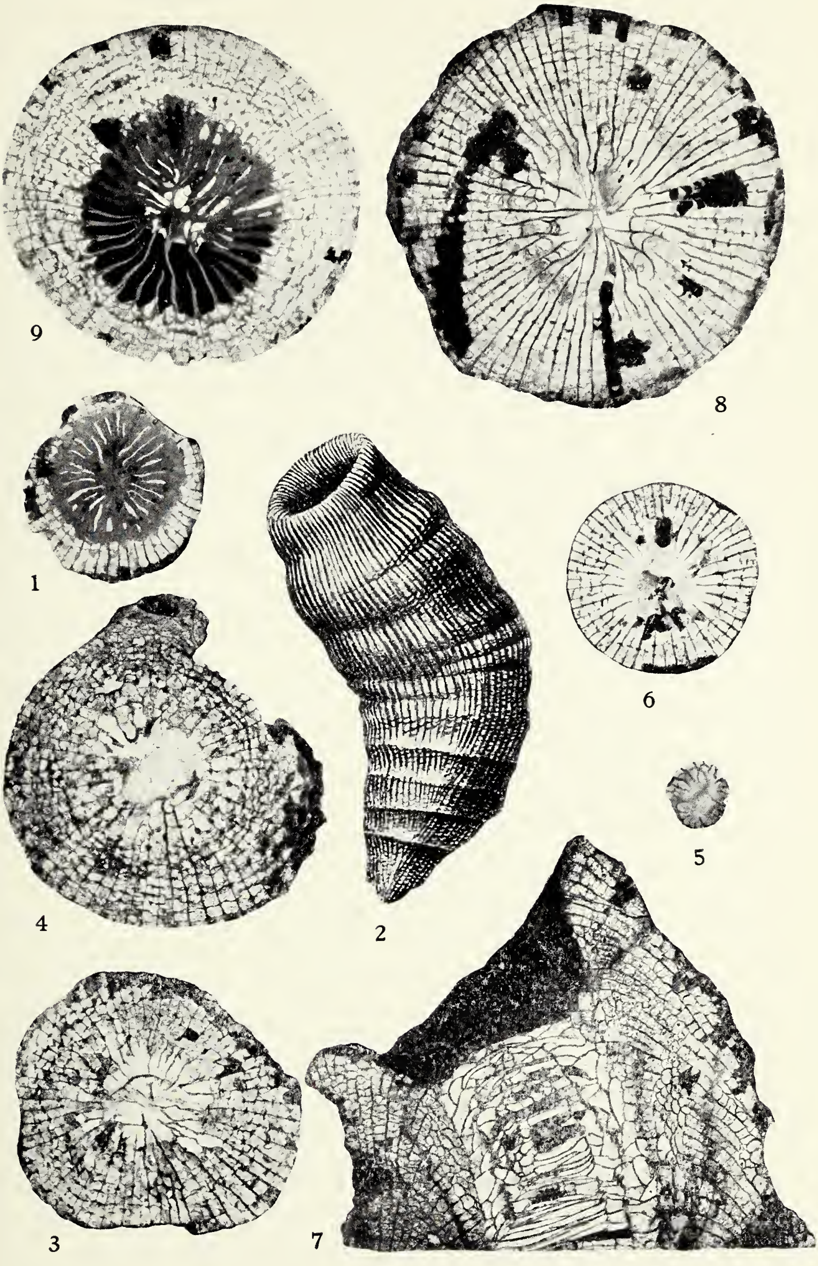
FIGS. 5-6. Transverse (early and late neanic) sections of a hypotype. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (6749-6750 Carnegie Museum.)

FIGS. 7-9. *Heliophyllum decorosum* sp. nov.

FIG. 7. Longitudinal section through ephebic to gerontic region of the holotype, shown in text figure 5. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (6755 Carnegie Museum.)

FIG. 8. Transverse (ephebic) section of the same, showing primary septa uniting in the axial region. (6754 Carnegie Museum.)

FIG. 9. Transverse (ephebic) section of an aberrant paratype, with heavily calcified primary septa. (6761 Carnegie Museum.)


9
8
1
6
5
4
2
3
7

EXPLANATION OF PLATE XIX.

All figures, except 4 and 5, × 1.6.

FIGS. 1-5. *Heliophyllum obconicum* Hall.

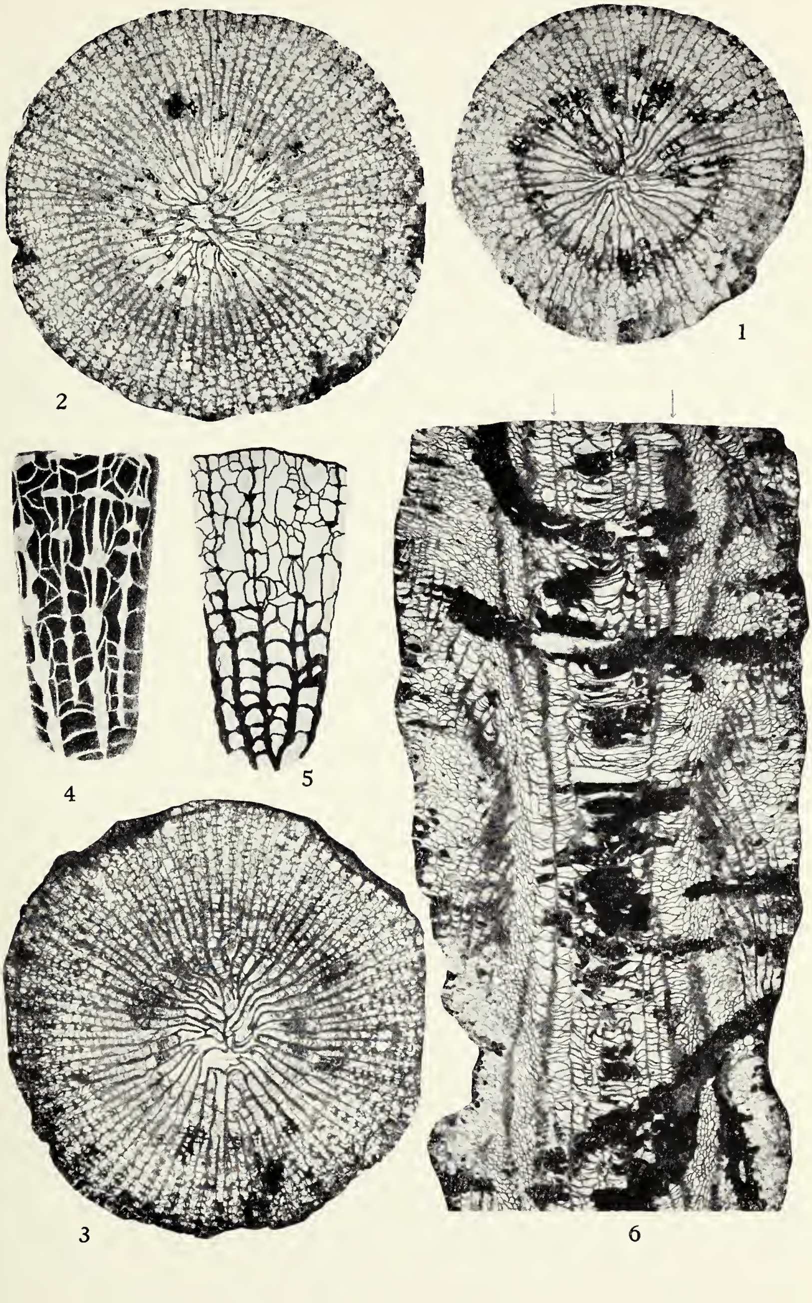
FIGS. 1-2. Transverse (late neanic and ephebic) sections of a specimen with moderate rate of expansion. Note secondary calcification of tabulæ within the stereothecal ring. Hamilton (Moscow), East Bethany, N. Y. (6819 and 6821 Carnegie Museum.)

FIG. 3. Transverse (late ephebic) section of the rapidly expanding specimen of text figure 10 showing cardinal and counter septa, union of septa and development of septal plates. Stereotheca more pronounced than it appears in the photograph. Hamilton (Moscow), Leicester, N. Y. (6815 Carnegie Museum.)

FIG. 4. Hall's figure 4 of plate 25 showing septal plates, thickened septa and carinæ. Hall assigned this specimen to *H. halli*. Magnification unknown.

FIG. 5. Semi-diagrammatic drawing of disintegrating septa, septal plates and secondary calcification of septa and dissepiments in a sector of figure 3. × 3.

FIG. 6. *Heliophyllum obconicum teres* subsp. nov. Longitudinal section of a paratype with very moderate rate of expansion; between the arrows is an exceptionally persistent false aulos. Hamilton (Moscow), near LeRoy, N. Y. (6868 Carnegie Museum.)


1
2
4
5
6
3

EXPLANATION OF PLATE XX.

All figures × 2.

FIGS. 1-7. *Heliophyllum obconicum teres* subsp. nov.

FIG. 1. Transverse (neanic) section of the holotype. Note aulos and stereotheca. (6841 Carnegie Museum.)

FIG. 2. Transverse (late neanic) section of the same. Aulos and stereotheca pronounced, though the latter shows poorly in the photograph. (6842 Carnegie Museum.)

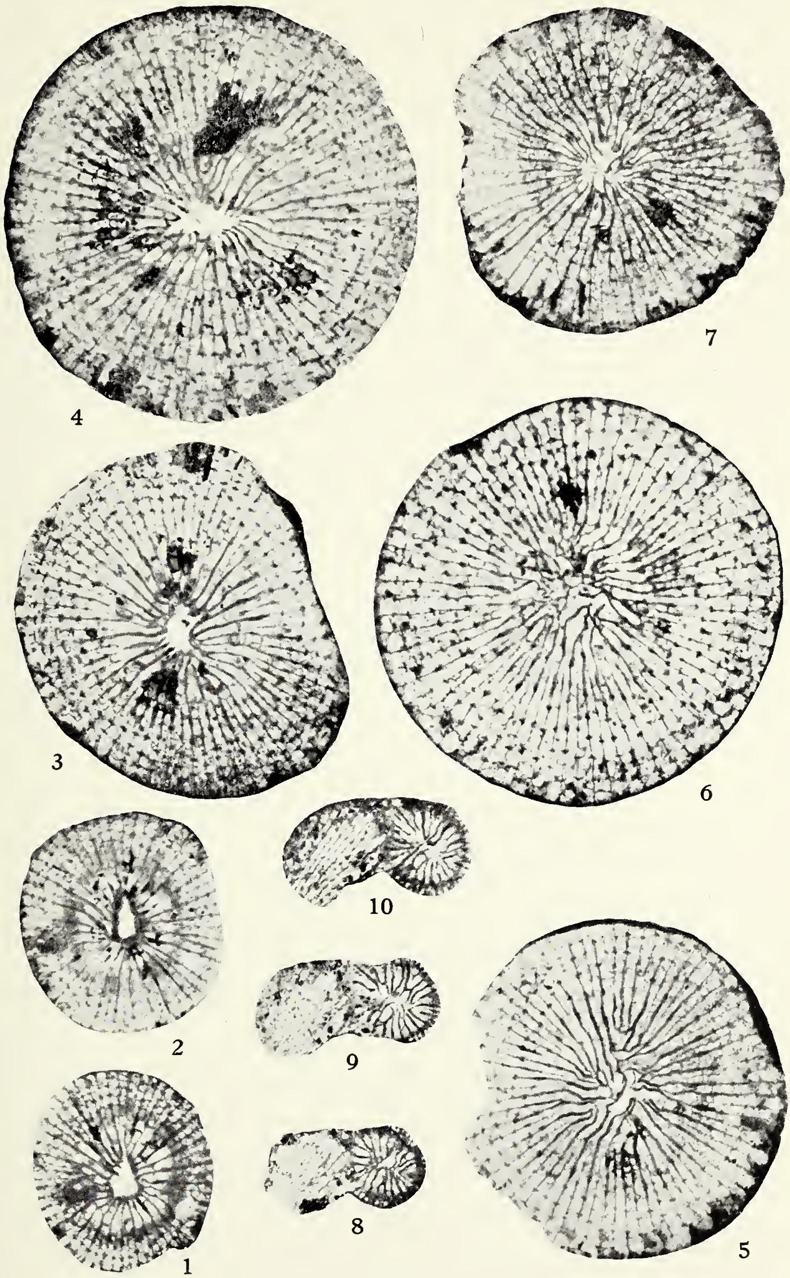
FIG. 3. Transverse (ephebic) section of the same. The aulos is virtually obsolete, and septa are united in groups with some twisting. (6846 Carnegie Museum.)

FIG. 4. Transverse (late ephebic) section of the same. No trace of the aulos remains. (6847 Carnegie Museum.)

FIGS. 5-6. Transverse (early and late ephebic) sections of a paratype in whose neanic stages a distinct but imperfect aulos is present. Hamilton (Moscow), near LeRoy, N. Y. (6857 and 6860 Carnegie Museum.)

FIG. 7. Transverse (ephebic) section of another paratype in which septal plates and dissepiments suggest those of *H. asperum* n. sp. Hamilton (Moscow?), Livingston County, N. Y. (33394 Walker Museum; section 6880 Carnegie Museum.)

FIGS. 8-10. *Heliophyllum obconicum* Hall. Three transverse sections in the early neanic region of the hypotype shown in text figure 9. They show early irregularity and grouping of septa. Hamilton (Moscow), East Alexander, N. Y. (6824-6826 Carnegie Museum.)



EXPLANATION OF PLATE XXI.

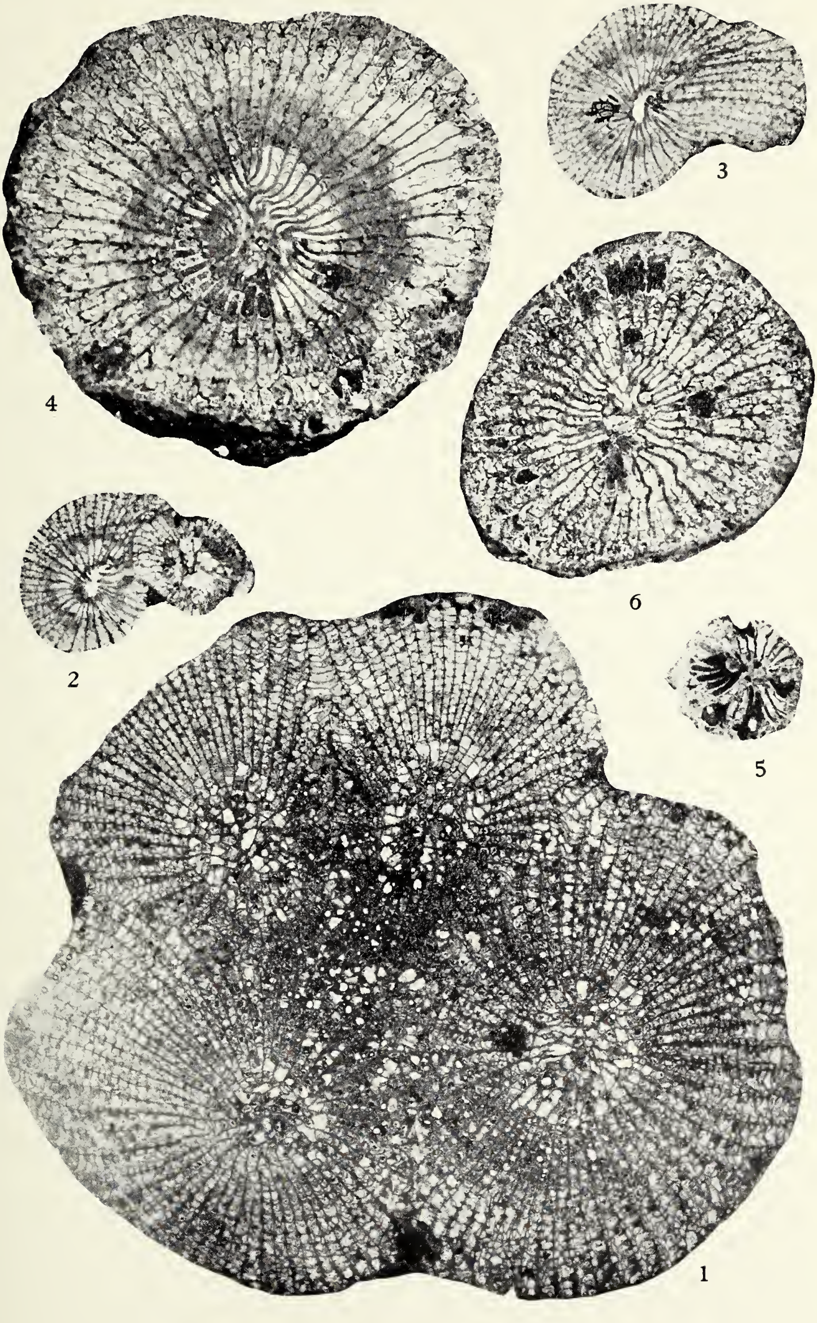
FIG. 1. *Heliophyllum obconicum* form *confluens* Hall. Transverse section of a hypotype showing well developed septal plates. Hamilton, western New York. (37765 Walker Museum; section 6881 Carnegie Museum.) × 1.6.

FIGS. 2-3. *Heliophyllum obconicum teres* subsp. nov. Transverse (neanic) sections of the paratype of text figure 11, having a small aulos. Hamilton, Livingston County, N. Y. (20793 Walker Museum; sections 6861 and 6862 Carnegie Museum.) × 1.6.

FIGS. 4-6. *Heliophyllum asperum* sp. nov.

FIG. 4. Transverse (ephebic) section of the holotype. Hamilton (Moscow), East Alexander, N. Y. (6886 Carnegie Museum.) × 2.

FIGS. 5-6. Transverse (early neanic and ephebic) sections of a paratype. Hamilton (Moscow), East Alexander, N. Y. (7337 and 7339 Carnegie Museum.) × 2.



4 3 6 2 5 1

EXPLANATION OF PLATE XXII.

All figures × 1.6, except fig. 8 which is × 0.8.

FIGS. 1-2. *Heliophyllum arachne* Hall.

FIG. 1. Transverse (early ephebic) section of a hypotype, with normal secondary calcification of primaries within the stereotheca. Comparison of this with plate XVIII, figure 9 shows the close relationship of *H. arachne* to *H. decorosum*. Hamilton (Moscow), East Alexander, N. Y. (6774 Carnegie Museum.)

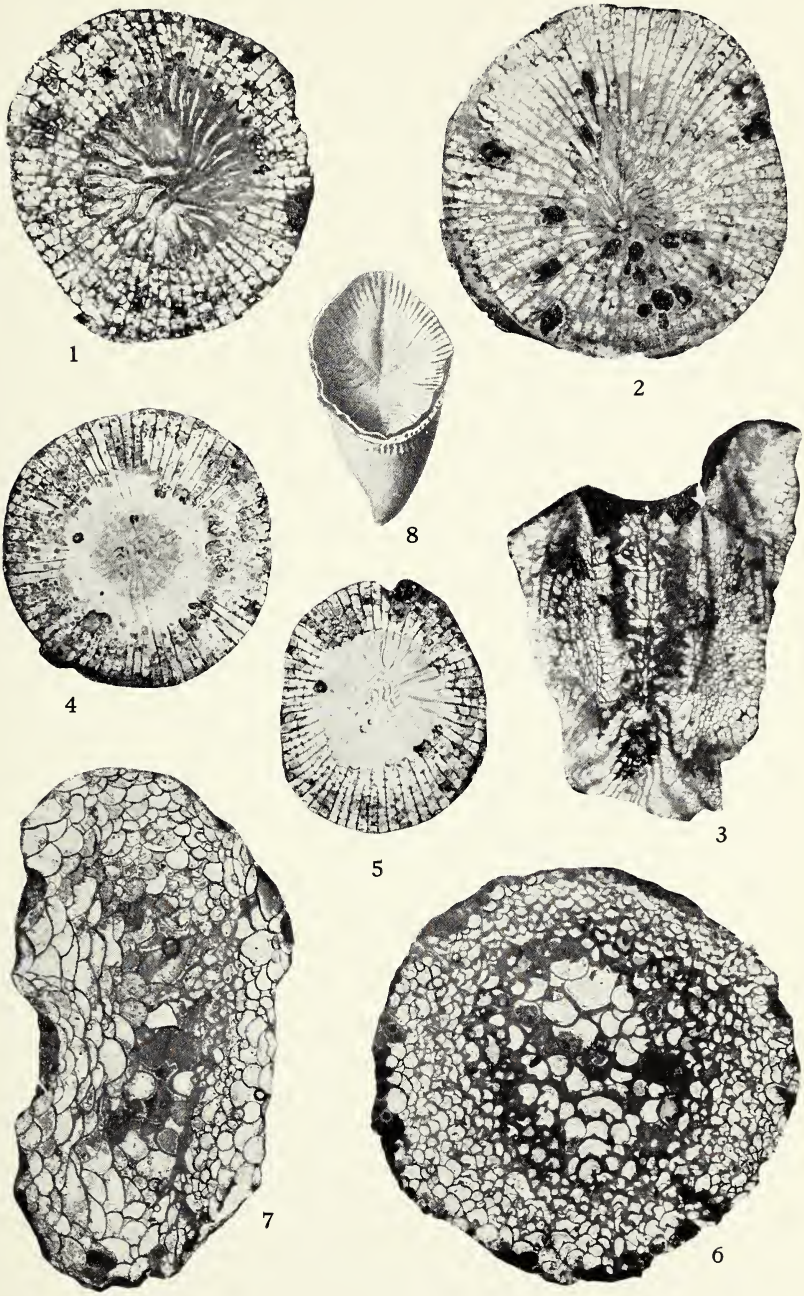
FIG. 2. Transverse (ephebic) section of a second hypotype, in which secondary calcification has progressed into the dissepimental region. Hamilton (Moscow), East Alexander, N. Y. (6772 Carnegie Museum.)

FIG. 3. *Heliophyllum obconicum teres* subsp. nov. Longitudinal section of a hypotype in which the septa are much twisted axially. Hamilton (Moscow), East Alexander, N. Y. (6850 Carnegie Museum.)

FIGS. 4-5. *Heliophyllum reflexum* Hall. Transverse (ephebic) sections of two hypotypes showing thickly calcified stereozone and streptocolumella. Hamilton (Moscow), East Alexander, N. Y. (6787 and 6782 Carnegie Museum.)

FIGS. 6-7. "*Cystiphyllum*" *americanum* Milne-Edwards and Haime. Transverse (early ephebic and constricted gerontic) sections of a large hypotype. Note heavy calcification and septal ridges. Hamilton (Moscow), Leicester, N. Y. (7362 and 7363 Carnegie Museum.)

FIG. 8. *Chonophyllum? sulcatum* (Billings). Hall's plate 32, figure 16, showing characters of the calyx.


1
2
8
4
3
5
7
6

EXPLANATION OF PLATE XXIII.

All figures × 2.

FIG. 1. *Heliophyllum reflexum* Hall. Longitudinal section of a typical specimen showing structure of the stereozone and streptocolumella. Hamilton (Moscow), East Alexander, N. Y. (6778 Carnegie Museum).

FIGS. 2-8. "*Cystiphyllum*" *americanum* Milne-Edwards and Haime.

FIG. 2. Transverse (ephebic) section of a small specimen of irregular growth. Hamilton (Moscow), Leicester, N. Y. (7372 Carnegie Museum.)

FIG. 3. Transverse (late neanic) section of a long, thin corallum in which the sclerotheca is imperfect. Hamilton (Moscow), Leicester, N. Y. (7367 Carnegie Museum.)

FIG. 4. Longitudinal section through the early ephebic portion of the same specimen. (7368 Carnegie Museum.)

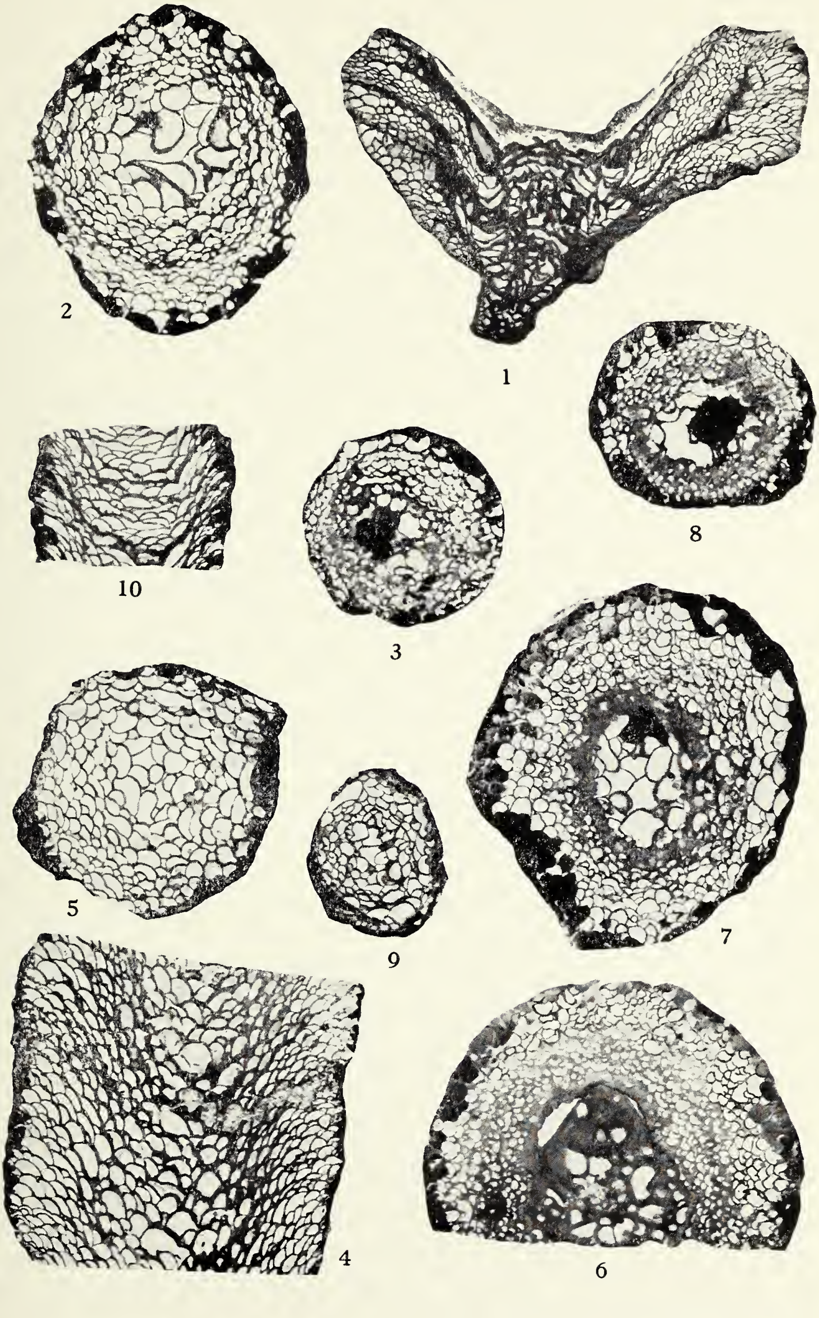
FIG. 5. Transverse (gerontic) section of the same; sclerotheca undeveloped. (7369 Carnegie Museum.)

FIG. 6. Transverse (early ephebic) section of a specimen in which both sclerotheca and tabular area are heavily calcified. This specimen is typical of the invalid "*C.*" *varians* Hall, plate 29, figures 1 to 13. Hamilton (Moscow), Leicester, N. Y. (7378 Carnegie Museum.)

FIG. 7. Transverse (gerontic) section with pronounced sclerotheca. The corallum shows pronounced expansions and constrictions; this section represents an expanding phase. The whole is typical of the invalid "*C.*" *corrugatum* Hall. Hamilton (Moscow), Leicester, N. Y. (7395 Carnegie Museum.)

FIG. 8. Transverse (early ephebic) section with thick sclerotheca. The corallum closely resembles "*C.*" *americanum?* of Hall, plate 30, figure 10. Hamilton (Moscow), Little Beard Creek, near Leicester, N. Y. (7374 Carnegie Museum.)

FIGS. 9-10. "*Cystiphyllum*" *conifollis* Hall. Transverse and longitudinal sections through the ephebic region of a corallum in which dissepiments are small and closely spaced. Hamilton (Moscow), Leicester, N. Y. (7417 and 7416 Carnegie Museum.)


2
1
8
10
3
5
9
7
4
6

EXPLANATION OF PLATE XXIV.

FIGS. 1-3. "*Cystiphyllum*" *americanum* Milne-Edwards and Haime.

FIGS. 1-2. Longitudinal and transverse (ephebic to early gerontic) sections of the large corallum shown in text figure 22. Note the discontinuous sclerothecal tube. Hamilton (Moscow), Leicester, N. Y. (7358 and 7359 Carnegie Museum.) × 1.6.

FIG. 3. Longitudinal section showing marginal calicular gemmation in the gerontic corallum of which a transverse section appears in plate XXIII, figure 6. Hamilton (Moscow), Leicester, N. Y. (7379 Carnegie Museum.) × 1.6.

FIGS. 4-7. *Cystiphyllum conifollis* Hall.

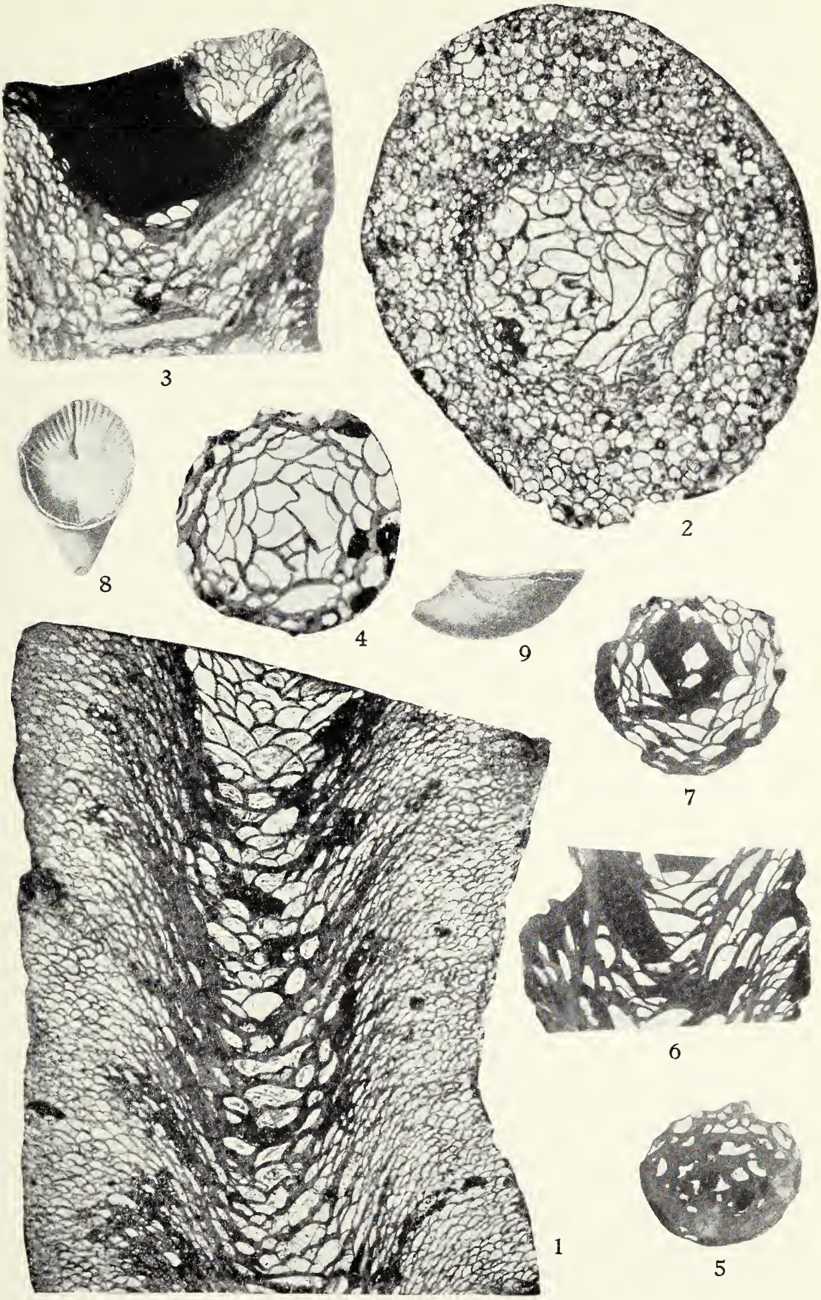
FIG. 4. Transverse (ephebic) section of a coarsely cystose corallum. Hamilton (Moscow), Leicester, N. Y. (7405 Carnegie Museum.) × 2.

FIG. 5. Transverse (late neanic) section of a heavily calcified specimen. Hamilton (Moscow), Leicester, N. Y. (7400 Carnegie Museum.) × 1.6.

FIG. 6. Longitudinal section through the ephebic region of the same specimen. (7400 Carnegie Museum.) × 1.6.

FIG. 7. Transverse (gerontic) section of the same specimen. (7400 Carnegie Museum.) × 1.6.

FIGS. 8-9. *Chonophyllum? sulcatum* (Billings). Hall's plate 32, figures 19 to 20, showing calyx and curvature. × 0.8.


3
2
8
4
9
7
6
1
5

ART. XV. A NEW WATER SNAKE OF THE GENUS *NATRIX* FROM MEXICO

By William M. Clay[1]

(Plate XXV)

Some years ago an unusual specimen of *Natrix* from Tampico, Mexico, was lent to me by the British Museum (Natural History). It bore many resemblances to *N. rhombifera* (Hallowell) but whether it represented an undescribed race or was merely an atypical individual could not be determined from a single specimen.

Recently, however, four additional specimens from near Tampico were sent to me for identification and study, by M. Graham Netting of the Carnegie Museum. These, in conjunction with a few other specimens in other collections, have demonstrated the existence of a southern race of *N. rhombifera.* The northern subspecies henceforth should be known as *Natrix rhombifera rhombifera* (Hallowell), and for the southern form I propose the name

Natrix rhombifera blanchardi[2] subsp. nov.

Diagnosis: Scutellation similar to that of *N. r. rhombifera* but color pattern much reduced. The belly of *N. r. blanchardi* is nearly immaculate which is in striking contrast to the strongly marked belly of *N. r. rhombifera.* The dorsal pattern is somewhat reduced, decidedly more obscure, and sometimes has a tendency to form longitudinal stripes.

Range: The geographic range of the specimens which have been examined extends from Garza Valdez, Tamaulipas, west to Valles, San Luis Potosí, and south to Tlacotalpan, Vera Cruz.

Types: Holotype, Carnegie Museum no. 9512, ♂, Tamaulipas, Mexico, within a radius of 85 miles of Tampico in the triangle formed by the Rio Tamesi and the Rio Panuco; collected between January 15 and February 20, 1937, by Mr. J. M. Sheppard. Paratypes, Carnegie Museum nos. 9513, 9514, and 9515 with same data as holotype;

[1] Contribution from the Department of Biology, University of Louisville.

[2] In honor of the late Dr. Frank N. Blanchard.

Issued October 5, 1938.

British Museum (Natural History) no. 267, Tampico, Mexico; Field Museum of Natural History no. 1389, Montemorlos, Nuevo Leon, Mexico, no. 2039, La Antigua, Vera Cruz, Mexico, no. 2079, Garza Valdez, Tamaulipas, Mexico; U. S. National Museum no. 46533, Tlacotalpan, Vera Cruz, Mexico; and private collection of E. H. Taylor and H. M. Smith no. 5412, twenty miles south of Valles, San Luis Potosí, Mexico.

Description of holotype: Scutellation of the head similar to that of *N. r. rhombifera.* The unpaired plates of the head are as follows: rostral wider than high; frontal pentagonal, somewhat longer than wide, with concave lateral borders, truncate anterior margin, and a slightly pointed posterior margin; mental triangular, slightly deeper than wide. The paired plates are as follows on each side: nasals 2, with the nostril between them; internasal subtriangular, longer than wide; prefrontal slightly wider than long; loreal about as deep as long; one preocular; one superciliary; 3 postoculars; temporals 1 + 3; one parietal; 8 upper labials, the fourth and fifth beneath the eye, the seventh the largest; 11 lower labials on the left side and 10 on the right, the sixth the largest on each side; posterior chin shield longer than the anterior and diverging widely from its fellow. Tubercles numerous on anterior chin shields and first pair of lower labials, fewer on posterior chin shields, mental, and second to sixth pairs of lower labials.

Dorsal scale formula of body, 25-25-21; 143 ventrals; anal divided; 82 pairs of caudals. Dorsal scales strongly carinated, less so on first row. Total length, 814 mm.; tail length, 215 mm.

Dorsal ground color slate grey upon which an obscure pattern of slightly darker blotches is arranged mainly into three series, a median dorsal series alternating with a lateral series on each side; about 30 blotches in dorsal series on body, 16 on tail, becoming progressively smaller and finally extinct in advance of the tip; dorsal blotches usually narrower in midline, expanding slightly laterally and connected by traces of diagonal bars with blotches of lateral series; in the neck region the dorsal and lateral blotches show a tendency to form longitudinal stripes; top of head almost uniform brownish-slate; centers of upper labials and rostral somewhat yellowish; lower labials and mental yellowish and mostly with dark margins; chin shields, gulars, and anterior ventrals yellowish to cream white; posterior ventrals greyish-white; caudals dusky and often with faint traces of spots along their anterior margins; belly practically immaculate.

Variation: Examination of the ten specimens at hand reveals no significant structural difference from *N. r. rhombifera.* Of the six male specimens, five have the dorsal scale row formula 25-25-19, one 25-25-21; the ventrals range from 141 to 151, average 144.66; the only two with complete tails have 80 and 82 caudals respectively. The four females have each a different dorsal scale row formula, as follows: 27-27-21, 27-27-20, 27-25-21, and 25-25-19; their ventral count ranges from 136 to 147, average 140.25; three with complete tails have 63, 67, and 70 caudals. All of these figures, and those of two other specimens which I have not examined personally, are within the extremes of similar data on *N. r. rhombifera.*

Most of the paratypes other than the Carnegie series are not so dark as the holotype and show almost no tendency toward the formation of longitudinal stripes. They agree with the holotype in being almost immaculate below.

One specimen, Field Museum no. 2039, from La Antigua, Vera Cruz, is surprisingly similar to *N. r. rhombifera;* its occurrence so far from the known range of the latter is not readily explained.

Acknowledgments: To the following persons I am indebted for the loan of specimens: Dr. Doris M. Cochran, U. S. National Museum; Mr. M. Graham Netting, Carnegie Museum; Mr. H. W. Parker, British Museum (Natural History); Mr. Karl P. Schmidt, Field Museum of Natural History; and Dr. E. H. Taylor, University of Kansas. Dr. Howard K. Gloyd of the Chicago Academy of Sciences kindly supplied me with data on numerous specimens of *N. r. rhombifera* and on two specimens of *N. r. blanchardi.*

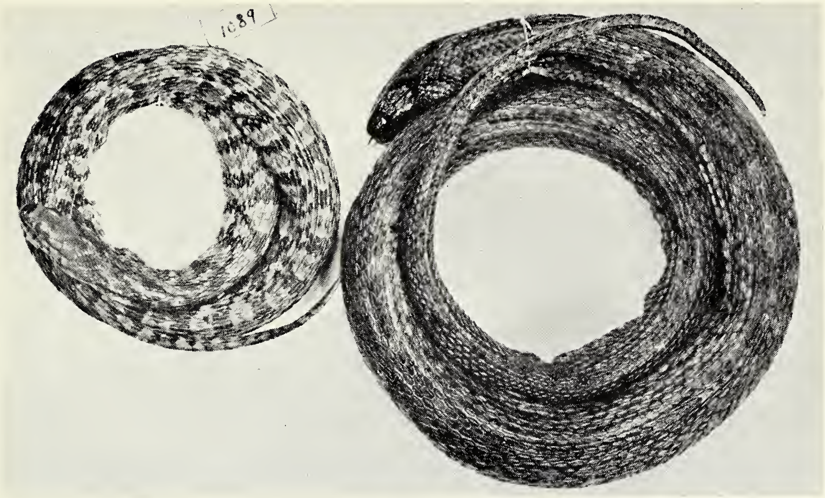


FIG. 1. Left: *Natrix rhombifera rhombifera* (Hallowell), Carnegie Museum no. 10,000 (formerly Wm. M. Clay no. 1089), San Antonio, Texas.
Right: *Natrix rhombifera blanchardi* Clay, TYPE, Carnegie Museum no. 9512.

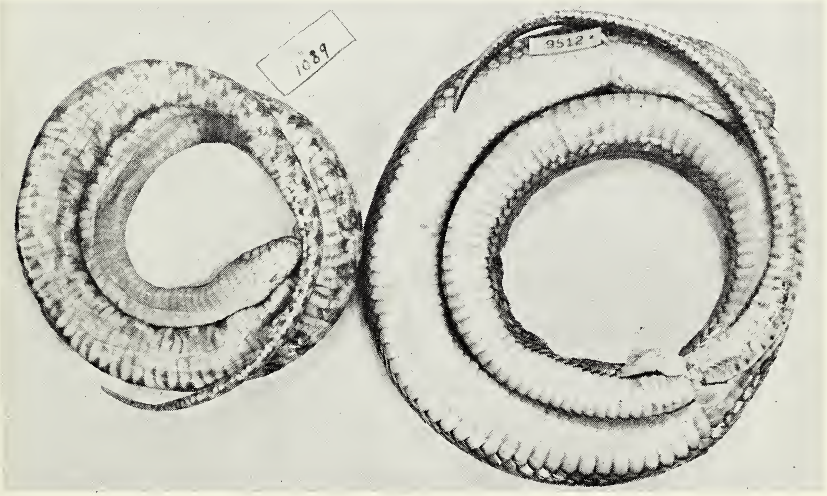


FIG. 2. Ventral views of the same specimens shown above.

ART. XVI. A NEW CYLINDRODONT RODENT FROM THE OLIGOCENE OF MONTANA

By J. J. Burke

(Plates XXVI-XXVII)

In the course of study of the Oligocene Tertiary collections made by the late Earl Douglass for the Carnegie Museum, I have had at hand for some time material representing an undescribed species of cylindrodont rodent which Douglass discovered in the McCarty's Mountain Oligocene of Madison County, Montana, in 1903. Until the present, I have refrained from publishing a description of the Douglass specimens, mainly because of their fragmentary nature. However, in the summer of 1937, a Carnegie Museum field party re-investigated the original Douglass locality, and discovered some excellently preserved specimens, which, together with the Douglass material, form the basis of the present description.

As in previous studies, I have been generously aided in this work through the loan of comparative material by the American Museum of Natural History at New York, the U. S. National Museum at Washington, and the Field Museum of Natural History at Chicago. Mr. Sydney Prentice of the Carnegie Museum made the drawings for the illustrations in this paper.

Order SIMPLICIDENTATA Lilljeborg

Family CYLINDRODONTIDÆ* Miller and Gidley

Genus Pseudocylindrodon Burke

Pseudocylindrodon medius sp. nov.

Holotype: Right ramus of mandible with broken incisor, P_4 and M_{1-3}, Carnegie Museum No. 9999.

*I feel that the rodent genera *Mysops* (as delimited by Wilson), *Pareumys*, *Pseudocylindrodon*, *Cylindrodon* and *Ardynomys* constitute a valid family assemblage. Tentatively, pending further study I am also including *Tsaganomys* and *Cyclomylus* in the family. Since communicating with R. W. Wilson and studying new fossil specimens now at hand, I hesitate to place *Sespemys* in this group; in any case I prefer not to pass upon the affinities of the latter genus until I can see the types of *Sespemys thurstoni* Wilson.

Issued October 22, 1938.

Referred specimens: Skull, well-preserved, but brain case somewhat shattered in parietal region, left malar missing, specimen distorted by crushing on right side of occiput and in right pterygoid region, and RP^3 lost, C. M. No. 10001.

Skull, anterior portion, zygomatic arches and nasals lost, RI and LP^3 broken away, RP^3 lost, C. M. No. 10000.

Skull, anterior portion, badly damaged, but rostrum in fair condition on right side. Posterior part of nasals preserved. RI and R and LM^{1-2} preserved, also stump of RP^4, C. M. No. 1135.

Left ramus of mandible with I and well-worn cheek teeth, C. M. No. 9998.

Horizon: McCarty's Mountain Oligocene.

Locality: Southeastern slope of McCarty's Mountain, Madison County, Montana, about sixteen miles north and a little east of Dillon, Montana.

Diagnosis: A smaller species than *Pseudocylindrodon neglectus* m.; lower jaw lighter, cheek teeth somewhat more brachyodont, hypoconids less produced laterally, hypolophid crest in P_4, internal intermediate cuspules absent on M_{1-2}, and central valley exits open, posterior valleys of molars not dammed at exits.

In dorsal profile the skull of *Pseudocylindrodon medius* m. is fairly evenly convex, except for some flattening in the interorbital and parietal regions. The occiput leans anteriorly to some extent (the condyles are visible in dorsal view). The dorsal profile in *Cylindrodon* appears somewhat more evenly and a little more strongly convex. The ventral profile of *Pseudocylindrodon medius* m. is broadly concave in the region of the diastema (anteriorly paralleling the dorsal profile, posteriorly diverging from it somewhat, but in this latter case not so markedly as in *Cylindrodon*). Along the tooth row the profile is essentially horizontal, *i.e.* flattened; it again approximates paralleling the dorsal profile in the pterygoid region. The audital bullæ, however, descend well below the pterygoids, and are most convex anteriorly. Neither *Cylindrodon* nor *Ardynomys* shows such ventral extent of the bullæ as the present species.

In superior view the brain case is somewhat pentagonal in outline caudad of the postorbital constriction; it is truncate posteriorly, expands laterally to the glenoid region, and then tapers anteriorly to the postorbital constriction, where the skull is quite narrow, as in cylindrodonts generally; there is again strong lateral expansion to the antorbital region. In degree of lateral expansion of the brain case caudad, from the postorbital constriction to the glenoid region, *Pseudocylindrodon* appears to approach *Ardynomys* rather than *Cylindrodon*, if I may judge from the mutilated skulls of the latter genera at my disposal. *Cylindrodon* would apparently come nearer to having the tubular "neck" in the postorbital region so characteristic of *Paramys* and *Sciuravus*, but it is not of the slender and more primitive type found in the Eocene forms; expansion of the brain case immediately caudad of the postorbital constriction seems to be a definite characteristic of the Oligocene *Cylindrodontidæ*. There is an interesting contrast between *Pseudocylindrodon medius* m. and *Ardynomys* in the region between the zygomatic process of the squamosal and the occiput; in *Ardynomys* the distance between these areas is lessened, due to the lateral flaring of the brain case and caudad shifting of the zygomatic process of the squamosal—both trends in the direction of *Tsaganomys*.

Both *Ardynomys* and *Cylindrodon* possess low but definite sagittal crests. In the present species a median crest, formed by orbital ridges which converge at the interorbital constriction, extends caudad to the neighborhood of the suture between the frontals and the parietals at which place it bifurcates. I am unable to trace the caudad reaches of these branches, however, since in C. M. No. 10001, the only skull showing the bifurcation, the dorsal surface of the paper-thin brain case is shattered away.

The dorsal profile of the occiput is more convex and angular than that of *Ardynomys*, and probably more than in *Cylindrodon* also, since in both the latter genera the lateral expansion of the brain case has depressed the skull in this region. The occiput is lower than in *Cynomys*, but not as low as in *Ardynomys* or *Aplodontia*. The *foramen magnum* is quite large, its width greater than its height, and subpentagonal in outline. The condyles are low and broad, and not well marked off from the skull, dorsally they extend but slightly laterad of the borders of the *foramen magnum*. There is no occipital crest comparable with the rather thin and sharp crest seen in *Cynomys*, but superior to the *foramen magnum* there is a large triangular, or better, arrowhead-shaped swelling of the supraoccipital, the apex dorsal; this structure produces some convexity in the occipital profile in lateral view.

The plane of the occipitals is fairly well marked off from those of the mastoids. The distinction between the mastoids and the occipitals is accentuated on the right side of C. M. No. 10001 because there has been some parting along the suture, but even on the left side the slope of the mastoid from the occipital plate, ventral above, anterolateral below, is well shown. Dorsally, the wings of the supraoccipital extend well laterad superior to the mastoids. The mastoid foramen seems to be almost entirely walled around by the bone of that name, however. The paraoccipital processes are short and blunt; even though they may have suffered some breakage in this skull, I doubt whether they ever extended below the condyles, against which they are much crowded. The marked narrowing or compression of the exoccipitals laterad of the condyles is one of the most characteristic features of the skull of this species.

The basioccipital is narrow, particularly in the region between the audital bullæ, where it is crowded. The median longitudinal crest is about as in *Neotoma*. The tendency for the basioccipital to build down on the median sides of the bullæ is slight, although the bullæ press against it. A small condyloid foramen is present on the caudo-median wall of the posterior lacerated foramen. A stapedial foramen is not shown. The posterior lacerated foramen is prominent and drawn-out anteriorly.

Laterally and anteriorly the parietals appear to have about the same extent as in *Ischyromys;* they almost reach the postorbital constriction. Concerning the interparietal I am unable to ascertain anything definite, due to the shattering of the brain case dorsally.

The extent that the posttympanic process of the squamosal overlaps the mastoid is considerably less than in *Ischyromys*, but at first glance the greater lateral exposure of the mastoid is not strikingly apparent, for the mastoid is not inflated as in the latter genus. Although it is somewhat difficult to trace the suture between the squamosal and the parietal, it is evident that the squamosal played a minor part in the formation of the skull roof, being restricted to the sides as in *Ischyromys*. Apparently, as in *Ischyromys*, the larger foramen postero-median to the postglenoid foramen in *Pseudocylindrodon medius* m. marks the suture between parietal and squamosal. The glenoid fossa is somewhat elongated antero-posteriorly, and is narrower transversely than that of *Arctomys*. The contribution of the squamosal to the zygomatic arch appears to have been slight, judging from C. M. No. 10001; it forms but a short part of the arch of this specimen, but there are some indications that it may have been damaged prior to fossilization; if such were the case, the zygoma may not have been as slender posteriorly as now appears.

In keeping with the reduction of the exoccipitals, the mastoids are transversely expanded below; the greatest lateral extent of each is about twice that of the adjacent portion of the exoccipital. Dorsally the mastoid is wedged in, medially by the body of the supraoccipital, dorsally and laterally by its descending lateral wing. There is a deep pit between the mastoid and the squamosal at the caudal side of the base of the mastoid process; this may lead into a foramen. In the present specimen, C. M. No. 10001, the mastoid process is small and not at all prominent. Between it and the external auditory meatus are found the tympanohyal pit and the stylomastoid foramen; the latter foramen is relatively small.

The audital bullæ are large and appear drawn out ventro-medially and anteriorly. They are compressed from a ventro-lateral direction, but more medially they are well inflated. In size, in their more uniform transverse dimensions (they show no marked tapering anteriorly and posteriorly) and in their marked inflation in a ventro-median plane they contrast with the bullæ of *Ardynomys* and *Cylindrodon*. In another respect, too, they differ from those of the latter two genera. Because thin fossil bone from the McCarty's Mountain Oligocene exposures is usually to some degree translucent, one can often study deeper details of the bone structure to considerable advantage; in the case of the audital bullæ of C. M. No. 10001 this holds true; by applying glycerine to the outer surface of the bone one can detect the structure of the internal surface of the bullar wall with considerable clarity; here one sees the *crista tympanica* carried well medially, and radiating from it, numerous bullar septa. This structure seems quite similar to that found in *Allomys cavatus* (Cope); indeed the entire bulla reminds me quite a little of the bulla of the latter, if I can trust Cope's illustration[1] and my memory of the type of that species, which I have never examined closely, but which I have seen in passing in the American Museum of Natural History. I do not find bullar septa of this type in our specimens of *Ardynomys* from the McCarty's Mountain Oligocene deposits and I have not discovered them in the skull of *Cylindrodon*, A. M. No. 14584 from the Beaver Divide, Wyoming. The audital meatus of *Pseudocylindrodon medius* m. C. M. No. 10001 shows the rudiment of a tubular ring, laterally directed, although the anterior lip shows some inclination forward; ventrally the rim is incomplete.

The suture between the basioccipital and the basisphenoid shows distinctly in this specimen. The basisphenoid is flat and in essentially the same plane as the basioccipital.

If present, the middle lacerated foramen must be insignificant. The audital bullæ are well rimmed with bone antero-medially, although in the region of the recess for the opening of the eustachian canal excavation cannot be carried to the point of demonstrating the presence or absence of the foramen.

The pterygoid is drawn out into a prominent but slender hamular process which extends to and contacts with the auditory bulla. Lateral to the pterygoid plate extends the external palatine plate, which splays laterally in its caudad course and ends in a free process. Although not elongate antero-posteriorly, the pterygoid fossa is quite wide for a skull of this size, even though the marked divergence of the pterygoid and external palatine plates be attributed to some extent to crushing of the specimen. It is also fairly deep, and the floor of the fossa is not crowded.

I believe one can be reasonably sure of the identification of the foramina of this region. In the pterygoid fossa there is a foramen of moderate size which has the position of the sphenopterygoid. Caudolateral to it, above the free external palatine process, we find the larger

[1] Cope, E. D., "The Vertebrata of the Tertiary Formations of the West." Rept. U. S. Geol. Surv. III, Pl. LXIII, Fig. 12, 1884.

inferior oval foramen. Anterior and ventral to the latter the root of the descending plate of the alisphenoid is pierced by an opening which occupies the proper location of the alisphenoid canal, in this case not at all as reduced as in the *Sciuridæ*, and easily discerned. Presumably the small foramen which occurs antero-lateral to this last, and which pierces the alisphenoid bone, being directed caudally (it would lead into the alisphenoid canal, in other words) is the masticatory foramen.

The sphenoidal fissure is large, slit-like, but broad transversely. The optic foramen is also prominent, and well separated from the sphenoidal fissure. Above and anterior to the optic foramen the anterior ethmoid foramen is shown. The sphenopalatine foramen is carried well forward (above M^1) but not as far as in *Aplodontia*. It is somewhat elongate antero-posteriorly, not rounded.

The frontals have an anterior extent dorso-medially nearly to the anterior orbital rim, and are but slightly invaded by the nasals. Caudo-median to the lacrimals, on the orbital rims, the frontals are slightly produced into what look like the rudiments of processes; more caudo-median arise the low orbital ridges, which converge posteriorly into a median crest.

The posterior palatine notch is carried anteriorly to a point opposite the anterior portion of the base of M^3—not quite as far anteriorly as in *Ardynomys* and *Cylindrodon*. The post-nareal trench is not narrow as in *Cylindrodon*, rather it approximates that of *Ardynomys*. The palate is narrowest in the region of M^1 and M^2; anterior to this place the tooth row bends laterally. The posterior palatine foramina show opposite the first molars but are not easily distinguishable from the maxillo-palatine sutures.

Posteriorly, a low ridge marks the maxillary suture, but in general the palate is smooth, more so than that of *Cylindrodon*, and without the better-defined ridges and channels of the *Ardynomys* palate. The maxillaries show little in advance of P^3; most of the area between P^3 and the incisor is taken up by the premaxillaries, which have an antero-posterior extent equal to that of the maxillaries. Considering the short rostral portion of the palate, the anterior palatine foramina have fair antero-posterior extent; they are confined to the premaxillaries, however. From the postero-lateral alveolar walls of the incisors low, sharp ridges converge to the anterior borders of the anterior palatine foramina. I have not detected an interpremaxillary foramen.

The zygomatic arch is slender, particularly when compared with that of *Cylindrodon*. In C. M. No. 10001 it roughly parallels the plane of the palate and does not drop to the level of the tooth row, although carried lower than that of *Aplodontia*. Its anterior root is not tilted dorsad from below to the extent seen in the zygomata of *Cylindrodon* and *Ardynomys*. The malar extends well dorsad against the zygomatic process of the maxilla, rising a little above the incisive swelling and well dorsad of the infraorbital foramen.

The zygomatic root of the maxillary is slenderly constructed, and strongly contrasts with the more robust structure seen in typical *Paramys*. Unlike the condition found in *Aplodontia*, there is no marked bending forward of that part of the zygomatic root which is ventral to the infraorbital foramen; in C. M. No. 10001 this portion of the root is moderately inclined forward before bending posteriorly as part of the arch. The zygomatic process of the maxillary is carried posteriorly to the vicinity of the posterior region of M^2.

The scar of the masseter muscle is not as distinct, or carried as far forward as in *Aplodontia*. The infraorbital foramen is of moderate size, and its anterior opening is visible in anterior and ventral views of the skull. In anterior view its course is seen to be somewhat oblique, rather than at a right angle to the lateral plane of the maxillary plate, but it does not excavate the plate dorso-laterally to any degree comparable with the condition found in *Aplodontia*.

Compared with those of *Ardynomys* and *Cylindrodon* the rostrum of *Pseudocylindrodon medius* m. is narrower transversely, and shows more tapering anteriorly. Neither *Cylindrodon* nor *Pseudocylindrodon* has quite the angular type of rostrum found in *Ardynomys*, although *Cylindrodon*, in the steep slope mediad of the inferior lateral wall of its rostrum differs from *Pseudocylindrodon* in the direction of *Ardynomys*.

The premaxillaries are somewhat short in posterior extent; they terminate just dorsad of the zygomatic or lateral plate of the maxillary and do not reach the interorbital region. Their contact with the frontals is slight, since they are crowded by maxillaries and nasals. The nasals in turn barely reach the interorbital region.

The nasals narrow posteriorly, but the narrowing is not at all as marked as in *Aplodontia*, and in the species under description these bones contribute to the crowding of the premaxillaries, as noted above. As the tip of the snout is approached the nasals again narrow, but not to the extent found posteriorly. Anteriorly, these bones are inflated, and project for a short distance anterior to the premaxillaries.

The lacrimal is a more prominent feature of the orbital border than that of *Cynomys*, and appears close to *Paramys* in extent and proportion in this region. The naso-lacrimal canal is essentially as in *Aplodontia*, but smaller.

The superior incisors of *Pseudocylindrodon medius* m. resemble those of *Cylindrodon*, differing strongly from those of *Ardynomys* in their lesser size and lack of flattening along the anterior face. In C. M. No. 10001 the incisors show a greater transverse than longitudinal measurement, but in C. M. No. 10000, a younger skull, the measurements are equal.

Taken as a whole, the superior cheek tooth row of *Pseudocylindrodon medius* m. bears quite a resemblance to that of *Ardynomys* when worn dentitions are compared, for the species under description shows oblique implantation of the superior cheek teeth and a degree of unilateral hypsodonty, approaching *Ardynomys* in these characters; consequently, with age the surface of wear of these teeth becomes increasingly broader on the protomere side, much as in *Ardynomys*,

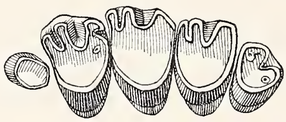


FIG. 1. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 10001, occlusal view of left superior cheek teeth, × 5.

while considerable of the original pattern is lost. We are quite fortunate in that we have for comparison, in addition to the nearly complete skull C. M. No. 10001, in which the dentition is much worn, other specimens which show the teeth in earlier stages of wear. From these latter, in comparison with little worn superior cheek teeth of *Ardynomys*, it is apparent that the latter genus has already gone beyond *Pseudocylindrodon medius* m. in dental specialization, and not in unilateral hypsodonty alone, for the superior cheek teeth of *Ardynomys* have taken on some of the characters of *Cylindrodon* in that they are drawn out into longer shafts than those of *Pseudocylindrodon medius* m. and they expand less rapidly from the root to the occlusal surface. These specializations in *Ardynomys* have carried with them some changes of the dental pattern which may be summarized as consisting in increased lophodonty and its attendant pattern modifications, the crests and the walls of the crown have been elevated, and are more delicate, cusp-crest structure gives way to lophs, and the tooth valleys are narrowed and more enclosed as basins. *Pseudocylindrodon medius* m. on the other hand, preserves, with surprisingly little change, much of the dental structure of the *Mysops*-group, the stem-stock of the cylindrodont rodents; the species retains much of the low, rapidly expanding tooth crown of *Mysops*, well-marked cusp-crest structure, broad valleys and shows less unilateral hypsodonty than *Ardynomys*.

In keeping with the lesser specialization of the species in general, the P^3 of *Pseudocylindrodon medius* m. is less reduced than that of *Ardynomys*. The tooth is preserved in C. M. No. 10001, where it shows as a spike-like shaft, but stouter than that of *Ardynomys occidentalis* m. The tooth is well-worn in this specimen, subcircular in section, and has equal transverse and longitudinal dimensions.

The P^4 of the species under description is the largest superior cheek tooth. In occlusal view the tooth is somewhat triangular in outline, with the angles rounded (it is seen in an early stage of wear in C. M. No. 10000). The pattern, in general is like that of P^4 of *Mysops*, but with the paracone and the metacone more widely separated and hypocone not distinct after wear. Protoloph and metaloph elements converge to the protocone; the protoloph is a definite crest and no protoconule is indicated. The metaconule is large, quite a distinct cusp and triangular, expanding toward the floor of the crown; at its angles the cusp connects by narrow spurs with the metacone and the pro-

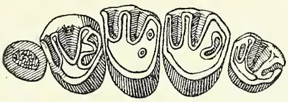


FIG. 2. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 10000, occlusal view of P^4, M^{1-3} left, × 5.

tocone, and posteriorly with the posterior wall of the crown. The anterior cingulum is elevated and the crest produced anteriorly, bending rather sharply to meet the protocone internally. The anterior valley is narrow, the central valley broad and V-shaped. Due to the connection of the metaconule with the posterior wall, the floor of the posterior valley is divided into external and internal "basins," which become fossetes or isolated enamel islands with wear. The floors of the anterior valley and of the posterior "basins" are higher than that of the broad central valley; the exit of the anterior valley is open, but that of the posterior valley, or better, postero-external "basin," is closed, due to fusion of the metacone and the posterior wall. The metacone projects well externally beyond the dam thus formed.

There is an intermediate tubercle in the outlet of the central valley in P^4 of C. M. No. 10000, but the tubercle is absent in P^4 of C. M. No. 10001. The tubercle bulges the crown externally at the outlet of the valley in C. M. No. 10000, a feature not found in C. M. No. 10001 also. P^4 in C. M. No. 10001 is well worn, but shows the postero-internal "basin" as a small enamel island. The postero-external "basin" of this tooth is not yet isolated as an island, due to a low gap in the posterior wall at that place.

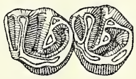


FIG. 3. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 1135, occlusal view of LM^{1-2}, × 5.

The molars of this species have the essentials of the pattern of P^4, and bear marked resemblances to those of *Mysops* likewise. The main pattern difference between P^4 and the molars of *Mysops* and the same teeth in *Pseudocylindrodon medius* m. is found in the metaconule and bordering elements; the metaconule has better connections with the metacone and the protocone, and a (usually) strong connection with the posterior wall with wear. (As a matter of fact, in M^2 the connection with the posterior wall is well down toward the floor of the tooth.)

The transformation of the *Mysops* molar into that of *Pseudocylindrodon* is not hard to visualize. Several workers have noted the unimportant role that the hypocone plays in *Mysops*, and its close proximity to the protocone. It is evident that the merging of hypocone and protocone to form the internal shelf is already well under way in *Mysops*. It has gone even farther in *Pseudocylindrodon*, and after a very little molar wear, one cannot distinguish the two cusps. I am fortunate, however, in having one specimen, (C. M. No. 1135) in which protocone and hypocone can be made out in M^1 and in M^2 but a slight amount of wear would even eliminate the internal enamel reentrant which demarks them. This reentrant is more persistent in *Mysops*. In *Pseudocylindrodon medius* m. the merging of the hypocone and the protocone may have been in itself sufficient to draw the internal reaches of the posterior wall anteriorly and impinge the wall against the large metaconule. But more likely this is not the whole story; we must not forget that the entire tooth is being affected by a common trend, and that we see here a stage in the transformation of a low crowned, wide flaring tooth to a higher crowned, more cylindrical shaft, in which process all the elements of the original occlusal pattern undergo crowding and readjustment.

At early stages of wear the molars have more of a quadrangular, rather than triangular appearance, since the migration of the surface of wear internally is less evident. Even then, however, their walls are produced internally in the region of the protocone, and externally, but much less so, at the outlet of the central valley, if the intermediate tubercle is present at that place. I do not attach any particular significance to the presence or absence of the tubercle, particularly since I find it present in RM^1 of C. M. No. 10000, and absent or only indicated in LM^1 of the same specimen. It is not shown in the second molars of C. M. No. 10000, but does occur in the third molars. It appears to be present or indicated in M^{1-2} on both sides in C. M. No. 1135, but is lacking in the molars of C. M. No. 10001.

The molars show a progressive decrease in size posteriorly, although the discrepancy between M^1 and M^2 is most evident in early stages of wear. The triangular outline of M^1 in most specimens is a product of wear, a factor which enters into almost any consideration of outline and pattern of cylindrodont teeth.

Contrary to the situation in P^4, the internal "basin" of the posterior valley sinks as low or lower than the central valley in M^{1-3}. Because of the greater depth at which the metaconule connects with the posterior wall in this tooth, M^2 bears resemblance to M^2 of *Mysops*, which has the posterior valley clear.

The posterior wall or cingulum crest in M^{1-2} is, as in P^4, connected with the metacone to block the posterior valley outlet, and as in P^4 the cingulum joins with the latter cusp well internal to its extreme lateral reaches, the posterior cingulum being of short transverse extent. Nevertheless, the posterior valley has the farthest internal extent of the transverse valleys of the crowns of these teeth.

The M^3 of C. M. No. 10000 is not badly worn and shows an interesting construction; the outlet of the posterior valley is not closed but opens posteriorly; the posterior cingulum and the metacone are not fused. This condition is much like that found in the molars of *Ardynomys.*

The mandible of this species is lighter than those of *Cylindrodon* and *Ardynomys;* it is also smaller and considerably lighter than that of *Pseudocylindrodon neglectus* m. The ramus is deep anteriorly, with the greater depth beneath P_4, yet there is a more rapid decrease in depth posteriorly than in *Cylindrodon.* In this last feature there is some approach to the ramus of *Ardynomys*, but in *Pseudocylindrodon medius* m. there is no flange-like ventral extension of the mandible such as is found in *Ardynomys*, and which renders the rami of the latter genus angular by emphasizing their anterior depth. While the symphysis is carried as far posteriorly as in *Cylindrodon* (beneath P_4) the articular area is not as extensive or roughened as in that form, particularly in its ventral and its posterior reaches.

The diastema would appear to be somewhat shorter than that of *Pseudocylindrodon neglectus* m. There are two mental foramina in the species under description, as in the species from Pipestone Springs; the anterior and larger of these occurs below P_4, or, as in one specimen, C. M. No. 9933, a little in advance of that tooth. In *Pseudocylindrodon* the prevailing tendency is for the mental foramina to be placed behind the diastema.

The masseteric fossa is rather shallow. The ridges for the masseteric muscles are not as prominent as in *Ardynomys, Cylindrodon* or *Pseudocylindrodon neglectus* m. The dorsal masseteric ridge also rises at a lower angle than in the latter forms. The masseteric scar does not extend anteriorly in advance of M_2.

In C. M. No. 9999 the coronoid process is broken off at the base; at that place it was extended antero-posteriorly, and must have presented much the same appearance as that of *Ardynomys chihi* M. & G., where it shows as a low plate, antero-posteriorly expanded. The anterior border of the coronoid process appears to have risen at a lower angle than in *Ardynomys, Cylindrodon* and in *Pseudocylindrodon neglectus* m.

The condyle is placed low. The articular surface is irregularly rounded, and, on the lateral side, extended, tapering ventrally. The angle arises from the base of the incisive alveolus. Above it the ascending ramus is more convex laterally than that of *Cylindrodon.*

The dental foramen is found posterior to M_3, just dorsad of the ridge extending from the base of the tooth row to the condyle. The fossa for the insertion of the internal pterygoid muscle is extensive and well excavated, in keeping with the broad pterygoid fossa of the skull.

The mandibular incisor of this species differs from that of *Pseudocylindrodon neglectus* m. is showing less transverse compression; the tooth shows only a slightly greater antero-posterior than transverse measurement. Its anterior face is rounded, much as in *Cylindrodon;* there is no suggestion of the flattening found in *Ardynomys.*

The mandibular cheek teeth of *Pseudocylindrodon medius* m. are definitely of the more brachyodont type found in *Ardynomys* and *Pseudocylindrodon neglectus* m. and contrast with the higher-crowned cheek teeth of *Cylindrodon.* "Unicuspal" hypsodonty is less evident than in *Pseudocylindrodon neglectus* m.; in the species under description there is less of a tendency for the enamel of the crown to be carried down the hypoconid root.

FIG. 4. *Pseudocylindrodon medius* Burke, holotype, C. M. No. 9999, occlusal view of mandibular cheek teeth, × 5.

Unlike that tooth in *Pseudocylindrodon neglectus* m., P_4 shows greater antero-posterior than transverse dimensions. The trigonid is elevated and relatively more transverse than in P_4 of the Pipestone Springs species, but as this tooth is either too worn or else damaged in the trigonid region in my specimens I cannot compare the trigonid cusps. Wear may also have eliminated the protolophid, if the crest were present. A distinct hypolophid is shown (the hypolophid is absent in the holotype of *Pseudocylindrodon neglectus* m.). The hypolophid in P_4 of *P. medius* is a strong crest, not reduced as in *Ardynomys occidentalis* m.; it extends antero-externally from the entoconid, its direction paralleling the course of the attenuated hypoconid. Due to the presence of the hypolophid crest, both the central and posterior valleys are distinguishable in this tooth, in contrast with the situation in P_4 of *Pseudocylindrodon neglectus* m., in which there is but a single valley, or rather, a basin, the floor of which is rounded, in this region. The central valley in the species under description is V-shaped, transversely directed, and rapidly widens to its internal exit. The entoconid is drawn posteriorly, and at its base is fusing with the hypoconulid ridge. As in *Pseudocylindrodon neglectus* m. the hypoconid is drawn out laterally and anteriorly, but it is not carried as far forward as in that species; in consequence, the broadly U-shaped external valley has more of an obliquely transverse, rather than antero-posterior direction, than in P_4 of *Pseudocylindrodon neglectus* m. The hypoconulid ridge originates from the postero-internal side of the out-jutting hypoconid and is directed postero-internally until it reaches the posterior wall of the tooth, then its course becomes sharply transverse. The crest becomes delicately attenuated in its internal extent. The posterior valley constricts and narrows to its internal exit, due to the close approximation of entoconid and hypoconulid ridge; the internal exit is quite narrow, and the ridge and cusp fuse below, elevating the valley exit. There is no cuspule in the outlet of the external valley, such as one finds in P_4 of the holotype of *Pseudocylindrodon neglectus* m.

The mandibular first molar of *Pseudocylindrodon medius* m. also contrasts with that of *Pseudocylindrodon neglectus* m. in proportions; its transverse measurement is only a little greater than its antero-posterior measurement, whereas in the Pipestone Springs species M_1 is much more transverse in the talonid region, with the hypoconid strongly produced. In C. M. 9999 M_1 is so much worn that many details of the original crown pattern are not distinguishable. A trace of the shallow central valley still remains; its general course is transverse, with a slight postero-external trend; it forms a less angular V than the central valley of P_4. The exit is clear; there is no internal intermediate cuspule such as occurs in *Pseudocylindrodon neglectus* m.

If one can judge from the antero-posterior extent of the talonid on the internal side of M_1 of C. M. No. 9999, this tooth unworn would not have shown the crowding and fusion of hypoconulid crest and entoconid observable in M_1 of *Pseudocylindrodon neglectus* m. There is hypertrophy of the hypoconid in M_1 of *Pseudocylindrodon medius* m., but in this region the crown bears more resemblance to that of *Ardynomys* than to *Pseudocylindrodon neglectus* m.; in fact, the entire tooth makes an approach to M_1 of *Ardynomys.* Since the hypoconid is not produced antero-externally as markedly as in M_1 of the genotype of *Pseudocylindrodon*, the external valley is less extensive than in that species. There is no cuspule in the outlet of the external valley.

In *Pseudocylindrodon medius* m. the antero-posterior measurement of M_2 exceeds the transverse measurement—the reverse of the condition found in *Pseudocylindrodon neglectus* m. In C. M. No. 9999 this tooth is not badly worn, but the protolophid has been eradicated. It must have been carried high on the trigonid, and may have been short and crowded against the trigonid cusps. The central valley is U-shaped, and wide throughout its course. There is no cuspule at the exit of the valley, but the posterior shoulder of the metaconid is carried well back toward the entoconid, which has the effect of raising the valley floor somewhat at the exit.

The posterior valley is also U-shaped at its initiation, but becomes somewhat constricted at its exit, due to the incipient fusion of the entoconid with the hypoconulid crest. The course of the latter crest is somewhat as in P_4, but the crest is less attenuate on the internal side. It is also short, not reaching as far internally as the entoconid does (this condition probably held true in M_1 as well). Hypertrophy of the hypoconid is not marked, but the cusp wall is somewhat produced externally. The external valley is nearly transverse.

It can be seen that this tooth preserves in detail many of the features of the tooth pattern of the *Mysops* stock of Eocene rodents—probably more so than does M_1 of any other Oligocene cylindrodont.

The M_3 of C. M. No. 9999 also shows greater extent antero-posteriorly than transversely. The tooth is not badly worn and preserves practically all details of the pattern. The protolophid is shown carried well up on the trigonid, extending from the protoconid to the posterior side of the metaconid; it does not reach as far internally as in M_3 of *Pseudocylindrodon neglectus* m.; the anterior valley is also narrower than in the latter species. The central valley is rounded (basin-like) with a tubercle rising from its floor and from the posterior side of the metaconid. The tubercle in this case is probably an individual variation, rather than a character of specific value. The internal exit of the central valley is almost entirely closed off; an intermediate tubercle is present, and, as in M_3 of *Pseudocylindrodon neglectus* m., it fuses with the posterior shoulder of the metaconid and with the entoconid, damming the central valley almost essentially as in the latter species. The entoconid is enlarged, extended antero-posteriorly and drawn out into a strong triangular hypolophid crest. The posterior valley narrows at its internal exit, where its valley floor rises, but the valley remains open. The talonid is narrower transversely than the trigonid; the hypoconulid crest is short, not reaching internally as far as the entoconid does. The external valley has more of a postero-median direction than that of M_2.

Pseudocylindrodon medius m. is the most conservative of the known Oligocene *Cylindrodontidæ.* While it has advanced beyond Eocene rodents such as *Sciuravus* and *Paramys* in such specializations as expansion of the brain case, modifications in the occipital region and an advanced type of auditory bulla, it does not show the extreme skull trends in the direction of *Tsaganomys* that are found in *Ardynomys,* and, but to a much lesser degree, in *Cylindrodon. Pseudocylindrodon medius* m. cannot be compared with *Cylindrodon* in dental specialization, for the latter species is the extreme among its contemporary cylindrodonts in this respect. Even *Ardynomys* has outstripped *Pseudocylindrodon medius* m. in dental structure. The dentition of the present species makes the nearest approach to that of the Eocene genus *Mysops* known among Oligocene rodents, and *Pseudocylindrodon medius* m. furnishes a most satisfactory link between *Mysops, Pareumys* and Oligocene cylindrodonts such as *Ardynomys* and *Cylindrodon.*

MEASUREMENTS.

Holotype right mandibular ramus, Carnegie Museum No. 9999.

	mm.
Mandibular I anteroposterior	1.8
Mandibular I transverse	1.7
P_4 anteroposterior	1.9
P_4 transverse	1.8
M_1 anteroposterior	1.8
M_1 transverse	1.9
M_2 anteroposterior	1.7
M_2 transverse	2.0
M_3 anteroposterior	2.0
M_3 transverse	1.8
Anteroposterior length of mandibular tooth row	6.9
Anteroposterior length of inferior molar series	5.0
Length of diastema between mandibular I and P_4	2.3
Depth of ramus under M_1	4.9

Referred specimens, skulls, Carnegie Museum Nos. 10001 and 10000.

	C. M. 10001 mm.	C. M. 10000 mm.
Greatest anteroposterior length of skull (anterior tips of nasals to occipital condyles)	29.4	....
Length of skull, anterior face of incisors to inferior margin of *foramen magnum*	26.0	....
Length of skull, anterior face of incisor to occipital condyle	27.8	....
Length of skull, anterior face of incisor to supra-occipital	27.7	....
Width of rostrum at premaxillary suture	8.5	8.0
Greatest width of maxillary region of zygomata	16.2	....
Width of skull at postorbital constriction	5.3	....
Greatest width across zygomatic arches (equals greatest width of squamosal region of arches)	19.5*	....
Distance between postglenoid foramina	8.9	....
Distance between postero-ventral tips of posttympanic processes of squamosals	14.0**	....
Depth of rostrum at premaxillary suture	6.2	....
Height of skull above M^1	8.0	8.4
Height of skull, occipital condyles to dorsal margin of supraoccipital	7.5	....
Least anteroposterior measurement of bony palate	11.6	11.1
Least breadth of palate inside molars	2.5	3.0
Greatest breadth of palate inside P^4	4.1	3.6

*Estimated.

**Actual measurement; specimen crushed on right side.

	C. M. 10001 mm.	C. M. 10000 mm.
Anterior border of postnareal trench to posterior border of basisphenoid	8.2	....
Anterior margin of basioccipital to *foramen magnum*	5.9	....
Tympanic bulla, greatest anteroposterior measurement	7.2	....
Tympanic bulla, greatest transverse measurement	6.2	....
Greatest width across occipital condyles	7.1	....
Height of *foramen magnum*	4.1	....
Width of *foramen magnum*	5.4	....
Superior margin of *foramen magnum* to dorsal margin of supraoccipital	3.3	....
Superior I anteroposterior	1.6	1.7
Superior I transverse	2.0	1.7
P^3 anteroposterior	1.0	....
P^3 transverse	1.0	....
P^4 anteroposterior	1.7	1.9
P^4 transverse	2.6	2.3
M^1 anteroposterior	1.5	1.6
M^1 transverse	2.6	2.5
M^2 anteroposterior	1.5	1.6
M^2 transverse	2.1	2.3
M^3 anteroposterior	1.6	1.5
M^3 transverse	2.0	1.9
Anteroposterior length of maxillary tooth row	7.1	7.2
Anteroposterior length of superior molar series	4.2	4.3
Diastema between superior I and P^3	4.7	4.9

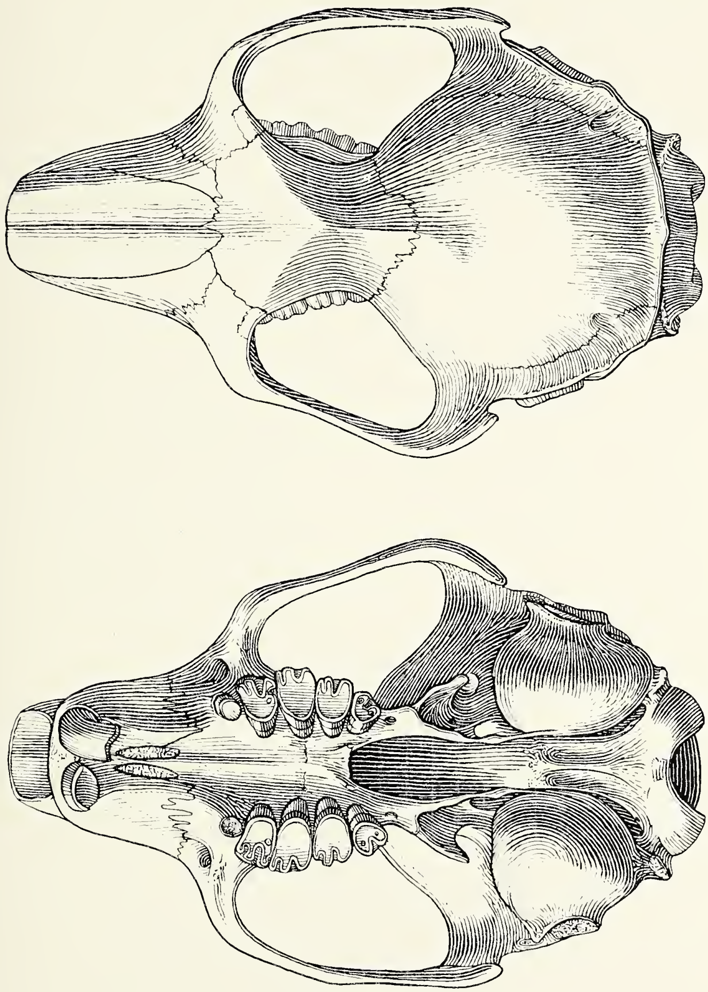
EXPLANATION OF PLATE XXVI.

All figures × 3.

(In the accompanying figures of the skull of specimen, C. M. No. 10001, the left zygomatic arch, the right pterygoid region, and the roof of the brain case in the parietal region, are shown in restoration.)

FIG. 1. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 10001, palatal view of skull.

FIG. 2. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 10001, superior view of skull.



2

1

Pseudocylindrodon medius Burke.

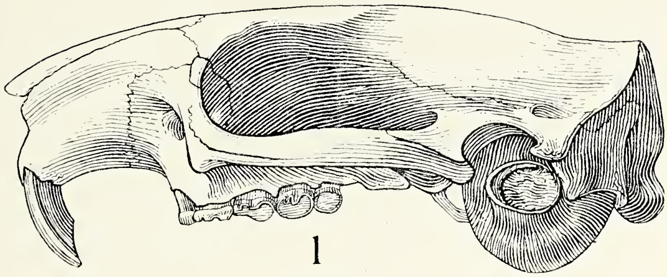
EXPLANATION OF PLATE XXVII.

FIG. 1. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 10001, lateral view of skull.

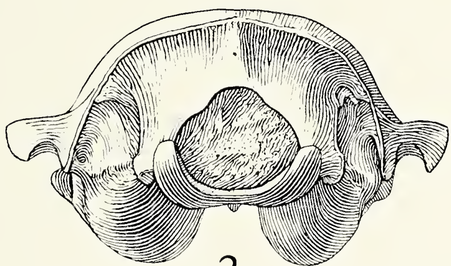
FIG. 2. *Pseudocylindrodon medius* Burke, referred specimen, C. M. No. 10001, occipital view of skull.

FIG. 3. *Pseudocylindrodon medius* Burke, holotype, right ramus of mandible, C. M. No. 9999, lateral view.

FIG. 3*a*. *Pseudocylindrodon medius* Burke, holotype, C. M. No. 9999, occlusal view of RP^4, M^{1-3}.

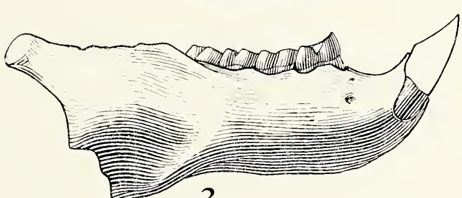


1



2

3a



3

Pseudocylindrodon medius Burke.

ART. XVII. SCOLECODONTS FROM THE POTTER FARM FORMATION OF THE DEVONIAN OF MICHIGAN

By E. R. Eller

Annals of the Carnegie Museum
Vol. XXVII, p. 275-286, 1938

Issued Oct. 22, 1938
Pittsburgh, Pa.

ART. XVII. SCOLECODONTS FROM THE POTTER FARM FORMATION OF THE DEVONIAN OF MICHIGAN

By E. R. Eller

(Plates XXVIII-XXIX)

Through the kindness of Doctor G. Arthur Cooper of the U. S. National Museum, I have been enabled to study a series of Scolecodonts, fossil polychæte jaws, collected from the Devonian strata of Michigan. The specimens are all from the Potter Farm Formation, from the ledges by the side of the road, $\frac{1}{4}$ to $\frac{3}{8}$ miles south of Four Mile Dam, Alpena County. At present the Potter Farm Formation has not been correlated with formations in other areas. Dr. Cooper suggests, in a personal communication, that it is in about the position of the Moscow but it appears to be Tully in age, perhaps also correlating with the Upper Cedar Valley of Iowa.

The jaws, collected by Dr. Cooper, were taken from the matrix by an acid solution and many of them are in a very fine state of preservation. In comparing the series with other described fossil polychæta it is interesting to note their general similarity to the Silurian forms of Gotland. The few known forms from the Cedar Valley Formation of Iowa compare rather well, but that fauna as yet has not been thoroughly studied. All of the forms described in this paper, including all of the types, are in the United States National Museum of Washington, D. C., and a representative series of duplicate material has been retained for the collections of the Carnegie Museum.

DESCRIPTION OF SPECIES

Genus Lumbriconereites, Ehlers, 1868

Lumbriconereites cooperi sp. nov.

Maxilla I, plate XXVIII, figs. 1-8.

The asymmetrical right and left jaws are elongate with from twelve to as many as nineteen sharp, flattened, backward pointing denticles which extend along the inner margin nearly to the posterior end. The average or usual number of denticles is fourteen. Measurements of

Issued October 22, 1938.

the specimens range in length from .77 mm. to 3.68 mm. Some fragmentary specimens indicate a probable size of over 4 mm. The denticles diminish in size from the anterior to the posterior. The fang or first denticle is large and is a continuation of the thickened portion of the outer margin. The second denticle is large but the third and usually the fourth are smaller, often minute. On the right jaw the thickened outer margin is notched posteriorly by a crescent-shaped bight while the outer thickened margin of the left jaw is rounded with but a slight suggestion of an indentation at about the mid-point. The muscle fossa extends nearly the full length of the outer side. The upper inner margins of the fossa of each jaw are thickened while the other margins of the fossa are thin and often broken away.

The larger part of the specimens in this collection are of this species. There are more right than left jaws. In the details the jaws are variable, but as a whole they correspond to each other. There does not seem to be any correlation between the size of the jaw and the number of denticles. The larger jaws often bear larger and less sharp denticles, while those of the smaller jaws are smaller, sharper and not so flattened. However, in some of the specimens this does not always hold true. At first the writer considered the left and right jaws as belonging to different species. When it was found that all jaws with the bight on the outer margin were right jaws, and that the outer margins of the left jaws corresponded to each other, the question arose as to whether they did not belong to the same species. Then too, when all other characters such as size, general shape, and number of denticles were found to be the same, the writer was convinced that the jaws should be of the same species.

There is a slight resemblance between Hinde's (1882) figures of *Lumbriconereites obliquus* Eichwald and *Œnoites major* Hinde and *Lumbriconereites cooperi* m. Stauffer (1933) described several species that have a general relationship to *Lumbriconereites cooperi* m. under the generic names *Lumbriconereites* and *Protarabellites.* From Stauffer's figures it would appear that *Lumbriconereites cameratus* Stauffer and *Lumbriconereites affinis* Stauffer are closely related to each other, if they are not the same species. They are right jaws and show the same general shape and arrangement of denticles and have an indentation on the outer margin similar to *Lumbriconereites cooperi* m. *Protarabellites fidelis* Stauffer, *Protarabellites delectus* Stauffer, *Protarabellites concavus* Stauffer and *Protarabellites productus* Stauffer, judging from the figures, resemble *Lumbriconereites cameratus* Stauffer and *Lumbriconereites affinis* Stauffer and are so slightly different from each other that they might be considered as individual variations of the same species. All are similar to *Lumbriconereites cooperi* m., except that the right side of the outer margin (anterior side as oriented by Stauffer) is wider and the bight on the left side of the outer margin is not so pronounced. Foerste (1888) described a species, *Lumbriconereites austini*, which is similar to *Lumbriconereites cooperi* m., but the denticles are less pronounced and the bight on the outer margin, apparently, is much deeper. A jaw figured, but not described, by Searight (1923, plate I, figure 5) from the Cedar Valley Limestone of Iowa corresponds to *Lumbriconereites cooperi* m. in a general way.

Genus ARABELLITES, Hinde, 1879

Arabellites comis sp. nov.

Maxilla I, plate XXVIII, fig. 9.

The jaw is small, narrow, triangular in outline, with the posterior extremity obliquely truncate. Nine denticles, including the fang, are present extending along about two-thirds of the inner margin. The fang is long, thin, and gracefully curved in a slightly oblique direction from the plane of the jaw. The denticle following the fang is often minute and may be directed forward. The remaining denticles are sharp, triangular in shape, and diminish in size posteriorly. A large fossa is present at the posterior end and the upper margin is thickened into a round rim which extends posteriorly at the inner and outer margins in the form of short spurs.

This delicate species is represented by only two complete specimens and a number of fragments. The form does not much resemble any other species. If the anterior portion of *Arabellites anglicus* Hinde (1882) were longer, perhaps a slight similarity could be noted with the species under description.

Arabellites (?) **conus** sp. nov.

Maxilla I, IV or V (?), plate XXIX, fig. 7.

The jaw is narrow with one large, sharply pointed, conical denticle. The fossa is oval in shape and the upper margin is thickened into a rounded rim. The length of these forms is from .88 mm. to 1.17 mm.

It is difficult to determine to which of the maxillæ this jaw belongs. From its shape it could be either maxilla IV or V but according to its size it should be maxilla I. Hinde (1882) described jaws very similar to these as the distal jaws of *Arabellites uncinatus* Hinde, but the latter were minute in size. Jaws of this kind, maxilla IV or V, are common in many species of recent forms, especially in the genus *Arabella.* If the relative proportions between maxilla I and V of most recent forms would be applied to *Arabellites conus* m. and the described maxilla V, then maxilla I would be about 12 mm. in length. So far no maxilla I of this size is known. However, in a few recent forms, *Lumbrinereis nasuta* Verrill, for example, the most distal maxillæ which are similar to *Arabellites conus* m. are quite large, nearly half the size of maxilla I.

Genus EUNICITES, Ehlers, 1868

Eunicites cornuformis sp. nov.

Maxilla I, plate XXVIII, fig. 10.

The jaw is oval in cross section, nearly straight in its posterior part, but curved obliquely in more than a ninety-degree angle at the anterior end which terminates with a sharp point.

This type of jaw or forceps is common among fossil and recent polychæta. *Eunicites simplex* Hinde (1879, 1882) is similar except that the curve of the forcep is more regular and not as great. Stauffer (1933) described two species, *Hyalinœcites subulatus* Stauffer and *Hyalinœcites plenus* Stauffer, that are comparable to *Eunicites cornuformis* m.

Eunicites angulatus sp. nov.

Maxilla I (forceps), plate XXVIII, fig. 13.

The jaw or forceps is massive in size and angular in cross section with a well defined fossa at the outer margin of the pointed posterior end. At the anterior end the jaw is flattened and turns obliquely downward. The surface of the jaw is uneven, and the outer margin at the posterior end is slightly grooved. The anterior end of the jaw is broken. The upper margin of the fossa is thickened into a wide, slightly rounded rim.

Among several recent genera this type of heavy, angular forceps is common but it has not previously been found in any fossil form.

Eunicites tanaodus sp. nov.

Maxilla IV (?), plate XXIX, figs. 5, 6.

The jaw is angular in outline with a very large conical denticle situated at the center of the outer margin. On each side of this denticle are two or three small denticles which irregularly decrease in size toward the ends. A large triangularly shaped fossa is present between the anterior and outer lateral margins.

Fossil polychæte jaws usually begin with a large denticle followed by smaller ones. A large denticle with smaller ones on each side is found more commonly among conodonts. These jaws, however, are not comparable to conodonts in any other way. As far as the writer knows, this type of jaw is not found in recent polychæta. As to the fossil forms, Stauffer (1933) described two species, *Ungulites bicuspidatus* Stauffer and *Ungulites tridentatus* Stauffer from the Ordovician of Minnesota, of this character.

Eunicites validus sp. nov.

Maxilla III (?), plate XXIX, fig. 4.

The jaw is thick and oval in outline. Ten large, conical, sharp pointed, backward curving denticles are present along the total length of the semicircular and well arched inner margin. The largest denticle is in the middle of the jaw and toward both ends the denticles decrease in size. A large oval fossa is present between the outer margins.

The only similarity of this species is, perhaps, with *Lumbriconereites arcuatus* Stauffer (1933).

Eunicites divergens sp. nov.

Maxilla III or IV, plate XXIX, figs. 8-11.

The jaws are large, irregularly oblong and rounded in outline, width greater than length, with a shallow concaveness on the lower side. A large fossa is present between the outer margins. In all examined specimens the outer margins were broken and incomplete. From two to six denticles are present on the inner margin. On the larger jaws the denticles are very large and blunt while in the smaller specimens they become correspondingly smaller and sharper. They are but slightly obliquely curved to the plane of the lower side. On the jaws, where several denticles are present, the larger ones are usually in the center and their size diminishes towards the ends.

In general these jaws resemble each other but there are wide individual differences. The jaws are so similar to *Eunicites mutabilis*

Eller (1934) of the upper Devonian of New York that the writer was tempted to place them in that species. Since *Eunicites divergens* m. is somewhat larger in size and greater in its width than length, it was thought best to make a new species for it. Maxillæ II and III of *Arabellites alfredensis* Eller (1934) also resemble those of *Eunicites divergens* m.

Genus ŒNONITES, Hinde, 1879

Œnonites orthodontus sp. nov.

Maxilla I, plate XXVIII, figs. 11, 12.

The jaw is long, sub-triangular in shape, and has straight margins that taper posteriorly to an acute angle. Including the fang, there are from ten to thirteen conical denticles, ranging from sharp to blunt, which diminish in size posteriorly. The usual number of denticles is thirteen, and they extend along about three-quarters of the inner margin. The large, sharply pointed, conical fang is nearly straight and points in a forward direction. The fossa is large and extends nearly the full length of the outer margin.

Three specimens of *Eunicites varians* (Grinnell) from the Cincinnati Group of Ontario and one specimen of *Œnonites amplus* Hinde from the Clinton of Ontario were described by Hinde (1879). Both of these species have characters that are similar to those of *Œnonites orthodontus* m. Hinde (1882) described several specimens from the Silurian of Gotland as *Œnonites naviformis* Hinde which, while not closely related, are of the same general character as *Œnonites orthodontus* m. Searight (1923) figured a number of specimens from the Cedar Valley Limestone of Iowa but he did not feel that it would be worthwhile to attempt generic and specific descriptions of these Devonian forms until more material had been obtained. One of his specimens (Searight, 1923, pl. I, fig. 1) is quite similar to *Œnonites orthodontus* m., except that the fang is shorter and curved backward. Stauffer (1933) described three species, *Œnonites inornatus* Stauffer, *Œnonites dignus* Stauffer, and *Œnonites tacitus* Stauffer that resemble each other very much and which are slightly similar to *Œnonites orthodontus* m.

Œnonites alpenæensis sp. nov.

Maxilla II (?), plate XXIX, figs. 1, 2.

The jaw is triangular in outline, measuring from .44 mm. to 1.68 mm. in length. The inner margin, bearing the denticles, is arched and, with the thickened outer margin, forms a shallow concave area. The number of denticles varies between eleven and eighteen but the usual number is thirteen. The fang, or first denticle, is usually long, pointed, and nearly straight; the second is very large, wide, and blunt and is followed by several more large denticles, often seven or eight, which diminish in size posteriorly. The last denticles are usually minute. Some of the denticles appear to be badly worn. Part of the outer margin has a round thickened rim and it makes about a right angled turn to form an anterior margin. The rest of the outer margin is very thin and is usually broken away. This wide angle on the outer margin helps to form a large, wide, triangular-shaped fossa.

These very powerfully constructed jaws are probably maxilla II, but the writer cannot associate them with any of the maxillæ I described in this paper. The jaws show individual variation, and perhaps some authorities would consider that there were several species represented. This form resembles *Œnonites radula* Hinde (1882) from the Silurian of Gotland very much. Both species have the same triangular shape, a slightly concave upper surface, and a deep hollow opening (fossa) on the upper surface of the outer side. The denticles are about the same in number but differ in form. *Œnonites alpenæensis* m. averages 1.20 mm. in length, while *Œnonites radula* Hinde averages .81 mm.

Œnonites abnormis sp. nov.

Maxilla II (?), plate XXIX, fig. 3.

This form is very much like the triangular shaped *Œnonites alpenæensis* m. but differs in having, besides the thirteen regular denticles, a large pointed flange or tooth on the outer margin near the fang. The fossa is rather shallow, but wide. The specimen measures 1.20 mm. in length. The writer hesitates in erecting a new species for this form, but the interesting structure on the outer margin seems to warrant some recognition. Hinde (1882) described a variety, *Œnonites radula cristula* Hinde, which possesses a flange, but from the figure it is not possible to make comparisons with *Œnonites abnormis* m.

DIOPATRAITES gen. nov.

Mandible, plate XXIX, figs. 12-15.

The mandible is large and consists of a three-toothed frontal plate followed by a tapering shaft. Fine striæ are present which are parallel to the outer and posterior margins of the plate. The inner margin of the plate is straight, and is the point of contact with the opposite mandible. The upper surface of the shaft is convex while the lower or inner side is angular and slightly concave.

Mandibles of *Diopatraites* are similar to those of certain recent *Diopatra*, especially to the mandibles of Ehler's (1887) *Diopatra pourtalesii* and *Diopatra glutinatrix*. However, Treadwell (1921) considers that these species belong to *Onuphis*.

Diopatraites conformis sp. nov.

The length of the mandible is from 2.85 mm. to 4.68 mm. with the frontal plate usually just a little smaller than the shaft. The frontal plate is large and angular in outline, with three very large conical denticles at the anterior end. The plate is set at about a forty-five degree angle with the shaft. The denticles are irregular in size and shape, and vary in the direction in which they point. The upper surface is comparatively flat, and on most specimens fine striæ are discernible on the posterior half of the frontal plate, the striæ extend parallel to the outer margin and then curve to conform with the posterior margin. The inner margin of the frontal plate is straight. The upper surface of the shaft is convex in form while the under surface is angular and slightly concave. In some specimens the shaft is slightly turned or twisted, and in that case the concave area is on the inner side. The shaft tapers to a pointed posterior extremity. No line of demarcation is evident between the shaft and plate on the under side of the mandible.

Mandibles seem to be very rare in collections of fossil polychæta. Stauffer (1933) described two species and Searight (1923) figured one but did not describe it. Hinde (1882) found it a curious circumstance that out of the hundreds of examples of jaws from the Silurian of Gotland that he observed, not a single mandible was detected. Nor did he, except for a questionable plate, find any true mandibles among the English and Canadian forms (1879, 1880). Dr. Hinde believed that if the lower plates of fossil polychæta were like the lower plates of recent forms, that is, more calcareous than the chitinous upper jaws, then there should be a better chance of their being preserved. This he felt was true in the Solenhofen forms described by Ehlers (1869) in which the lower plates are preserved and only impressions of the upper jaws are present. The writer believes that the chitinous jaws would have more chance of resisting destruction by waters circulating in the ground than calcareous forms but the latter are stronger and less breakable. There are a number of well preserved mandibles of *Diopatraites conformis* m., and they seem to be of the same chitinous material as the maxillæ. The mandibles conform well with the maxillæ I described in the paper, being about twice their size. This is about the same proportion as found between mandibles and maxillæ I in most of the recent forms.

BIBLIOGRAPHY

EHLERS, E.

1869. Palæontographica, Vol. 17, 1867-70.

HINDE, A. J.

1879. Quart. Jour. Geol. Soc. London, Vol. 35, pp. 370-389, pls. 18-20.

1880. Idem., Vol. 36, pp. 368-378, pl. 14.

1882. Bihang till k. Svensk Akad. Handl., Vol. 7, N: 05, pp. 1-28, pls. 1-3.

EHLERS, E.

1887. Mem. Mus. Comp. Zool., Harvard Coll., Vol. 15.

FOERSTE, A. F.

1888. Amer. Geologist, Vol. 2, pp. 412-419.

TREADWELL, A. L.

1921. Carnegie Inst. of Washington, Vol. XV, No. 293.

SEARIGHT, W. V.

1923. Iowa Acad. Sci., Vol. 30, pp. 433-436.

STAUFFER, C. R.

1933. Bull. Geol. Soc. Amer., Vol. 44, pp. 1173-1218.

ELLER, E. R.

1934. Ann. Carnegie Mus., Vol. 22, pp. 303-316.

EXPLANATION OF PLATE XXVIII

Figures magnified about 18 times

All specimens figured here are in the U. S. National Museum

FIGS. 1-3. *Lumbriconereites cooperi* sp. nov. Maxilla I, left jaw.
Fig. 1. Side view.
Fig. 2. Under side, outer margin.
Fig. 3. Upper side.

FIG. 4. *Lumbriconereites cooperi* sp. nov. Maxilla I, left jaw, under side.

FIGS. 5, 6. *Lumbriconereites cooperi* sp. nov. Maxilla I, right jaw.
Fig. 5. Under side.
Fig. 6. Side view, outer margin.

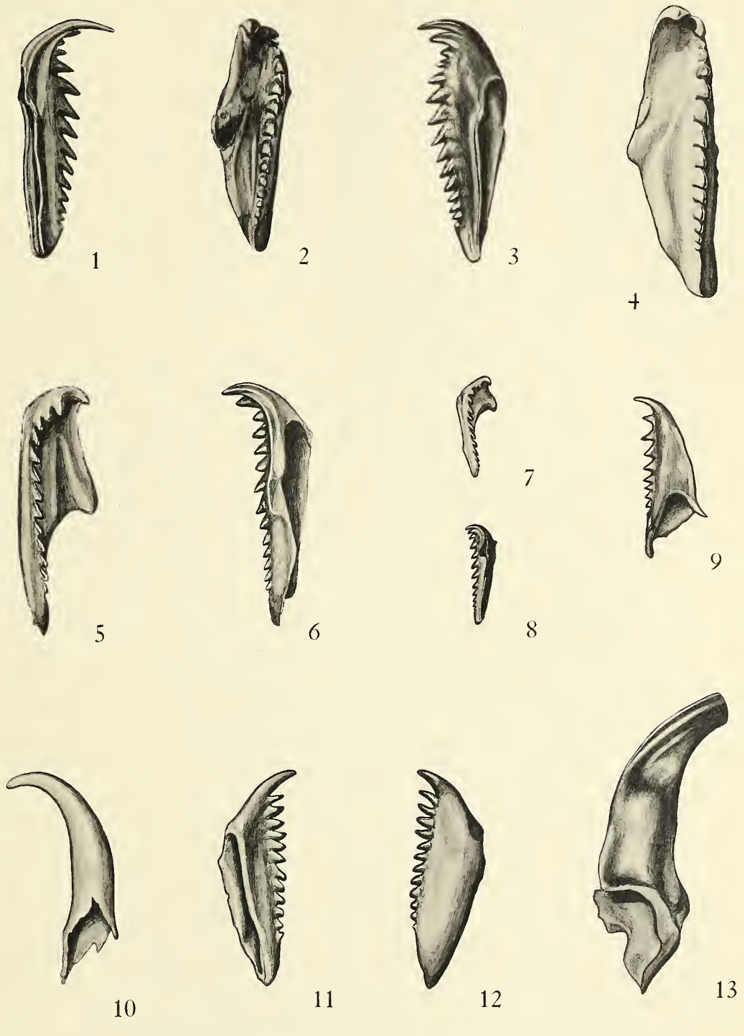
FIGS. 7, 8. *Lumbriconereites cooperi* sp. nov. Maxilla I, right jaw.
Fig. 7. Under side.
Fig. 8. Side view.

FIG. 9. *Arabellites comis* sp. nov. Maxilla I, right jaw, upper side.

FIG. 10. *Eunicites cornuformis* sp. nov. Maxilla I, forceps.

FIGS. 11, 12. *Œnonites orthodontes* sp. nov. Maxilla I, left jaw.
Fig. 11. Upper side.
Fig. 12. Under side.

FIG. 13. *Eunicites angulatus* sp. nov. Maxilla I, forceps.



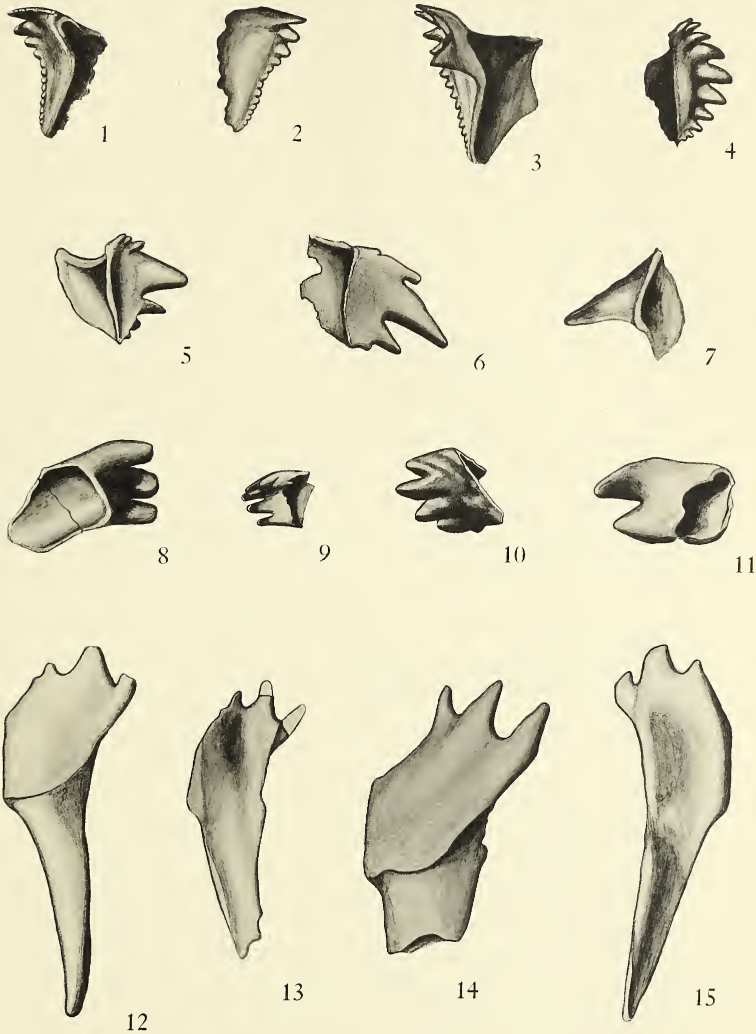
Scolecodonts from Devonian of Michigan.

EXPLANATION OF PLATE XXIX

Figures magnified about 18 times

All specimens figured here are in the U. S. National Museum

FIGS. 1, 2.	*Œnonites alpenæensis* sp. nov. Maxilla I or II, right jaw. Fig. 1. Upper side, outer margin. Fig. 2. Under side.
FIG. 3.	*Œnonites abnormis* sp. nov. Maxilla I or II, right jaw, upper side, outer margin.
FIG. 4.	*Eunicites validus* sp. nov. Maxilla III (?), left jaw.
FIGS. 5, 6.	*Eunicites tanaodus* sp. nov. Maxilla IV (?), left jaws.
FIG. 7.	*Arabellites* (?) *conus* sp. nov. Maxilla I, IV or V (?), right jaw.
FIGS. 8-11.	*Eunicites divergens* sp. nov. Maxilla IV, right and left jaws.
FIGS. 12, 15.	*Diopatraites conformis* sp. nov. Right mandible. Fig. 12. Upper side. Fig. 15. Under side.
FIG. 13.	*Diopatraites conformis* sp. nov. Left mandible, under side.
FIG. 14.	*Diopatraites conformis* sp. nov. Right mandible, upper side.



Scolecodonts from Devonian of Michigan.

ART. XVIII. DESCRIPTION OF *PLETHODON RICHMONDI*, A NEW SALAMANDER FROM WEST VIRGINIA AND OHIO

By M. Graham Netting, Carnegie Museum
and
M. B. Mittleman, Ohio University[1]

(Plate XXX)

In 1931, the senior author collected a series of salamanders at Oglebay Park, near Wheeling, West Virginia, which appeared to be unusually attenuated examples of the dark phase of *Plethodon cinereus*. Since this occurred shortly after the initiation of a collecting program in West Virginia and at a time when there were no large or well-rounded state collections in existence, the specimens were put aside to await the collection of additional material. It must be confessed that as more specimens accumulated the senior author continued to regard them as aberrant *cinereus*, and even postulated a genetic relation between color of back and size in West Virginia specimens. Various collaborators in the state were notified of this situation and the specimens received from them thereafter led to the conclusion that some of the dark-backed specimens represented a remarkable new species of the genus *Plethodon*.

Correspondence between the present authors during September 1938, accidentally disclosed the fact that the junior author had independently reached a similar conclusion in regard to certain Ohio specimens. The present collaboration is the happy and natural outcome.

It is especially gratifying to the senior author that, after a number of years devoted to the study of West Virginia herpetology, he is able to participate in the description of the first herpetological novelty ever described from that interesting state. He is also grateful that the junior author has shared in this sentiment by agreeing both to the selection of a specimen from West Virginia as the holotype, and to the dedication of the species to a collector, Mr. Neil D. Richmond, who has done much to increase our knowledge of the herpetofauna of his state.

[1]Contribution from the Department of Zoology, Ohio University, Athens, Ohio.

Issued Dec. 8, 1938.

Plethodon richmondi sp. nov.

Plate XXX, figure 1.

Diagnosis: A very elongate *Plethodon* with small legs; costal grooves 20-23, usually 21-22; vomerine teeth 3-9 in row, usually 5-7; vomerines extending to, or beyond, the outer edge of the internal nares; dorsum in life without any trace of a light dorsal band, usually with minute greenish-gold flecks, which disappear in preserved specimens, or remain faintly visible as minute white flecks; venter dark, with small irregular white dots.

Type locality: Huntington, Cabell County, West Virginia.

Range: From Everett, Bedford County, and Pittsburgh, Allegheny County, Pennsylvania; south to Dorcas, Grant County, and Wayne, Wayne County, West Virginia; southeastern Ohio generally, at least as far westward as Cincinnati, Hamilton County, Ohio.

Description of Holotype: Carnegie Museum no. 14189, adult male, collected in Ritter Park, Huntington, Cabell County, West Virginia, at an altitude of 600-700 feet, on October 15, 1938, by Neil D. Richmond and N. Bayard Green; 21 costal grooves; 9 intercostal spaces between appressed toes; head width 9.09 in length from snout to vent; head length 5 in length from snout to vent; eye slightly longer than its distance from its anterior angle to nostril; snout swollen; a small tubercle at lower end of naso-labial groove; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1, in order of length, considerably webbed at base; first finger very short, entirely in web; toes 3, 4, 2, 5, 1, in order of length, webbed to second joint, first toe entirely in web; vent papillate; tail slightly longer than head and body, round at base and throughout its length, except the tip, which is slightly compressed laterally; vomerine teeth 5-5 in series, beginning behind outer border of nares, the two rows separated in mid-line by a distance slightly greater than the width of naris, and from the parasphenoids by two times the width of naris; parasphenoids in two patches, beginning at middle of eye sockets; black above, with very minute greenish-gold flecks in life; venter dark slaty gray, with scattered white dots, which are most numerous ventrolaterally; gular region lighter; under surface of tail uniform slaty gray; total length 102 mm., length of head 10, width of head 5.5, body 40, tail 52.

Description of Allotype: Ohio University Zoology no. 632, adult female, collected in Alexander Township, Athens County, Ohio, at an altitude of 800 feet, on October 30, 1938, by H. T. Gier, differs from the holotype as follows: 22 costal grooves; 11 intercostal spaces between appressed toes; head width 9.5 in length from snout to vent; head length 5.1 in length from snout to vent; eye slightly shorter than its distance from its anterior angle to nostril; snout not swollen; no tubercle at lower end of naso-labial groove; vomerine teeth 5-5; lining of vent grooved vertically, not papillate; tail slightly shorter than head and body; total length 111 mm., length of head 11, width of head 6, body 46, tail 54.

Description of Juvenile: Carnegie Museum no. 14212, same data as holotype, has 4 intercostal spaces between appressed toes; total length 23 mm., length of head 4, head width 2.5, body 11, tail 8.

Coloration: A freshly killed specimen, Ohio University Zool. no. 631, same data as allotype, has dorsal surface of body and tail finely maculated with white and underlain by a piceous band which extends from the snout to a point directly over the cloaca (in preserved specimens, this becomes a dark chocolate brown, which is much more visible than in the living animal). The band is interrupted in the interocular region by a dark grayish blue patch. Ventral surface of body lighter than dorsum, with this lighter hue extending onto the lateral areas; it is separated from the dorsal coloration by a narrow, indefinite band of dark grayish blue. Entire ventral surface of body and tail finely maculated, the gular region more so than the rest of the body. Ventral surface of tail darker, and less maculated than ventral surface of body, with coloration comparable to that of dorsum.

An alcoholic specimen, O. U. Zool. no. 342, Athens, Ohio, has dorsal maculation barely visible, the dorsal band a dark chocolate brown, bordered on either side by a darker band, which separates it from the ventral coloration. Occasionally, in alcoholic specimens, the entire dorsal surface is a uniform dark grayish blue.

Paratypes: Localities and allocation in respective collections.

OHIO

Athens Co., Athens—O. U. Zool. nos. A341-42, A344-45, A347-48, A350
- 1 mi. SE of Athens—O. U. Zool. nos. A6, A289-94
- 1 mi. SW of Athens—O. U. Zool. no. A1
- Alexander Twp.—O. U. Zool. nos. A2, A631
- Lodi Twp., sec. 30—O. U. Zool. nos. A278-84

Hamilton Co., Cincinnati, Eden Park—Cincinnati Soc. Nat. Hist. no. 1270 (21 specimens)

Jackson Co., Jackson Twp.—O. U. Zool. nos. A356-58

Lawrence Co., S of Crown City—CM nos. 14102-04

Meigs Co., Bedford Twp.—O. U. Zool. nos. A3-5

WEST VIRGINIA

Cabell Co., Huntington—CM nos. 14182-88, 14190-215, 14271-81
2 mi. S of Huntington, Pleasant Valley—CM nos. 14258 (43), 14264 (11), 14265-68

Lewis Co., Jane Lew—CM nos. 7515, 9773
near Weston—CM no. 6097

Marion Co., Ida May—CM no. 14072
1 mi. W of Fairmont—CM no. 14136
no locality—CM no. 5599

Ohio Co., Oglebay Park near Wheeling—CM nos. 5278-79, 5294-96, 5303-08, 5285 a-c and f, 5985 a-b, 5986, 8775

Wayne Co., 3 mi. S of Wayne—CM no. 6079
7 mi. SW of Huntington—CM no. 14101

Upshur Co., French Creek—CM no. 11256

Variation: In specimens with the highest costal groove count (23) the last complete groove is almost invariably the 21st, if the groove immediately over the foreleg is counted as the first. Either one or two forks posterior to the 21st groove may be connected with it to form a two- or three-pronged Y. If all forks are counted the total reaches 22 or 23. Counting in this fashion results in considerable variation in tabulations but it may be justified on the ground that the last complete costal groove is normally located much more anterior to the hind leg in *richmondi* than in *cinereus*. Thus the counting of all forks yields figures which reflect the greater elongation of the body observed in this salamander. This method of counting also follows the standard practice and allows ready comparison with published statistics. If the groove over the foreleg and the forks of the last complete groove are *not* counted the figure should be 19 or 20 for *richmondi*. Of 68 specimens in the Carnegie Museum collection, 7 have 20 costal grooves, 39 have 21, 18 have 22, and 4 have 23 by the maximum count. For this series the average is 21.28.

The highest intercostal count (12) invariably occurs in fully adult specimens, and conversely, the lowest count (4) occurs in juveniles. This indicates that the body length increases at a ratio greater than the growth rate of the limbs. On the basis of percentage of tail length into head-body length the lowest figure, 59.9 per cent, occurs in a juvenile specimen, and the highest, 122.6 per cent, in an adult female. This proves that the growth rate of the tail is more rapid than that of the head and body. In adult females the tail is generally longer than the head-body length.

The following computations were made by the junior author on fifty adult Ohio specimens (Cincinnati Soc. Nat. Hist. no. 1270, from Eden Park, Cincinnati) selected at random from several collections made on the same day. In this series of fifty there were 21 *P. richmondi* and 29 *P. cinereus*.

Extension of Vomerine Series

	richmondi	*cinereus*
Vomerines to inner edge of nares	_____ per cent	20.68 per cent
Vomerines to middle of nares	_____ " "	58.62 " "
Vomerines to outer edge of nares	33.33 " "	20.68 " "
Vomerines to beyond nares	66.66 " "	_____ " "

Intercostal spaces between Appressed Toes

	richmondi	*cinereus*
Range	10–14	6–11
Average	11.80	8.48

Total length

(specimens with regenerated tails included)

	richmondi	*cinereus*
Range	72–130 mm.	74–108 mm.
Average	105 mm.	81 mm.

Head-body length

	richmondi	*cinereus*
Range	41–64 mm.	32–56 mm.
Average	53.33 mm.	47.00 mm.

Habitat: In both West Virginia and Ohio, *Plethodon richmondi* exhibits a marked preference for the slopes of valleys and ravines, never occurring on the hilltops, and only rarely on the valley floors. In the regions of Athens, Huntington, and Oglebay Park, it is the dominant *Plethodon*.

More detailed studies of the habitat, behavior, and general ecology will be published subsequently.

Relationships: Specimens from Watauga County, North Carolina, and certain other localities outside the range of *richmondi* as here defined, bear a remarkable resemblance to this form although they display variations which do not fall within the normal limits of this species. These specimens may be tentatively referred to *richmondi* until the collection of material from intervening areas makes possible a thorough study of the problem.

The relationships of *richmondi* are by no means clear. There are three previously described slender species of the genus *Plethodon* in eastern North America; namely, *cinereus*, *dorsalis*, and *welleri*. Of these *cinereus* has the highest costal groove count (published range 17-21, but 18-20 in specimens counted by us) and it most closely approaches *richmondi* in total length. However, in dorsal and ventral coloration *richmondi* is most similar to *welleri*. Revolutionary as it may seem, we are forced to consider *richmondi*, which has the highest costal groove count, and the greatest number of costal folds between toes, most closely allied to *welleri*, which has the lowest costal groove count, and the lowest number of costal folds between toes, of any of the slender eastern Plethodons. As we have shown above, in its development the legs of *richmondi* grow at a rate much slower than the rate of lengthening of the body, and the body growth rate is slower than the rate of increase in tail length. If *welleri* lived in an environment which permitted it to reach the maximum size of *richmondi*, similar differential growth rates might result in the production of a salamander closely similar to *richmondi*. It is apparent that in each of the slender Plethodons, at least, the number of costal folds between the appressed toes increases with size. It is improbable that the number of costal grooves changes during the development of an individual salamander, but it is conceivable that certain environments may exert a selective influence which favors short or long-bodied hatchlings. Consequently, we feel that the similarities in coloration are a better indication of relationship in this instance than are structural features which vary with age, and possibly with environment. It is our present opinion, therefore, that *welleri* is a dwarfed, montane derivative from a widespread *richmondi* or pre-*richmondi* stock.

Acknowledgments: The senior author is indebted to Mr. Neil D. Richmond and to Mr. N. Bayard Green for their constant interest in this study and for their donation of living and preserved specimens from Huntington, West Virginia.

The junior author especially wishes to express his gratitude to Dr. Herschel T. Gier, of the Ohio University Zoology Department, for his aid in the field, as well as for his tireless efforts in the laboratory, and his helpful criticisms and suggestions in the preparation of the manuscript; also to Mr. Ralph Dury, Director of the Cincinnati Society of Natural History, for his generous loan of specimens.

1

2

Fig. 1. *Plethodon richmondi* Netting and Mittleman. Paratype. Ventral view of adult female, Carnegie Museum no. 5294, Oglebay Park, Wheeling, W. Va. Natural size.

Fig. 2. *Plethodon cinereus* (Green). Ventral view of adult female, Carnegie Museum no. 4878, Ann Arbor, Michigan. Natural size.

ART. XIX. A NEW SALAMANDER, *PLETHODON NETTINGI*, FROM WEST VIRGINIA.

By N. Bayard Green
Marshall College, Huntington, W. Va.

During the period from June 22 to July 2, 1935, the members of the Oglebay Park Nature Training School of Wheeling, camped at White Top Mountain near Cheat Bridge, Randolph County, West Virginia, to study the natural history of that region. While encamped at this spot a trip was taken to Barton Knob a few miles away, and among the salamanders collected by Messrs. M. Graham Netting and Leonard Llewellyn was a single specimen of a salamander which seemed quite distinct from any described species. Netting (1937: 92) in his discussion of this collection, lists this as "*Plethodon* sp?" No additional specimens were collected at this time but extensive collecting in this section during the summer of 1936 increased the collection to eleven specimens.

The author desires to thank Mr. Neil D. Richmond for a critical examination of this manuscript and for permission to quote from his field notes.

I take pleasure in naming this species for M. Graham Netting in recognition of his valuable contributions to West Virginian herpetology, not only directly through his own researches but also indirectly through his constant and unselfish encouragement and inspiration to other workers.

Plethedon nettingi sp. nov.

Diagnosis: A small *Plethodon* with an elongate body; costal grooves 18-19, usually 18; vomerine teeth 4-8 in row extending to outer edge of nares; belly uniformly dark with throat lighter than belly; back with many fine gold flecks extending to base of tail, not evident in preserved specimens.

Range: Known only from Cheat Bridge and Barton Knob, Randolph County, West Virginia.

Description of holotype: Carnegie Museum no. 10279; adult male collected above 4,000 feet on Barton Knob, near Cheat Bridge, West

Issued December 14, 1938.

Virginia, on June 29, 1935, by M. Graham Netting; 18 costal grooves; 4 costal folds between appressed toes; head width 7.5 in length from snout to vent; head length 4.7 in length from snout to vent; eye slightly longer than distance from its anterior angle to nostril; snout swollen; a small tubercle at lower end of naso-labial groove; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold, a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1, in order of length, slightly webbed at base, first finger very short, entirely in web; toes 3, 4, 2, 5, 1, in order of length, webbed at base; vent papillate; tail slightly longer than body, terete; vomerine teeth 4-6 in series beginning behind outer edge of nares; the two rows separated in midline by a distance equal to .5 width of naris and from the parasphenoids by a distance of 1.5 width of naris; parasphenoids in two patches, faintly separated, beginning at middle of eyesockets; black above; belly uniformly dark slaty gray, throat grayish mottled with white; total length 81 mm., length of head 9.5, width of head 6, body 35.5, tail 36.

Description of allotype: Carnegie Museum no. 11900; adult female collected in the same locality on August 4, 1936, by Maurice Brooks; differs in having snout not swollen; no tubercle at lower end of naso-labial groove; lining of vent folded, not papillate; vomerine teeth 7-7 in series, separated from parasphenoids by a distance equal to twice width of naris; total length 80 mm., length of head 9, width of head 5.5, body 34, tail 37.

In the smallest specimen examined (NBG 245), measuring 28 mm. from snout to vent, the toes of the appressed limbs are separated by two costal folds.

In ten of the eleven specimens examined there are 18 well-defined costal grooves. The eleventh specimen has 19. Five of the specimens have a groove over the hind leg. The practice followed in counting costal grooves has been to count the one over the front leg as the first and to continue to the hind leg, counting both forks of the last groove. In counting costal folds between appressed toes, only entire folds were counted.

The number of vomerine teeth in a row varies from four to eight, with six occurring most frequently. In two specimens the two patches of parasphenoids are faintly separated, in the others they form a single patch. Two specimens have a sparsely spotted belly somewhat reminiscent of *Plethodon richmondi*. None of the specimens have any white on their sides; the amount of white on the throat varies from a light gray to almost white.

Material: Holotype, CM 10279, from Barton Knob, Randolph County, West Virginia, collected by M. Graham Netting; allotype, CM 11900, from same locality, collected by Maurice Brooks. Paratypes, CM 11901, from Barton Knob, collected by Maurice Brooks;

CM 11809-11814, from Cheat Bridge, collected by Neil D. Richmond; NBG 245 and 323 from Barton Knob, collected by the author.

Eggs: A nest of eight eggs was exposed by Neil Richmond while opening a decayed hemlock log near Cheat Bridge, on July 15, 1936. The eggs were scattered in tearing the log open so that it was not possible to determine how they were attached. One egg had a small pedicel attached to it which had probably served to attach the eggs to the nest. Two adults were taken with the eggs but their sex was not determined at the time of capture and as they were put with the others of the series their identity was lost. Each egg is 4 mm. in diameter and contains a well-developed embryo. The eggs are deposited in the Carnegie Museum, CM 11808.

Remarks: The places, where the specimens were collected, are in the southern part of Randolph County, one of the east-central counties of West Virginia. These localities are about twelve miles from the Virginia State Line which follows the crest of the Alleghenies. Barton Knob is one of the peaks in the Cheat Mountain range, with an elevation of 4433 feet, while at Cheat Bridge, three miles away, the elevation is 3557 feet. The region in and around Cheat Bridge is the region of heaviest precipitation in the state, averaging more than sixty inches a year. The area was originally covered with spruce forest which is now almost entirely restricted to the higher peaks, with *Tsuga canadensis*, *Betula lutea*, and *Rhododendron maximum* replacing it on the lower slopes and in the ravines. Many of these cool shady ravines abound and it was in this type of habitat that most of the specimens were taken.

The species associated with *Plethodon nettingi* on Barton Knob were *Plethodon cinereus*, *Plethodon wehrlei*, and *Desmognathus fuscus ochrophaeus*. *Plethodon wehrlei* is common, more than 100 specimens having been collected and many others observed at this place. Netting (1937: 89-93) discusses the occurrence of *P. wehrlei* on Barton Knob and gives a description of its habitat. *P. cinereus* is even more abundant than the larger *wehrlei*. Of the hundreds of specimens that have been collected at this locality all were of the typical red-backed phase. *Desmognathus f. ochrophaeus* is common throughout the area and may be taken in almost any conceivable habitat. Noble (1931: 90-91) discusses the variation in color among specimens of this salamander taken at Durbin, which is five miles distant from Cheat Bridge.

The new form, *Plethodon nettingi*, seems to prefer cool shady ravines where it occurs in moist decayed logs and under rocks, especially where one rock is found resting on another. Quoting from Neil Richmond's field notes on the series of eight collected at Cheat Bridge (of which two living specimens were lost during transit to Pittsburgh): "two specimens were taken together, beneath a stone on top of a large boulder; the others were found in the same type of places except three which were taken in logs. Two of these were in one log with an egg mass." The author collected one specimen on the slope of Barton Knob in a decayed Yellow Birch log. The specimen was very active and behaved much like *cinereus* in attempting to escape. Of the eleven specimens in the collection, seven have some or all of their tails missing. In only one of these is the tail regenerating; the other six had their tails broken during collecting. This salamander is active and attempts to escape when disturbed.

Plethodon nettingi seems to be most closely related to *Plethodon welleri* and *Plethodon richmondi.* It differs from *welleri* in the more elongate form, longer tail length in proportion to body length, two more costal grooves, dorsal color pattern of small flecks instead of larger bronze areas, a higher vomerine tooth count, and lighter throat. A costal groove count made on 25 topotypes of *welleri* showed an average of 16.04 while the eleven specimens of *nettingi* showed an average of 18.09. An average of the costal folds between the appressed toes in the 25 *welleri* topotypes showed an average of 2.68 while an average of the *nettingi* showed 4.5. *Plethodon nettingi* is similar to *welleri* in body size and coloration, but in *nettingi* the dorsal coloration is conspicuously black and the tiny gold flecks, although abundant in some of the specimens, are diffusely distributed and never coalesce to form the typical dorsal pattern of *welleri.* The author has collected and observed both *welleri* and *nettingi* in the field and finds no similarity in the pattern except that in both species the bronze markings are of an iridescent greenish gold suggestive of those of *Aneides aeneus.*

Plethodon nettingi differs from the recently described *richmondi* in being a shorter form, with the tail length shorter in proportion to the body length, fewer costal grooves, shorter vomerine series and more uniformly colored venter. It resembles *richmondi* in having a black back with fine gold flecks.

Adult males of *welleri* and *nettingi* do not have enlarged premaxillary teeth as do those of *cinereus.*

P. nettingi is related to *P. welleri,* in all probability, through a genetic bridge with a common ancestor. This common ancestor may have been *richmondi*. But any discussion of the relationships of these forms must wait until we have more knowledge of their distribution, particularly in the regions where their ranges may overlap. There is a need for collections from lower altitudes around Grandfather Mountain, North Carolina, and White Top Mountain, Virginia, in both of which localities *welleri* has been taken.

DATA ON SPECIMENS STUDIED.

Catalogue Number Carnegie Museum	Sex	Head Length	Head Width	Body Length	Total Length	Vomerine Teeth	Costal Grooves	Costal Folds between Toes
10279	male	9.5	6	35.5	81	4–6	18	4
11900	female	9	5.5	34.0	80	7–7	18	4
11901	male	8.5	6	33.5	48+	6–6	18	4
11809	male	9	6	34	78+	6–6	18	3
11810	male	8	6	34	65+	6–8	19	4
11811	female	8.5	5.5	32.5	78	6–6	18	5
11812	female	9	5.5	31	76	6–6	18	4
11813	female	7.5	5	26.5	48+	5–5	18	4
11814	female	7	5	25	33+		18	4
N. B. Green, coll.								
245		6.5	4	21.5	41+		18	2
323	female	8	5	29	70	7–6	18	4

LITERATURE CONSULTED

DUNN, E. R.

1926. The Salamanders of the Family Plethodontidae. Smith College, Northampton, Mass.

NETTING, M. GRAHAM

1937. Wehrle's Salamander, *Plethodon wehrlei* Fowler and Dunn, in West Virginia. Proc. W. Va. Acad. Sci., **10**: 89-93.

NETTING, M. GRAHAM AND MITTLEMAN, M. B.

1938. Description of *Plethodon richmondi*, a New Salamander from West Virginia and Ohio. Ann. Carn. Mus., **27**: 287-293, pl. XXX.

NOBLE, G. KINGSLEY

1931. The Biology of the Amphibia. McGraw-Hill Book Co., New York.

WALKER, CHARLES F.

1931. Description of a New Salamander from North Carolina. Proc. Junior Soc. Nat. Sci., Cincinnati, **2**: 48-51.

ART. XX. NOTES ON A COLLECTION OF AMPHIBIANS AND REPTILES FROM NEW KENT COUNTY, VIRGINIA

By Neil D. Richmond, Marshall College

and

Coleman J. Goin, University of Florida

From May 10-30, 1938, the senior author made a collection of reptiles and amphibians on the property of Mr. W. R. Shackleford, near Lanexa, New Kent County, Virginia, which he donated to the Carnegie Museum. There are 231 specimens, representing 33 species, in the collection.

The area in which the collection was made is a peninsula at the southern end of New Kent County, bounded on the north by the Chesapeake and Ohio Railroad, on the west and southwest by the Chickahominy River, and on the east and southeast by Diascund Creek. This peninsula is on the Atlantic Coastal Plain about forty miles east of the Fall Line. The northern end is a plateau which drops off to the river level in three terraces, the Wicomico, Chowan, and Pamlico. The center portion of each terrace is cleared and cultivated but the remainder of the area is wooded. Pine, American Holly, Swamp Red Oak, Beech, and Sweet Gum are the principal trees on the higher portions of the peninsula, Cypress replacing them in the lower sections. A broad marshy zone, covered with Spatter-dock (*Nymphaea*), separates the land from the open water of the streams and a carpet of *Sphagnum* covers the damper parts of the region.

All of the colors which we have capitalized in this paper are taken from Ridgway's "Color Standards and Nomenclature."

We wish to acknowledge our thanks to Mr. M. Graham Netting and Dr. E. R. Dunn for their criticisms of this manuscript and also to Mr. W. R. Shackleford, of Newport News, Virginia, for his many courtesies to the senior author during his stay at Lanexa.

Issued December 23, 1938.

CAUDATA

SALAMANDRIDÆ

1. **Triturus viridescens viridescens** Rafinesque 1 (CM 13202), May 10-14.

PLETHODONTIDÆ

2. **Hemidactylium scutatum** (Schlegel) 1 (CM 13203), May 10-14.

3. **Plethodon glutinosus** (Green) 4 (CM 13204-07), May 27.

These specimens exhibit a marked concentration of large white spots along the sides of the body. Only a few flecks of white are visible dorsally.

Two of the series were secured in a rotted, standing tree; the other two were found beneath a log.

SALIENTIA

PELOBATIDÆ

4. **Scaphiopus holbrookii holbrookii** (Harlan) 2 (CM 13208-09), May 27.

During the day (May 27), about seven egg masses, which appeared to agree with published descriptions of the eggs of this species, were observed in a small rain pool, approximately four by fifteen feet, in an orchard. Rain had fallen throughout most of the previous night. The orchard pool was visited at 10:30 P.M., on the night of May 27 but specimens were neither seen nor heard. However, two specimens were secured about one fourth of a mile away in company with *B. w. fowleri.*

BUFONIDÆ

5. **Bufo woodhousii fowleri** Hinckley 33 (CM 13210); 6 males, 10 females, 17 immature.

This series exhibits wide variation in both color and dorsal markings. Four specimens were obviously reddish in life with red warts, a condition much less frequently observed in *fowleri* than in *americanus.* One subadult female is abnormal in lacking all pigment except black. The ventral skin is so transparent that the pinkish cast of the underlying tissue is plainly visible, which is in sharp contrast to the pronounced cream color of the ventral surfaces of normal individuals. The ground color of the back is pale gray although the dorsal spots resemble those of normal specimens. The majority of the specimens are immaculate beneath except for a pectoral spot. The males have black throats, and four of the six specimens are much darker dorsally than any other specimens in the series. A narrow mid-dorsal light line is present in nearly all specimens.

The following field notes are of interest: "May 23, 1938—In the plowed field here specimens of *B. w. fowleri* are very abundant. During the day they may sit in the openings of their burrows, but if it is rainy or cloudy they come out in abundance. May 27, 1938—*B. w. fowleri* is calling in loud chorus tonight for the first time since I have been here. Previously, isolated individuals or small groups have been heard but tonight they seem to be everywhere."

HYLIDÆ

6. **Acris gryllus** (Le Conte) 17 (CM 13211).

These specimens are tentatively referred to *gryllus*. Most of the individuals have unbroken femoral stripes and rather roughened skin. The webbing does not extend to the disks of the toes.

7. **Hyla cinerea cinerea** x **evittata** 17 (CM 13212-16).

We agree with Dunn[1] that the Green Tree Frogs from this area are intermediate between *cinerea* and *evittata*. Of the seventeen specimens at hand one has the stripe extending to the groin, eight have a stripe to midbody, three have a vestige anteriorly, and five are without a lateral stripe. In those which have a stripe to midbody the posterior portion is frequently indistinct. We have noted also that both tibial and foot stripes are much less sharply defined in the Virginia specimens than in northern Florida *cinerea*.

These frogs were abundant in the large marsh where many specimens were found on the leaves of Spatter-dock. Typical *cinerea* occurs in similar situations in Florida. Occasional calls were heard from early morning until 11 P.M., except during cool weather, but the largest choruses were recorded from shortly before sunset until shortly after sunset, following warm rains in the afternoon.

8. **Hyla versicolor versicolor** Le Conte 2 (CM 13217-18), males, May 27.

These were found on branches of trees more than fifteen feet from the ground.

[1] Dunn, Emmett R. *The Status of Hyla evittata Miller*. Proc. Biol. Soc. Wash., **50**: 9-10, 1937.

RANIDÆ

9. **Rana catesbeiana** Shaw 6 (CM 13219-24), 2 adult females and 4 juveniles.

10. **Rana clamitans** Latreille 27 (CM 13225).

11. **Rana palustris** Le Conte 4 (CM 13226-29), May 10-14.

12. **Rana sphenocephala** Cope 7 (CM 13230-36) New Kent Co., near Lanexa. May 10-14. 2 (CM 13237-38) Norfolk Co., 6 miles south of Deep Creek. May 30.

These specimens are in general agreement with Florida specimens of *sphenocephala*. The head lengths (snouts to posterior border of tympanum) enter the total lengths (snout to anus) from 2.5 to 2.9 times, average 2.67. These figures, even without additional confirming characters, would justify the use of *sphenocephala*, as defined by Kauffeld,[2] for the series. Two specimens lack distinct tympanic spots, but the junior author has seen Florida *sphenocephala* in which these spots were indistinct.

TESTUDINATA

KINOSTERNIDÆ

13. **Sternotherus odoratus** (Latreille) 1 (CM 13249), May 10-14.

Several additional specimens were seen, some away from the water.

14. **Kinosternon subrubrum subrubrum** (Lacépède) 10 (CM 13239-48).

The head markings of these specimens vary from numerous amoeboid spots on some specimens to distinct lines on others. Subsequent to May 20 specimens were found some distance from water, one even occurring under a piece of sheet metal in a corn field, but no evidences of egg-laying could be found.

TESTUDINIDÆ

15. **Clemmys guttata** Schneider 3 (CM 13250-52), May 27-28.

These specimens exhibit greatly reduced temporal spots which are

[2] Kauffeld, Carl F. The Status of the Leopard Frogs, *Rana brachycephala* and *Rana pipiens*. Herpetologica, 1, no. 3: 84-87, 1937.

oval in shape and 2 x 4 mm., or less, in size. The yellow spots on the carapace are smaller and less conspicuous than in northern specimens.

The specimens were found in wooded marshy areas in which *Sphagnum* occurred.

16. **Terrapene carolina** (L.) 6 (CM 13256-61); 4 adults and 2 immature.

One of the young specimens was found in a marsh pool in company with *Clemmys guttata.*

17. **Chrysemys picta** (Schneider) 3 (CM 13253-55), 2 females and 1 juvenile.

Plastral markings are present posteriorly on both of the females but the juvenile specimen has the plastron immaculate. The young specimen has the dorsal stripe complete and there are evidences of a dorsal stripe in both of the females.

May 16 was a clear, sunny day, and about 1:00 P.M., a female was found just as she had finished laying. She was filling the nest hole, which was about twenty feet from the water, with sand. This nest, which contained five eggs, was about an inch wide at the top and about three inches wide at the bottom. The next day another female was found filling her nest, which also contained five eggs. During the week several nest holes without eggs were found, as if the site had proved unsatisfactory because of the presence of roots or stones. In all of these nests there were indications that the turtle had moistened the soil. Those in clay were damper than those in sandy situations. One turtle, discovered in the process of digging her nest, was using her right hind foot for scooping out the sand.

18. **Pseudemys rubriventris rubriventris** (Le Conte) 2 (CM 13262 and Univ. of Florida 1820), adult females. 14 (CM 14022-29 and Univ. of Florida 1821), hatchlings.

In life UF 1820 had a plastron of Light Ochraceous-Buff interspersed with Rainette Green, and without black plastral markings. There was only a slight tinge of orange on the plastron whereas a red plastron is characteristic of *P. r. bangsi.* The lower jaw is serrate with a tooth at the symphysis and the upper jaw is notched at the center with a cusp on each side of the notch. Several of the dorsal scutes are abnormally formed and misplaced. This specimen measures 282 mm. in length, 103 mm. in height, and 200 mm. in maximum width.

CM 13262 had a plastron of Light Ochraceous-Buff chiefly interspersed with Rainette Green. The anterior portions of the carapace and plastron were tinged with Apricot Orange. The gular and humeral scutes have black markings on their anterior borders and the dorsal scutes are typical in their formation. The lower jaw is serrate with a tooth at the symphysis; the upper jaw with a median notch between two cusps. This turtle measures 280 mm. in length, 102 mm. in height, and 195 mm. in maximum width.

On May 18, during a steady rain, a female was found at her nest about 11:00 A.M. She had one foot in the hole when first noticed. The presence of the observer apparently caused a cessation of digging for during the succeeding twenty minutes the female remained motionless at the nest. She was then captured and the nest, which contained twelve eggs, was found to be oval in shape with a width of about one and one-half inches at the opening spreading to about four inches underground. This nest was about fifty feet from the edge of a pond.

On May 19, a female was found at her nest as she was filling it with sand. This nest, which was similar to that found on the previous day, contained thirteen eggs and was about four and one-half feet from a pond. As the turtle had fresh duckweed on its shell it probably came from the pond and not from nearby Diascund Creek.

The eggs of these two females were placed in a can of dirt and fifteen of them hatched shortly prior to September 1, the date on which the senior author returned to his home. These young have plastrons ranging in color from Light Ochraceous-Buff to bright orange red. Plastral markings are present and are usually dispersed over the greater portion of the plastron, most individuals having black markings evident on each plastral scute. These markings consist of asymmetrically placed spots and broad bands along the sutures. There is a band of black on the bridge. The ground color of the soft parts is dark green and the markings present are greenish yellow. There are from five to eight stripes between the supra-temporal stripes in the post-orbital region; the auxiliary stripes on the side of the head are distinct. The post-femoral pattern consists of numerous small, horizontal bands and small dots which are sometimes connected to form perpendicular stripes. A tooth is present at the symphysis of the lower jaw and the upper jaw has a median notch between two weak cusps.

Comparison between young of *Pseudemys r. rubriventris* and young of *P. nelsoni.*

nelsoni	*rubriventris*
Bridge immaculate or with only a few spots present.	A heavy black band on the bridge.
Plastral markings absent or restricted to the region of the median suture.	Plastral markings spread out over plastron, some usually present on each scute.
One to three stripes present between the supra-temporal stripes in the post-ocular region.	Five to eight stripes present between the supra-temporal stripes in the post-ocular region.
Post-femoral pattern composed mainly of two or three broad yellow bands.	Post-femoral pattern composed of several faint, horizontal bands and numerous spots.
Ground color of soft parts dark black.	Ground color of soft parts very dark green.
Auxiliary stripes on the side of the head indistinct or absent.	Auxiliary stripes on the side of the head distinct.

Nine nests were found on May 24 which had been opened by predators and the eggs eaten. Six of these were nests of *Chelydra serpentina* and three were those of *Pseudemys.*

SQUAMATA

SAURIA

IGUANIDÆ

19. **Sceloporus undulatus fasciatus** (Green) 14 (CM 13300-13), 9 males and 5 females.

The number of dorsal scales in this series, counted on a median line from the interparietal to a point just above the posterior borders of the hind legs, ranges from 37 to 43, with an average of 40.28. The number of femoral pores varies from 13 to 17, only one specimen having the count of 17.

During the last week of the month several females were seen with mud and dirt on their heads, and their abdomens deflated, possibly indicating that they had just completed laying.

TEIIDÆ

20. **Cnemidophorus sexlineatus sexlineatus** (L.) 11 (CM 13289-99).

On clear, warm days these lizards were to be found along the sandy road and in the borders of the fields.

SCINCIDÆ

21. **Leiolopisma unicolor** (Harlan) 4 (CM 13285-88), May 10-17.

Two of these were found under the bark of fallen logs. The remainder were found under leaves. In the leaves along the western edge of the woods they were particularly abundant. In the late afternoon as the last rays of the sun touched this strip of weeds and grass they could be seen moving about over the leaves. When disturbed they would seek shelter under leaves and remain motionless.

22. **Eumeces fasciatus** (L.) 11 (CM 13314, 13317, 13320-26, 13329-30), 4 males, 5 females, and 2 immature.

Scale rows of this series vary from 28 to 31, occurring in the following order of frequency: 28, 1; 29, 2; 30, 6; and 31, 2. Seven specimens have a supralabial count of 7-7, three have a count of 7-8, and one specimen has the count 8-8. The specimen (a female) which has the eight supralabials on each side also has a transverse suture on the anterior portion of the frontal scale, thus forming an extra scale between the frontal and the prefrontals. All of these specimens have two postlabials which are much smaller than the primary temporals. In life a female had a dorsal stripe of Olive-Buff, and the tail was Pale Olive-Gray. All of the females and immatures have five stripes.

Since the senior author did not distinguish the species of *Eumeces* in the field the following notes may apply, in part, to the next two forms:

"Most commonly found on exposed logs and trees in the vicinity of water. On damp, cold days they could be found under the bark of both standing dead trees and fallen logs, and under bark, boards, and stones on the ground."

23. **Eumeces inexpectatus** Taylor 5 (CM 13315-16, 13319, 13327-28), 3 males, 1 female, and 1 young.

All of these specimens have thirty or more scale rows in the middle of the body. Two of the males and the juvenile have thirty scale rows, one male has thirty-one scale rows, and the female has thirty-two. The three males have a supralabial count of 7-7, while the young and the female have an extra supralabial present on one side. In life the dorsal stripe of the female was Salmon-Buff, and the posterior portion of the tail was Dark Heliotrope Gray. There are seven stripes present on the female and the young.

The most convenient character for separating this species from *fasciatus* and *laticeps* is the presence of uniform sized subcaudals at the base of the tail in *inexpectatus*. Both *fasciatus* and *laticeps* have the median row of subcaudals noticeably enlarged for the entire length of the tail.

The northernmost record of this species listed by Taylor (1935, Revision of Genus Eumeces: 233) is Norfolk, Va. Consequently, the present specimens extend the range of *inexpectatus* approximately fifty miles northwestward along the Atlantic Coastal Plain.

24. **Eumeces laticeps** (Schneider) 1 (CM 13318), subadult male.

This specimen has 32 scale rows, supralabials, 8-8, the sixth beneath the eye, median row of subcaudals enlarged, and a single postlabial which is as large as the primary temporal. There is a small scale above the posterior end of the postlabial.

SERPENTES

COLUBRIDÆ

25. **Carphophis amoena amoena** (Say) 6 (CM 13279-84).

All six specimens are typical of *amoena* with the internasals and prefrontals separate. They are brown above with the light color of the ventrals extending onto the first or second row of dorsal scales.

These were found to be fairly common in open fields, and in the edge of the woods, usually in small, well rotted, partially buried pieces of decayed wood. One was found under the bark of a log and another under a board. The remainder were taken from pieces of fallen branches from one to two feet in length and from three to five inches in diameter.

26. **Abastor erythrogrammus** (Daudin) 1 (CM 13267), male.

The specimen at hand has 19 rows of smooth scales, 158 ventrals, 49 caudals, 7 supralabials, and the anal divided. There are 6 infralabials on the left side and 8 on the right side. Local residents say that this is a common snake and that many of them are plowed up in a field of loose, sandy soil which is surrounded by marsh. They call this species the "Sand Snake" or "Sand Hog."

27. **Opheodrys aestivus** (L.) 1 (CM 13264), female.

This specimen has 158 ventrals and 133 caudals.

28. **Coluber constrictor constrictor** L. 3 (CM 13272-74).

One specimen was found to have its stomach full of June Bugs (*Phyllophaga*) and another contained an adult *Peromyscus leucopus* subsp.

29. **Elaphe obsoleta obsoleta** (Say) 4 (CM 13275-78), 2 adults, 2 immature.

One of the young, 351 mm. in length, which was "shot out" of a tree about twenty feet from the ground, contained an adult *Sceloporus* in its stomach. The other young specimen, 238 mm. in length, during the second week in captivity, ate an adult *Eumeces*.

30. **Natrix sipedon sipedon** (L.) 2 (CM 13270-71), adult males.

This species was common in a small pond and in Diascund Creek.

31. **Natrix taxispilota** (Holbrook) 2 (CM 13268-69), adult males.

This species was found only in the vicinity of Cypress trees and stumps along the Chickahominy River, a stream much larger than Diascund Creek.

32. **Storeria dekayi** (Holbrook) 1 (CM 13263), immature.

This specimen was found under trash near buildings.

33. **Virginia valeriae valeriae** Baird & Girard 2 (CM 13265-66), 1 male, 1 female, May 10-17.

The female has 15 scale rows with faint keels posteriorly, 121 ventrals, and 28 caudals. The male has 15 rows of scales with faint keels posteriorly, 112 ventrals, and 33 caudals.

These two specimens were taken under sticks in a wooded pasture. This woods is little more than a thicket but pasturing has kept it clear underneath.

ART. XXI. AN ANNOTATED LIST OF THE MEXICAN AMPHIBIANS AND REPTILES IN THE CARNEGIE MUSEUM

By Hobart M. Smith

The seventy-six specimens of amphibians and reptiles from Mexico in the Carnegie Museum represent forty-four species, a surprisingly high proportion of the total fauna. Although devoid of novelties, except for the recently described *Natrix rhombifera blanchardi*, the collection includes a number of highly interesting examples of species either quite rare or unknown previously (*Elaphe subocularis*) from Mexico.

I am indebted to Mr. M. Graham Netting for permitting the study of this material, and for much assistance in the preparation of the present list of the specimens.

1. **Oedipus bellii** (Gray)

Spelerpes bellii Gray, Cat. Batr. Grad. Brit. Mus., p. 46, 1850.—Mexico.
Oedipus bellii Dunn, Bull. Mus. Comp. Zool., 62, p. 471, 1918.

Michoacán: Pátzcuaro, 5 specimens (5807-11).

2. **Scaphiopus hammondii** Baird

Scaphiopus hammondii Baird, Rep. Pac. R. R. Surv., 10, (pt. 4), p. 12, pl. 28, fig. 2, 1859.—Fort Reading, California.

Baja California: 5 miles south of Ensenada, 1 specimen (6050).

3. **Bufo valliceps** Wiegmann

Bufo valliceps Wiegmann, Isis, 1833, 26, p. 657, 1833.—Mexico.

Nuevo León: Linares, 8 specimens (13404-11).

4. **Leptodactylus melanonotus** (Hallowell)

Cystignathus melanonotus Hallowell, Proc. Acad. Nat. Sci. Phila., 12, p. 485, 1860.—Nicaragua.
Leptodactylus melanonotus Brocchi, Miss. Sci. Mex., Batr., p. 20, 1881.

Issued March 14, 1939.

Colima: 1 specimen (9316).

The specimen does not agree with the characters of the recently described *Leptodactylus occidentalis** from Nayarit and Sinaloa. It is a male measuring 32 mm. from snout to vent. The head length enters the body length 2.7 times. Apparently there are no postaxillary or postfemoral glands.

5. **Hyla baudinii** Duméril and Bibron

Hyla baudinii Duméril and Bibron, Erpet. Gén., 8, pp. 564-5, 1841.—Mexico.

Nuevo León: Linares, 6 specimens (13398-403).

6. **Hyla regilla** Baird and Girard

Hyla regilla Baird and Girard, Proc. Acad. Nat. Sci. Phila., 6, p. 174, 1852.—Sacramento River, in Oregon and Puget Sound.

Baja California: San Ignacio, 1 specimen (8672).

7. **Rana pipiens** Schreber

Rana pipiens Schreber, Der Naturforscher, Halle, 18, p. 185, pl. 4, 1782.—New York.

Nuevo León: Sabinas Hidalgo, 1 specimen (13414). Tamaulipas: Rancho Rosa, near Victoria, 2 specimens (13412-3).

8. **Rana tarahumarae** Boulenger

Rana tarahumarae Boulenger, Ann. Mag. Nat. Hist., (8), 20, p. 416, 1917.—Sierra Tarahumare, Chihuahua.

Sonora: El Tigre Mts., below Santa María Mine, 1 specimen (13021).

9. **Amyda emoryi** (Agassiz)

Aspidonectes emoryi Agassiz, Contr. Nat. Hist. U. S., 1, p. 407, 2, pl. 6, figs. 4, 5, 1857.—Rio Grande River near Brownsville, Texas.

Amyda emoryi Stejneger and Barbour, Check List N. Amer. Amph. Rept., p. 124, 1917.

Tamaulipas: Nuevo Laredo, 1 specimen (3037).

*Taylor, E. H. 1937. New species of amphibia from Mexico. Trans. Kans. Acad. Sci., 39, pp. 349-352, pl. 1, figs. 1, 2, 7.

10. **Gopherus berlandieri** (Agassiz)

Xerobates berlandieri Agassiz, Contr. Nat. Hist. U. S., 1, p. 447, 2, pl. 3, figs. 17-19, 1857.—Lower Rio Grande, Texas.
Gopherus berlandieri Stejneger, N. Amer. Fauna, 7, p. 161, 1893.

Tamaulipas: 10 miles north of Tampico, 1 specimen (9508).

Upper jaw hooked; gular plates produced 28 mm. beyond anterior outline of plastron; carapace length (straight line) 193 mm.

11. **Terrapene mexicana** (Gray)

Cistudo mexicana Gray, Proc. Zool. Soc. London, 1849, p. 17, pl. 2, 1849.—Mexico.
Terrapene mexicana Baur, Amer. Nat., 27, p. 677, 1893.

Tamaulipas: 45 miles northwest of Tampico, 1 specimen (9507).

The specimen is referred to *mexicana* in deference to the work of Müller,* who showed that *goldmani* is probably a synonym, as indicated by a series of 29 specimens from the region about Tampico.

The nostrils are oval, visible from the side; hind feet with four clawed toes; upper jaw weakly notched; carapace with a strong, median keel, terminating on the fourth vertebral scute. Top of snout yellow, other dorsal and also the lateral surfaces of head yellowish with a heavy, irregular blotching of brown. Carapace clay color, with black borders to the sutures; plastron dull yellow, the posterior edge of each plate (except anals) black; median ventral suture edged with black.

Carapace length (straight line), 152 mm.; carapace width (middle of seventh marginal), 97.9 mm.; plastron length, 147 mm.; plastron width (middle of femoral scutes), 89.6 mm.

12. **Phyllodactylus homolepidurus** Smith

Phyllodactylus homolepidurus Smith, Kans. Univ. Sci. Bull., 22, pp. 121-125, pl. 25, fig. 2, text fig. 1A, 1935.—Five miles southwest of Hermosillo, Sonora.

Sonora: five miles southeast of Hermosillo, 1 specimen (13022).

13. **Basiliscus vittatus** Wiegmann

Basiliscus vittatus Wiegmann, Isis, 1828, p. 273, 1828.—Mexico.

Indefinite: "Mexico," 3 specimens (4288-9, 4855).

*Beiträge zur Kenntnis der Schildkrötenfauna von Mexiko. Zool. Anz., 113, pp. 97-114, figs. 1-4, 1936.

14. **Callisaurus draconoides carmenensis** Dickerson

Callisaurus carmenensis Dickerson, Bull. Amer. Mus. Nat. Hist., 41, p. 465, 1916.—Carmen Is., Gulf of California.
Callisaurus draconoides carmenensis Van Denburgh, Occ. Papers Calif. Acad. Sci., 10, pp. 145-148, 1922.

Baja California: San Ignacio, 2 specimens (7745-6).

15. **Crotaphytus wislizenii** Baird and Girard

Crotaphytus wislizenii Baird and Girard, Expl. Surv. Great Salt Lake, p. 340, pl. 3, 1852.—Santa Fe, New Mexico.

Sonora: 5 miles northeast of Libertad, 1 specimen (4810).

16. **Ctenosaura acanthura** (Shaw)

Lacerta acanthura Shaw, Gen. Zool., 3, (1), p. 216, 1802.—Tampico, Tamaulipas.
Ctenosaura acanthura Gray, Cat. Liz. Brit. Mus., p. 191, 1845.

Veracruz: 70 miles west of Tampico, along Rio Panuco, 2 specimens (9509-10).

17. **Dipsosaurus dorsalis dorsalis** (Baird and Girard)

Crotaphytus dorsalis Baird and Girard, Proc. Acad. Nat. Sci. Phila., 6, p. 126, 1852.—Colorado Desert, California.

Baja California: San Ignacio, 2 specimens (7747-8).

18. **Holbrookia texana** (Troschel)

Cophosaurus texanus Troschel, Arch. Naturg., 1, p. 389, pl. 6, 1852.—Neubraunfels, Guadelupe River, Texas.
Holbrookia texana Baird and Girard, Proc. Acad. Nat. Sci. Phila., 6, p. 124, 1852.

Nuevo León: Sabinas Hidalgo, 1 specimen (9786).

19. **Phrynosoma blainvillii blainvillii** Gray

Phrynosoma blainvillii Gray, Zool. Beechey's Voyage, p. 96, pl. 29, fig. 1, 1839.—California.
Phrynosoma blainvillii blainvillii Bryant, Univ. Calif. Publ. Zool., 9, pp. 5, 29, 1911.

Baja California: 1 specimen (4297).

20. **Phrynosoma orbiculare orbiculare** Gray

Phrynosoma orbiculare Wiegmann, Isis, 1828, p. 367, 1828.—Mexico.
Phrynosoma orbiculare orbiculare Smith, Trans. Kans. Acad. Sci., 37, p. 290, 1935.

Durango: Coyotes, 1 specimen (8117).

The specimen seems fairly typical of the subspecies. The occipital spines are distinctly, although not greatly, larger than the posterior temporals, and project farther posteriorly.

21. **Phrynosoma platyrhinos goodei** Stejneger

Phrynosoma goodei Stejneger, N. Amer. Fauna, 7, p. 191, pl. 2, fig. 3, 1893.—Coastal desert of the state of Sonora, Mexico.
Phrynosoma platyrhinos goodei Klauber, Copeia, 1935, pp. 178-9, 1936.

Sonora: 5 miles northeast of Libertad, 1 specimen (4812).

The three posterior temporal spines are distinct, and sharply defined from the anterior temporals. The occipital and posterior temporal spines are of nearly equal size. Venter with faint, scattered dots; dorsal color light gray interspersed with areas of light pink, blotches dark brown.

22. **Sceloporus couchii** Baird

Sceloporus couchii Baird, Proc. Acad. Nat. Sci. Phila., 1858, p. 254, 1859.—Santa Caterina, Nuevo León.

Nuevo León: Santa Caterina, Huasteca Canyon, 1 specimen (9784).

23. **Sceloporus cyanogenys** Cope

Sceloporus torquatus cyanogenys Cope, Proc. Amer. Philos. Soc., 22, p. 402, 1885.—Monterrey, Nuevo León.
Sceloporus cyanogenys Smith, Kans. Univ. Sci. Bull., 24, p. 599, 1938.

Nuevo León: Sabinas Hidalgo, 1 specimen (9787).

24. **Sceloporus olivaceus** Smith

Sceloporus olivaceus Smith, Trans. Kans. Acad. Sci., 37, pp. 277-9, 1924.—Arroyo los Olmos, 3 miles southeast of Rio Grande City, Starr Co., Texas.

Tamaulipas: Matamoras, 1 specimen (8469).

25. **Sceloporus poinsettii** Baird and Girard

Sceloporus poinsettii Baird and Girard, Proc. Acad. Nat. Sci. Phila., 1852, p. 126, 1852.—Rio San Pedro, Texas, and Sonora.

Indefinite: "Mexico," 1 specimen (4294).

26. **Uta microscutata** Van Denburgh

Uta microscutata Van Denburgh, Proc. Calif. Acad. Sci., (2), 4, p. 298, 1894.

Baja California: San Ignacio, 1 specimen (7744).

27. **Bipes canaliculatus** Sonnini and Latreille

Bipes canaliculatus Sonnini and Latreille, Hist. Nat. Rept., 2, p. 90, 1802.—Mexico.

Indefinite: "Mexico," 1 specimen (4321).

28. **Heloderma horridum** (Wiegmann)

Trachyderma horridum Wiegmann, Isis, 1829, p. 421, 1829.—Mexico.
Heloderma horridum Wiegmann, Isis, 1829, p. 624, 1829.

Colima: Colima, 1 specimen (6904).

29. **Cnemidophorus gularis** Baird and Girard

Cnemidophorus gularis Baird and Girard, Proc. Acad. Nat. Sci. Phila., 1852, p. 128, 1852.—Indianola and the Valley of the Rio Grande del Norte.

Coahuila: 13 miles east of Saltillo, 2 specimens (9779-80).

Jalisco: Zapotlán, 1 specimen (8116, cotype of *communis occidentalis* Gadow).

Morelos: Puente de Ixtla, 1 specimen (8114, cotype of *mexicanus balsas* Gadow).

Nuevo León: San Juan, 1 specimen (8113, cotype of *gularis meeki* Gadow).

Oaxaca: Cuicatlán, 1 specimen (8115, cotype of *communis australis* Gadow).

30. **Cnemidophorus hyperythrus hyperythrus** Cope

Cnemidophorus hyperythrus Cope, Proc. Acad. Nat. Sci. Phila., 1863, p. 103, 1863. —Cape San Lucas, Baja California.
Cnemidophorus hyperythrus hyperythrus Burt, Proc. Biol. Soc. Wash., 42, p. 154, 1929.

Baja California: San Ignacio, 1 specimen (7743).

31. **Drymarchon corais melanurus** (Duméril and Bibron)

Spilotes melanurus Duméril and Bibron, Erpet. Gén., 7, p. 224, 1854.—Mexico and Central America.

Drymarchon corais melanurus Stejneger and Barbour, Check List. N. Amer. Amph. Rept., p. 85, 1917.

Colima: Cualata, 1 specimen (7254).

A female, with 17-17-15 scale rows, 195 ventrals, 70 caudals, 8-8 supralabials, 8-8 infralabials, 1-1 preoculars, 2-2 postoculars, 2-2 temporals. It measures 1523 mm. in total length, of which the tail forms 278 mm. The anterior three-fourths of the body is very light, with irregular, small, dark brown markings, and indistinct, large, median dorsal blotches.

32. **Drymobius margaritiferus** (Schlegel)

Herpetodryas margaritiferus Schlegel, Essai Physion. Serp., 2, p. 184, 1837.—New Orleans (in error).

Drymobius margaritiferus Cope, Proc. Acad. Nat. Sci. Phila., 1860, p. 561, 1860.

Colima: Cualata, 1 specimen (7252).

33. **Elaphe subocularis** (Brown)

Coluber subocularis Brown, Proc. Acad. Nat. Sci. Phila., 1901, p. 492, pl. 29, 1901.—Davis Mountains, Jeff Davis Co., Texas.

Elaphe subocularis Stejneger and Barbour, Check List N. Amer. Amph. Rept., p. 84, 1917.

Coahuila: 28 miles east of Saltillo, 1 specimen (9781).

Scale rows 21-23-21, ventrals 281, caudals 60+, supralabials 10-11, infralabials 13-13, preoculars 1-1, postoculars 2-2, temporals 4-5 and 2-4; 23 spots on body, 7+ on tail; total length 1635+ mm., tail 179+ mm. The fifth supraocular on one side and the sixth on the other enters the orbit; the suboculars are 2-2, one below the preocular and one below the postoculars. The specimen is a male.

34. **Eudryas boddaertii slevini** Stuart

Eudryas slevini Stuart, Occ. Papers Mus. Zool. Univ. Mich., 254, pp. 9-10, 1933.—Maria Madre Island, Tres Marias Islands.

Eudryas boddaertii sleveni Oliver, Occ. Papers Mus. Zool. Univ. Mich., 360, p. 19, 1937.

Colima: Cualata, 1 specimen (7253).

Ventrals 179, caudals 177.

35. **Natrix rhombifera blanchardi** Clay

Natrix rhombifera blanchardi Clay, Ann. Carnegie Mus., 27, pp. 251-253, pl. 25, 1938.

Tamaulipas: vicinity of Tampico, four specimens (Holotype 9512, and paratypes 9513-15).

36. **Pituophis sayi sayi** (Schlegel)

Coluber sayi Schlegel, Essai Physion. Serp., 2, p. 157, 1837.—Missouri.
Pityophis sayi sayi Cope, Ann. Rept., U. S. Nat. Mus., 1898, p. 870, fig. 204, 1900.

Tamaulipas: near mouth of Tamesi River, 1 specimen (9511).

A female, with 29-33-25 scale rows, 238 ventrals, 48 caudals, 8-8 supralabials, 12-12 infralabials, 1-1 preoculars, 3-4 postoculars, four anterior temporals; total length 1580 mm., tail 165 mm. The anterior, median blotches are considerably darker than the posterior.

37. **Pituophis sayi affinis** (Hallowell)

Pituophis affinis Hallowell, Proc. Acad. Nat. Sci. Phila., 1852, p. 181, 1852.—New Mexico.
Pituophis sayi affinis Van Denburgh, Occas. Papers Calif. Acad. Sci., 10, p. 737, 1922.

Chihuahua: San Blas Mts., 1 specimen (7250).

A male, with 27-29-23 scale rows, 220 ventrals, 62 caudals, 8-8 supralabials, 13-13 infralabials, 1-1 preoculars, 3-4 postoculars, 3-4 anterior temporals; total length, 1283 mm., tail 177 mm. The anterior, median blotches are but very slightly darker than the posterior.

38. **Salvadora grahamiae virgultea** Bogert

Salvadora grahamiae virgultea Bogert, Bull. Southern Calif. Acad. Sci., 34, pp. 88-94, 1935.—Deerhorn Flat, San Diego Co., Calif.

Baja California: Ensenada, 1 specimen (6123).

A female, with 17-17-15 scale rows, 193 ventrals, 91 caudals, 9-9 supralabials, 11-11 infralabials, 2-3 preoculars, 2-2 postoculars, 2-3 temporals; total length, 593 mm., tail 142 mm. The first supralabial is separated from the posterior section of the nasal; the second is separated from the loreals; and the sixth enters the orbit.

39. **Thamnophis sauritus proximus** (Say)

Coluber proximus Say, Long's Exped. Rocky Mts., 1, p. 187, 1823.—Stone quarry on west side of Missouri River, 3 miles above the mouth of Boyer's River.
Thamnophis sauritus proximus Ruthven, Bull. U. S. Nat. Mus., 61, p. 98, 1908.

Nuevo León: 7 miles west of Monterrey, 2 specimens (9782-3).

Females; ventrals and caudals respectively are 163 and 99 in 9782, and 160 and 96 in 9783. The total ventral and caudal counts are well within the limits of variation of *s. proximus*.

40. **Thamnophis scalaris** Cope

Thamnophis scalaris Cope, Proc. Acad. Nat. Sci. Phila., 1860, p. 369, 1861.—Jalapa, Vera Cruz.

Veracruz: Mt. Orizaba, 1 specimen (8098).

A male, scale rows 17-17-15, ventrals 135, caudals 77, supralabials 7-7, infralabials 8-9, preoculars 1-1, postoculars 2-2, temporals 1-2-2; total length 172 mm.; tail 48 mm. There are 59 pairs of spots on the body.

41. **Oxybelis acuminatus** (Wied)

Coluber acuminatus Wied, Beitr. Nat. Bras., 1, p. 322, 1825.—Espirito Santo River, Brazil.
Oxybelis acuminatus Steindachner, Rept. Reise Novara, p. 72, 1867.

Colima: Cualapa, 1 specimen (7251).

A female, with 17-17-13 scale rows, 187 ventrals, 183 caudals, 8-8 supralabials, 10-10 infralabials, 1-1 preoculars, 2-2 postoculars, 1-2 temporals; it measures 1226 mm. in total length, 537 mm. of which comprise the tail length.

42. **Agkistrodon bilineatus** Günther

Ancistrodon bilineatus Günther, Ann. Mag. Nat. Hist., (3), 12, p. 364, 1863.—Pacific Coast of Guatemala.

Colima: Colima, 1 specimen (6908).

Ventrals 132, caudals 48+.

43. **Crotalus cinereous** LeConte

Crotalus cinereous LeConte, Proc. Acad. Nat. Sci. Phila., 6, pp. 177-182, 1862.—Colorado Desert, vicinity of Yuma.

Chihuahua: Lake Santa María, 1 specimen (6369).

44. **Crotalus triseriatus pricei** Van Denburgh

Crotalus pricei Van Denburgh, Proc. Calif. Acad. Sci., (2), 5, p. 856, 1895.—Huachuca Mts., Arizona.
Crotalus triseriatus pricei Klauber, Copeia, 1934, p. 52, 1934.

Chihuahua: Colonia García, 1 specimen (6368).

4/26/39.

ART. XXII. NEW NEOTROPICAL LEPIDOPTERA OF THE FAMILY NOTODONTIDÆ

BY WILLIAM SCHAUS

Annals of the Carnegie Museum
Vol. XXVII, p. 321-348, 1939

Issued April 22, 1939
Pittsburgh, Pa.

ART. XXII. NEW NEOTROPICAL LEPIDOPTERA OF THE FAMILY NOTODONTIDÆ

By William Schaus
United States National Museum

(Plates XXXI-XXXIII)

Most of the following species are described from specimens in the Carnegie Museum; a few are from material in the collection of Cornell University.

Proelymiotis melites sp. nov. (Plate XXXI, fig. 1)

Male: Palpi fuscous. Head and collar laterally light vinaceous fawn; a light vinaceous tuft from behind antenna. Collar and thorax fuscous brown, the tegulæ light vinaceous lilac. Abdomen above fuscous, the basal segment buffy brown, the terminal segment and anal hairs écru drab with a dorsal black spot; abdomen below, vinaceous lilac with a fine central dark line, the two basal segments with transverse fuscous bands. Fore wing: from base of median vein an excurved vinaceous buff dentate line, rather broad, containing some irregular small black lines, and outwardly edged by a fine black line, partly double, followed distally by a small vinaceous buff spot; the basal space above to costa mottled light cinnamon drab and wood brown; a vinaceous buff dentate line postmedially from below vein 2 upcurved to above vein 4, then expanding to termen; a black point below, discocellular and a benzo brown triangular space below it; from costa to cell, not reaching apex, dark grayish brown, mottled with fine dark longitudinal lines and fuscous lines on veins; apex broadly paler with white costal points; the terminal space below the upcurved line dark brownish drab; a subterminal white point below vein 3 and traces of a pale mark on interspaces. Hind wing drab, the cilia whitish. Fore wing below, mostly light drab, pale at base and with faint traces of the markings above. Hind wing below, pale grayish vinaceous, the costa and termen pale brownish drab with a fuscous streak on basal half of costa.

Expanse: 42 mm.

Issued April 22, 1939.

Habitat: Nova Olinda, Rio Purus, Brazil; May 1922; S. M. Klages, coll.

Type: Acc. no. 7088, Carnegie Museum.

Allied to *P. lignicolor* Moesch.

Antiopha gunneri sp. nov. (Plate XXXI, fig. 2)

Male: Head cinnamon buff. Collar and thorax tawny olive. Abdomen above, wood brown with whitish hairs at base; underneath, vinaceous white. Fore wing buffy brown, the veins black and similar subterminal streaks on interspace; a white streak from cell below vein 5 with a small black spot on its end; a white and cinnamon streak above vein 5 to termen; postmedial pale points on veins, and short whitish lines terminally on interspaces. Hind wing whitish slightly irrorated with drab; termen rather broadly drab; cilia white. Fore wing below, mostly drab; a fine terminal fuscous line preceded by the small white spots as above. Hind wing below, white, the termen partly écru drab.

Expanse: 32 mm.

Habitat: Rio de Janeiro, Brazil; November; H. H. Smith, coll.

Type: In the Carnegie Museum.

Allied to *A. multilinea* Schaus and *A. didugana* Draudt, the latter also from Rio de Janeiro.

Lepasta asaphina sp. nov. (Plate XXXI, fig. 3)

Female: Palpi fuscous fringed with light drab. Head écru drab with a benzo brown spot on vertex. Collar buffy citrine. Tegulæ vinaceous white. Abdomen écru drab. Fore wing: costa broadly buffy citrine; below it postmedially a large triangular white spot; from above proximally, a white line downcurved to median vein; distally a short curved line towards termen, below this a buffy olive space, not reaching inner margin or tornus, which are pale vinaceous lilac, the lilac shade at tornus extending upwards on termen to vein 4; a subterminal series of black points. Hind wing dark drab. Wings below dark drab, the costa of hind wing broadly whitish lilacine.

Expanse: 36 mm.

Habitat: Hyutanahan, Rio Purus, Brazil; February 1922; S. M. Klages, coll.

Type: Acc. no. 6963, Carnegie Museum.

Farigia lantana sp. nov. (Plate XXXI, fig. 4)

Male: Palpi fuscous, fringed with vinaceous buff. Head and thorax hair brown, mottled with vinaceous and white hairs. Abdomen above and laterally benzo brown, underneath vinaceous. Fore wing at base of inner margin vinaceous edged by a blackish brown shade from base of costa outcurved and downbent to inner margin, followed on costa by a large white spot slightly irrorated with dark scales; some slight whitish lilacine scales from it to inner margin; a large dark patch on inner margin to near tornus irrorated on inner margin with some whitish blue scales, above this a fuscous patch below vein 2 to near outer margin, the patch surmounted in cell by a quadrate black spot; costa beyond white basal spot and entire apical and terminal space light vinaceous buff; a fine dark postmedial line edged with white on costa at the medial dark space below vein 3, followed by some irregular dark shading on interspaces; a subterminal dark line partly cut by veins; cilia dark purplish brown. Hind wing white on costa, suffused with vinaceous below it, darker on inner margin. Fore wing below white at base, then light vinaceous drab; basal half of costal edge fuscous. Hind wing below, white, at base slightly yellow.

Expanse: 44 mm.

Habitat: Cochabamba, Bolivia; J. Steinbach, coll.

Type: Acc. no. 6873, Carnegie Museum.

Allied to *F. tulana* Schaus.

Cerura olindata sp. nov. (Plate XXXI, fig. 5)

Male: Head mostly white, a black spot posteriorly. Collar white in front, cinnamon drab behind. Thorax mottled brown and white; tegulæ white, the edges tipped with fuscous. Abdomen dorsally whitish at base, then dusky drab with transverse fuscous lines; the terminal segment and anal hairs white; underneath mostly white with dark transverse lines. Fore wing white, the markings fuscous; fine subbasal and antemedial lunules above and below cell; two larger medial spots on costa, a longitudinal mark in cell; an excurved line beyond cell and a lunule below vein 2; postmedial line with a spot and a line on costa, partly double, very irregular, the costal line distally edged by a large blackish brown spot from costa to below vein 6; a subterminal irregular line from apex to vein 3, partly lunular. Hind wing largely light drab with whitish suffusions at base of costa and postmedially; cilia white with fuscous streaks at veins. Wings below, mostly white; the fore wing with costal markings very much as above, the veins tipped with fuscous expanding on cilia; the hind wing with a dark streak from costa close to apex.

Expanse: 18 mm.

Habitat: Nova Olinda, Rio Purus, Brazil; May 1922; S. M. Klages, coll.

Type: Acc. no. 6962, Carnegie Museum.

Gopha melanitis sp. nov. (Plate XXXI, fig. 6)

Male: Palpi and shaft of antenna dark brown, a white spot at antenna below. Collar light vinaceous drab. Thorax fuscous with pale lines, the tegulæ dark brownish drab. Abdomen above fuscous, underneath white with dark transverse lines; the tip and anal hairs black. Fore wing dark brownish drab; a fine subbasal, outcurved, punctiform white line; a similar wavy antemedial line, with some paler shading proximally, followed by a slightly darker shading; postmedial line deeply excurved on costa, then wavy, faintly edged in part with some whitish scales followed by white points on vein 4 to inner margin; the veins on terminal space fuscous; faint subterminal black marks; terminal white points on veins; some white at base of inner margin. Hind wing brownish drab, becoming slightly paler at base, the cilia white. Fore wing below light brownish drab; inner margin white, the costal margin narrowly vinaceous buff. Hind wing below white, the apex narrowly light brownish drab.

Expanse: 30 mm.

Habitat: Hyutanahan, Rio Purus, Brazil; February 1922; S. M. Klages, coll.

Type: Acc. no. 6963, Carnegie Museum.

Drugera tapella sp. nov. (Plate XXXI, fig. 7)

Male: Head, collar, and thorax mottled white, mouse gray and fuscous hairs. Abdomen above mostly avellaneous with light cinnamon drab transverse lines, underneath vinaceous white, the basal half with light brownish drab transverse lines. Fore wing grayish white partly irrorated with dark scales; costal margin from beyond base much darker to apex, crossed by fine black lines; base of inner margin white, followed by two fine black lines and the outbent antemedial line, the latter broad and inwardly white edged, these lines faintly indicated in cell; medial space with the irrorations forming fine, faintly indicated lines, more prominent on inner margin and in cell; postmedial line more distinct, fuscous, sinuous, followed by fine interrupted lines; a subterminal fuscous line proximally edged with pale mouse gray, cut by veins, from near apex to vein 3; a fine terminal dark line. Hind wing white, the inner margin écru drab. Wings below white, faintly vinaceous, the costa of fore wing with a fine vinaceous line, below it pale vinaceous drab scaling at end of cell.

Expanse: 36 mm.

Habitat: Hyutanahan, Rio Purus, Brazil; January 1922; S. M. Klages, coll.

Type: Acc. no. 6963, Carnegie Museum.

Salluca telano sp. nov. (Plate XXXI, fig. 8)

Male: Head and front of collar pinkish buff, the collar behind, front of thorax, and base of abdomen russet, the tegulæ outwardly pinkish buff; abdomen above beyond base russet vinaceous, the last segment with a dorsal pinkish buff spot, underneath avellaneous. Fore wing mostly dark vinaceous, paler towards costa; the costal margin pinkish buff and a similarly colored subterminal line from apex to tornus; a medial and a postmedial fine darker line from below costa to inner margin crossing a narrow pale streak on the margin. Hind wing whitish, somewhat iridescent, the termen at anal angle dark vinaceous, becoming paler along termen to costa. Fore wing below white; the termen below apex to vein 2, onion-skin pink. Hind wing below suffused with buff pink, the anal angle dark vinaceous; a fine subterminal whitish line, proximally dark edged.

Expanse: 41 mm.

Habitat: Chapada near Cuyabá, Matto Grosso, Brazil; H. H. Smith, coll.

Type: In the Carnegie Museum (Holland Coll.).

CORANIA gen. nov.

Male: Antenna pectinated to beyond middle. Palpus upcurved to vertex, thickly scaled, the third joint short. Tibia clothed with long hairs. Abdomen extending well beyond anal angle. Fore wing: costa straight, termen obliquely rounded; vein 2 well before lower angle of cell; 3 and 4 from a point; 5 from just above middle of discocellular; areole long and narrow, originating from before end of cell; vein 6 from before end of areole; 7 and 8 from end of areole; 10 from areole. Hind wing: termen rounded; veins 3 and 4 from lower angle; 6 and 7 stalked; 8 touching 7 at middle of cell, then diverging.

Type of genus, *Corania pedrana*, sp. nov.

Corania pedrana sp. nov. (Plate XXXI, fig. 9)

Male: Palpi fuscous below, white above; vertex light grayish olive mottled with grayish olive. Collar and thorax grayish olive, the tegulæ with fuscous streaks. Abdomen above dull citrine with slightly paler transverse lines and a black triangular spot on basal segment; underneath white. Fore wing dark olive citrine with fine fuscous irrorations; subbasal and antemedial lines double, black filled in with white, the subbasal almost vertical from costa to submedian, the antemedial slightly sinuous from costa to inner margin; medial space somewhat paler; a finer black postmedial line from subcostal slightly inbent and closely followed by a postmedial black line, outcurved at vein 3, incurved below it; a subterminal series of small, dentate spots on interspaces, replaced at tornus by an upright black line; cilia black with white hairs at tips of veins. Hind wing white with a few dark scales at anal angle. Wings below white, the fore wing broadly deep heliotrope gray at apex, this color area narrowing to tornus, becoming very narrow on costa; the veins from cell with dark streaks. Hind wing with some dark scaling on costa.

Expanse: 32 mm.

Habitat: Prov. Oran, North Argentina (300 m.); January 1916; J. Steinbach, coll.

Type: Acc. no. 5571, Carnegie Museum.

Misogada rhymba sp. nov. (Plate XXXI, fig. 10)

Female: Head, collar, and tegulæ pale mouse gray, the thorax fuscous, almost entirely hidden by collar and tegulæ. Abdomen above grayish with dorsal dark transverse lines, underneath pale vinaceous fawn. Fore wing pale mouse gray; a fine subbasal black line on costa; antemedial line almost medial, double, outbent in cell, below this with only a few dusky scales; medial line consisting of a few black points, expanding, linear; in cell at vein 3 with a short black-angled line on and below median, then obsolescent to a small irregular fuscous mark on inner margin, on costa followed by a black line and three costal points to apex; a dark vinaceous gray suffusion subterminally between veins 4 and 6. Hind wing grayish olive with pale suffusions on costa and inner margin, on the latter a subterminal short double black line. Fore wing below deep grayish olive, the costa terminally pale mouse gray, the inner margin whitish. Hind wing below as above, the inner margin more broadly white.

Expanse: 30 mm.

Habitat: Nova Olinda, Rio Purus, Brazil; May 1922; S. M. Klages, coll.

Type: Acc. no. 6962, Carnegie Museum.

Misogada alicina sp. nov. (Plate XXXIII, fig. 44)

Male: Head, collar, and thorax light russet vinaceous with darker mottling, the head with fuscous lines. Abdomen above, dusky drab, underneath with the base deep red, the two last segments with a medial white line connecting two transverse white lines. Fore wing mostly dark vinaceous brown, the veins terminally more vinaceous; a double antemedial black line on costa, followed by a white and vinaceous space to apex, where it is narrower, crossed by a medial dark line; the veins from cell mostly black with faint paler postmedial points; the submedian vein with an interrupted black line. The two fore wings are not absolutely alike and are difficult to describe. Hind wing bright purplish brown, the termen darker; cilia pale grayish. Fore wing below, brownish drab, the termen and a spot on costa somewhat vinaceous. Hind wing below écru drab, darker on termen; cilia pale vinaceous.

Expanse: 23 mm.

Habitat: Tumatumari, Potaro River, British Guiana.

Type: In the Cornell University Collection.

Misogada hazuela sp. nov. (Plate XXXI, fig. 11)

Male: Head and collar white. Thorax white with a few black hairs. Abdomen above, drab with a central vinaceous line and whitish segmental lines; a lateral broken dark line and a sublateral black line at base; terminal segments vinaceous gray; underneath white with gray transverse lines. Fore wing: inner margin for two-thirds white, the base of costa drab gray crossed by a subbasal black line; an antemedial dark shade in and below cell; close to middle of costa an oblique broad fuscous shade to near tornus, outbent from costa and irregular, partly crossed and edged by a black line, below cell vertical, lunular, double and followed on costa by pale mouse gray crossed by a fine dark line, then by a double black line; costa to apex white with three black points on costa; termen below apex mostly drab gray. Hind wing white, the termen drab gray. Fore wing below dark mouse gray, the costa narrowly white with the black points before apex. Hind wing below white with dark mouse gray scaling at anal angle.

Expanse: 24 mm.

Habitat: Nova Olinda, Rio Purus, Brazil; May 1922; S. M. Klages, coll.

Type: Acc. no. 7088, Carnegie Museum.

Paratypes: In U. S. National Museum from type locality and Tumatumari, British Guiana. Paratype from Tumatumari also in Cornell University Collection.

Notoplusia licasia sp. nov. (Plate XXXI, fig. 12)

Female: Vertex and front of collar greenish white, the collar tipped with cinnamon scales. Thorax mottled drab and white, the tegulæ mostly greenish white. Abdomen above, light grayish olive, with whitish transverse lines, some cinnamon scales on basal segment; the under side light buff. Fore wing with base, termen, and inner margin medially white with scattered dark scales; subbasal double black lines on costa and below cell; a double fuscous antemedial lunular line filled in with tawny olive scales from costa to just below cell; end of cell buffy brown edged by a thick fuscous line proximally edged with white; a double postmedial fuscous lunular line partly filled in with purplish brown scales, followed on costa by a broad fuscous shade between veins 5 and 7; subterminal black marks on interspaces, proximally white edged, distally followed by denser irrorations; a terminal fuscous line, broken from vein 3 to tornus; cilia white mottled with dark hairs. Hind wing drab, the costa white, also the cilia. Fore wing below drab, the base and inner margin white; the costa and apex finely white, also the cilia. Hind wing below as above.

Expanse: 34 mm.

Habitat: Mana River, French Guiana; May 1917; S. M. Klages, coll.

Type: Acc. no 6008, Carnegie Museum.

Nearest to *Notoplusia sabrena* Schaus.

Notoplusia menica sp. nov. (Plate XXXI, fig. 13)

Male: Head écru olive. Collar and thorax citrine drab. Abdomen above similar with darker transverse lines; underneath pale grayish vinaceous. Fore wing pinkish buff due to dark irrorations on a whitish ground; traces of subbasal and antemedial fine lines, partly punctiform; from middle of costa to near apex a dark grayish olive patch somewhat triangular, crossed on costa by two short lines and three points; a series of small fuscous spots along the patch distally continued as a broken line from vein 4 to inner margin; from vein 6 to vein 3 a subterminal narrow olive-brown shade; fuscous terminal spots on interspaces and a few dark spots extending on the cilia. Hind wing above like fore wing with postmedial and subterminal dark olive streaks on veins, the latter suffusing with the similar termen; cilia white. Fore wing below, drab; the costal edge narrowly light buff with four black points; a fine dark terminal line on interspaces; cilia white. Hind wing below without the dark streaks on veins, and only faint traces of the dark termen.

Expanse: 28 mm.

Habitat: Pied Saut, Oyapok River, French Guiana; March 1918; S. M. Klages, coll.

Type: Acc. no. 6173, Carnegie Museum.

PAGRASANA gen. nov.

Female: Antennæ with a few minute bristles. Palpus upturned, roughly scaled, the 3d joint short. Legs smooth. Fore wing rather long, narrow, the costa slightly convex, the termen faintly rounded, the inner margin straight; vein 2 well before angle of cell; vein 5 from middle of discocellular; areole small; 7 also 8 and 9 from areole; 10 from cell. Hind wing rather narrow and long, the termen rounded; veins 2 and 3 from angle; vein 4 on long stalk with vein 3; 6 and 7 from upper angle; 8 close to 7 to end of cell.

Type of genus, *Pagrasana bermejona*, sp. nov.

Pagrasana bermejona sp. nov. (Plate XXXI, fig. 14)

Female: Head and collar deep mouse gray. Thorax fuscous, the tegulæ dorsally edged with mouse gray. Abdomen above mouse gray with dark transverse lines and a black dorsal spot at base. Fore wing: black scaling at base below costa with short black lines on veins; a conspicuous black line above submedian from cell to termen edging a quadrate black spot on inner margin, the latter otherwise gray irrorated with small black scales; cell and area above the black line to termen pale cinnamon buff; costa medially drab; apex benzo brown with a small grayish spot on costa close to apex; veins 5 and 6 fuscous from beyond cell to termen; from vein 3 to the black line a postmedial fine incurved line. Hind wing white with terminal drab gray shading and a dark terminal line. Fore wing below drab gray, the dark line of upper side indicated. Hind wing below white on basal third below costa, the termen broadly drab gray with a slight postmedial dark curved line.

Expanse: 35 mm.

Habitat: Rio Bermejo, Salta, Argentina; J. Steinbach, coll.

Type: Acc no. 5228, Carnegie Museum.

Malocampa dianora sp. nov. (Plate XXXI, figs. 15, 16)

Female: Palpus white with a fuscous line at apex. Head pale drab gray. Collar and thorax fuscous, the latter white beneath, the tegulæ dark brownish drab. Legs mostly white. Abdomen on basal half brownish drab becoming pale drab gray on last segment; underneath mostly white. Fore wing: on inner margin from near base to postmedial line, a large oval dark brownish drab patch partly edged by a black line; costa from base to postmedial line white crossed by fine wavy dark lines, the antemedial, medial, and a broken line before the subterminal more distinct; a narrow reniform spot at discocellular cinnamon buff edged by a fine black line; postmedial line faintly outcurved to vein 3, then wavily downbent to inner margin, this line indistinctly double, and followed by a brownish gray space which is strongly produced below costa, and incurved below vein 6 to vein 4, distally edged with fuscous and the vinaceous white terminal space on which are some slightly darker spots; a terminal fine dark line, lunular from vein 3 to tornus. Hind wing white suffused with écru drab, the veins finely dark; a streak of dark grayish brown along inner margin cut at anal angle by a white line. Fore wing below mostly drab; costal margin finely white broken into spots on terminal third; large terminal white spots on interspaces and a few smaller ones beyond cell. Hind wing below glossy lilacine white, the costa at base yellowish white; a subterminal écru drab shading below apex.

Expanse: 52 mm.

Habitat: Hyutanahan, Rio Purus, Brazil; March 1922; S. M. Klages, coll.

Type: Acc. no. 6963, Carnegie Museum.

A second specimen in the Carnegie Museum, accession no. 6960, also from the Rio Purus, differs only in the absence of the dark oval patch although it has the outline of it. Without more material I prefer to leave it unnamed. This specimen is from Miracena, Rio Purus, Brazil; April 1922; S. M. Klages, coll., fig. 16.

Malocampa manana sp. nov. (Plate XXXI, fig. 17)

Male: Palpus light grayish olive, the base and third joint fuscous. Head vinaceous buff, the vertex with a fuscous angled line. Collar vinaceous buff with posteriorly a large black spot. Thorax black, the tegulæ vinaceous buff tipped with black hairs. Abdomen above vinaceous fawn with broad black transverse lines, the last segment vinaceous gray with a narrower black transverse line. Fore wing yellowish olive, the base white extending slightly on inner margin with a black point at base below cell and a larger point subbasally in cell, the balance of wing with numerous points and streaks of pale olive ocher; a broad antemedial fascia edged with black lunules and containing dark buffy green spots crossed by fuscous lines; a small curved medial line on costa followed by a point and an angled line; streaks on interspaces below veins 2 and 3, and a point above vein 2; a series of small postmedial points from costa to submedian, closely followed by small spots or paired upright streaks; termen from apex to vein 3, olive yellow cut by veins outwardly edged by a black line, and olive green small spots at tornus. Hind wing drab with the costa white and the inner margin vinaceous buff preceded by a vinaceous rufous streak. Fore wing below whitish; a black streak along costa, the costal edge medially white followed by five white points to apex; the veins, apex, and termen suffused with drab; whitish spots beyond cell, and larger spots on terminal interspaces. Hind wing below white, the veins on termen mostly light drab.

Expanse: 50 mm.

Habitat: Mana River, French Guiana; May 1917; S. M. Klages, coll.

Type: Acc. no. 6008, Carnegie Museum.

Allied to *M. ecpantheroides* Schaus.

Malocampa cadajoa sp. nov. (Plate XXXIII, figs. 40, 41)

Female: Head pallid mouse gray. Collar mottled mouse gray, fuscous, and light drab. Abdomen above with the base black followed by two pallid mouse-gray segments, then two amber brown black-edged segments, the terminal segments and anal hairs pallid mouse-gray; the under side white. Fore wing: base pallid mouse-gray with dark irrorations, limited by a double lunular black line, excurved on costa; a black wavy subbasal line, faintly indicated below cell; the antemedial followed by two black lines across cell; medial space grayish on costa and clay color above submedian; end of cell anteriorly black, below it whitish; costa to subterminal fuscous; medial space citrine drab, outwardly edged by a double black incurved line filled in with white from veins 6-4, distally edged from costa with a broad white line which at vein 3 expands to termen and tornus; termen from apex to vein 4 mottled brown and lilacine gray; a terminal black line of lunules on interspaces; cilia with black spots at tips of veins. Hind wing with termen broadly fuscous, extending on costa to near base, this latter narrowly tawny olive at base expanding to inner margin; cilia grayish. Fore wing below with the hair brown; white points on outer half of costa; inner margin narrowly whitish, cilia white with black points at veins. Hind wing below with the hair brown, the base and inner margin broadly white; cilia white with fine black lines at tips of veins.

Expanse: 40 mm.

Habitat: Below Cadajoa, Rio Solimoens, Brazil.

Type: In the Cornell University Collection.

Malocampa mardonia sp. nov. (Plate XXXII, fig. 18)

Male: Palpi fuscous fringed and tipped with white. Head with white spots. Collar fuscous. The tegulæ vinaceous buff, outwardly edged with black, more strongly so dorsally. Abdomen dorsally, dark vinaceous drab, paler on terminal segments, underneath white with a ventral vinaceous fawn spot near base. Fore wing: base vinaceous gray with some dark scaling limited by a double fuscous antemedial line, partly interrupted; medial space citrine drab, its outer edge excurved from costa to vein 4, then irregularly incurved to inner margin, followed on costa by a light drab shade to apex crossed by dark streaks on costa which continue as small black lunules to within cell, then by two postmedial costal streaks which continue as broken fuscous lunules to inner margin; termen mostly vinaceous drab, crossed by a subterminal slightly paler line, and terminal black spots on interspaces. Hind wing tawny ocher, paler at base; termen broadly benzo brown, the cilia white. Fore wing below deep brownish drab; termen narrowly white; outer half of costa with small whitish spots; the base and a short streak below costa whitish, the inner margin pinkish buff. Hind wing below whitish with brown streaks on inner margin; termen broadly black, the cilia white.

Expanse: 36 mm.

Habitat: Nova Olinda, Rio Purus, Brazil; May 1922; S. M. Klages, coll.

Type: Acc. no. 7088, Carnegie Museum.

Chadisra arimata sp. nov. (Plate XXXII, fig. 19)

Male: Head white with some fuscous points on vertex, the eyes laterally edged with fuscous. Collar avellaneous, the thorax and metathorax white. Abdomen above avellaneous, the terminal segments white. Fore wing white with steel gray irrorations before the antemedial line and medially below the cell to inner margin; subbasal cinnamon points above and below cell; an antemedial sayal brown streak on costa and below cell; an outbent lunular cinnamon line; a medial point on costa, below it a line bifurcating from base of vein 5, inangled at vein 2, formed of dark irrorations; postmedial line inbent from below costa, partly punctiform, distally with dark lines on veins 7, 6, 5 and below vein 5 with cinnamon spots on interspaces, and from vein 3 to below vein 2 a double excurved dark line; a marginal lunular black line and some dark scaling on termen. Hind wing white, the inner margin narrowly vinaceous buff; some dark points at tips of veins. Wings below white; the fore wing with veins terminally finely dark streaked, and with traces of the postmedial line.

Expanse: 32 mm.

Habitat: Arima, Rio Purus, Brazil; November 1922; S. M. Klages, coll.

Type: Acc. no. 7088, Carnegie Museum.

Chadisra sericana sp. nov. (Plate XXXIII, figs. 42, 43)

Female: Frons light grayish vinaceous; head behind and collar anteriorly fuscous, the latter whitish mottled with light grayish vinaceous and a few fuscous hairs. Tegulæ white, tipped with black. Abdomen above mostly light brownish drab, underneath whitish vinaceous on terminal half. Fore wing above silvery white, the costa for two thirds and inner margin suffused with light vinaceous fawn; a vertical subbasal thick fuscous line from costa to below cell followed on costa by a fine, irregular dark line; from costa at apex a broad benzo brown fascia, inbent to vein 4, interrupted and forming a spot between veins 3 and 2, inwardly edged by a wavy black line, and distally edged by a similar line to vein 4; a subterminal black line, lunular from vein 5 to tornus. Hind wing whitish suffused with écru drab, the termen broadly drab, the cilia white. Fore wing below white on inner margin, otherwise suffused with light drab, the termen drab; some white streaks on costa, and a dark spot on costa before apex. Hind wing below as above.

Expanse: 36 mm.

Habitat: Moengo, Boven Cottica River, Dutch Guiana.

Type: In the Cornell University Collection.

The species is allied to *C. albidula* Dogn.

Meragisa pseudothia sp. nov. (Plate XXXIII, figs. 38, 39)

Male: Palpi pinkish buff with a fuscous streak above. Head, collar, and thorax mouse-gray, the latter posteriorly mottled with white hairs. Abdomen above whitish gray with faint darker transverse lines, the base discolored. Fore wing white irrorated with dark mouse-gray scales, more thickly so along the costal margin, the lines fine, fuscous; a slight subbasal mark; antemedial line slightly outbent, lunular to submedian vein where it is outset; postmedial line sinuous, very irregular, partly lunular; marginal line nearly straight from costa to vein 3, then irregular to tornus; the lines marked with black points on costa; costal edge finely white. Hind wing grayish olive, the cilia white. Fore wing, below: costa narrowly light buff; termen and inner margin whitish; interspaces grayish olive. Hind wing, below: grayish olive streaks on terminal interspaces, the wing otherwise mostly pale yellowish.

Expanse: 50 mm.

Habitat: Tumatumari, Potaro River, British Guiana.

Type: In the Cornell University Collection.

Meragisa methosema sp. nov. (Plate XXXII, fig. 20)

Male: Palpi lavender with a lateral fuscous spot. Head dark brownish drab, the collar light hissop violet. Thorax pale mauve with a dark medial and a thicker black line at base of wing not reaching costa. Abdomen above, with the three basal segments light purplish vinaceous, the following four segments are vinaceous drab crossed by dull purplish segmental lines; terminal segments pale vinaceous. Abdomen below, pale vinaceous. Fore wing pale vinaceous, finely irrorated with dark scales; a broad antemedial, oblique, dusky brown shade formed by close-set fuscous lines, below cell to inner margin much paler; a postmedial fine outcurved dark line, incurved and lunular below vein 3; a subterminal fuscous brown fascia, forming two spots on costal margin, edged with black, then narrowly lunular, expanding again between veins 5 and 3, and vaguely connected with the antemedial dark patch; the inner margin without dark markings; termen paler with small dark spots on margin and a terminal broken black line; cilia white. Hind wing vinaceous fawn, slightly darker along termen; cilia tipped with white. Fore wing below, vinaceous fawn, the inner margin broadly; the termen more slightly whitish. Hind wing below, light vinaceous fawn.

Expanse: 42 mm.

Habitat: Teffee, Brazil; Jan. 17, 1920; H. S. Parish Collection.

Type: Acc. no. 6473, Carnegie Museum.

Rifargia hecina sp. nov. (Plate XXXII, fig. 21)

Male: Palpi white, fuscous above. Head and front of collar light neutral gray, the collar behind and thorax chætura drab, the tegulæ grayish white. Abdomen dorsally grayish white, the basal half suffused with cartridge buff with grayish segmental lines. Body below white. Fore wing white irrorated with fine mouse-gray scales, especially along inner margin, the lines slate color; a double subbasal line, outangled below costa and again at submedian vein; antemedial line double, lunular below cell to inner margin; postmedial line outangled on costa, oblique to vein 3 at cell, below vein 3 inbent, lunular, followed on costa by an outbent fine line; short dark lines on costa; subterminal line with dark gray shading, dentate, incurved opposite cell; a lunular fine black marginal line. Hind wing white, the termen broadly dark citrine, the cilia white. Fore wing below dark citrine, the inner margin white except on termen, also white in cell and just beyond. Hind wing below as above.

Expanse: 41 mm.

Habitat: Prov. del Sara, Bolivia (450 m.); August 1914; J. Steinbach, coll.

Type: Acc. no. 5571, Carnegie Museum.

Talmeca aluva sp. nov. (Plate XXXII, fig. 22)

Male: Palpi fuscous fringed with vinaceous buff. Head, thorax, and terminal segments of abdomen vinaceous buff, abdomen above otherwise light drab, underneath white. Fore wing partly pale ochraceous buff, the costal margin broadly so; a broad dark olive buff shade from base, through cell and between veins 4 and 5 to termen, edged below with pale ochraceous buff; inner margin broadly dark olive buff; a medial series of black points on veins; a postmedial double series of black points, these are deeply outcurved on costa; a terminal series of black points on interspaces. Hind wing dark olive buff; pale streaks on interspaces along inner margin. Fore wing below mostly smoky drab. Hind wing below, white.

Expanse: 31 mm.

Habitat: Chapada near Cuyabá, Matto Grosso, Brazil; H. H. Smith, coll.

Type: In the Carnegie Museum (Holland Collection); paratype in the U. S. National Museum.

Talmeca cleontis sp. nov. (Plate XXXII, fig. 23)

Male: Head fuscous edged with white. Collar tawny olive. Thorax mottled with black and white hairs; tegulæ white at shoulders. Abdomen above pyrite yellow, suffused at base and laterally with vinaceous. Fore wing: base buffish crossed by a double very irregular and broken fuscous line; a double antemedial line from costa to inner margin; the proximal line lunular dentate; the distal line slightly sinuous; the space between bass and proximal line somewhat greenish with dark streaks on veins; space beyond distal line light mostly pale greenish with a velvety black point below subcostal vein, and a velvety black vertical streak at end of cell; postmedial black line outcurved and dentate, filled in with pale greenish on costa and inner margin, below vein 2 vertical; terminal space yellowish green; subterminal black spots on interspaces inwardly edged with whitish; a terminal broken dark line; cilia like terminal space. Hind wing whitish; subterminal pale olivaceous suffusions on interspaces; the termen narrowly olivaceous; cilia white. Fore wing below dull olivaceous, the base and termen olivaceous white. Hind wing below olivaceous white, the termen white.

Expanse: 30 mm.

Habitat: Prov. Oran, N. Argentina (300 m.); January 1916; J. Steinbach, coll.

Type: Acc. no. 5571, Carnegie Museum; paratype from the same locality in the U. S. National Museum.

Goaxis manaca sp. nov.(Plate XXXII, fig. 24)

Male: Palpi vinaceous drab above, deep brownish drab below; frons and vertex white with a few dark scales forming a spot between the antennæ. Thorax medially light grayish vinaceous, the tegulæ tipped with army brown and white hairs. Abdomen above vinaceous drab with dorsal whitish segmental spots, underneath white. Fore wing largely white along the inner margin and postmedially; basal third from just below cell to costa mottled with pale drab gray spots and army brown spots and lines; a fine dark line on discocellular followed by some short lines from costa; from apex to tornus a terminal dark vinaceous drab space, its proximal edge well incurved. Hind wing wood-brown; cilia white; a whitish streak above anal angle. Fore wing below brownish drab; a white streak along costa; the inner margin white. Hind wing below brownish drab; white on costa and along inner margin.

Expanse: 33 mm.

Habitat: Nova Olinda, Rio Purus, Brazil; May 1922; S. M. Klages, coll.

Type: Acc. no. 6962, Carnegie Museum.

Lobeza panchoya sp. nov. (Plate XXXII, fig. 25♂, fig. 26♀)

Male: Head, collar, and thorax hair brown mottled with white hairs, the tegulæ somewhat grayish; the metathorax tipped with white hairs. Abdomen above cinnamon drab with a fine black lateral line, the anal hairs mottled with gray; abdomen below light ochraceous salmon, with darker transverse line. Fore wing whitish, almost entirely obscured by black and dark brown streaky scales so that only vague markings are discernible; an antemedial dark point on costa; below cell a double, wavy, outbent line to inner margin; a small fuscous spot at end of cell, below it a vertical fuscous line to vein 2; a subterminal well defined, lunular dentate line incurved opposite cell, expanding to tornus; terminal dark streaks on veins, and small terminal dark spots on interspaces. Hind wing largely cinnamon drab, the cilia white. Wings below dull white, the veins dark with postmedial streaks on the interspaces of hind wing. The female has the markings of fore wing more obscured; the hind wing more thinly scaled. The wings below with all the veins dark, well defined.

Expanse: Male 52 mm., female 77 mm.

Habitat: Cochabamba, Bolivia; J. Steinbach, coll.

Type: Acc. no. 6873, Carnegie Museum.

Schizura (?) **madara** sp. nov. (Plate XXXII, fig. 27)

Male: Collar and thorax fuscous black; a white streak on outer edge of tegulæ. Abdomen above with the hair brown; fine paler segmental lines on terminal half; the under side mostly bone white. Fore wing: a large round basal space light vinaceous buff with some fuscous scales forming a fine subbasal line, double on costa, slightly outbent and vertical from median vein; the termen broadly and similarly colored, slightly incurved proximally; crossed by a macular subterminal line of fine streaks contiguous from vein 7 to vein 4; terminal fuscous spots on interspaces; medial space fuscous black, broad on costa from near base to near apex, on inner margin narrow from near middle of inner margin to tornus. Hind wing benzo brown; base of costa whitish; cilia white. Fore wing below drab; a fuscous shade in cell; a similar shade on costa postmedially to end of cell. Hind wing below whitish with brownish terminal suffusions; a small black medial spot on costa and faint medial streaks on interspaces.

Expanse: 33 mm.

Habitat: Colombia; H. S. Parish Collection.

Type: Acc. no. 5255, Carnegie Museum.

The position is doubtful, as the antennæ are broken.

Goacampa olcesta sp. nov. (Plate XXXII, fig. 28)

Female: Palpi with a black streak above, fringed with pale drab gray; vertex with an angled fuscous line. Collar and thorax vinaceous gray mottled with dark hairs, the tegulæ tipped with black. Abdomen above light vinaceous, the base and anal segment pale vinaceous; underneath vinaceous gray. Fore wing with the inner margin and terminal third grayish vinaceous; a short black basal line, curved from costa, followed by fuscous mottling in cell; a double antemedial line outangled on subcostal and slightly inbent to inner margin, somewhat lunular, followed on costa by some whitish scaling; a thick, outcurved medial line edging the end of cell, fine, dentate below vein 2, preceded in cell by a small grayish spot, crossed by a fine fuscous line; veins, except at apex, finely fuscous; postmedial line double, the inner line indicated by thicker black lines on veins and partly connected by slight dark shading, and followed by pale vinaceous gray scaling to the more distinct distal line; subterminal fuscous spots below costa and from vein 3 to inner margin; cilia fuscous; apex grayish olive. Hind wing white; the costa broadly, the termen narrowly, drab; the cilia white. Fore wing below dark vinaceous drab, the apex and termen vinaceous white. Hind wing below white; a light drab streak below costa; a small drab spot at anal angle.

Expanse: 38 mm.

Habitat: Prov. Oran, N. Argentina (300 m.); January 1916; J. Steinbach, coll.

Type: Acc. no. 5571, Carnegie Museum.

Kurtia purusata sp. nov. (Plate XXXII, fig. 29)

Female: Palpi white in front, tipped with black. Collar and thorax dark vinaceous drab, the former partly edged with fuscous, the latter almost completely hidden by the light purplish vinaceous tegulæ. Abdomen above light drab, underneath light purplish vinaceous. Fore wing: base light russet vinaceous with an antemedial black spot on costa and a fine wavy interrupted dark line below it; a fine dark medial line distally followed by whitish shading containing a black point in cell and a similar spot with two black points at end of cell; terminal space broadly paler than the base, crossed by a postmedial curved line followed by four semifuscous spots on veins 5, 4, and 3; also a few intermediate spots on the interspaces; terminal irregular black spots between the veins. Hind wing vinaceous buff with darker suffusions. Fore wing below purplish drab; the base and inner margin vinaceous white; the costa light pinkish cinnamon. Hind wing below whitish; a faint curved postmedial line; the termen narrowly pale vinaceous fawn.

Expanse: 39 mm.

Habitat: Hyutanahan, Rio Purus, Brazil; March 1922; S. M. Klages, coll.

Type: Acc. no. 7088, Carnegie Museum.

Hemiceras timea sp. nov. (Plate XXXII, fig. 30)

Male: Head, collar, and thorax medially mikado-brown, the tegulæ and fore wing cinnamon. Abdomen whitish vinaceous. Fore wing with the base slightly oblique, the inner margin straight to tornus; traces of a sinuous antemedial dark line; the outer line from apex fine, dark, distally paler edged, slightly sinuous to middle of inner margin; black subterminal points below veins 3 and 4. Hind wing white; the termen light vinaceous fawn; cilia white. Fore wing below avallaneous; the inner margin faintly whitish. Hind wing below white.

Expanse: 30 mm.

Habitat: Manaos, Brazil; H. S. Parish Collection.

Type: Acc. no. 6473, Carnegie Museum.

The species is allied to *H. striolata* Butl.

Hemiceras tabona sp. nov. (Plate XXXIII, fig. 31)

Male: Head and collar cinnamon buff, the tegulæ similar with a few dark hairs. Abdomen above pinkish buff, at base becoming more grayish with dark transverse lines; underneath light viridine green. Fore wing pinkish vinaceous with darker suffusions terminally; costal edge white; an antemedial black point on submedian; a subterminal series of black points on veins; inner margin excised before tornus. Hind wing white, medially thinly scaled; termen narrowly vinaceous; stigma small, orange vinaceous. Fore wing below whitish, partly suffused with hydrangea pink. Hind wing below with the termen opaque, white.

Expanse: 32 mm.

Habitat: Rio San Francisco, Brazil (Isla de Cauropot, 150 miles above Joazeiro); December 3, 1907; J. D. Haseman, coll.

Type: Acc. no. 3533, Carnegie Museum.

Hemiceras francina sp. nov. (Plate XXXIII, fig. 32)

Male: Palpi tipped with white. Head partly white. Collar and tegulæ pinkish vinaceous, also the base of abdomen, which becomes somewhat duller with dark transverse lines. Fore wing pale vinaceous slightly darker on inner margin; antemedial black points on veins connected by an interrupted line; a medial black point on subcostal, and some dark scaling on discocellular; a postmedial series of black points on veins connected by a faint dark line; the inner margin excised at tornus; no stigma. Hind wing white, partly semihyaline; very faint terminal vinaceous scaling. Hind wing below as in *H. tabona* Schaus.

Expanse: 27 mm.

Habitat: Rio San Francisco, Brazil (Isla de Cauropot, 150 miles above Joazeiro); Dec. 3, 1907; J. D. Haseman, coll.

Type: Acc. no. 3533, Carnegie Museum.

Hemiceras mezata sp. nov. (Plate XXXIII, fig. 33)

Male: Head and thorax light cinnamon drab. Abdomen above drab, the under side and anal hairs white. Fore wing glossy cinnamon drab, the costa slightly paler, similar hairs at base of inner margin; an antemedial vertical dark line proximally pale edged, distally with pale points at subcostal, median, and submedian veins; postmedial line remote on costa, inbent to below vein 2, then obliquely downbent, fine, black, distally pale edged; subterminal dark streaks on veins; a pale line from vein 2 to tornus; the wing broad, slightly toothed at base and then excurved to tornus. Hind wing drab, more whitish along costa and inner margin; cilia white. Fore wing below vinaceous fawn, the inner margin white. Hind wing below white.

Expanse: 40 mm.

Habitat: Hyutanahan, Rio Purus, Brazil; April 1922; S. M. Klages, coll.

Type: Acc. no. 6963, Carnegie Museum.

Hemiceras jophona sp. nov. (Plate XXXIII, fig. 34)

Male: Tips of palpi and vertex white; head otherwise and collar light vinaceous fawn. Thorax darker. Abdomen vinaceous fawn, darker on dorsum. Fore wing chiefly avellaneous, the inner margin darker above lobe to outer line; a dark antemedial line, irregular and deeply lunular; a dark line on discocellular; outer line from costa near apex dark with black points on veins, inbent to vein 2, then almost vertical to inner margin; from the outer side of line below vein 4 to near termen at vein 2 a narrow brownish shade. Hind wing white; the termen narrowly suffused with light vinaceous fawn. Wings below white; on fore wing some pale vinaceous fawn suffusions beyond cell to near termen.

Expanse: 31 mm.

Habitat: Januaria, Minas Geraes, Brazil; Dec. 11, 1907; J. D. Haseman, coll.

Type: Acc. no. 3533, Carnegie Museum. Paratype in the U. S. National Museum from the type locality.

Hemiceras kartabena sp. nov. (Plate XXXIII, fig. 35♂, fig. 36♀)

Male: Head and collar avellaneous, some white hairs at base of antennæ. Thorax medially dark brown largely obscured by the avellaneous tegulæ. Abdomen dorsally buffy brown with traces of fine pale segmental lines; underneath colonial buff. Fore wing cinnamon drab with a silky gloss; an antemedial line of black points from subcostal to inner margin, proximally edged by a faint vinaceous fawn line; a curved dark line on discocellular; a postmedial series of black points on veins from costa before apex to near middle of inner margin; an irregular subterminal dark shade, broader and outbent from vein 4 to vein 2. Hind wing white with dark suffusions on termen; the stigma dark; cilia white. Wings below white; cilia on fore wing argus brown; a vinaceous fawn shade from base of costa, expanding beyond cell and not reaching termen; the tooth at base of inner margin very slight.

Female: Abdomen much paler. Fore wing as in male; hind wing with the suffusions paler and narrower.

Expanse: Male 32 mm., female 36 mm.

Habitat: Kartabo, British Guiana; June 22, 1925 at 9:00 P.M.; B. Maguire, coll.

Type: Acc. no. 7975, Carnegie Museum. Paratypes in U. S. National Museum, one from the type locality and two from Moengo, Boven Cottica River, Dutch Guiana.

Rosema ocama sp. nov. (Plate XXXII, fig. 37)

Male: Head pale pinkish buff with a few brownish hairs. Collar and thorax bice-green; some white hairs from metathorax. Abdomen above orange cinnamon with very fine pale transverse lines and dark green dorsal points, the terminal segment and anal hairs white; underneath mostly white with some cinnamon scaling. Fore wing bice-green; costal edge narrowly white; some white points on subcostal, median, and submedian veins; a large dresden-brown spot on discocellular; a postmedial fine white streak from costa, continued as a curved series of white points on veins; base of inner margin white; cilia vinaceous fawn with white points at veins. Hind wing white. Wings underneath white, the fore wing with vinaceous scaling on costa; the cilia fuscous.

Expanse: 40 mm.

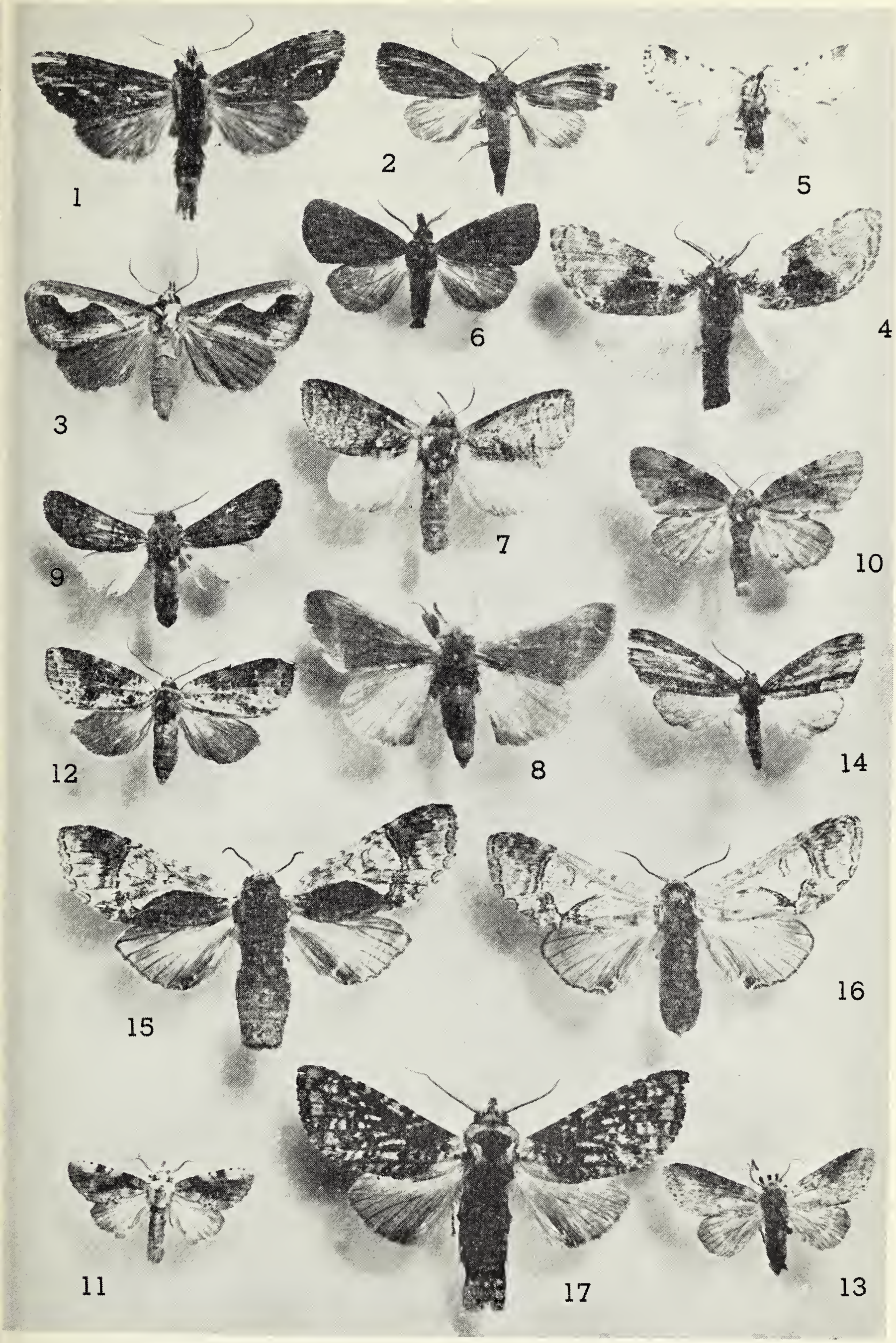
Habitat: Hyutanahan, Rio Purus, Brazil; March 1922; S. M. Klages, coll.

Type: Acc. no. 6963, Carnegie Museum.

EXPLANATION OF PLATE XXXI

New Neotropical Lepidoptera of the family Notodontidæ, described by William Schaus.

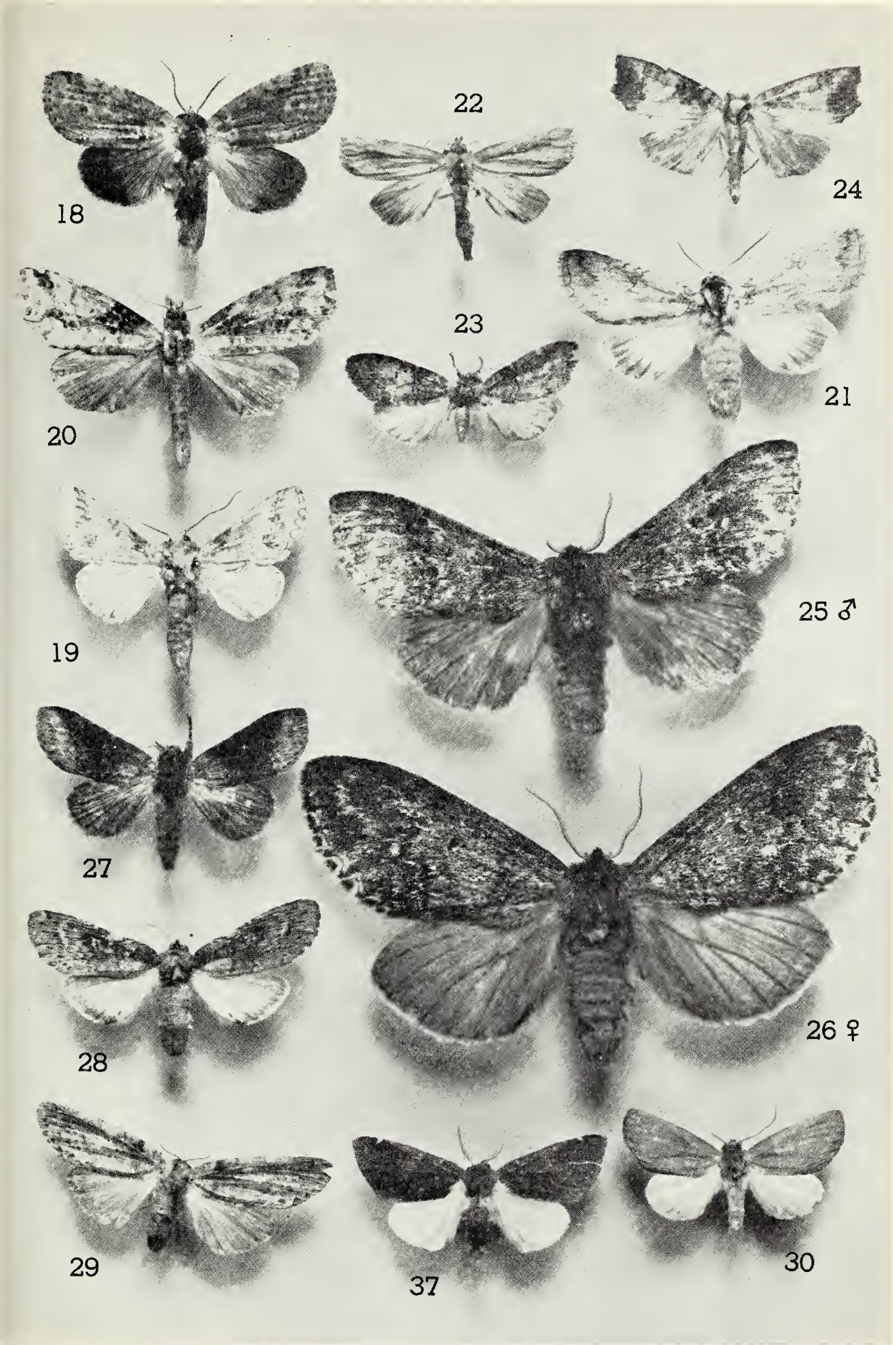
1. *Proelymiotis melites*
2. *Antiopha gunneri*
3. *Lepasta asaphina*
4. *Farigia lantana*
5. *Cerura olindata*
6. *Gopha melanitis*
7. *Drugera tapella*
8. *Salluca telano*
9. *Corania pedrana*
10. *Misogada rhymba*
11. *Misogada hazuela*
12. *Notoplusia licasia*
13. *Notoplusia menica*
14. *Pagrasana bermejona*
15. *Malocampa dianora* (type)
16. *Malocampa dianora*
17. *Malocampa manana*


1
2
5
6
4
3
7
9
10
12
8
14
15
16
11
17
13

EXPLANATION OF PLATE XXXII

New Neotropical Lepidoptera of the Family Notodontidæ, described by William Schaus.

18. *Malocampa mardonia*
19. *Chadisra arimata*
20. *Meragisa methosema*
21. *Rifargia hecina*
22. *Talmeca aluva*
23. *Talmeca cleontis*
24. *Goaxis manaca*
25. *Lobeza panchoya*, ♂
26. *Lobeza panchoya*, ♀
27. *Schizura*(?) *madara*
28. *Goacampa olcesta*
29. *Kurtia purusata*
30. *Hemiceras timea*
37. *Rosema ocama*


18
22
24
20
23
21
19
25 ♂
27
28
26 ♀
29
37
30

EXPLANATION OF PLATE XXXIII

New Neotropical Lepidoptera of the Family Notodontidæ, described by William Schaus.

Figures 38, 40, and 42 are reproductions of colored drawings, slightly reduced, made by Francis H. Noyes.

31. *Hemiceras tabona*
32. *Hemiceras francina*
33. *Hemiceras mezata*
34. *Hemiceras jophona*
35. *Hemiceras kartabena*, ♂
36. *Hemiceras kartabena*, ♀
37. On plate XXXII
38. *Meragisa pseudothia*
39. *Meragisa pseudothia*
40. *Malocampa cadajoa*
41. *Malocampa cadajoa*
42. *Chadisra sericana*
43. *Chadisra sericana*
44. *Misogada alicina*


31
34
35
36
32
33
38
39
40
41
42
43
44

ART. XXIII. *MIACIS GRACILIS*, A NEW CARNIVORE FROM THE UINTA EOCENE

By John Clark

Plates XXXIV-XXXVII

More or less fragmentary specimens of several Miacid genera, especially of *Uintacyon*, are known from the Uinta. The genus *Miacis* itself, however, is very poorly represented in collections. Especial interest attaches to the two specimens described in this paper, therefore, because the dentition and most of the limb bones are very well preserved. If, as Matthew supposed, the genus *Miacis* is directly ancestral to *Pseudocynodictis* (*Cynodictis*), this species might represent an important connecting link between the two. For these reasons, the osteology of the new species will be described at some length.

I am indebted to Mr. J. LeRoy Kay, of the Carnegie Museum, for lending me the new specimens for study; to Dr. Walter Granger of the American Museum of Natural History, for lending several specimens for comparison; and to Drs. Granger and Simpson, and several other members of the American Museum staff, for their helpfulness and patience during my several visits to the Museum in the course of this study. The illustrations were drawn by Mr. Sydney Prentice of the Carnegie Museum.

Miacis gracilis sp. nov.

Type: Carnegie Museum no. 11900; skull, lower jaws, scapula, humerus, radius, ulna, femur, tibia, fibula, most of pes, fragmentary vertebræ, pelvis, and ribs.

Referred specimen: Carnegie Museum no. 12063; consisting of partial skull with good palate, and lower jaws.

Horizon: (Type)—Horizon C, Uinta Eocene; (referred)—C., Uinta Eocene.

Locality: type and referred specimens; 7 miles east and south of Myton, Uinta County, Utah.

Issued Nov. 6, 1939.

Specific characters: taken only from the type. The characters of the referred specimen will be noted in the discussion.

(1) Differs from *M. parvivorus* in having the paraconid of M_2 low, relative to the protoconid, and having no cingular cuspule, while in *M. parvivorus* the paraconid is high, and the cingulum anterior to the protoconid is drawn into a tiny cuspule.

(2) Differs from *M. medius* in that the $\underline{C}$, M^2, and M^3 are almost twice as large in *M. medius* as in *M. gracilis*, although the cheek-tooth rows are about of the same length. M^2 and M^3 of *M. medius* are sharply cusped, while in *M. gracilis* the cusps are low, almost extinct. M^1 of *M. medius* has a broad external cingular table at the postero-external corner of the tooth, while the cingulum is close to the metacone in *M. gracilis*.

(3) Differs from *M. latidens* in having the cingulum of M^1 close to the metacone, and the cingulum prominent and continuous internally while in *M. latidens* there is a broad postero-external table and the internal cingulum is low and discontinuous. Also, M^2 of *M. latidens* is almost as broad transversely as is M^1, while in *M. gracilis*, M^2 is markedly reduced. M_2 of *M. latidens* is somewhat larger than M_2 of *M. gracilis*, and M_3 is twice as large as the corresponding tooth in *M. gracilis*.

(4) The chief differences between *M. exiguus* and *M. gracilis* are proportional. Total length of the lower cheek-tooth dentition in *M. exiguus* is less than $\frac{3}{4}$ that in *M. gracilis*, while M_2 of *M. exiguus* is almost as large, and M_3 fully as large, as the corresponding teeth in *M. gracilis*.

(5) The referred specimen of *M. sylvestris* in the American Museum (A.M.N.H. no. 13071), has the molars approximately half as large as the corresponding teeth in *M. gracilis*. I have not had the opportunity to make a direct comparison with the type in this case.

(6) The type of *M. washakius* has the broad postero-external cingular table on M^1, which occurs also in *M. medius* and *M. latidens*, and is not present in *M. gracilis*. Also, M^2 of *M. washakius* is extremely short antero-posteriorly, and very low-crowned, while in *M. gracilis* it is longer and higher crowned.

(7) In the fragmentary type of *Mimocyon longipes* Peterson, sometimes referred to *Miacis*, each bone is almost exactly twice as large as the corresponding bone in *M. gracilis*. In the absence of good characters for comparison in *Mimocyon longipes*, this seems a valid basis for a specific distinction between the two.

(8) The type of *Prodaphoenus* (?) *robustus* Peterson, referred by Hay[1] to *Miacis*, is twice as large as *M. gracilis*, and has a heavy mandible with a distinct chin, while in *M. gracilis* the mandible is slender and tapering.

[1] Hay, O. P., Second Bibliog. and Cat. of the Fossil Vertebrata of North America. Carnegie Inst. of Wash., Publication 390, 1930, Vol. II, p. 485.

(9) The extremely fragmentary type of *M. uintensis* is a third larger than *M. gracilis*, has the mandible massive, and P_4 fully twice the size of P_4 in *M. gracilis*.

(10) *Miacis hargeri* has the broad cingular table on M^1, internal cingulum discontinuous, and M_3 relatively unreduced, while *M. gracilis* has the cingulum closely applied to the metacone, internal cingulum of M^1 complete, and M_3 almost vestigial. I have not had the opportunity of examining the type of *M. hargeri;* this distinction is, therefore, based only on descriptions and figures.

(11) The fragmentary specimen described by Schlaikjer[2] as *Miacis matthewi* differs from *M. gracilis* chiefly in size, as it is almost or quite twice as large as *M. gracilis*. The limited number of characters exhibited by the type of *Miacis matthewi* makes comparison extremely difficult in this case. However, *M. gracilis* is sufficiently different in size to warrant a specific distinction in the absence of other evidence, so the relationships of "*M.*" *matthewi* are not of importance in the present discussion.

In brief summary: the distinctive dental characters of *Miacis gracilis* are: (1) cingulum of M^1 close to the metacone, while in most other species it is separated from the metacone by a broad table; (2) internal cingulum of M^1 complete; (3) second and third molars, both upper and lower, sharply reduced, $M\frac{3}{3}$ almost to extinction.

FURTHER DESCRIPTION

Osteology: Miacis gracilis will be compared with the following specimens: *Miacis parvivorus* (A.M.N.H. no. 11496), partial skeleton, described by Matthew in the monograph on the Bridger[3]; *Miacis uintensis* (A.M.N.H. no. 1964), partial skeleton, and *Vulpavus profectus* (A.M.N.H. no. 12626), both described by Matthew[4]; *Pseudocynodictis gregarius*, Princeton Museum nos. 10493, 10944, 11012, 11382, 11432, 13137, and 13365.

The skull is so badly crushed that many important characters are lost. In size and general appearance it resembles *Vulpavus profectus;* the muzzle is slightly longer proportionally than that of *Pseudocynodictis gregarius*. As nearly as can be determined, the upper contour

[2] Schlaikjer, E. M., Contributions to the Stratigraphy and Paleontology of the Goshen Hole Area, Wyoming, III, a New Basal Oligocene Formation. Bull. Mus. Comp. Zool. Harvard, vol. 76, 1935, p. 77.

[3] Matthew, W. D., The Carnivora and Insectivora of the Bridger Basin, Memoirs, American Museum of Natural History, Vol. IX, 1905-09, p. 365.

[4] Matthew, W. D., *ibid.*, pp. 371, 382.

of the skull follows more closely the slight curve of *V. profectus* than the more highly convex line of *P. gregarius*, especially in the facial region.[5] The sagittal crest is extremely low.

The basicranial foramina resemble those of *Vulpavus* and *Pseudocynodictis* in all essential respects. The mastoid process is stronger than that of *Vulpavus*, while the paroccipital process is very decidedly weaker, which gives the extra-otic region a distinctly cynodictoid aspect.

The tympanic cavity is more elongate antero-posteriorly than that of *Vulpavus;* the basisphenoidal and anterior squamosal portions of the rim are slightly elevated, as if for reception of a tympanic bulla. No portion of either bulla, if such ever existed, is in place. However, there is a large, extraneous piece of bone adhering to the right alisphenoid just anterior to the inner part of the glenoid fossa, which I can interpret only as a portion of the rim of the tympanic, probably the left. If this interpretation is correct, it indicates a very important cynodictoid character not previously known in *Miacis* or, to the best of my knowledge, in any of the Miacidæ.

The characters of the upper dentition are those typical of *Miacis.* The canine is small and laniary. The premolars are well spaced; P^1 is single-rooted, P^{2-3} double-rooted. The P^1 has a tiny heel; P^2 and P^3 have a heel and a faint posterior accessory cusp, and P^4 resembles P^4 of *Pseudocynodictis* except that the external cingulum is better developed and the division of the posterior blade into two cusps, incipient in *Pseudocynodictis*, is not present.

In the molars, M^1 differs from M^1 of *Pseudocynodictis* in the development of the internal cingulum. In *M. gracilis* the cingulum is a low, continuous ridge, paralleling the base of the protocone. In *Pseudocynodictis*, the cingulum swings far out from the base of the protocone and is produced into a strong hypocone. Also, in many specimens of *Pseudocynodictis*, the antero-external angle of M^1 is not so sharply extended as it is in *M. gracilis*. The internal cingulum of M^2 is stronger in *Pseudocynodictis* than in *M. gracilis*, and *M. gracilis* retains a vestigial M^3 which does not occur in *Pseudocynodictis*.

The dentition of the co-type of *Procynodictis vulpiceps* (A.M.N.H. no. 2514), possesses characters midway between the two. In general it resembles *M. gracilis;* however the external cingula are obsolete, the

[5] Scott, W. B., Notes on the Canidæ of the White River Oligocene. Trans. Amer. Philos. Soc., XIX, 1898, p. 368.

internal cingulum of M^1 is drawn away from the protocone into a rudimentary hypocone, and the other co-type (A.M.N.H. no. 2506) shows that M^3 was not present. This intermediate anatomical facies should not be used as *a priori* evidence of phylogenetic relationships, because, if the localities given on the field labels are correct, *Procynodictis vulpiceps* occurred at a lower horizon within the Uinta than did *M. gracilis*.

The mandible of *M. gracilis* differs from that of *Pseudocynodictis* in a few simple characters. The premolars are spaced rather than in contact; they have not undergone such extreme lateral compression as those of *P. gregarius*, and the anterior accessory cusps are antero-internal rather than directly anterior. The anterior mental foramen lies below the diastema between P_1 and P_2 in *M. gracilis*, and below P_1 in *Pseudocynodictis*. Otherwise, the mandible of *M. gracilis* possesses only characters which appear within the limits of variation of *Pseudocynodictis*.

Aside from the dental characters, which were adequately discussed by Matthew in his original description, the mandible of *Vulpavus profectus* differs from that of *M. gracilis* in several ways. The tooth row of *V. profectus* is a fourth shorter than that of *M. gracilis*, although the mandibles are of the same length; correspondingly, of course, the ascending ramus is much broader and more recurved than that of *M. gracilis*. The dental ramus is of the same height throughout, while in *M. gracilis* the jaw swells to a notable angle below M_1. Finally, *V. profectus* exhibits a slight symphyseal angle or chin, which is totally absent in *M. gracilis*.

Vertebral Column: the atlas, most of the cervicals, and many thoracics and lumbars are represented; all except the atlas in so crushed and fragmentary a condition that distinctive characters are obliterated. The posterior opening of the vertebrarterial canal in the atlas opens directly backward, rather than slightly on the dorsal

FIG. 1. *Miacis gracilis* Clark, Atlas vertebra. (1) Dorsal, (2) lateral, and (3) anterior views.

side of the transverse process as does the canal of *Pseudocynodictis.* Otherwise the atlas is similar to that of *Pseudocynodictis.*

Fore Limb: the scapula is low, with the blade rounded and almost lobate. For the lower fourth of its course, the spine practically forms the posterior border of the scapula, with the ear-shaped post-scapular blade extending as a flat lobe from the upper three-fourths of the spine. The pre-scapular blade consists of a large, anteriorly directed lower lobe, and a smaller upper lobe whose rim is directly confluent with that of the post-scapular lobe along the vertebral border of the bone. The spine itself is seriously damaged, but there is evidence of a long acromion and a large metacromion, as in *Pseudocynodictis.* The neck of the scapula is broad, the glenoid cavity long antero-posteriorly, and the coracoid process well developed.

Humerus: several points of close similarity with *Pseudocynodictis* have been mentioned in the discussion thus far. In the humerus, radius, and ulna, the similarity is so great that discussion becomes almost impossible. The smallest details of proportion, relative development, and minor surface topography in the humerus of *Pseudocynodictis* find their almost perfect homologues in the humerus of *M. gracilis.* The head of the humerus of *M. gracilis* is slightly broader transversely than that of *Pseudocynodictis.* Otherwise, no differences are apparent.

Correspondingly, the humerus of *M. gracilis* differs notably from the humerus in other species of the genus, and exceedingly from the humerus of *Vulpavus profectus. Miacis parvivorus* and, according to Matthew[6], "all the species" have "a long, prominent, abruptly ending deltoid crest, high supinator crest." The deltoid crest of *M. gracilis* is long, but it is very weakly developed and its distal termination grades imperceptibly into the shaft of the humerus. The supinator crest is, relative to the other species, extremely low and weak. The inner flange of the ulnar facet of the trochlea is high and sharp, rather than low and rounded as in almost all other Miacidæ.

The differences between the humerus just described and that of *Vulpavus profectus*, with its generally massive build, high, powerful, sharply terminated deltoid crest, and tremendous supinator ridge, are obvious.

Radius: the radius and ulna bear almost as many cynodictoid resemblances as do the humerus. The radius has the same curvature,

[6] Matthew, W. D., *loc. cit.*, p. 363.

position of bicipital tubercle, and shape of capitellum as has the radius of *Pseudocynodictis*. The distal tendinal sulci are even less developed than those of *Pseudocynodictis*. Scott states[7] that in the latter genus "the carpal facet . . . . does not extend over upon the styloid process, from which it is separated by a broad and deep notch." In the two radii of *Pseudocynodictis* at hand, and also in *M. gracilis*, this is not the case; there is no notch, and the carpal facet does extend on to the styloid process.

The chief characters differentiating the radius of *M. gracilis* from that of *M. parvivorus* are its much straighter shaft, more posteriorly situated bicipital tubercle, and more elongate capitellum. All of the bones of *M. parvivorus* are, of course, much smaller than those of *M. gracilis*, and as this character is obvious it will not be mentioned separately for each bone.

The radius of *Vulpavus profectus* is massive, strongly bowed, with a sub-circular capitellum and a well-marked, concave distal ulnar facet extending as a narrow band from the back almost to the front on the inner face of the distal articular expansion. The distal tibial facet on the radius of *M. gracilis* appears as a tiny, ill-defined surface, occupying less than one-third the width of the bone.

Ulna: unfortunately, the specimens of *Pseudocynodictis* at hand do not have the ulnæ well preserved. However many essential features are preserved, and some comparison is possible.

The olecranon of *M. gracilis* is very similar, both in topography and proportions, to that of *Pseudocynodictis*. The sigmoid notches are cut to corresponding depths, but the upper and lower facet surfaces diverge at an angle slightly more than 60° in *M. gracilis*, and about 50°—55° in *Pseudocynodictis*. The shaft is laterally compressed proximally, and is trihedral distally, like that of *Pseudocynodictis*. The distal radial facets of both are extremely reduced.

The sigmoid notch in *M. parvivorus* is very much shallower than that of *M. gracilis*, and the upper and lower facet surfaces diverge at 90°. The shafts are similar except that the area of origin of the pronator quadratus is flat in *M. gracilis* and sharply concave in *M. parvivorus*. This concavity occurs also in the ulna of *Vulpavus profectus*, which is massive and bowed, with a shallow, open sigmoid notch and a tapering olecranon.

Unfortunately, the carpus of *M. gracilis* is not preserved.

[7] Scott, W. B., *loc. cit.*, p. 383.

Hind limb: pelvis: part of the right ilium and of the left ischium are all that has been preserved. The ventro-external ridge of the iliac peduncle is less prominent than in *Pseudocynodictis*, while the psoas tubercle is well developed. Otherwise the known parts resemble those of *Pseudocynodictis*. The iliac peduncle of *M. parvivorus* resembles that of *Pseudocynodictis* more closely than does *M. gracilis*, in the details mentioned above, although by its elongation it shows less real relationship than does *M. gracilis*.

Femur: the neck is heavier and shorter than that of *Pseudocynodictis*, and the greater trochanter is slightly higher. The lesser trochanter is

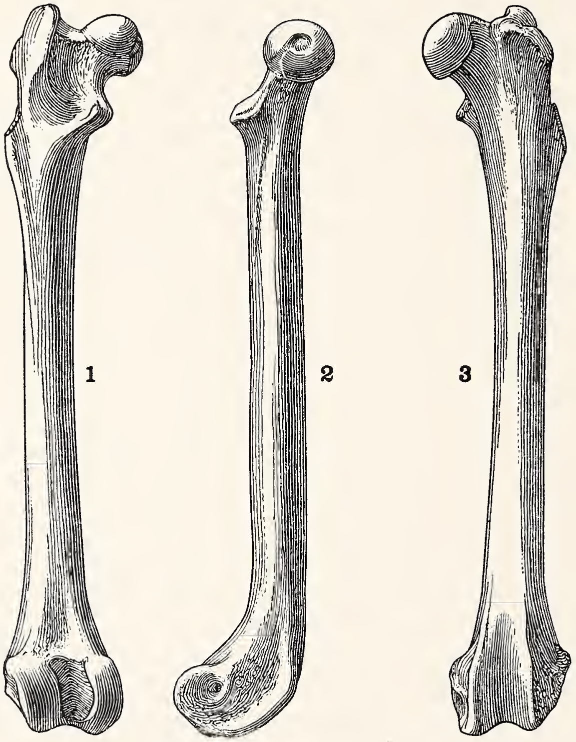


FIG. 2. *Miacis gracilis* Clark. (1) Posterior, (2) medial, and (3) anterior views of the left femur.

prominent, and the third trochanter is present but small and low. The shaft is almost perfectly straight. The distal termination of the bone is like that of *Pseudocynodictis*, with the condyles slightly crowded together. The somewhat crushed femur of *M. parvivorus* shows no points of difference from *M. gracilis.*

Patella: Scott's description of the patella in *Pseudocynodictis*[8] can be quoted directly for *M. gracilis:* "it is a short, rather wide, thin and scale-like bone, of subquadrate more than ovate shape. The articular surface for the femur . . . . is but slightly concave proximo-distally, and even less convex transversely."

Tibia: the proximal portions of both tibiæ are so crushed that few characters are discernible. The spine is small and slightly bifid; the cnemial crest is long but quite low. The medial malleolus is large, and as wide antero-posteriorly as the tibia itself; it bears a sharp groove for the tendon of the flexor digitorum longus muscle. The distal fibular facet is plainly marked, about three-fourths as large as the facet of *Pseudocynodictis.* The distal articular surface is somewhat less deeply sulcated than that of *Pseudocynodictis*, but very much more so than *M. parvivorus* and *Vulpavus profectus.*

Fibula: I am unable to find the proximal end of the fibula of *P. gregarius*, Princeton Museum no. 11012, which Scott used in his study of the osteology of *Pseudocynodictis.* By comparison with his description, the proximal head of the fibula of *M. gracilis* seems less compressed transversely, but otherwise similar. The reduction of the shaft is about equal in the two forms. The distal head in *M. gracilis* differs from that in *Pseudocynodictis* in several quite insignificant details of relative development. The only point worthy of mention is that the lateral tubercle bounding the peroneus tertius sulcus is large and rounded in *M. gracilis*, and smaller and pointed in *Pseudocynodictis.*

Comparison with the fibula of *Vulpavus profectus* is almost fruitless, as the two are extremely different. A catalogue of differences would merely expend much time over anatomical details whose interpretation is difficult or for which no interpretation is known.

Briefly, then, the fibula of *V. profectus* has the shaft proportionally heavier, and the peroneus tertius sulcus extremely shallow, with its median bounding tubercle almost opposite the lateral tubercle rather than distal to it.

Pes: astragalus: the astragalus is similar to that of *Pseudocynodictis.* The tibial trochlea is not quite so deeply grooved as in the latter genus and in general the facet borders, sulci, and eminences fall short of its crisp distinctness of outline, but these differences are very slight. The

[8] Scott, W. B., *loc. cit.*, p. 391.

trochlear facet does not extend forward on to the neck as, according to Matthew[9], it does in *Miacis*. The inner crest is low but present, another character which is absent in *Miacis* generally.

Calcaneum: the calcaneum presents some definite points of difference from that of *Pseudocynodictis*. The tuber is almost equidimensional with the dorso-internal angle expanded, rather than being laterally compressed. The sustentaculum is actually and proportionally larger, while the sustentacular facet is a short ovoid, elongated antero-posteriorly, rather than being almost circular. A sharply demarcated sulcus curves around the externo-distal end of the area of attachment of the short plantar ligament and extends on to the face of the cuboidal facet, where it expands into a small depressed area. In *Pseudocynodictis*, a shallow, poorly marked notch in the rim of the cuboidal facet extends slightly on to the area of ligamentous attachment, and there is no depressed area on the face of the cuboidal facet.

Cuboid: I have been unable to find the cuboid in any of the specimens of *Pseudocynodictis* mentioned by Scott; the cuboid from another specimen, Princeton Museum no. 10496, is, therefore, used for comparison here.

The tendinal sulcus on the external surface is as deep as in *Pseudocynodictis*, but considerably wider. The navicular facet has a distal extension along the dorso-internal edge of the bone, which gives the facet a shape like a triangle with the distal side bent inward, rather than an irregularly ovoid shape. The plantar edge of the calcanear facet bears a wide, deep notch, in contrast to the shallow excavation in *Pseudocynodictis*. Otherwise the bones are similar.

Navicular: the navicular of *M. gracilis* is quite strikingly different from that of *Pseudocynodictis*. It is much wider transversely, and has undergone proportionately more compression antero-posteriorly. The cuboid facet is large, circular, and flat, rather than small, sub-circular, and concave. The astragalar facet is more deeply concave than that of *Pseudocynodictis*. The distal surface is like that of *Pseudocynodictis*, except that the facet for the ectocuneiform is more nearly triangular, that for the mesocuneiform is less elevated, and the interarticular sulci, especially the distal-plantar sulcus, are less sharply incised.

Ectocuneiform: the ectocuneiform is essentially similar to that of *Pseudocynodictis*. As in the other tarsal elements, all of the topog-

[9] Matthew, W. D., *loc. cit.*, p. 363.

raphy of the bones is less sharply sculptured than in the latter genus.

The mesocuneiform, the entocuneiform, and the first metatarsal are lost.

Metatarsals: of those metatarsals remaining, the fourth is longest, then in order come the third, fifth, and second. Accidental loss of the first accentuates the almost paraxonic condition of the metatarsus.

The second metatarsal is somewhat stouter than the fifth, but more slender than the third and fourth. As nearly as can be determined from the fragmentary metatarsals of *Pseudocynodictis*, it is similar to the second metatarsal in that genus. The third metatarsal is the most massive of the group, being slightly heavier than the longer fourth. It is like that of *Pseudocynodictis* save that the ectocuneiform facet is narrower transversely and the plantar process is slightly longer. The fourth metatarsal resembles that of *Pseudocynodictis*, and distally the shaft becomes transversely oval, as Scott postulated for *Pseudocynodictis*. The fifth metatarsal has the external ascending process much more reduced than that of *Vulpavus profectus*, but extremely prominent in comparison with the condition in *Canis*.

Many phalanges are preserved, but as there are none in association I have not attempted to determine their position. The ungual phalanges are very high, laterally compressed, and unfissured; on the dorsal edge, as it rises in a convex curve from the tip, is a peculiar, double flattened area, which looks like a facet for articulation of another bone. I do not know what the significance of this flattened zone might be. It is not present in *Canis*, in *Vulpavus profectus*, or in other described species of *Miacis*. I cannot find any ungual phalanges in the Princeton specimens of *Pseudocynodictis*, so direct comparison with that genus is, most unfortunately, impossible.

Characters of referred specimen: with the exception of two characters, the referred specimen is almost identical with the type. As the table of measurements shows, the tooth row of the referred specimen is distinctly shorter than that of the type; the carnassials, however, and especially the lower carnassials, are notably larger than those of the type. This difference becomes even more evident, when one compares the specimens, than a mere table of measurement can reveal.

Differences no greater than these have been used as criteria for differentiating species of *Miacis*, in the past, and ultimately a series of specimens from the type horizon and locality may demonstrate that the two at hand are representatives of two well-defined groups.

However, the manifest impossibility of determining the taxonomic significance of minor differences between two specimens, in the absence of others, leads me to describe the referred specimen, for the present, as a variant rather than a separate species. No conceivable benefit could arise from the creation of another name at this time, and a name can be applied at whatever time the need for one develops.

Conclusions: Miacis gracilis is a form intermediate in its anatomy, as it is in time, between the more typical species of *Miacis* and *Pseudocynodictis.* Its chief Miacid characters are: (1) Retention of M^3; (2) absence of the hypocone on M^1; (3) open spacing of premolars; (4) almost straight rather than curved contour of top of skull; (5) indistinct sculpturing and many details of anatomy in tarsals. Its outstanding Cynodictoid characters are: (1) presence of an ossified tympanic; (2) suppression of the deltoid and supinator ridges; (3) high, sharp ridge bounding the ulnar facet of the humerus; (4) deep sigmoid notch on the ulna; (5) relative lengthening, straightening, and delicacy of the radius and ulna; (6) ovate rather than sub-circular capitellum of the radius. Briefly, the skull, dentition, and tarsus are Miacid, while the limbs are Cynodictoid. All of the characters mentioned can be derived from earlier species of *Miacis*, and no characters have been observed which preclude an ancestral relationship to *Pseudocynodictis.* However, additional specimens must be collected and studied before any phylogenies can be considered to be more than mere suggestions.

SKULL MEASUREMENTS

	C. M. 11900	C. M. 12063	AMNH 1896	AMNH 2514	AMNH 11496
Length—incisors to basion	91.4*+				
Length—nasal tips to inion	82.6				
Bregma to inion	46.5				
Ant. orbit to post. arch	44.7				
Breadth at postorbital processes	24.8	23.0			
Breadth at postorbital constriction	13.3	15.0			
Distance, postorbital process-postorbital constriction	3.6				
Distance between infraorbital foramina	*				
Width of cranium at post. side of arch	*				
Width of lambdoid crest	17.6*				
Length of palate	42.9	44a			
Basion—postglenoid	21.7				
Postglenoid to squamoso-maxillary angle	28.8*				
Width between postglenoid tips	24.8*−				
Length of condyle	10.8				
Ant. of canine alveolus—post. of M^2	42.3	38.8		37.4a	
$\underline{\text{PM}}$ series (Measured externally)	27.8	25.8		28.1	
$\underline{\text{M}}$ series (Measured externally)	11.7	11.3			
Length of P^4 (Measured externally)	8.9	9.5		10.1	7.1
Length of M^1 (Measured externally)	6.4	6.5		6.3	3.3
Width (outside) at P—M angle	25.8−	32.0+			
Width (outside) at canines	*	14a		16.a	
Width (outside) at M^{2-3}	22.9	26.2			
Alveolar border—infraorbital foramen	3.5			3.5	
Alveolar border—lower rim of orbit	8.8				
Infraorbital foramen lies over	ant P^3	ant P^3		Post P^3	
$\underline{\text{P}}$ series—measured ant.-post.	27.0	24.6		27.0	
$\underline{\text{M}}$ series—measured ant.-post.	9.7	10.0			
Length M^1—measured ant.-post.	5.7	5.5		5.0	3.1
Width M^1	9.5	9.8		10.0	6.3

a—Approximate.
*—Crushed.
*+—Crushed, longer than originally.
*−—Crushed, shorter than originally.

LOWER JAW MEASUREMENTS

	C. M. 11900	C. M. 12063	ANNH 1896	ANNH 2514	ANNH 11496
Canine alveolus to condyle	63.3	59.1a			
Canine alveolus to M_3 alveolus (outside)	43.8	37.7a	38.7	42.0a	32.a
M_3 alveolus—condyle	23.4	22.5			
Angle to coronoid tip	30.3				
Preangular hollow to coronoid tip	28.9				
Condyle to coronoid tip	13.4				
Angle to condyle	16.0	15.2			
Height below M_1	11.4	9.7	14.7	11.4	
Base of masseteric fossa, ant.-post. (inside)	16.2				
$\overline{P}$ series	24.0	21.2		22.3	15.a
$\overline{M}$ series	15.1	15.4	17.8	16.2	12.6
Tubercular	9.4	10.3	12.8	10.0	8.8
Sectorial	29.6	27.3		27.5	19.1a
Length M_1	8.4	10.0	10.8	9.3	5.6
Mental foramina lie below	Ant P^3	Ant P^3	ant. P_3	mid P^3	? Ant P^3
Diastema	P_1–P_2	P_1–P_2		?	
Length of coronoid	10.3				

OTHER MEASUREMENTS

	C.M. 11900	AMNH 11496	AMNH 12626	AMNH 1964
HUMERUS: Length (notches)	75.6	56.6	81.0	
Width, maximum, across epicondyles	18.0	16.2	27.0	
ULNA: Length, maximum	79.6	57.0	89.4	
RADIUS: Maximum length	64.0	47.5	71.0	
FEMUR: Length (notches)	90.6	75.5		127.
TIBIA: Length, trochlea to spine	93.0	70.8	90.	116.

a—Approximate.

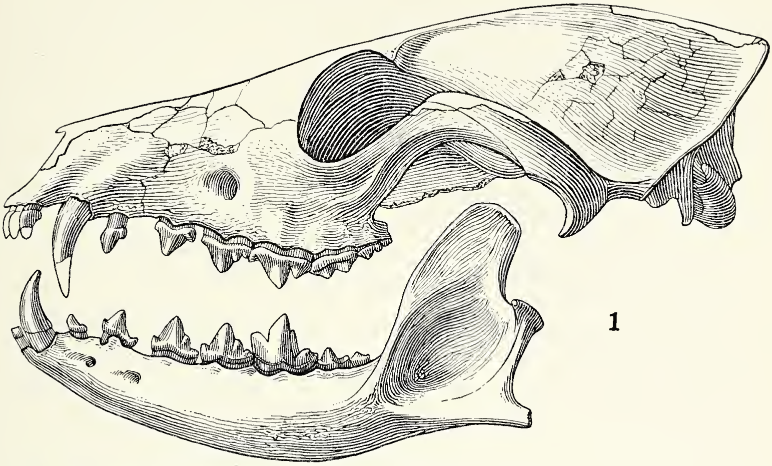
EXPLANATION OF PLATE XXXIV

Miacis gracilis Clark

FIG. 1. Skull and mandible, left side.

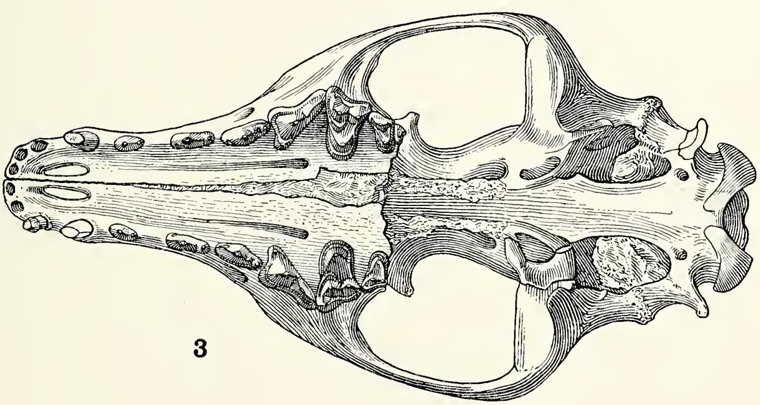
FIG. 2. Left lower dentition, crown view.

FIG. 3. Skull, palatal view. Note the piece of bone, possibly a portion of the left tympanic, adhering to the right alisphenoid.



1

2



3

EXPLANATION OF PLATE XXXV

Miacis gracilis Clark

FIG. 1. Right scapula, lateral view.

FIG. 2. Right ulna, anterior view.

FIG. 3. Right ulna, medial view.

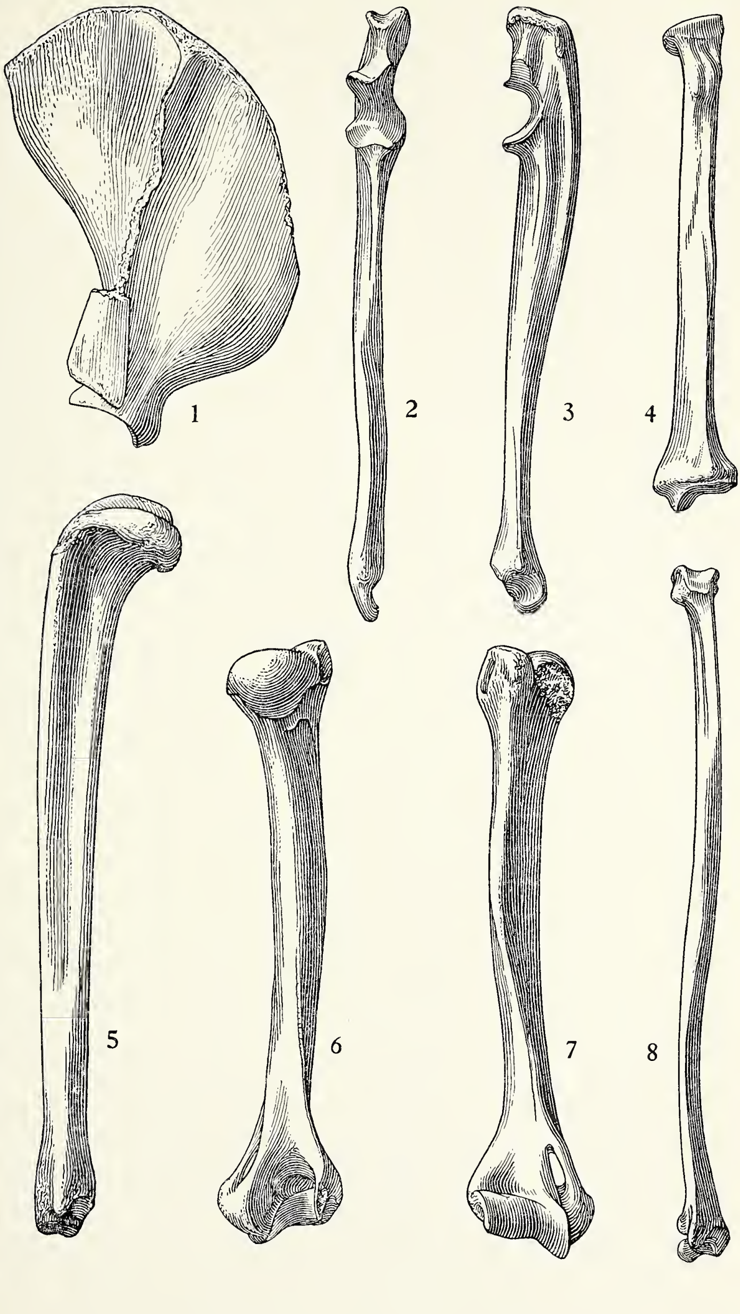
FIG. 4. Right radius, posterior view.

FIG. 5. Left tibia, medial view.

FIG. 6. Right humerus, posterior view.

FIG. 7. Right humerus, anterior view.

FIG. 8. Left fibula, posterior view.

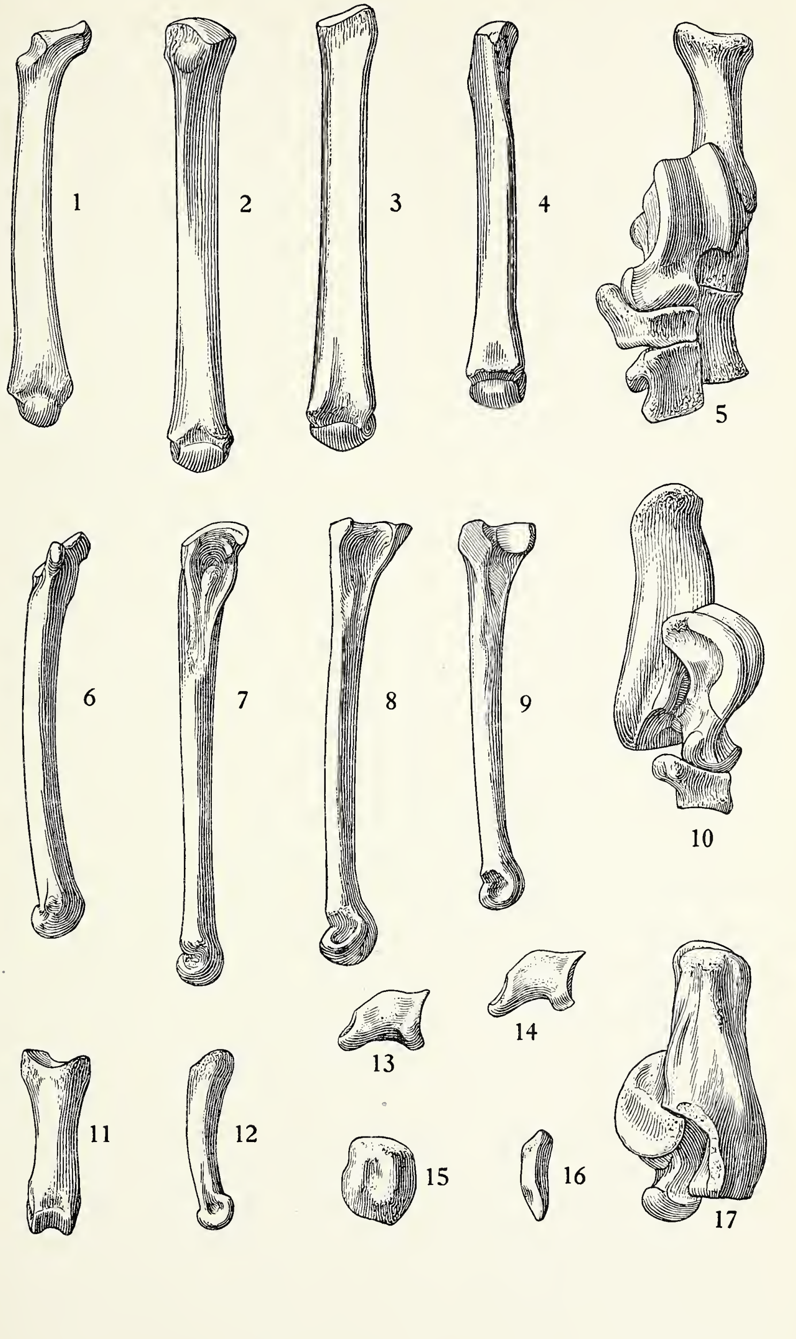

1
2
3
4
5
6
7
8

EXPLANATION OF PLATE XXXVI

Miacis gracilis Clark

All bones are from the left pes.

Fig. 1. Metatarsal V, anterior view.
Fig. 2. Metatarsal IV, anterior view.
Fig. 3. Metatarsal III, anterior view.
Fig. 4. Metatarsal II, anterior view.
Fig. 5. Tarsus, anterior or dorsal view.
Fig. 6. Metatarsal V, lateral view.
Fig. 7. Metatarsal IV, lateral view.
Fig. 8. Metatarsal III, lateral view.
Fig. 9. Metatarsal II, lateral view.
Fig. 10. Tarsus, medial view.
Fig. 11. Proximal phalanx, dorsal view.
Fig. 12. Proximal phalanx, lateral view.
Fig. 13. Ungual phalanx.
Fig. 14. Ungual phalanx.
Fig. 15. Patella, anterior aspect.
Fig. 16. Patella, lateral view.
Fig. 17. Calcaneum and astragalus, lateral view.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

EXPLANATION OF PLATE XXXVII

Miacis gracilis Clark

Photographs of the skull; lateral and palatal aspects.

ART. XXIV. A MONOGRAPHIC STUDY OF THE SNAILS OF THE GENERA *ANGUISPIRA* AND *DISCUS* OF NORTH AMERICA, EXCLUSIVE OF MEXICO

By Gordon Kutchka MacMillan*

(Plates XXXVIII–XLII)

Introduction

During the past forty years many changes have taken place in the taxonomy of the land snails of North America. These changes have left the present taxonomical references and notes, especially the data on *Anguispira* and *Discus*, distributed throughout many diversified publications. Since 1897, when H. A. Pilsbry published "A Classified Catalogue of the Land Shells of America north of Mexico," no general taxonomical paper has appeared dealing with *Anguispira* and *Discus*.

This paper attempts to collect, collate, and bring up to date, the scattered references and notes on all the species and subspecies of *Anguispira* and *Discus* for the purpose of organizing these genera into a complete, modern, and scientifically sound classification. While engaged in the task of reorganizing the collection of North American Land Snails at the Carnegie Museum, I noted many obvious differences existing in the genera *Anguispira* and *Discus*. These differences were not characteristic of occasional specimens only, but existed throughout a large series. These differences were so general and so distinct as to suggest that a thorough revision of these genera was needed. This resulted in the present paper.

In this study the subspecies *alba* of *alternata* and *cronkhitei* and *albina* of *kochi* have been made synonyms of their respective species. I consider these albino forms as mere aberrations due to environmental influences, the characters having been brought about by chemical and physiological differences existing in their habitat.[1]

*By decree of the Court of Common Pleas of Allegheny County, Pennsylvania, dated July 27, 1938, the name of the author of this paper was changed from Gordon M. Kutchka, under which patronym publications have previously appeared, to Gordon Kutchka MacMillan as it appears here. Editor.

[1] Kutchka. G. M., "Coloration of Land Snails," Proc. Penna. Acad. Sci., vol. 10, 1936, pp. 143-146.

Issued Jan. 11, 1940.

The reader will notice that in the synonymy there is, on the average, only one reference to each species mentioned. It is my contention that the only references that are absolutely necessary in synonymy are those in which the species has been originally described and those in which a generic change of the species has first been made. However, I admit, that a complete reference list for all species constitutes an excellent bibliography.

I wish to express my appreciation to Dr. Stanley T. Brooks for his co-operation in this study of the shells of the combined Museum-Clapp-Sterki Collection and for his advice and helpful criticism, and for his aid in photographing the shells; to Dr. S. H. Williams for his advice and encouragement in this dissertation; to Dr. H. A. Pilsbry for his help and direction during my stay at The Academy of Natural Sciences at Philadelphia; and to the Carnegie Museum for its support which enabled me to study the collections at the Academy.

PALEONTOLOGY OF SPECIES

Many conchologists are of the opinion that the North American species and subspecies of the genera *Anguispira* and *Discus* migrated to this continent either from Europe or Asia by means of land bridges that once connected these continents. If this is true, the migration must have occurred before the Eocene Epoch of the Cenozoic Era as the "parental stock" or ancestral forms of these two genera are found in certain formations in the western United States of that time. R. F. Scharff[2] considers *Anguispira kochi* and *Discus patulus* as strictly American, but makes no mention of the other species occurring here. It is not clear as to whether he implies that these two species are the ancestral forms of all of the other American species.

The earliest geological evidence of any of the modern species of land snails is to be found in the Pleistocene Epoch of the Cenozoic Era. The two above mentioned species, *A. kochi* and *D. patulus*, are found in this epoch, together with *Anguispira alternata*, *Discus cronkhitei*, and *Discus shimekii*. The Pleistocene Epoch was characterized by periods of intense cold, during which Canada and the northeastern portion of the United States were successively covered by five or six huge ice sheets. This ice invasion greatly changed the topography, replacing the old rivers and streams by ponds, lakes, and swamps. All

[2] Scharff, R. F., Distribution and Origin of Life in America, p. 72.

life was probably exterminated within the glaciated area or driven south by it. At each successive interglacial period the biota followed the retreating ice and again occupied the devastated territory, only to be driven south again by the return of the ice. The terrestrial life followed closely the margin of the ice, occupying the areas in turn, as the climate became suited to each.

Most of the fossils of the Pleistocene Epoch are Mollusca, which may be accounted for by the fact that the hard shell is better adapted to preservation than are the bodies of other invertebrates. The land snails are perhaps the best represented of the molluscs. Many genera existed throughout all the intervals. These are *Vallonia*, *Strobilops*, *Gastrocopta*, *Succinea*, *Helicodiscus*, *Anguispira*, *Discus*, *Zonitoides*, (*Vitrea*), *Euconulus*, and *Polygyra*. These genera and their species do not differ materially from those of today, and it may be inferred from this statement that the conditions during at least part of the Pleistocene did not differ from those of today in the same regions.

In the studies of more ancient related faunas than those of the Pleistocene Epoch we find that there exist four species of *Anguispira* and *Discus* very much older than those of the comparatively recent Pleistocene mollusca. I regard these four species as the true ancestral forms, in America, of the present day species of *Anguispira* and *Discus*. They are as follows:

Anguispira (?) **mascallensis** (Hanna)

Pyramidula mascallensis, Hanna, Univ. Kan. Sci. Bull., vol. 13, 1920, pp. 6-7, pl. 1, figs. 4-6.

"Whorls 6¾, rounded below and flat above; spire not greatly elevated; sutures apparently channeled; last whorl carinated through the first two-thirds, the carina gradually disappearing; latter part of the last whorl depressed below the carina of the one preceding; the shell substance of the apical whorl is preserved, but the sculpture is absent; the body whorl is an internal cast but shows on the upper sides some coarse uneven growth ridges; umbilicus widely open. Greater diam. 33.50. Least diam. 30.25. Alt. 28 mm."

Type locality: Cove Inlet, John Day River, Oregon.

Distribution: Found only in the John Day deposits.

Remarks: "The flattened upper whorls and the apparently deeply channeled sutures distinguishes this shell from other species." The John Day Formation belongs to the Miocene Epoch of the Cenozoic Era, which is much older, geologically, than the Pleistocene Epoch in which the shells were very abundant and in which, or perhaps even before, the present distribution of the land snails of North America took place. According to Pierson and Schuchert the Miocene Epoch occurred from forty million to eight million years ago in contrast to the Pleistocene Epoch which ended approximately two million years ago.

Discus sandersoni (Russell)

Gonyodiscus sandersoni, Russ., Trans. R. Soc. Can., vol. 23, 1929, pt. 4, pp. 86-87, pl. 1, figs. 16-18.

"Shell small, depressed concoid; apex flattened. Volutions 5, closely coiled, gradually increasing in size; outer surface of whorls gently convex; sutures moderately depressed; body whorl not inflated, probably subangular at periphery. Ventral surface moderately concave; umbilicus wide and shallow, diameter being equal to breadth of body whorl at aperture. Aperture transversely ovoid, apparently simple. Surface of first two whorls smooth, remainder ornamented with sharp, regular, retractively transverse costulae, six to one millimeter on the body whorl. Maximum diameter, as preserved, 7.5 mm.; height 2.4 mm.; diameter of umbilicus 2.2 mm."

Type locality: North Saskatchewan River, near Lamond, Alberta, Canada.

Distribution: Found only at the type locality.

Remarks: "This species is a typical *Discus* and may be compared with *patulus* and its allies in eastern United States." The species was found in the Saunders Formation, which is believed to be a formation in the Upper Cretaceous, a period of the Mesozoic Era, which was in existence about sixty million years ago.

Discus simillimus (Stearns)

Helix (*Patula*) *perspectiva*, Stearns, in White, Bull. 18, U. S. Geol. Surv., 1885, p. 14, pl. 3, fig. 1.

Pyramidula perspectiva simillima, Stearns, Proc. Wash. Acad. Sci., vol. 2, 1900, p. 657.

Pyramidula simillima, Hanna, Univ. Oregon Pub., vol. 1, 1920, p. 8.

Gonyodiscus simillimus, Wenz, Foss. Catal., Animalia, pt. 17, 1923, p. 346.

"In the number and closeness of its whorls and general aspect, although somewhat distorted by compression, this species points directly to the living species *Helix* (*Patula*) *perspectiva*, Say."

Type locality: John Day Group in Eastern Oregon.

Distribution: Found only at type locality.

Remarks: "The collection of the United States National Museum contains only one example of this form, and this specimen is imperfect in condition. The specimen, though somewhat distorted by compression, in the closeness and number of its whorls and general facies, points directly to *patulus*. It also bears a strong resemblance to *cronkhitei anthonyi*. *Discus simillimus* may be the ancestral form of *cronkhitei anthonyi*, *cronkhitei catskillensis*, and *patulus*."

If, as R. E. C. Stearns[3] pointed out above, *simillimus* is considered the ancestral form of *patulus*, it should hold the position of a full species. The writer, therefore, has raised *simillimus* to the rank of a separate species. This is further indicated by its antiquity.

G. D. Hanna[4] makes the statement that the published figure of *simillimus*, owing to the lack of a description, is not sufficiently adequate to give the name specific standing.

Discus ralstonensis (Cockerell)

Pyramidula ralstonensis, Cock., Am. Mus. Nat. Hist. Bull. 33, 1914, pp. 101-102, pl. 8, figs. 1-2.

Gonyodiscus ralstonensis, Wenz, Foss. Catal., Animalia, pt. 17, 1923, p. 344.

"Diameter max. 7, min. 6; alt. 4½ mm.; whorls 5½, rounded, sutures deep; apical whorl and a half smooth, without sculpture; remaining whorls with very strong, regular, oblique riblets, about six to one millimeter. A short distance from the aperture, 11 or 12 to a millimeter on the third whorl; no sign of any depressed line above the suture; umbilicus widely open, about 1½ mm. in diameter, but exposing very little of the penultimate whorl; the beginning of the last whorl shows a slight obtuse peripheral angulation, which is soon lost. There is evidently no distinct keel, even in the young."

Type locality: Ralston Beds, top of red beds, three miles southeast of mouth of Pat O'Hara Creek, Big Horn Basin, Wyoming.

Distribution: Found only at type locality.

Remarks: "A little species, with all the characters of a *Discus*, and so far as anything shows, is closely related to our modern form. The very characteristic ribbing, the rounded whorls, the form of the umbilicus, etc., all agree; the apical (embryonic) whorl is distinctly smaller than in the modern shell."

L. S. Russell[5] says that the type locality of *ralstonensis* is in the Sand

[3] Stearns, R. E. C., in White, Bull. 18, U. S. Geol. Surv., 1885, p. 14.

[4] Hanna, G. D., Univ. Oregon Pub., vol. 1, 1920, p. 8.

[5] Russell, L. S., Bull. Am. Pal., vol. 18, 1931, p. 24.

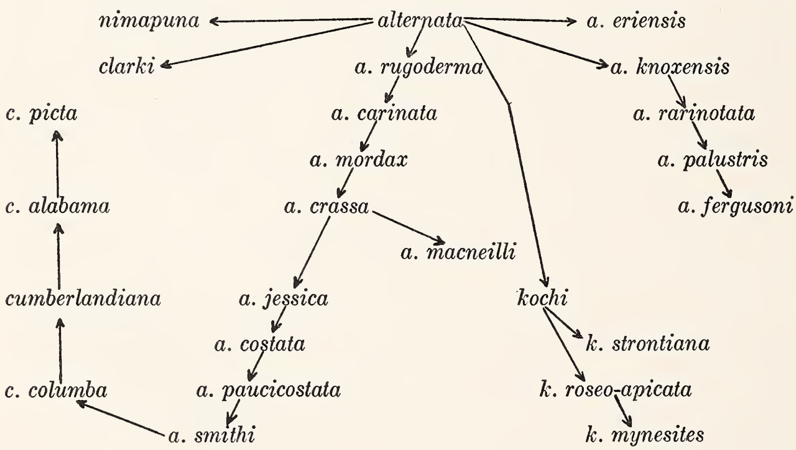
Coulee Beds, and not the Ralston Beds. The Sand Coulee, together with the Gray Bull Beds, are from the Eocene Epoch of the Cenozoic Era, which was in existence about fifty-five million years ago.

From the above evidence I have come to the conclusion that the species and subspecies of *Anguispira* and *Discus* are American in origin. The descendants of the fossil ancestors of the modern species and subspecies gradually dispersed from these ancient geological localities, until today they occupy the entire area of the United States and a portion of Lower and Northwestern Canada, and also a part of southern Alaska.

INTERRELATIONSHIP OF SPECIES

The linear descent, or interrelationship, of the various species and subspecies is best illustrated by the following diagrams. It is to be noted that not only does the so-called "parental species" give rise to related species and subspecies, but the various subspecies, in their reaction to the environment, give rise to other subspecies and in certain cases species.

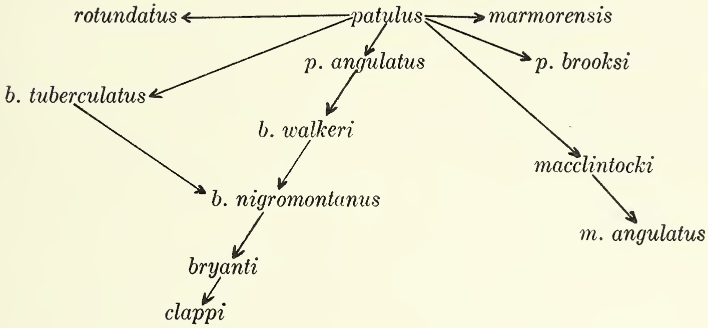
Genus ANGUISPIRA



Three different groups of species have descended from the "parental species," *alternata*. This has resulted in the formation of a number of varieties and four distinct species. Through *carinata* all the costate and carinate species and subspecies were formed. From *knoxensis* the smooth and shiny forms developed; *eriensis* being different from this latter subspecies and its related forms. *A. kochi roseo-apicata* and *A. k. mynesites* are, like *kochi*, banded. *A. k. strontiana* is a bandless form of *kochi*, which, I believe, is an off-shoot from a different branch of *kochi* that produced *roseo-apicata* and *mynesites*.

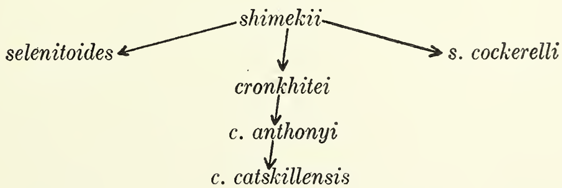
Genus Discus

patulus group



With *bryanti* we are confronted with two possible lines of descent. There is the possibility that *bryanti* developed from *patulus* through *p. angulatus*, *b. walkeri*, and *b. nigromontanus;* and again the development could have taken place through *b. tuberculatus* and *b. nigromontanus. D. bryanti tuberculatus* is the only *bryanti* that possess the internal columellar tubercle, which is characteristic of all the *patulae.*

shimekii group



The descendants of *shimekii* have been so influenced by changes that some of the species have become so distinct from the "parental species" as to form separate species. This is true of *cronkhitei* and *selenitoides*.

DISTRIBUTION OF SPECIES

The distribution of all animal life is limited by natural and physical conditions existing in the form of the geographical features of the country, climate, food, and humidity.

Many of the natural barriers, which would seem to be potential boundaries in the course of a migration of land snails, have been surmounted by these animals. The higher mountain ranges have been traversed by means of valleys and water courses. Rivers and lakes have distributed these forms by the agencies of floating logs and drifting debris, usually during flood periods. The physical conditions of various sections and regions of a country have a profound effect upon the snail fauna. This is especially true of the region occupying the southern Appalachian Mountains. Here the higher ranges of North Carolina, Tennessee, and Alabama have been peculiarly conducive to the development of many varieties of *Anguispira* and *Discus*. Of the forty-two known species and subspecies of these two genera, twenty-four of them are found in this area.

In the extreme desert regions of the west, the snails are found only in the higher elevations where there is enough vegetation and shelter to protect them from the heat and dryness. In the region west of the Rocky Mountains the species and subspecies of *alternata* are replaced by *Oreohelix*, with the exception of one species of *Anguispira* that has been found in Idaho.

The key to the present distribution of the molluscan life in North America is their great antiquity, which has enabled them to develop and migrate during the Tertiary and Quaternary Periods.

DESCRIPTION OF SPECIES

Genus ANGUISPIRA Morse

Patula, Held, Isis, 1837, p. 918 (proposed for *alternata, rotundata, solaria, perspectiva, ruderata, pygmaea, rupestris*).—*Eyryomphala*, Beck, Index Moll., 1837, p. 8 (proposed for *solaria, alternata, perspectiva, ruderata, solitaria, rudis, rotundata, rupestris, pygmaea, pusilla, lineata*, and some undescribed *Amphidoxa* or *Stephanoda* species).—*Euryomphala*, Herm. et al.—*Pyramidula*, Fitz., Syst. Verz., 1833, p. 95 (for *H. rupestris*, Drap.)—*Anguispira*, Morse, Obs. Terr. Pulm. Maine, 1864, p. 11, type *H. alternata*, Say.

Shell rather large and solid, with convex spire and open umbilicus; whorls rounded or carinated at the periphery. Surface striate or rib-striate, obliquely flamed, unicolored or spirally banded; lip thin, simple. Type, *A. alternata* (Say).

Animal having a large foot, its length greater than the diameter of the shell, the tail rounded; sole without traces of longitudinal divisions; foot margins having a wide border above, bounded by a distinct groove, the grooves meeting over the tail. Eye-peduncle long and slender, tentacles minute. Mantle edge thick.

Jaw strong and opaque, arcuate, with a slight or obvious medium projection; surface rather faintly subvertically striated.

This genus consists of rather dull-colored ground living snails, the species of which occur in the temperate and subtropical regions of North America. They are oviparous, the eggs being small, round, and soft-shelled.

The present genus was proposed for a group of shells by Morse, using *Helix alternata*, Say, as the type. Many of the western species included by Morse under this genus have now been transferred to the genus *Oreohelix*.

In earlier times the name *Patula*, as well as *Euyromphala*, was intended to include all of the forms referred now to the genus *Anguispira*. *Pyramidula*, *Delomphalus*, and *Euyromphala* were all proposed in the same year (1837), and it was impossible, for a long time, to decide which should be given priority. In von Marten's edition of Albers, the type of *Patula* is said to be *Helix rotundata*, but this species was already used as the type of *Discus*, a prior group.

Hugh Watson[6] shows that *Pyramidula*, of which *rupestris* is the type, belongs to the *Pupillidæ* or near it, and is not to be used for the North American *Pyramidula* (*Anguispira*). S. S. Berry[7] suggests that *Gonyodiscus* be used for this group (*Pyramidula*). *Anguispira* and *Planogyra* have previously been classed as subgenera of *Pyramidula*.

Until 1932 *Anguispira* was known only from east of the Rocky Mountains. During the previous year a species of *Anguispira*, designated as *nimapuna*, was discovered by H. B. Baker to occur in Idaho. That other species of *Anguispira* and subspecies of *alternata* occur west of the Rocky Mountains is probable. Further and more thorough collecting in the less accessible parts of the states in this area may unearth more specimens of *Anguispira* and may extend its present range westward.

[6] Watson, H., Proc. Malac. Soc. London, vol. 14, 1919, pp. 6-30.

[7] Berry, S. S., Bull. 36, Ser. 8, Vict. Mem. Mus., Can. Dept. Mines, 1922, p. 9.

Anguispira alternata alternata (Say)

(Plate XXXVIII, figs. 1, 2)

Helix alternata, Say, Nicholson's Encyclopaedia, 1816, p. 8, pl. 1, fig. 2.
Helix dubia, Shep., Trans. Lit. Hist. Soc. Quebec, vol. 1, 1829, p. 194.
Helix strongyloides, Pfr., Proc. Zool. Soc., 1854, p. 53.
Helix infecta, Parr., Ms., Pfr., Mal. Bl., 1857, p. 86.
Anguispira alternata, Morse, Journ. Port. Soc., vol. 1, 1864, p. 11.
Patula alternata, Binn., Proc. Acad. Nat. Sci. Phila., vol. 27, 1875, p. 153.
Pyramidula alternata, Pils., Proc. Acad. Nat. Sci. Phila., vol. 46, 1894, p. 17.
Anguispira alternata alba, Try., Am. Journ. Conch., vol. 2, 1866, p. 261.
Discus alternatus, Blake, Naut., vol. 49, 1935, p. 58.

"Shell somewhat convex, fuscus varied or alternating with pale rays; whorls 5, striated across with raised equi-distant acute lines, forming grooves between them. Aperture thin and brittle; lip regularly curved, within glossed with perlacesus, and when placed before the light the fuscus lines appear sanguineous. Umbilicus large, exhibiting all the volutions. Three-fourths of an inch wide."

Type locality: Middle States.

Distribution: Nova Scotia to Minnesota and south to Comal County, Texas.

Remarks: The shell varies in being more or less depressed, and the wrinkles more or less obvious. Sometimes no bars are observable on the surface. Of the fossil forms, *alternata* averages somewhat smaller in size than the recent shells.

Habits: This species occupies a variety of habitats. The best collecting is on hillsides covered with timber, sticks, and forest debris. In the hardwoods and aspens it is found under leaf mould, the underside of rotten logs, fallen bark, rotten stumps, ferns, and poison ivy. In pine groves it lives under rotten wood that is frequently covered with lichens. After rains it has been observed to crawl over reindeer-moss in considerable numbers. In bog woods it often lives at the base of *Arbor vitae* and spruce. It is not uncommon in open country in moist situations, where shelter is found under logs and stumps. It often congregates in great numbers under flat rocks in the late autumn, hibernating in similar situations.

According to observations made by D. T. Jones,[8] *alternata* burrows into the loose soil, by lifting the adhering particles of dirt with the sole of the foot. As these are moved aside the shell is usually turned side-

[8] Jones, D. T., Nautilus, vol. 48, 1935, pp. 140-142.

wise and wedges in the excavation. This process is repeated at the side of the shell until the shell is covered. *A. alternata* has a peculiar habit of clustering at about 4°C. during the process of burrowing. The cluster, composed of varying numbers of individuals, then goes downward. It seems probable that the large snails do most of the excavating, while the small ones follow afterwards down the same hole. At zero C. all the active individuals of *alternata* are usually buried.

Anguispira alternata mordax (Shuttleworth)

(Plate XXXVIII, figs. 3, 4)

Helix mordax, Shutt., Bern. Mitt., 1852, p. 195.

Patula (Anguispira) alternata mordax, Pils., Proc. Acad. Nat. Sci. Phila., vol. 41, 1889, p. 199.

Pyramidula (Patula) alternata mordax, Pils., Man. Conch., vol. 9, 1894, p. 50.

"Testa late et perspectiva umbilicata, depressa, sublenticularis, carinata, tenuis, luteo-cornea, strigis rufis interruptis fasciatum ornatus, costis validis flexuosis remotis utrinque eximie asperata; anfr. 5½, plani; apertura peroblique, angulatim lunari-ovalis; perist. simplex, acutum. Diam. max. 18 mm., min. 16 mm., alt. 6 mm."

"Shell widely and perspectively umbilicated, depressed, sublenticular, carinate, thin yellow-horn color, ornamented with interrupted red streaks in bands, beautifully sculptured with strong flexuose ribs above and below; whorls 5½, flat; aperture very oblique, angularly crescentric, oval; peristome simple, acute. Greater diam. 18, lesser 16, height 6 mm." (Pilsbry)

Type locality: Mountains of North Carolina.

Distribution: W. Va.; Va.; Ky.; Tenn.; N. Car.; S. Car.; Ga.; and Ala.

Remarks: In 1852 Shuttleworth described this species as *Helix mordax* from a specimen collected by (T. E.) Rugel in the mountains of North Carolina. The original description was reprinted by W. G. Binney in "Terrestrial Mollusca of the United States" vol. 3, 1857, p. 19, but by a clerical error the dimensions of *Zonites placentula*, which had been described at the same time, were included in the description of *mordax*.

"This species is very similar to *alternata*, but is distinguished from it by the stronger ribs, which are 1 mm. apart at the periphery and which extend on the under side into the umbilicus. The carina is well developed, though rather more rounded than in *carinata*, but the under side, just below the carina, is distinctly concave, as in *Discus bryanti*.

This disappears somewhat in full grown specimens towards the aperture, but is always evident on the two-thirds of the last whorl, and is particularly marked in young shells. The micro-sculpture is well developed, consisting of very fine irregular lines of growth between the ribs, which are cut transversely by numerous fine revolving lines. It differs from *cumberlandiana* in having the shell strongly striate and costate."

Shuttleworth observed that *mordax*, being costate, was distinct from *alternata* and *cumberlandiana;* the fact is that both *mordax* and *cumberlandiana* are costate, but those of *cumberlandiana* are not so sharp and regular and on the last whorl near the aperture they are partially obsolete. Shuttleworth states that *mordax* agrees with *cumberlandiana* with regard to the carina.

Habits: It has the same habits as the common form (*alternata*), found around old basswood and tulip tree logs, but the two are never together. *A. a. mordax* dwells in the tulip tree belt, and *alternata* is above and below, but never in that belt.

Anguispira alternata costata (Lewis)

(Plate XXXVIII, figs. 5, 6)

Helix alternata costata, Lewis, Am. Journ. Conch., vol. 6, 1871, p. 188.
Pyramidula (*Patula*) *alternata costata* (Lewis), Clapp, Naut., vol. 13, 1899, pp. 41-42.
Pyramidula alternata costifera, Lewis, Ferriss, Naut., vol. 12, 1899, p. 98.
Pyramidula costigera, Bland, Bull. Am. Mus. Nat. Hist., vol. 14, 1901, p. 357.
Anguispira alternata costata, Kutch., Naut., vol. 52, 1938, p. 12.

"A smaller shell with a more depressed spire, strongly marked striae or ribs."

"Shell flattened on upper surface, more convex below, carinated, heavily ribbed above, the ribs ending *on the carina*, almost smooth below, but faintly continued into the umbilicus with light intermediate ribs radiating from the umbilicus and ending at the carina. Color like the type, generally yellow or yellowish-white with very faint or no brown patches on the under surface. Whorls about 5½. Greater diameter 19 mm., lesser 17; height 9 mm." (Clapp)

Type locality: East Tennessee.

Distribution: Great Smoky Mountains of Tennessee and North Carolina.

Remarks: The very heavy ribs ending *on the carina* distinguishes this form from any other costate and carinate varieties of *alternata*.

There is a wide variation in the number of ribs on the body whorl, as the following figures show:

Diameter	19 mm.,	24 ribs
"	19 mm.,	38 "
"	17½ mm.,	32 "

Anguispira alternata knoxensis (Pilsbry)

(Plate XXXIX, figs. 2, 3)

Pyramidula (*Patula*) *alternata*, var., Clapp, Naut., vol. 13, 1899, p. 42.
Pyramidula alternata knoxensis, Pils., Naut., vol. 15, 1901, p. 6.

"A more robust, larger shell than the typical *alternata*, with more widely open umbilicus; dull rusty brown, with comparatively inconspicuous or much-reduced flame markings. Whorls 5½, not carinated. Sculpture of fine and even rib-striae, but little weaker on the base, the whole covered with a secondary sculpture of fine wrinkles, partially cuticular, and running a little more obliquely than the rib-striae. This minute wrinkling is barely visible to the naked eye, but is much stronger than in other forms of *alternata*, and gives the surface a peculiar dull appearance. Diameter 23-25 mm., width of umbilicus 6½-7½ mm.; height 11-13 mm."

Type locality: Knox County, Tennessee.

Distribution: Great Smoky Mountains of Tennessee and North Carolina, and northern Alabama.

Remarks: Although this variety was described by Dr. H. A. Pilsbry, it was first noted by Dr. G. H. Clapp, who made mention of it in an earlier volume of the Nautilus.[9] Of this variety, Dr. Clapp said, "Another variety of *alternata* is found near Knoxville, Tenn. It is large, coarse shell with rounded body whorl and scarcely a trace of carination. Color dull brown with *very faint* darker markings, ribs low but fairly strong, epidermis very heavy and wrinkled, the wrinkles under a glass having a netted appearance like the venations in the wing of insects. Whorls 5½. Greater diam. 25½ mm., lesser 20 mm.; height 12½ mm."

This variety belongs to the valleys and slopes of the Great Smoky Mountains, and those ranges of this same mountain system that reach into northern Alabama. The localities for this shell in the mountain ranges are usually below the 2000 foot elevation. The shell is remarkable for the strong development of the secondary sculpture,

[9]Clapp, G. H., Nautilus, vol. 13, 1899, p. 42.

with fine primary sculpture of rib-striae, the unkeeled, copacious whorls, wide umbilicus, and dead, rusty surface.

Anguispira alternata eriensis (Clapp)

(Plate XXXIX, figs. 6, 7)

Pyramidula alternata eriensis, Clapp, Ann. Car. Mus., vol. 10, 1916, p. 535, pl. 32, figs. 9-12.

Anguispira alternata eriensis, Ahlst., Naut., vol. 44, 1930, p. 45.

"Shell very dark, flame markings dark chocolate brown and coalescing into almost two solid bands at the periphery, frequently the bands are hardly separated, below a band of the body-color with irregular flames in the umbilical region. Ribs strong and running well down to the umbilicus, regular on the upper whorls, but less so on the body-whorl, being very irregular near the aperture. Body-whorl subcarinate, upper lip considerably flattened. Lip thickened and the parietal callus very heavy, frequently forming a strong ridge. Whorls 5½ to 6½. Diam. 17-25 mm.; height 11-17½ mm."

Type locality: Middle Sister Island, Lake Erie, Ontario, Canada.

Distribution: Islands of Western Lake Erie; various localities situated around the Great Lakes; Cliff Island and Eagle Island, Casco Bay, Maine; Cap Rouge, Quebec, Canada; and Frenchman's Bay, Maine. (A specimen resembling *eriensis* was found along the drift of the White River, either in Dallas or Ellis Counties, Texas, by E. P. Cheatum. Until other specimens are collected at definite localities in this state, this specimen may be referred to *eriensis*.)

Remarks: "There appears to be a greater tendency to albinism on Middle Sister than on the other islands of Lake Erie." Out of the 176 specimens collected by Dr. G. H. Clapp, five immature shells were a uniform straw-color and some of the adults, though badly weathered, seemed by transmitted light to be albinos. Others were straw-colored with indistinct flames.

A. a. eriensis was first found on the islands of western Lake Erie. Since studying the collection of *alternata* in the Carnegie Museum I have discovered that it also exists along the Great Lakes, and the St. Lawrence River. From this it appears that *eriensis* is an ecological variety, living in a sandy habitat. It would not be surprising if this variety should occur around lakes, and along the Atlantic coast and river courses, although there are at present no evidences to indicate its distribution along these areas.

Anguispira alternata fergusoni (Bland)

(Plate XXXVIII, figs. 13, 14)

Helix alternata fergusoni, Bland, Lyc. Nat. Hist. N. Y., Ann., vol. 7, 1861, p. 421.
Anguispira alternata fergusoni, Tryon, Am. Journ. Conch., vol. 2, 1866, p. 261.
Patula (*Anguispira*) *alternata fergusoni*, Pils., Proc. Acad. Nat. Sci. Phila., vol. 41, 1889, p. 199.
Pyramidula (*Patula*) *alternata fergusoni*, Pils., Man. Conch,. vol. 9, 1894, p. 50.

"The variety is small, comparatively smooth, especially at the base, has a shining somewhat transluscent epidermis, which on dead shells becomes opaque. The suture is well impressed and the outer whorl is not, as usual in the species, obsoletely carinated. The deep red flammules are disposed with much regularity on a pale horn-colored ground. An average sized specimen, with 5 whorls, is diam. maj. 15½, min. 14, height 6½ mm."

Type locality: Helderberg Mountains, New York.

Distribution: Mass.; R. I.; Conn.; N. Y.; N. J.; Del.; Md.; Penna.; Ohio; Ind.; Ill.; Mich.; and Wis.

Anguispira alternata carinata (Pilsbry and Rhoads)

(Plate XXXVIII, figs. 9, 10)

Pyramidula alternata carinata, Pils. & Rhds., Proc. Acad. Nat. Sci. Phila., vol. 48, 1896, p. 490.
Anguispira alternata carinata, Walk., Terres. Shell Bearing Moll. Ala., 1928, p. 110.

"Most Tennessee specimens of this species are more coarsely and strongly ribbed than the northern and western examples and there is often a more or less peripheral keel. The culmination of this type of shell is *P. alternata mordax*. The form called *carinata* contrasts with these, being very fine ribbed and distinctly carinated and not at all the *mordax* type."

Type locality: Emory River, Harriman, Tennessee.

Distribution: Ind.; Ohio; Penna.; Md.; W. Va.; Va.; Ky.; Tenn.; N. Car.; and Ala.

Remarks: "In this form the periphery has a distinct, bluntly angulated, but not acute, carina; the earlier whorls are quite strongly ribbed, but the ribs diminish in strength on the penultimate whorl and the last whorl becomes finely and closely striate. The striae pass over the carina and continue into the umbilicus, but become much weaker below the carina and in fully mature specimens become subobsolete towards the aperture. The young shells are quite strongly carinated and somewhat excavated below the carina. Between the ribs is developed a fine vertical striation."

Habits: It is commonly found among rocks, and sometimes in rotten wood.

Anguispira alternata crassa Clapp

(Plate XLI, figs. 9, 10)

Anguispira alternata crassa, Clapp, in Walker, Univ. Mich., Mus. Zool., Misc. Publ. 18, 1928, p. 111, fig. 161.

"Shell somewhat depressed, rather heavy for the genus; upper surface with strong ribs, which pass uninterruptedly over the periphery and across the base into the umbilicus; whorls rounded, apparently very bluntly angulated, but this seems to be caused by the oblique turning of the ribs at the periphery as they pass towards the umbilicus; aperture nearly rounded, slightly flattened above. The microsculpture consists of fine vertical striae between the ribs, which are crossed by very fine, more or less irregular, spiral striae. The type measures, diam. 18, height 10.5 mm."

Type locality: Wetumpka, Elmore County, Alabama.

Distribution: Va.; Ky.; Tenn.; N. Car.; S. Car.; Ga.; Fla.; Ala.; Miss.; La.; and Ark.

Remarks: This heavily ribbed form is nearest to *costata* of the Tennessee Mountains. It differs in its rounded, not carinated, periphery and in the character of the ribs, which pass over it and across the base into the umbilicus. The strong sculpture is characteristic and easily differentiates it from the other varieties.

Anguispira alternata macneilli Walker

(Plate XXXIX, figs. 11, 12)

Anguispira alternata macneilli, Walk., Univ. Mich., Mus. Zool., Misc. Publ. 18, 1928, p. 112, fig. 162.

"Shell relatively small, depressed, thin, quite highly colored, with reddish spots rather than flames; body whorl rounded, with rarely a slight appearance of angulation on the periphery; aperture nearly round; upper surface strongly ribbed, the ribs extending continuously over the base into the umbilicus, but are much weaker below and frequently bifurcate towards the periphery; the micro-sculpture consists of very fine striae between and parallel with the ribs. The type measures, diam. 15.2, height 8.3 mm."

Type locality: Salco, Mobile County, Alabama.

Distribution: Confined to the coastal regions of the southern part of Alabama.

Habits: Anguispira alternata macneilli has the same type of habitudinal distribution as the other forms of *alternata* in this region of central and southern Alabama. In the prairie region it is confined to hardwood forests, beech-maple (plus magnolia and tulip trees), either on the lower slopes of loam hills or in forest gallery woods along streams in the prairies. In the forest region of southern Alabama it is again confined to the hardwoods, beech-maple-magnolia or oak-hickory woods, either on the slopes of rocky limestone hills or in wooded ravines on the non-calcareous soils.

Its habitats are leaf-mould, the underside of rotten logs, under started bark, and under fallen bark. It is apparently almost entirely absent in open country.

Anguispira alternata palustris Clapp

(Plate XL, figs. 13, 14)

Anguispira alternata palustris, Clapp, in Walker, Univ. Mich., Mus. Zool., Misc. Publ. 18, 1928, p. 112, fig. 163.

"The fine striations of the upper surface fade out below the periphery and in the fully mature examples become subobsolete towards the aperture, so that the base is practically smooth or only slightly striate; the body whorl is scarcely angulated and is rounded at the aperture. Immature shells are bluntly carinated on the periphery. The microsculpture consists of a fine vertical striation between the ribs, which is cut by very fine spiral striae. The type measures, diam. 25.1, height 12.6 mm."

Type locality: Princeton, Jackson County, Alabama.

Distribution: Tennessee and Alabama.

Remarks: This form differs from *carinata* in possessing much finer striations on the upper surface.

Habits: Anguispira alternata palustris is characteristic of the low, swampy flood-plain of the Tennessee River and along rivers in the localities in which it is found and which have the same type of conditions.

Anguispira alternata smithi Walker

(Plate XL, figs. 6, 7)

?*Patula alternata mordax*, Binn., Terr. Moll., V, 1878, p. 162.
?*Patula alternata*, Binn., Manual, 1885, p. 481.
?*Pyramidula alternata* var., Wheeler, Naut., vol. 26, 1912, p. 16.
Anguispira alternata smithi, Walk., Univ. Mich., Mus. Zool., Misc. Publ. 18, 1928, p. 113, fig. 164.

"Shell depressed, sublenticular, carinated, strongly constricted below the carina; upper surface with strong ribs, which pass over the carina and continue uninterruptedly into the umbilicus; aperture angulated at the periphery. The micro-sculpture consists of fine vertical striae between the ribs, crossed by very fine spiral striae. The type measures, diam. 17.6, height 9 mm."

Type locality: Monte Sano, Huntsville, Jackson County, Alabama.

Distribution: Huntsville, Ala.; Cumberland Gap and Newcombe, Tenn.

Remarks: "*Anguispira alternata smithi* is quite closely related to *mordax* and it is possibly a derivation from the same stock or the result of similar ecological conditions. It differs in having the ribs on the upper surface more numerous, closer together and less pronounced, those of the base are much finer and frequently anastomose as they approach the umbilicus. This also occurs occasionally in *modax*. The strong constriction just below the carina, which gives the latter a cord-like appearance, and the sudden diminution in strength of the basal ribs below the carina, are characteristic. In *mordax* the basal ribs are quite as strong as those of the upper surface."

Anguispira alternata rarinotata (Pilsbry)

(Plate XXXVIII, figs. 11, 12)

Pyramidula alternata rarinotata, Pils., Naut., vol. 13, 1900, p. 114.
Anguispira alternata rarinotata, Van., Naut., vol. 40, 1926, p. 17.

"Similar to the typical form in size, form and sculpture, but very sparsely marked with comparatively small chestnut spots on a pale brownish-corneous or dirty buff ground, streaks on base nearly obsolete."

Type locality: Jackson County, Texas.

Distribution: South Central Texas.

Remarks: This species is very difficult to separate from the typical *alternata.* One of the most distinguishing characteristics is the rounded whorls, in contrast to the slightly angulated whorls of *alternata.*

Anguispira alternata jessica Kutchka

(Plate XXXVIII, fig. 15; Plate XXXIX, fig. 1)

Anguispira alternata jessica, Kutch., Naut., vol. 52, 1938, pp. 11, 12, pl. 2, fig. 1.

Shell slightly elevated, light reddish-brown, somewhat shiny; surface above covered with rows of reddish squares, below with one row of these dots just beneath periphery; whorls 5½, angulated; embryonic whorl covered with criss-cross markings; remaining whorls covered with rib-striations, which are prominent above, and weaker below; intermediate striae many, coarse and deep; spiral striae faint; periphery slightly angulated, possessing a slight carina in some specimens; aperture somewhat ovate, parietal wall with a very thin callus deposit; umbilicus narrow, deep, showing all inner whorls. Greater diam. 20.75, lesser 18.75 mm.; height 11 mm.

Type locality: Stevenson, Jackson County, Alabama.

Distribution: Tennessee and Alabama.

Remarks: The slight carina places this variety close to some of the specimens of *alternata carinata* that are found in Tennessee and Alabama; these varieties also belong close to *jessica* in coloration. *A. alternata jessica* lacks the carina, flat shell, and rhomboidal aperture of *cumberlandiana columba* and *cumberlandiana alabama.*

This variety was named in honor of my wife, who has been a constant companion and an ever present inspiration to me.

Anguispira alternata paucicostata Kutchka

(Plate XLI, figs. 1, 2)

Anguispira alternata paucicostata, Kutch., Naut., vol. 52, 1938, p. 12, pl. 2, fig. 2.

Shell slightly depressed, buckthorn-brown color, dull; spire slightly elevated; whorls 5½, flattened; embryonic whorl slightly criss-crossed; surface covered with only a few brown spots; heavily ribbed, the rib-striations continuing over the angulated periphery to the umbilical region; *rib-striations 1.5 mm. apart,* smooth on top; intermediate striae many, coarse and deep; spiral striae few and very faint, their continuation around whorls broken by rib-striations; aperture wider than high, rendered somewhat rhomboidal by slightly acute carina, parietal wall covered with a slight callus deposit; umbilicus narrow and deep, showing all inner whorls. Greater diam. 16.75, lesser diam. 13.75 mm.; height 8.5 mm.

Type locality: Mt. Mitchell, Buncombe County, North Carolina.

Distribution: Known only from the type locality.

Remarks: The dorsal rib-strations are much like those found on *costata*, but those of *paucicostata* are much further apart and they continue over the periphery to the umbilical region. The shell is much duller in coloring than in *costata*, much more like that of *smithi*, but even somewhat darker.

Anguispira alternata rugoderma Hubricht

(Plate XLI, figs. 7, 8)

Anguispira rugoderma, Hub., Naut., vol. 51, 1938, p. 131.

"Shell similar in general form and color to *Anguispira alternata* (Say), but larger. Whorls 5.5 to 6, periphery rounded in adults, subangulate when young. Body-whorl with about 14 strong ribs to the cm., which extend over the periphery and into the umbilicus. Under a hand-lens the epidermis of *A. alternata* shows very fine wrinkles; in this species the wrinkles are quite conspicuous. Greater diam. 25, less. 22.5; height 14 mm."

Type locality: Pine Mountain, 5.6 miles east of Pineville, Bell County, Kentucky.

Distribution: Has been found only at the type locality.

Remarks: From the above description and from a study of the type specimen at the Academy of Natural Sciences, it is apparent that this shell is a variety of *A. alternata*, and not a new species as the author indicated in the article in which he described the specimen.

Habits: A. alternata rugoderma is found under logs in well developed, second growth deciduous forests which grow on the lower half of the north side of Pine Mountain.

Anguispira clarki Vanatta

(Plate XL, fig. 15)

Anguispira clarki, Van., Proc. Acad. Nat. Sci. Phila., vol. 76, 1924, pp. 423-424, fig. 4.

"Shell small, broadly umbilicated, low conic, thin, costate above, nearly smooth below, grayish yellow, with two interrupted spiral bands of irregular chestnut maculations above, and a third below the periphery. Apex obtuse, horn colored, suture impressed, whorls 5, slowly increasing, the first sculptured with microscopic reticulations as in *alternata*, the remainder provided with close vertical costae, becoming almost obsolete near the aperture. Periphery slightly angular, base convex, sculptured with fine incremental striae. Umbilicus broad, deep, about two-sevenths the entire diameter of the shell, showing all the whorls within. Aperture broadly lunate, lip thin, evenly arcuate, parietal callus thin; a few external maculations may be seen in the upper part of the palatal region; provided with a thick, white basal callus. Height 6 mm., diam. 9.5 mm."

Type locality: Near Beachy Farm, near Bittinger, Garrett County, Maryland.

Distribution: Has been recorded only from the type locality.

Anguispira nimapuna H. B. Baker

(Plate XXXVIII, figs. 7, 8)

Anguispira nimapuna, H. B. B., Naut., vol. 45, 1932, p. 82, pl. 5, figs. 4-6.

"Shell small, much depressed to depressed conical, angulated at periphery; olive-brown to straw-color, often with very vague, darker flammulae, and with greenish tinge predominating in young specimens; transluscent when fresh and with satin-like luster. Whorls 5¾, gradually increasing and depressed. Embryonic whorls 2; first almost smooth but with weak traces of the oblique sculpture of *alternata*; second gradually assuming nepionic ribs. Young shells more sharply angulated than adults. Last whorl with 54, heavy, low, widely spaced growth ribs (about one-fifth as wide as interspaces), which are positively arcuate above the periphery and negatively so below, and with extremely delicate, closely spaced, fairly regular, secondary riblets which are crossed, in the major interspaces, by fine, irregular, spiral striae. Umbilicus large, 3.19 to 3.64 times in major diameter; ogival. Aperture depressed, angulate. Peristome simple and sharp; markedly oblique (about 50° to axis of shell); emarginate just below suture. Greater diam. 12.2, lesser 10.7 mm.; height 5.33 mm.; diam. of aperture 4.52 mm. and height 3.09 mm."

Type locality: East side of South Fork of Clearwater River, one mile south of Stites, Idaho County, Idaho.

Distribution: Found only at the type locality.

Remarks: This is an *Anguispira* of the typical group that has been found west of the Rocky Mountains. Its relatively thin shell, very delicate microscopic sculpture and almost uniform coloration immediately distinguishes it from the species of the eastern United States.

Habits: It is quite common in small, shallow, lava rock-slides on slopes covered with sparse brush and a few yellow pines. It aestivates especially near the roots of scattered service berry bushes; more deeply hidden than *Mesodon ptychophorus*, but less so than *Mesodon devius mullani* and *Polygyroidea polygyrella*, which bury themselves in the black, coarsely granular soil beneath the rock-slides.

Anguispira cumberlandiana cumberlandiana (Lea)

(Plate XXXIX, figs. 9, 10)

Carocalla cumberlandiana, Lea, Proc. Am. Phil. Soc., vol. 1, 1840, p. 289[10].
Helix cumberlandiana, Pfr., Mon. Hel. Viv., vol. 1, 1848, p. 125.
Anguispira cumberlandiana, Try., Am. Journ. Conch., vol. 2, 1866, p. 262.
Patula cumberlandiana, Binn., Proc. Acad. Nat. Sci. Phila., vol. 27, 1875, p. 153.
Pyramidula (*Patula*) *cumberlandiana*, Pils., Man. Conch., vol. 9, 1894, p. 50.

"Testa lenticulata, carinata, striata, albida, fusco-notata, late umbilicata, ad carinam suprene et inferne impressa; anfractibus quinis; apertura angulata, intus sulcata; labro acuto."

"Shell lenticular, carinate, striate, whitish, brown-spotted, widely umbilicated; impressed above and below the carina; whorls 5; aperture angular, within furrowed; lip acute. Diam. .54 of an inch. (13 mm.) and length .14 of an inch. (5 mm.)" (Lea)

Type locality: Cumberland Mountains, near Jasper, Tenn.

Distribution: Tenn.; N. Car.; S. Car.; Ga.; and Ala.

Remarks: "It has some resemblance to *alternata* but may at once be distinguished by its depressed, flat, lenticular form and carina. It has a remarkable furrow above and below the carina; all the whorls are visible in the umbilicus and are striate all over. Both Lea and Binney failed to note that the ribs became much stronger on the carina, giving it a saw-tooth effect."

This species was extremely rare, even in American Cabinets, until Bishop Elliot, after diligent search during several summers, rediscovered it in August, 1860, inhabiting a single spur of the Cumberland Mountains, near University Place, Franklin County, Tennessee. In one of his letters to T. Bland he mentions having found it on the ground, under stones and wood, in company with *Stenotrema spinosa*, and also after a rain, creeping upon precipitous faces of rocks, with a few *alternata* and *Helicina orbiculata*.

Habits: Lives in the crevices of precipitous rocks, over the face of which they may be found crawling after rains.

[10] This shell was first mentioned and described by Lea in Proc. Am. Phil. Soc., vol. 1, 1840, p. 289. It was redescribed in Trans. Am. Phil. Soc., vol. 8, 1843, p. 229. In this latter reference a wood cut of it is found on plate 6, fig. 61.

Anguispira cumberlandiana alabama (Clapp)

(Plate XLI, figs. 3, 4)

Pyramiduala cumberlandiana alabama, Clapp, Naut., vol. 34, 1920, p. 25, pl. 1, fig. 3.
Anguispira cumberlandiana alabama, Kutch., Naut., vol. 52, 1938, p. 12.

"Differs from the type by its large size, *much finer and flatter ribs,* and more convex shape; carina white, sharp, but less pinched than in the type and the ribs on the carina much lower and less accentuated. Ground color lighter than in *cumberlandiana* and markings darker. There is a single row of squarish flames just below the carina on the base. Umbilicus about one-fourth the diameter of the shell. Greater diam. 21.75, lesser 19.5, height 9.5 mm. Aperture 9.5 x 8 mm. Whorls 6."

Type locality: Vincent Mountain, near Gurley, Madison County, Alabama.

Distribution: Vincent and Smithers Mountains, Huntsville and Monte Sano, Alabama.

Anguispira cumberlandiana columba (Clapp)

(Plate XL, figs. 4, 5)

Pyramidula cumberlandiana columba, Clapp, Naut., vol. 34, 1920, p. 25, pl. 1, fig. 5.
Anguispira cumberlandiana columba, Kutch., Naut., vol. 52, 1938, p. 12.

"Like the type in sculpture, color and markings, *but not pinched at the carina.* Heavily ribbed above and on the carina, but below the ribs are much finer, about 2.1. There is a single row of chocolate brown, diagonal markings immediately below the carina. Greater diam. 18½ mm., lesser 16½ mm.; height 8 mm. Aperture 7½ x 7 mm. Whorls 5."

Type locality: East Slope of Battle Creek Valley, near Dove, Marion County, Tennessee.

Distribution: Dove and Careyvill, Tenn., and Princeton and Woodville, Ala.

Anguispira cumberlandiana picta (Clapp)

(Plate XLI, figs. 5, 6)

Pyramidula picta, Clapp, Naut., vol. 34, 1920, p. 23, pl. 1, fig. 4.

"Shell thin, the color markings showing through, broadly umbilicate, the umbilicus dome-shaped, exhibiting all of the whorls to the apex and about one-fourth the diameter of the shell; whorls very convex above and below with a sharp *perfectly smooth, white* carina; apex delicately granulated for nearly a complete whorl before the ribs begin to show, first 2½ whorls rounded then a distinct *ribbed* carina is formed and the ribbing continues, getting gradually weaker and finally disappearing on the penultimate whorl. There is a distinct impressed line above the carina on the upper whorl. Ribs weak and almost obsolete on the body whorl. Body color a delicate cream tint with irregular, chocolate-brown blotches which stop at the carina; below a row of squarish-blotches immediately below the carina and a second row of narrow flame-like markings extending, faintly, into the umbilicus. Lip thin; aperture very oblique, much wider than high. Whorls 6. Greater diam. 20½, lesser 18¾, height 9 mm. Aperture 9 x 7."

Type locality: "Buck Creek Cove" or "No Business Cove," about three miles north of Anderson, Franklin County, Tennessee.

Distribution: Found only at the type locality.

Remarks: "In shape, sculpture and markings, but particularly in the *perfectly smooth* carina, this species stands out from all others of the group; it is the most distinctly marked and richest in coloring of all of the *Pyramidulas*."

After comparing the type specimen of *picta* with *cumberlandiana* and the types of its subspecies, I came to the conclusion that *picta* is a subspecies of *cumberlandiana*, being a smooth form of this species. It possesses the carina and oblique aperture, much wider than high, which are typical of *cumberlandiana*, *columba*, and *alabama*.

Anguispira kochi kochi (Pfeiffer)

(Plate XL, figs. 2, 3)

Helix kochi, Pfr., Proc. Zool. Soc., 1845, p. 127.

Helix solitaria, Say, Journ. Phila. Acad., vol. 2, 1821, p. 151.

Auguispira solitaria, Try., Am. Journ. Conch., vol. 2, 1866, p. 260.

Patula solitaria, Bland and Binney, Proc. Acad. Nat. Sci. Phila., vol. 25, 1873, p. 249.

Patula solitaria occidentalis, Mart., Sitz. Ber. Ges. Nat. Freunde, Berlin, 1882, p. 140.

Pyramidula (Patula) solitaria, Pils., Man. Conch., vol. 9, 1894, p. 50.

Pyramidula solitaria albina, "W. G. B." Walk., Ill. Cat. Moll. Mich., 1906, p. 492.

Description of *kochi*—"Hel. testa umbilicata, globoso-depressa, solidula, oblique distincte striata, albida, fasciis pluribus rufis ad peripheriam ornata; spira parum elevata, obtusiuscula; anfractibus 6 convexis, sensim accrescentibus, ultimo subcylindrico; umbilico magno, pervio; apertura lunato-orbiculari, intus concolore, nitida; peristomate simplice, acuto, marginibus conniventibus dextro antrorsum arcuato, columellari dilatato, patente. Diam. 30, alt 16 mm."

Description of *solitaria*—"Shell subglobose, with 2 or 3 revolving, rufous lines; spire conico-convex; volutions 5½, wrinkled across and rounded; suture rather deeply impressed; aperture wide, embracing a rather smaller portion of the penultimate whorl; labrum not reflected; umbilicus large, distinctly exhibiting all the volutions to the apex. Greater transverse diameter, near one and one-fifth inches."

Type locality: of *solitaria*. Lower Missouri.

Distribution: Western Pennsylvania and Central Mississippi Valley to Louisiana, west to California and north to Southwestern British Columbia.

Remarks: The specific name *kochi* is now used in place of *solitaria* as *Helix solitaria* was pre-empted by Poiret in 1805.

The western form of *kochi*, called *occidentalis*, is, in my opinion, only a narrower and taller form of this species. The differences are so slight in comparison with *kochi*, that there is nothing to warrant its separation as a subspecies, or even as a form.

E. von Martens said the following about *occidentalis*, "the specimens of this species show on an average a relatively higher whorl and a narrower umbilicus (height 19, greater diam. 24 mm.), as well as a more chestnut-brown ground color, on account of which the bands appear smaller, in comparison to the specimens of the eastern place of discovery."

A. kochi has a thick and coarse shell, when full grown. It is distinguished by its coarse texture, deep and ample umbilicus, and dark rufous bands on its whorls; but it is occasionally destitute of these bands, and rather light in coloration. The spire varies considerably in the degree of elevation, but the apex is always obtuse.

Habits: The animal buries itself from five to six or more inches in the soft soil of the moist hillsides to begin its period of hibernation. It issues forth when the first warm rays of the vernal sun penetrate its hiding place. During the summer it is usually found in great numbers under leaves and partly buried, an inch or two, in the soft soil.

Dr. J. G. Cooper collected many specimens of this species on both slopes of the Coeur d'Alene Mountains, Idaho, particularly in the bush and fern covered openings in the forests, at elevations exceeding 2500 feet.

Anguispira kochi strontiana (Clapp)

(Plate XXXIX, fig. 8; Plate XL, fig. 1)

Pyramidula solitaria strontiana, Clapp, Ann. Car. Mus., vol. 10, 1916, p. 532, pl. 32, figs. 1-3.

"Shell very heavy, coarsely striate, *uniform straw-color without a trace of bands.* Most specimens show traces of impressed spiral lines. This variety is much more elevated, heavier, and smaller than the typical banded forms from the mainland. Diam. 26.75 mm. and height 19 mm."

Type locality: Green Island, Lake Erie, Ohio.

Distribution: Green Island; Middle Sister Island and Starve Island, Lake Erie.

Remarks: In many of the older collections of North American land shells the locality is given as "Strontian Island." This island is now officially known as Green Island.

This species of snail is not *Pyramidula solitaria albina* (W. G. B.) mentioned by Walker,[11] as the locality there is given as Kent County.

W. G. Binney's figure, number 268 in Man. Am. Landshells, page 254, was probably drawn from one of the small shells from Strontian Island, as he had them in his collection. Number 38,987 of the Binney collection, now in the National Museum, is labeled "Strontian Island and Cunningham Island." Cunningham Island is now known as Kelley's Island.

Anguispira kochi roseo-apicata (Clapp)

(Plate XXXIX, figs. 4, 5)

Pyramidula solitaria roseo-apicata, Clapp, Ann. Car. Mus., vol. 10, 1916, p. 534, pl. 32, figs. 4-6.

"Shell small, elevated, very heavy, with apical whorls pink. In color they are generally darker than *strontiana*, some being almost chestnut and others brownish straw-color, mottled with chestnut on the upper whorls. Mature shells are mostly largely denuded, the epidermis which remains being in ragged patches. The *pink apex* is very characteristic in this variety and this feature, together with the darker color and smaller size, readily separates it from *strontiana*. Diam. 25.5 mm., height 19.5 mm."

Type locality: North Harbor Island, Lake Erie, Ontario, Canada.

[11] Walker, B., Terrestrial Mollusca of Michigan, 1899, p. 22.

Distribution: North Harbor Island, East Sister Island, Middle Sister Island, Middle Island, New Island, Sugar Island, Rattle Snake Island, North Bass Island, Hen Island, and Mouse Island, Lake Erie.

Anguispira kochi mynesites (Clapp)

(Plate XLI, figs. 11, 12)

Pyramidula solitaria mynesites, Clapp, Ann. Car. Mus., vol. 10, 1916, p. 535, pl. 32, figs. 7-8.

"Shell small, solid, straw-colored, with two brown bands, the lower wider and darker than the upper one which is sometimes almost obsolete. Apex pink like in *roseo-apicata*. Whorls 5½. Diam. 21 mm. and height 16. mm."

Type locality: Mouse Island, Lake Erie, Ottawa County, Ohio.

Distribution: Found on Mouse Island and Ballast Island, Lake Erie.

Remarks: Compared with *strontiana* and *roseo-apicata* it is constantly much smaller and intermediate in color, but with the banding of the latter.

Genus Discus Fitzinger

Gonyodiscus, Fitz., Syst. Verz., 1833, p. 98, proposed for *G. perspectivus*, Muhl. = *H. solaria*, Mke.—*Discus*, Fitz., Syst. Verz., 1833, p. 99, proposed for *H. rotundata, ruderata, pygmaea, cristallina* (not *Discus*, Less., 1837, nor Held., 1840, nor of Alb., 1850, nor of Campb., 1879).—*Patula*, Held., in part.—*Delomphalus*, Agassiz, in Charp., Catal. des Moll. Terrest. et Fluv. de la Suisse, p. 12, in Nouv. Mem. de la Soc. Helvetique de Sci. Nat. I, Neuchatel, 1837, proposed for *H. rotundata, ruderata, pygmaea.*—*Eyryomphala* (in part), Beck, Index, 1837, p. 8.—*Patularia*, Cless., Die Molluskenfauna Oesterreich-Ungarns und der Schweiz, 1887-90, p. 104 (proposed for *P. rotundata, hauffeni, ruderata, solaria, pygmaea*).—*Spelaeodiscus*, Brusina, Mittheil. naturwissensch. Ver. Steirermark, 1885, type *H. hauffeni.*—*Allerya*, Bourguignat, Atti Ac. Palermo, 1876 (=embryonic shells of *H. rotundata*, etc.).

Shell widely umbilicated, depressed, discoid or turbinate, rugose or costulately striate; whorls equal or gradually increasing; aperture lunately rotund; peristome simple, straight, acute. Type, *H. ruderata*, Stud.

This genus is chiefly confined to the temperate regions of North America, and the species and subspecies are inhabitants of the whole of this area.

The genus *Gonyodiscus* was proposed for *G. perspectivus* by Fitzinger in 1833, for a species of snail found in Austria and Italy. Fitzinger, also in 1833, proposed the name *Discus* for *H. rotundata, ruderata, pygmaea*, and *cristallina*, species found in Europe, northern Asia, and United States.

Discus pygmaea has been placed in the genus *Punctum*, and *cristallina* is an inhabitant of Europe.

The only remaining species under *Discus* is *ruderata*, which is considered by W. G. Binney[12] as synonymous with *striatella*, Anth. As *striatella* had been preoccupied in taxonomy, *cronkhitei anthonyi* was proposed by H. A. Pilsbry.

Concerning this genus, H. B. Baker[13] makes the following comments, "*Discus* has been used here as the genus and *Gonyodiscus* as section for the following reasons. Fitzinger[14] proposed two genera which include species that are now combined in one. *Gonyodiscus* (p. 98) had, for monotype, *G. perspectivus* (Meg. v. Muhlf.), from southern Europe, which should not be confused with Say's preoccupied name for the nearctic *D. patulus* (Desh.). *Discus* (p. 99) included its type by subsequent designation of Gray[15] *Helix ruderata* Stud., which is very close to the nearctic *Discus cronkhitei* (Newc.). Page priority was formerly considered valid, and *Gonyodiscus* has been given precedence over *Discus* by most recent authors, but the International Commission has wisely decided (Opinion 40) that priority (at least in the case of species) is not affected by mere paginal sequence, but must be determined by subsequent selection. So far as I can ascertain H. and A. Adams[16] were the first to take definite action in the present case and they used *Discus* as a genus, with *Gonyodiscus* as one of its synonyms."

The closest affinities that *Discus* has with the European and Asiatic species of *Discus* are through *rotundatus*, Mull. and *pauper*, Gould. *D. rotundatus* is slightly more elevated than *patulus*, but similar in shape, but slightly narrower in size and has a narrower umbilicus. The angulated periphery of *rotundatus* is like that of *patulus angulatus;* it also lacks the inner columellar tubercle that is characteristic of certain species and subspecies of *Discus*. *D. pauper* is slightly more elevated than *patulus*, but the striations are not as pronounced and

[12] Binney, W. G., Manual of American Land Shells, 1885, p. 70.

[13] Baker, H. B., Nautilus, vol. 45, 1932, p. 84.

[14] Fitzinger, Beitr. Landesk. Oesterr., III; 1833, p. 98, 99.

[15] Gray, J. E., Proc. Zool. Soc., 1847, p. 174.

[16] Adams, H. & A., Genera of Recent Mollusca, vol. 2, 1855, p. 116.

the umbilicus is narrower; there is present no inner columellar tubercle. The periphery of *pauper* is slightly angulated, but not as much as in *patulus angulatus*.

Discus patulus patulus (Deshayes)

(Plate XLI, figs. 16, 17)

Helix patula, Desh., Encycl. Meth., vol. 2, 1830, p. 217.
Helix perspectiva, Say, Journ. Phila. Acad., vol. 1, 1817, p. 18.
Anguispira perspectiva, Try., Am. Journ. Conch., vol. 2, 1866, p. 262.
Patula perspectiva, Bland and Binney, Proc. Acad. Nat. Sci. Phila., vol. 24, 1872, p. 136.
Pyramidula (*Gonyodiscus*) *perspectiva*, Pils., Man. Conch., vol. 9, 1894, p. 48.
Gonyodiscus perspectiva, Pils., Naut., vol. 38, 1925, p. 65.
Discus patulus, Van., Naut., vol. 49, 1936, p. 100.

Description of *patulus*—"H. testa orbiculato-depressa, corneo fulva, longitudinaliter striata, subtus late umbilicata; striis numerosis, angulatis, regularibus in umbilico continuatis; apertura minima, obliqua, simplii."

Description of *perspectiva*—"Shell very much depressed, with about 6 whorls; whorls striated across, with raised, parallel, acute lines, forming strongly impressed sulcae between them. Umbilicus very large, resembling an inverted spire, in diameter at least equal to the breadth of the body whorl, and exhibiting distinctly all the volutions. Diameter, three-tenths of an inch."

Type locality: Of *perspectiva*—near Lake Erie; of *patulus*, environs of New York.

Distribution: Minnesota to Texas, east to the Atlantic and north to South Central Ontario.

Remarks: In 1817 Thomas Say described a new American snail as *Helix perspectiva.* This same specific name had been given to a *Helix* described by Megerle von Muhlfeld in 1816. As Megerle's species had been described first, it had the priority over Say's species. Consequently Say's name became a synonym of *Helix patula* of Deshayes.

The existence of the tooth (internal columellar tubercle) within the aperture had been overlooked by all other earlier authors, but A. Binney.

Habits: This animal selects drier stations than those of related species, and is commonly found under dead trees, under bark close to the ground, or between the bark and wood. It is occasionally found under flat stones. Under the bark of decaying trees it is particularly abundant, sometimes found in vast numbers there.

Discus patulus brooksi Kutchka

(Plate XLII, figs. 6, 7)

Discus patulus brooksi, Kutch., Naut., vol. 52, 1938, p. 13, pl. 2, fig. 3.

Striations much pronounced and wide apart; shell honey-yellow in color, shiny, comparatively flat; whorls 5½, rounded; aperture oval, slight callus on parietal wall; striations continue around periphery to umbilicus without decreasing in size; umbilicus wide, showing all inner whorls; embryonic whorls smooth, rest heavily striated; intermediate striae very faint; rib-striations white on top, without any striae crossing them transversely; some of striations do not enter umbilical region but anastomose with others which enter this region; internal columellar tubercle small. Greater diam. 7.125, lesser 6.25 mm.; height 2.5 mm.

Type locality: Pyriton, Clay County, Alabama.

Distribution: Ala.; Tenn.; S. Car.; N. Car.; and Ga.

Remarks: Shell usually flatter and much lighter in color than typical *patulus;* also the umbilicus is wider, the striations are farther apart, and the intermediate striae are weaker.

This sub-species ranges in measurement from 7.125 to 8.25 mm. for the greater diameter, and 6.25 to 7.25 for the lesser diameter.

This subspecies has been named in honor of Dr. S. T. Brooks, Curator of Recent Invertebrates at the Carnegie Museum, who has given me much aid and many useful suggestions during the preparation of this paper.

Discus patulus angulatus Kutchka

(Plate XLII, figs. 8, 9)

(?) *Helix (Patula) perspectiva carinata*, Gratacap, Bull. Am. Mus. Nat. Hist., vol. 14, 1901, p. 358 (collection name).

Discus patulus angulatus, Kutch., Naut., vol. 52, 1938, p. 13, pl. 2, fig. 4.

Shell slightly elevated, reddish-brown color, dull; spire elevated; whorls 5½, angulated; embryonic whorl smooth; surface heavily ribbed above, the rib-striations forming a carina as they pass over the periphery; rib-striations smooth on top; intermediate striae faint; rib-striations below continue into umbilicus; umbilicus moderately wide, deep, showing all inner whorls; aperture somewhat rounded; internal columellar tubercle medium in size. Diameter 8 mm.; height 3.5 mm.

Type locality: Paint Rock, Madison County, North Carolina.

Distribution: Western Pennsylvania and Maryland; West Virginia; Kentucky; Great Smoky Mountains of Tennessee and North Carolina; and Appalachian Mountains of South Carolina, Georgia, and Alabama.

Remarks: This subspecies can readily be distinguished from the typical *patulus* by the angulated periphery; the rib-striations, in passing over the periphery, form a carina, which is more or less prominent.

Discus bryanti bryanti (Harper)

(Plate XLII, figs. 1b, 2b)

Patula bryanti, Harp., Journ. Cincin. Soc. Nat. Hist., vol. 4, 1881, p. 258, figs. 1, 1a & 2.

Pyramidula (*Gonyodiscus*) *bryanti*, Pils., Man. Conch., vol. 9, 1894, p. 48.

Gonyodiscus bryanti, Pils., Proc. Acad. Nat. Sci. Phila., vol. 76, 1924, p. 418.

Discus bryanti, Kutch., Naut., vol. 52, 1938, p. 14.

"Shell broadly and perspectively umbilicate, discoidal, nearly flat above, and deeply excavated below; whorls 5, gradually increasing, regularly ribbed, outer whorl bicarinate; color light brown; aperture small, rhomboidal; peristome simple, acute, having its extremities united. Greater width 6½, least 5½; height 2; width of umbilicus 4½ mm."

Type locality: Mitchell County, North Carolina.

Distribution: Alabama, Tennessee, and North Caroliua.

Remarks: W. G. Binney thought that this species was a bicarinate form of *perspectiva*, but worthy of a distinct name.

This species has been reported from Virginia and Kentucky, but these reports should be verified before being accepted. It would not be surprising to find it in either of these states as it is an Alleghenian form, likely to be found in the Lower or Southern Appalachian Mountains.

In the several descriptions by Harper, Wetherby, and Binney, it was not noticed that the embryonic whorls had a special sculpture. After the first whorl, which appears smooth, fine, and slightly protractive, radial wrinkles (or grooves) appear; these are crossed approximately at right angles by retractive grooves and scratches. This sculpture continues over the short first ribs, then disappears. It is readily lost by wear.

Discus bryanti nigromontanus (Pilsbry)

(Plate XLII, figs. 1c, 2c)

Gonyodiscus bryanti nigromontanus, Pils., Proc. Acad. Nat. Sci. Phila., vol. 76, 1924, pp. 419-420, figs. 2c & 3c.

"Spire somewhat convex; peripheral angle blunt, the basal angle very blunt in the first part of the whorl, entirely rounded off in the last half; space between the periphery and the base flat or very slightly concave in the first half of the last whorl, and convex in the latter part, the riblets continue as striae across it. Microscopic criss-cross sculpture of the embryonic shell is very much weaker than in *bryanti*, but of the same character, though almost effaced. Aperture very shortly ovate, slightly angular at the periphery; the lip well thickened a short distance within, but there is no columellar tubercle; umbilicus as in *bryanti*. Height 2.4 mm., diam. 7.4 mm.; 5¼ whorls."

Type locality: Potato Top, Black Mountains, North Carolina.

Distribution: Va.; Ky.; Tenn.; N. Car.; S. Car.; Ga.; and Ala.

Remarks: "The resemblance to *bryanti* is more marked in the young than in the mature specimens, in which the last whorl is far less strongly angular. In the characters differentiating this form from *bryanti* it approaches *patulus;* but the small caliber of the whorls, the angulation, and the very broad excavation of the base, are characters of *bryanti*, and unlike *patulus*."

Discus bryantwalkeri (Pilsbry)

(Plate XLII, figs. 1d, 2d)

Gonyodiscus bryantwalkeri, Pils., Proc. Acad. Nat. Sci. Phila., vol. 76, 1924, p. 420, figs. 2d & 3d.
Discus bryantwalkeri, Kutch., Naut., vol. 52, 1938, p. 14.

"The shell is weakly convex above, broadly concave beneath, the periphery very bluntly subangular, base strongly convex, rounded; between the periphery and the basal convexity the surface is only slightly convex in front of the aperture, but on the last part of the whorl it becomes quite convex. The whorls are moderately convex above. The shell is cinnamon buff, paler beneath. The first half whorl is smooth, the radial ribs appear below the suture, at first short, but rapidly lengthening, reaching across the whorl at the end of the first whorl; the succeeding whorls having regular, curved re-tractive riblets; along the periphery on the face of the last whorl there are about five riblets in 1 mm. Below the periphery of the last whorl the riblets diminish to striae, others being intercalated between them, and within the umbilicus they become larger again, as in all of this group of species. The very oblique aperture is rounded ovate, angular only at the upper insertion of the lip. Lip thin, but a slight callus appears a short distance within the basal lip. There is no trace of an internal columellar tubercle. Height 2.6 mm., diam. 7 mm.; barely 5 whorls."

Type locality: Mt. Mitchell, North Carolina.

Distribution: Has been found only at type locality.

Remarks: "In this species the riblets are much smaller and closer than in *patulus*, the basal concavity is wider and shallower, and there is no columellar nodule within. It agrees with that in sculpture of the embryonic shell. The basal excavation is decidedly smaller than in *bryanti*, and the carinae of that species are lacking."

Discus bryanti tuberculatus Kutchka

(Plate XLII, figs. 4, 5)

Discus bryanti tuberculatus, Kutch., Naut., vol. 52, 1938, p. 14, pl. 2, fig. 5.

Shell depressed, reddish-brown color, dull; spire slightly elevated; whorls 5½, somewhat rounded; embryonic whorl smooth, remaining covered with rib-striations; body whorl bicarinate, somewhat flat or very slightly concave between the carinae; flat space somewhat smooth, the rib-striations continue across it as striae; intermediate striae faint; umbilicus moderately wide, deep, showing all inner whorls; aperture somewhat ovate, *internal columellar tubercle present and prominent.* Diam. 7 mm.; height 3.25 mm.

Type locality: Careyville, Campbell County, Tennessee.

Distribution: Va.; Ky.; Tenn.; N. Car.; and Ala.

Remarks: The prominent *internal columellar tubercle* distinguishes this subspecies from *bryanti* and its allies. The periphery, which is characteristic of *clappi*, *bryanti*, and *bryanti nigromontanus*, sets it apart from *patulus*. It can be regarded as an intermediate form of *patulus* and *bryanti*.

Discus clappi (Pilsbry)

(Plate XLII, figs. 1a, 2a)

Pyramidula sub-sp. nov., "Pils." Wheeler, Naut., vol. 26, 1912, p. 16.
Gonyodiscus clappi, Pils., Proc. Acad. Nat. Sci. Phila., vol. 76, 1924, p. 417, figs. 2a & 3a.
Discus clappi Kutch., Naut., vol. 52, 1938, p. 14.

"The shell is rather thin, flat above, broadly concave beneath, with carinae at the periphery and base; cartridge buff. Inner whorls are simply convex, but the last three are convex with a concavity near the periphery; the last whorl is squarish in section, strongly concave between the peripheral and basal keels, and having a circular impression inside of the basal keel. Sculpture; most of the first whorl is smooth; then very fine, slightly protractive striae appear, and below the suture short, weak traces of radial riblets, which become longer, crossing the whorls, after the first 1½ whorls. There are also very fine and weak traces of strongly retractive striae over the sculpture described, mainly near the periphery. On the neanic whorls the radial riblets become strong, slightly curved and retractive. On the last whorl these riblets are strong, crenulating the two keels, becoming weak and reduced to mere striae between them, with some additional short striae in their intervals. In the concave base the riblets are moderately strong. The aperture is quadrate, or rather, stirrup-shaped, with the angles produced at the keels, a flat margin between them, and opposite to that margin a concave parietal margin; upper and lower margins somewhat signoid. There is no internal thickening or callus. Height 2.3, diam. 7.4 mm.; 5⅓ whorls."

Type locality: Jasper Point, a spur of the Cumberland Plateau, about 5 miles north to northeast of Gurley, Madison County, Alabama.

Distribution: Found at Jasper Point and Monte Sano, Ala.

Remarks: "The characters of *bryanti* are exaggerated in this species, which is more highly evolved along the same lines. The basal concavity is wider, the basal keel is more pinched out, and the concavity between the keels is deeper. The shape of the aperture differs. It has sculpture similar to that of *bryanti* on the last half of the embryonic shell, but decidedly more strongly developed."

Discus marmorensis H. B. Baker

(Plate XXXIX, figs. 13, 14)

Discus (*Gonyodiscus*) *marmorensis*, H. B. B., Naut., vol. 45, 1932, p. 84, pl. 5, figs. 1-3.

"Shell small but heavy, moderately to decidedly depressed, dome-shaped above with flatter base; thread-carinate at periphery; dull, with narrow varices of buff and brown alternating with broader flammulae of dark chestnut (often more evident in young and in bleached shells than in fresh adults). Whorls 6½, very gradually increasing; suture abruptly impressed. Embryonic whorls 2, half of first almost smooth but remainder with fine, protractive and retractive striae; about ¼ of last showing slight traces of nepionic ribs. Young shells biconvex, much more depressed but with vaguer carina than adults. Last whorl with lateral surface about 40° from vertical, with moderately convex base and with peripheral angulation marked off as a thread-carina by shallow grooves above and below it; with about 70, low, heavy growth-ribs, which are one-third to one-half the width of the inter-spaces and which extend from suture to below periphery but disappear almost completely on most of the base, although traces are often present on the umbilical wall; with microscopic sculpture (more distinct above carina) consisting of irregular, anastomosing growth-wrinkles, crossed by occasional spiral striae that seldom can be traced beyond a single major inter-space. Umbilicus large and funicular, 2.94 times in maj. diam. Peristome simple and sharp, slightly oblique (about 30° to axis of shell), very slightly emarginated below the suture. Height 4.64; greatest diam. 8.13, lesser diam. 7.72 mm. Aperture, height 1.81, diam. 2.82 mm."

Type locality: Mossy talus slopes, about 2 miles up Middle Fork of John Day Canyon, Idaho County, Idaho.

Distribution: Found only at type locality.

Remarks: "This species is very different from any of the other nearctic species. It does resemble considerably, both in shell and soft parts, the palearctic *D. perspectivus* (Muhlf.), but has a much heavier, more elevated shell, with greater contrast between the sculpture of its apical and that of its basal sides."

Discus cronkhitei cronkhitei (Newcomb)

(Plate XXXIX, figs. 15, 16)

Helix cronkhitei, Newc., Proc. Cal. Acad. Nat. Sci., vol. 3, 1865, p. 180.

Patula cronkhitei, Try., Am. Journ. Conch., vol. 2, 1866, p. 263.

Patula striatella cronkhitei, Pils., Proc. Acad. Nat. Sci. Phila., vol. 41, 1889, p. 200.

Pyramidula (*Gonyodiscus*) *striatella cronkhitei*, Pils., Man. Conch., vol. 9, 1894, p. 48.

Pyramidula cronkhitei, S. S. Berry, Naut., vol. 23, 1909, p. 76.

Pyramidula (*Gonyodiscus*) *cronkhitei*, Pils. & Ferr., Proc. Acad. Nat. Sci. Phila., vol. 61, 1909, p. 513.

Gonyodiscus cronkhitei, Pils. & Ferr., Proc. Acad. Nat. Sci. Phila., vol. 70, 1918, p. 301.

Discus cronkhitei, S. S. Berry, Naut., vol. 50, 1937, p. 87.

"Hel. testa aperta umbilicata, depressa, luteo-cornea sub-lente regulariter costulato-striata; spira depressa-convexa; sutura excavata; anfractibus quatuor, sub-cylindraceis; umbilica ampla, sub-perspectiva; apertura rotundata; peristomata simplici, acuto, marginibus conniventibus. Alt. 15 pol., diam. maj. 2 pol., min. 1.5 pol."

"Shell openly umbilicate, depressed, yellowish horn color, under the glass regularly rib striated; spire depressed, a little convex; suture wide and deep; whorls 4, rather cylindrical; umbilicus large, indistinctly perspective; aperture rounded; lip simple, acute, margins approximating."

Type locality: Klamath Valley, Oregon.

Distribution: Newfoundland and Alaska, south to California and east to South Dakota.

Remarks: It is larger and more elevated, of a lighter color and has coarser striae and stronger suture than the typical *anthonyi.*

Discus cronkhitei anthonyi (Pilsbry)

(Plate XL, figs. 10, 11)

Pyramidula cronkhitei anthonyi, Pils., Proc. Acad. Nat. Sci. Phila., vol. 58, 1906, p. 153.

Helix striatella, Anth., Bost. Journ. Nat. Hist., vol. 3, 1840, p. 278, pl. 3, fig. 2.

Helix ruderata, Adams, Still. Journ., (1), 40, 408.

Patula striatella, Morse, Journ. Port. Soc., vol. 1, 1864, p. 21.

Anguispira striatella, Try., Am. Journ. Conch., vol. 2, 1866, p. 262.

Pyramidula (Gonyodiscus) striatella, Pils., Man. Conch., vol. 9, 1894, p. 48.

Gonyodiscus cronkhitei anthonyi, Van., Naut., vol. 38, 1925, p. 92.

Discus cronkhitei anthonyi, Good., Naut., vol. 47, 1935, p. 8.

Pyramidula striatella alba, Walk., Terr. Moll. Mich., 1899, p. 22.

Pyramidula striatella albina, "Mse." Cock., Naut., vol. 3, 1890, p. 102.

"Shell remarkably thin, somewhat depressed; of a very delicate horn color, transparent; whorls 4, very finely striated transversely; spire scarcely elevated; suture moderate; aperture nearly round; labrum not reflected nor thickened. Umbilicus not remarkably large, in diameter not equal to body whorl; transverse diameter one-fifth of an inch. Greater diam. 6 mm., lesser 5½ mm.; height 5 mm."

Type locality: Cincinnati, Ohio (*striatella*). Near Strawberry Mansion, Fairmont Park, Philadelphia, Pennsylvania (*cronkhitei anthonyi*).

Distribution: Newfoundland and New Brunswick to British Columbia, south to California and east to Florida.

Remarks: Dr. H. A. Pilsbry changed the terminology of this species from *striatella* to *cronkhitei anthonyi,* as *striatella* had been used by Rang in 1831 for a species of *Helix.* J. G. Anthony used the name *striatella* for a species of *Helix* which he described in 1840.

"This shell has typically a rounded periphery and moderately developed oblique and sigmoid rib-striae, 4 or 5 in the space of a millimeter on the front of the last whorl at the periphery. There are 3½ to 3¾ whorls. Height 2.7 mm. and diam. 5.25."

The widespread Eastern race is not specifically distinct from *cronkhitei* of northern California, but it evidently requires separation as a subspecies.

D. cronkhitei anthonyi differs from *patulus* in being altogether a more delicate shell in structure and markings, the number of whorls is one less, the color is lighter, and the shell smaller; the sharp external edge is also more conspicuous, and looking into the throat, we do not find the tooth-like thickening which exists within the lower margins of *patulus*. (Modified after A. A. Gould, Invertebrates of Massachusetts, 1841.)

Habits: This little shell occurs in moist situations, with vegetation, along river and creek bottoms, under old logs, trees, and even under stones, and usually in numbers. After a warm rain it my be found crawling around on the moist sands of creek bottoms, or upon the upper surface of fallen logs.

Discus cronkhitei anthonyi will often seal itself to leaves or twigs, and remain dormant for a long period of time, after it has formed the usual epiphragm.

Discus cronkhitei catskillensis (Pilsbry)

(Plate XXXIX, figs. 17, 18)

Pyramidula (*Gonyodiscus*) *striatella catskillensis*, Pils., Man. Conch., vol. 9, 1894, p. 48 (Name only).

Pyramidula striatella catskillensis, Pils., Naut., vol. 12, 1898, p. 86.

Gonyodiscus cronkhitei catskillensis, Wins., Occas. Paps. Mus. Zool. Univ. Mich., 181, 1926, p. 9.

Discus cronkhitei catskillensis, W. J. Clench & G. Banks, Naut., vol. 52, 1939, p. 108.

"Sculpture sharper than typical form, umbilicus wider and shallower, and periphery angulated."

Type locality: Tannersville Valley, Catskill Mountains, New York.

Distribution: Ontario; New England States; New York and New Jersey to Wisconsin and Minnesota.

Remarks: This specimen was first mentioned by H. A. Pilsbry in the ninth volume of The Manual of Conchology of 1894 on page 48, but had not been described before.

Habits: It lives under rotten logs, loose bark, in leaf mold, and around rotten stumps in the woods. In open country it is found most frequently under old planks or discarded building plaster.

Discus shimekii shimekii (Pilsbry)

(Plate XLI, fig. 18; Plate XLII, fig. 3)

Zonites shimekii, Pils., Proc. Acad. Nat. Sci. Phila., vol. 42, 1890, p. 297, pl. V, figs. 9, 10, 11.

Zonitoides shimekii, Pils., Naut., vol. 11. 1898, p. 131.

Pyramidula shimekii, Cock., Proc. Acad. Nat. Sci. Phila., vol. 55, 1903, p. 616.

Gonyodiscus shimekii, F. C. Baker, Naut., vol. 40, 1927, p. 117.

Discus shimekii, H. B. Baker, Naut., vol. 48, 1934, p. 71.

"A shell about the size and shape of *Z*(*onitoides*) *nitidus;* moderately umbilicated; chalky-white, without epidermis, on account of its fossil condition. Surface sculptured with strong curved riblets above, rather finely striated beneath. Spire low-concoidal; apex obtuse; first (or nuclear) whorl planorboid but noticeably projecting, a trifle mammillated, snowy-white, smooth and polished. Whorls 4½, the outer three ribbed-striate. Aperture oblique, nearly circular, the ends of the peristome approaching. Height 4, greater diam. 5¾, lesser 5¼ mm.; width of umbilicus 1¼ mm."

Type locality: Loess formation, Iowa City, Iowa.

Distribution: Nebraska; Iowa; New Mexico; South Dakota; Alberta; and Loess formations of Illinois and Indiana.

Remarks: This species had been familiar to Dr. Pilsbry for some years under the name of *Zonites limatulus*. It agreed with that form in the number of whorls and sculpture, except that *shimekii* was more strongly ribbed above. It differed from *limatulus* in being far more robust, more elevated, with rounder mouth and narrower, deeper umbilicus. Except in sculpture, *shimekii* is far more like *nitidus* than *limatulus*.

D. shimekii was originally described as a loess fossil from near Iowa City, Iowa. Later, a living subspecies, *shimekii cockerelli*, was recognized from high altitudes in the Rocky Mountains. On September 15, 1931, H. B. Baker[17] found a living colony of specimens, that more closely resembled the typical than they did the Rocky Mountain race, on the underside of moist boulders at the bottom of a large pile along the edge of the flats of Spearfish Creek, just above Savoy, Lawrence County, South Dakota, (alt. 4900 ft.). The color of the living forms is a reddish-brown, compared to the chalky-white color of the type specimen.

[17] Baker, H. B., Nautilus, vol. 48, 1934, p. 71.

Dr. H. B. Baker says, "*Discus shimekii* appears to be the nearest United States relative of the European type of this Genus."

Discus shimekii cockerelli (Pilsbry)

(Plate XL, fig. 12; Plate XLI, fig. 13)

Pyramidula cockerelli, Pils., Naut., vol. 12, 1898, p. 85.

Gonyodiscus shimekii cockerelli, Pils. & Ferr., Proc. Acad. Nat. Sci. Phila., vol. 61, 1909, p. 514.

Patula ruderata cronkhitei form *viridula*, Cock., Naut., vol. 3, 1890, p. 102.

"Shell having the general shape of *patula*; thin, greenish, more or less streaked and dotted with light yellow; a little shining, very irregularly wrinkle-striata, some specimens unequally ribbed in places above and at the margin of the umbilicus. Spire convex, the first whorl a little protruding. Whorls four and one-fifth; the first whitish-corneous and glabrous when unworn, the rest convex, regularly widening, separated by a deep suture; last whorl obtusely angular at periphery in front, becoming rounded on its latter portion; base well rounded, the umbilicus showing all the whorls, its width contained about 3.7 times in that of the shell. Aperture oblique, rounded, the penultimate whorl cutting out a segment of about one-fourth the whorl circle of the thin and simple peristome; the greater diameter of aperture contained about 2.4 times that of shell. Height 2.8-3.2 mm.; diam. 5.5-6.5 mm."

Type locality: Saguache County, Colorado.

Distribution: Cal.; Ariz.; N. Mex.; Utah; Colo.; Nev.; Wyo.; Kans.; Neb.; and S. Dak.

Remarks: Dr. Pilsbry based this subspecies upon a series of shells from Labelle, Taos County, New Mexico, and Custer and Saguache Counties, Colorado. The specimen designated as the type in the Academy of Natural Sciences of Philadelphia is from Saguache County, Colorado, and is so indicated under "Type locality" above.

"This species is what has been very generally known as *Patula cronkhitei*, Newc.; but reference to cotypes of that species in the collection of the Academy of Natural Sciences at Philadelphia (part of the original lot), shows it to be very strongly ribbed. *D. s. cockerelli* is far smoother than *patulus*, and, indeed, is so distinct from that species that no detailed comparison is needed. *D. s. cockerelli* is far more like the Japanese *Pyramidula pauper*, Gould, than any American species; but there is no evidence showing *P. pauper* or *flocculus*, Morel, to occur in American territory."

Discus macclintocki macclintocki (F. C. Baker)

(Plate XLII, figs. 10, 11)

Gonyodiscus macclintocki, F. C. B., Naut., vol. 41, 1928, p. 133.

"Shell orbicular, with convex, dome-shaped spire; whorls 6, slowly and regularly increasing in size, tightly wound, slightly convex, the body whorl typically flatly rounded; sutures well impressed; base flatly rounded, excavated near the widely open umbilicus, which exhibits all of the whorls including the nucleus; sculpture of many close-set, distinct ribs, which become finer on the base, there being usually an almost smooth space in the center of the lower part of the body whorl; aperture widely or roundly lunate, arched above where the outer lip joins the body whorl; peristome simple, acute, without parietal callus, the terminations of the outer and columellar lip being widely separated. Height 3.2-3.6; diam. 6-6.5 mm."

Type locality: Peorian loess, 3½ miles east and 1¾ miles south of Lewiston, Liverpool Township, Illinois.

Distribution: Recorded only from Pleistocene deposits at type locality.

Remarks: "This species is related to *patulus*, differing in being smaller, and having a more convex spire, a smaller umbilicus, a rounded aperture, and finer sculpture, the ribs being more numerous and closer together, almost disappearing on the base. It has been confused with *shimekii*, which is smaller, has fewer whorls, which are wider, and the sculpture is coarser. The spire, also, is quite different."

This species has been seen only from deposits of Peorian Age, as *patulus* is not at present known from Pleistocene deposits earlier than the Late Wisconsin (at least in Illinois); it is thought that this species may be ancestral to the large, widely umbilicated form so common in Illinois and other parts of the United States in the recent fauna.

Discus macclintocki has been figured in an article written by F. C. Baker in the Journal of Paleontology, vol. 5, 1931, with figures 3a and 3b of Plate 32, on page 279, of this same publication.

Discus macclintocki angulatus (F. C. Baker)

(Plate XLII, figs. 12, 13)

Gonyodiscus macclintocki angulatus, F. C. B., Naut., vol. 41, 1928, p. 134.

"Shell differing from typical *macclintocki* in having a more depressed somewhat flattened spire, flatter base and shallower umbilicus, and a subangulated periphery. On the average rather larger than the typical form. Height 2.9-3; diam. 6.2-8 mm."

Type locality: Loess of Yarmouth Age, east of Havana, Fulton County, Illinois.

Distribution: Has been found only in loess of type locality.

Remarks: "This race differs uniformly from the more abundant *macclintocki* of the Peorian interval in its depressed spire, wide umbilicus and subangulated periphery. This angulated form persisted throughout the Yarmouth interval and died out in the Peorian, a few scattered specimens having been seen among a large number of the rounded-whorled Peorian forms."

Discus (?) **selenitoides** (Pilsbry)

(Plate XL, figs. 8, 9)

Zonites selenitoides, Pils., Proc. Acad. Nat. Sci. Phila., vol. 41, 1889, p. 413, pl. 12, figs. 13-15.

Zonitoides selenitoides, Pils., Naut., vol. 11, 1898, p. 131.

Gonyodiscus (?) *selenitoides*, Pils., Proc. Acad. Nat. Sci. Phila., vol. 81, 1929, p. 262.

"This species is similar in form and general appearance to *Z. minusculus*, Binn., though decidedly larger. The umbilicus is broad, as in the latter species. The shell is thin, light yellowish-horn color, almost white. Surface shining, covered with close strong oblique rib-striae, like *Patula striatella;* these striae while generally regular, sometimes bifurcate, or separate to give room for another to be intercalated. The spire is flatter than *minusculus*, nearly plane. The earlier 1¾ to 2 whorls are smooth, polished, not striate, the sutures are well impressed. There are 3½ whorls in all, convex, gradually widening, the last proportionately wider than in *Z. minusculus.* Aperture slightly oblique, lunate, narrower than in *Z. minusculus*, its margins thin, acute, scarcely converging, the columella shortly subreflexed. Height 1.2 mm., diam. 3 mm."

Type locality: Mariposa Big Trees, California.

Distribution: Found only at type locality.

Remarks: "The name *selenitoides* was given because of a certain resemblance to the little *Selenites* (*Haplotrema*) *duranti* of southern California. It has a quite strong, closely spaced, growth thread-riblets, with an anastomosing maze of very fine lines between them. Under low magnification, these interstitial lines give, in some light, the appearance of spirals, but this effect disappears when higher powers are used. The texture of the shell and the form of its whorls are most like those in *Discus*."

Undoubtedly the Mariposa Big Tree is *Sequoia gigantea* (the Giant Redwood), which forms a series of forests in the mountains from

Placer to Tulare Counties, California. The exact locality where *selenitoides* was found is not mentioned, but its distributional range is probably the same as *Sequoia gigantea.*

Discus rotundatus (Muller)

(Plate XLI, figs. 14, 15)

Helix rotundata, Mull., Verm. Hist., vol. 2, 1774, p. 29.
Helix radiata, DaCosta, Test. Brit., 1778, p. 57, pl. 4, figs. 15, 16.
Vortex rotundata, Oken, Lehrb. Naturg., vol. 3, abth. 1, 1815, p. 314.
Helix (Helicella) rotundata, Fer., Tabl. syst. Limacons, Jan. ed., 1821, p. 44.
Helix turtoni, Fleming, Hist. Brit. Anim., 1828, p. 260.
Gonyodiscus rotundatus, Fitz., Beitr. Landesk. Oesterr., vol. 3, 1833, p. 98.
Discus rotundatus, Fitz., t. c., p. 99.
Helix (Delomphalus) rotundata, Charp., Neue Denkschr. Allg. Schweiz. Gesell., vol. 1, no. 2, 1837, p. 12.
Helix (Eyryomphala) rudis, Gray: Beck, Index Moll., 1837, p. 9 (Non Gray).
Helix (Eyryomphala) rotundata, Beck, l. c.
Patula rotundata, Held, Isis, vol. 30, hft. 12, 1837, col. 916.
Zonites rotundatus, Turton's Manual, new ed., 1840, p. 165.
Helix (Verticillatae) rotundata, Brown, Illust. Conch. Brit., ed. 2, 1840, p. 51.
Helix striatula, Nardo, Sinon. Chiereghini, 1847, col. 85.
Helix (Euryomphala) rotundata, Beck, Amth. Ber. 24 Versamm. Deutsch. Naturf., 1847, p. 122.
Helix (Patula) rotundata, Albers, Heliceen, 1850, p. 64.
Patula (Patularia) rotundata, Cless., Deutsh. Excur. Moll. Fauna, 1876, p. 87.
Pyramidula (Gonyodiscus) rotundata, Pils., Man. Conch., vol. 9, 1894, p. 47.
Patula (Discus) rotundata, Weiss, Nachrbl. Deutsch. Malak. Gesell., vol. 26, 1894, p. 151.
Helix (Gonyodiscus) rotundata, Germain, Bull., Soc. Sci. Nat. Elbeuf., vol. 26, 1908, p. 79.
Helix (Goniodiscus) rotundata, Jodot, Compte Rend. Assoc. Franc., Sess. 37, 1909, p. 427.
Pyramidula (Discus) rotundata, Taylor, Monog. Moll. Brit. Is., vol. 3, 1909, p. 180.
Goniodiscus rotundatus, Kennard & Woodward, Syn. Brit. Non-Marine Moll., 1926, p. 154.

"Shell almost discoidal, but more depressed above than below; whorls six or seven, slowly and regularly increasing, subcylindrical in shape, but with a subangulate periphery; of a yellowish-brown color, moderately opaque and glossy, and ornamented with a regularly placed series of rufous flames and blotches, which often alternate with those of the preceding whorl; the sculpture consists of curved transverse ribs, of which there may be 120 or more on the last whorl, with finer intermediate striae, which encircle the whorls and are only slightly stronger on the upper side; suture well marked; mouth transversely ovaliform, with a sharp and thin peristome, which is reflected basaly and slightly inflected above; umbilicus extremely wide, open, and deep, exposing all the internal spire; epiphragm very thin, whitish, and semi-transparent. Diam. 7 mill.; alt. 3 mill." (Taylor)

Type locality: Germany (?).

Distribution: Newfoundland, Ferryland; Massachusetts, Dorchester. W. J. Clench and G. Banks, Naut., vol. 52, 1939, p. 108.

Remarks: Recently, this species, new to the fauna of North America, was found in Newfoundland by Mrs. S. T. Brooks of the Carnegie Museum during the summer of 1937. It has also been recorded recently from Massachusetts by Harry K. Clench.

D. rotundatus, found in western Europe, the British Isles, and the extreme northwestern tip of Africa (Algeria), has been found to occur in southeastern Newfoundland and in eastern Massachusetts. The occurrence of this European snail in Newfoundland strengthens the theory that *D. rotundatus* forms a part of a relic fauna that has inhabited Newfoundland since before the last glacier, and remained intact in an unglaciated portion of the island during the progression and recession of the last glacier. The members of this species, undoubtedly, were the remains of a circumpolar snail that had been distributed not only to North America, but also to Europe and Asia. Whether or not others of this same species were distributed to other sections of North America besides Newfoundland and Massachusetts and then destroyed by the oncoming glacier is not known, but is probable. Those snails in Newfoundland, according to the belief of Dr. M. L. Fernald, together with certain plants, were given shelter on islands amid the ice and snow during the last glacier. A few conchologists are still of the opinion that many of the European snails found in Newfoundland and in certain other sections of North America were "introduced" there, but they fail to state under what circumstances this "introduction" occurred.

The discovery of *Discus rotundatus* in Massachusetts helps to to strengthen the theory that this snail forms a part of a relic fauna inhabiting the extreme northeastern North America. It reached this section of the continent either by means of land bridges that connected North America with Europe, or as off-shoots of a circumpolar fauna. Further explorations in sections of North America between south-eastern Newfoundland and eastern Massachusetts may bring to light more specimens of this species.

BIBLIOGRAPHY

ADAMS, H., AND ADAMS, A.

The Genera of Recent Mollusca, vol. 2, 1858, p. 116.

ANTHONY, J. G.

"Description of Three New Species of Shells," Boston Journal of Natural History, vol. 3, 1840, p. 278.

BAKER, F. C.

"Life of the Pleistocene or Glacial Period," Illinois University Bulletin, vol. 17, 1920, 476 pp.

"Description of New Varieties of Land and Fresh Water Mollusca from Pleistocene Deposits in Illinois," The Nautilus, vol. 41, 1928, pp. 133-135.

BAKER, H. B.

"New Land Snails from Idaho and Eastern Oregon," The Nautilus, vol. 45, 1932, pp. 82-85.

BINNEY, W. G.

Terrestrial Mollusca and Shells of the United States, vols. 1-4, 1851-1859.

Manual of American Land Shells, United States National Museum, Bull. 28, 1885, 528 pp.

BINNEY, W. G., AND BLAND, T.

Land and Fresh-water Mollusca of North America, pt. 1, 1869, 316 pp.

BLAND, T.

"Remarks on Certain Species of North American Helicidae," Lyceum of Natural History of New York, vol, 7, 1861, pp. 421-422.

CLAPP, G. H.

"Notes on Two Varieties of Pyramidula (Patula) alternata (Say)," Nautilus, vol. 13, 1899, pp. 41-42.

"Notes on the Land-shells of the Islands at the Western End of Lake Erie and Descriptions of New Varieties," Annals of the Carnegie Museum, vol. 10, 1916, pp. 532-540.

"A New Species of Pyramidula from Alabama and Notes on P. cumberlandiana with New Varieties," Nautilus, vol. 34, 1920, pp. 23-26.

In B. Walker, Terrestrial Shell-bearing Mollusca of Alabama, University of Michigan Miscellaneous Publication, 18, 1928, pp. 111-112.

Cockerell, T. D. A.

"A List of the Mollusca of Colorado," Nautilus, vol. 3, 1890, p. 102.

"Tertiary Mollusca from New Mexico and Wyoming," American Museum of Natural History, Bull. 33, 1914, pp. 101-102.

Dall, W. H.

Land and Fresh-water Mollusca of Alaska, 1905, pp. 49-51.

Deshayes, G. P.

Encyclopedie Methodique, vol. 2, 1830, p. 217.

Goodrich, C.

"A Trip to the Islands in Lake Erie," Annals of the Carnegie Museum, vol. 10, 1916, pp. 527-531.

Hanna, G. D.

"Miocene Land Shells from Oregon," University of Kansas, Science Bulletin, vol. 13, 1920, pp. 6-7.

Harper, G. W.

"Description of a New Species of Patula and Remarks upon a Hyalina," Cincinnati Society of Natural History, vol. 4, 1881, p. 258.

Henderson, Junius.

Fossil Non-marine Mollusca of North America, 1935, pp. 157-158.

Hubricht, Leslie.

"A new *Anguispira* from Kentucky," Nautilus, vol. 51, 1938, p. 131.

Kutchka, G. M.

"Coloration of Land Snails," Proceedings of the Pennsylvania Academy of Science, vol. 10, 1936, pp. 143-146.

"New Varieties of *Anguispira* and *Discus*," Nautilus, vol. 52, 1938, pp. 11-14.

Lea, Isaac.

"Description of New Fresh Water and Land Shells," Proceedings of the American Philosophical Society, vol. 1, 1840, p. 289.

"Description of New Fresh-water and Land Shells," Transactions of the American Philosophical Society, vol. 8, 1843, p. 229.

Lewis, J.

"Notes on the Land Shells of Eastern Tennessee," American Journal of Conchology, vol. 6, 1871, p. 188.

NEWCOMB, W.

"Description of New Species of Land Shells," Proceedings of the California Academy of Science, vol. 3, 1865, p. 180.

PFEIFFER, L.

"Description of 36 New Species of *Helix* belonging to the Collection of H. Cuming, Esq.," Proceedings of the Zoological Society of London, 1845, p. 127.

PILSBRY, H. A.

Manual of Conchology, Second Series, vols. 3 and 9, 1887 and 1894.

"A Classified Catalogue of American Land Shells, with Localities," Nautilus, vol. 11, 1898, pp. 140-141.

"Description of New Species and Varieties of American *Zonitidae* and *Endodontidae*," Nautilus, vol. 12, 1898, pp. 85-86.

"New Species and Subspecies of American Land Snails," Nautilus, vol. 13, 1900, p. 114.

"The Subspecies *Pyramidula alternata*," Nautilus, vol. 15, 1901, pp. 5-6.

"Some Alleghenian Forms of the Land Snail *Gonyodiscus*," Proceedings of the Academy of Natural Sciences, Philadelphia, vol. 76, 1924, pp. 417-421.

PILSBRY, H. A., AND FERRISS, J. H.

"Mollusca of the Southwestern States, II," Proceedings of the Academy of Natural Sciences, Philadelphia, vol. 58, 1906, pp. 153-154.

PILSBRY, H. A., AND RHOADS, S. N.

"Contribution to the Zoology of Tennessee, No. 4," Proceedings of the Academy of Natural Sciences, Philadelphia, vol. 48, 1896, p. 48.

RUSSEL, L. S.

"Upper Cretaceous and Lower Tertiary Gastropoda from Alberta," Transactions of the Royal Society of Canada, vol. 23, pt. 4, 1929, pp. 86-87.

SAY, T.

"Description of Seven Species of American Fresh Water and Land Shells, not Noticed in the System," Journal of the Academy of Natural Sciences, Philadelphia, vol. 1, 1817, p. 18.

"Conchology," Nicholson's Encyclopaedia, 1816, p. 8.

"Description of Univalve Shells of the United States," Journal of the Academy of Natural Sciences, Philadelphia, vol. 2, 1821, pp. 157-158.

Scharff, R. F.

Distribution and Origin of Life in America, 1911, p. 72.

Shuttleworth, R. J.

"Diagnosen Neuer Mollusken," Berne Naturforschende Gesellschaft Mitheilungen, 1852, p. 195.

Stearns, R. E. C.

"Marine Eocene, Fresh Water Miocene and Other Mollusca of Western North America," in C. A. White, United States Geological Survey, Bull. 18, 1885, p. 14.

Tryon, G. W.

"Monograph of the Terrestrial Mollusca of the United States," American Journal of Conchology, vol. 2, 1866, p. 261.

Vanatta, E. G.

"Four New Species of Shells," Proceedings of the Academy of Natural Sciences, Philadelphia, vol. 76, 1924, pp. 423-424.

Walker, B.

An Illustrated Catalogue of the Mollusca of Michigan, 1906, p. 492.

The Terrestrial Shell-bearing Mollusca of Alabama, Michigan University Miscellaneous Publication No. 18, 1928, pp. 112-113.

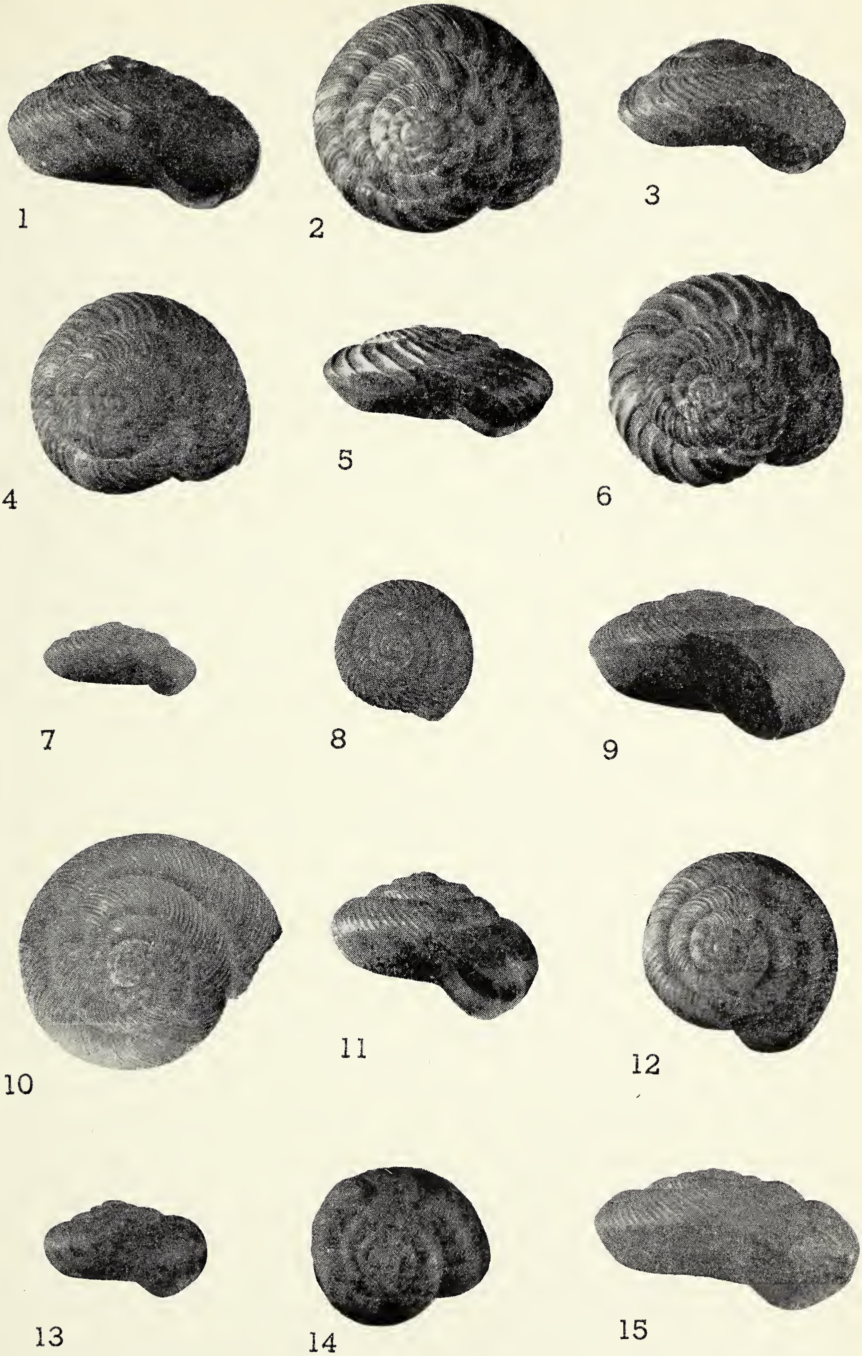
Wheeler, H. E.

"Additions to the List of Mollusca of Monte Sano, Alabama," Nautilus, vol. 26, 1912, p. 16.

EXPLANATION OF PLATE XXXVIII

(Slightly larger than natural size)

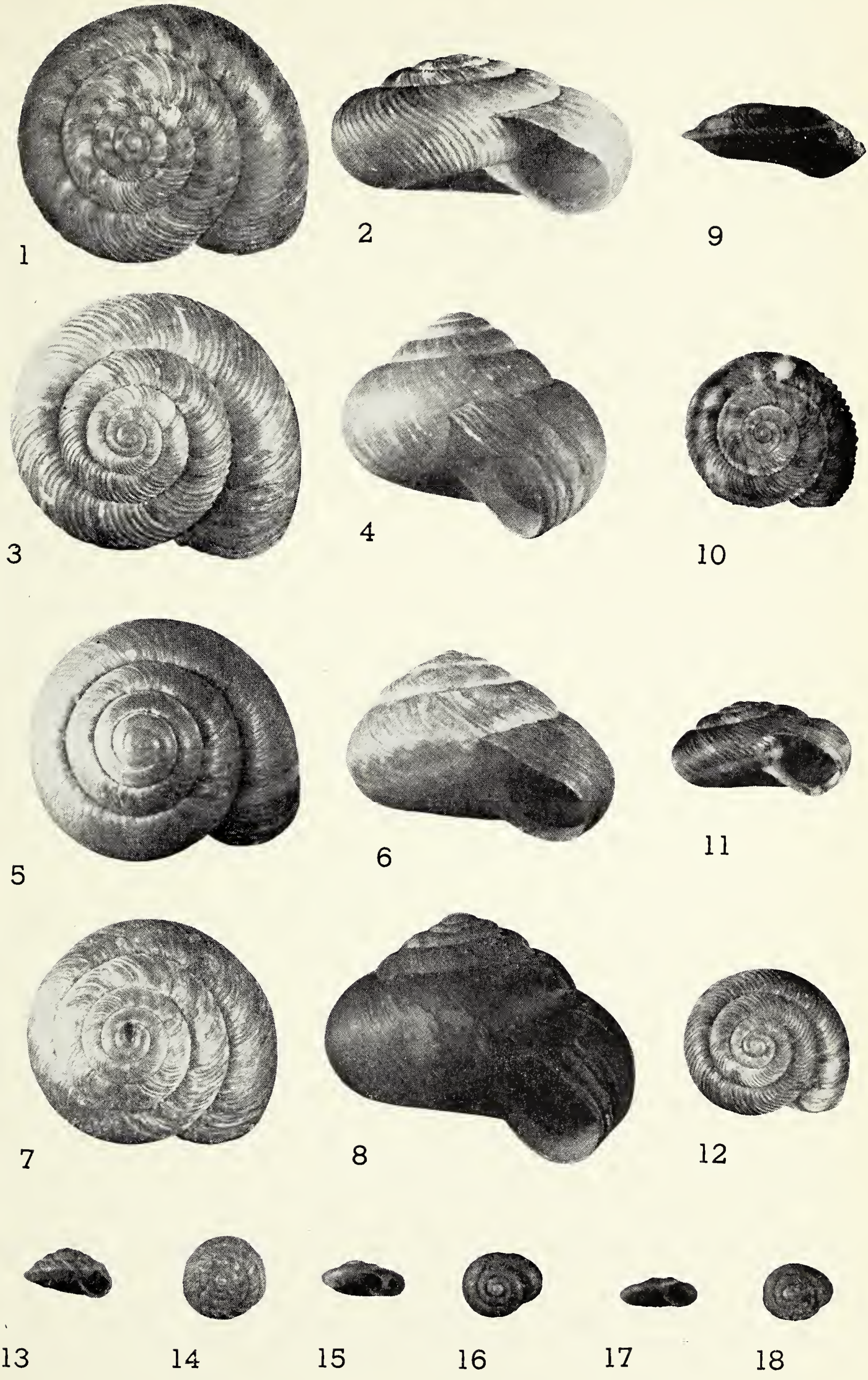
FIGS. 1, 2. *Anguispira alternata* (Say).
FIGS. 3, 4. *Anguispira alternata mordax* (Shuttleworth).
FIGS. 5, 6. *Anguispira alternata costata* (Lewis).
FIGS. 7, 8. *Anguispira nimapuna* H. B. Baker.
FIGS. 9, 10. *Anguispira alternata carinata* (Pilsbry and Rhoads).
FIGS. 11, 12. *Anguispira alternata rarinotata* (Pilsbry).
FIGS. 13, 14. *Anguispira alternata fergusoni* (Bland).
FIG. 15. *Anguispira alternata jessica* Kutchka.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

EXPLANATION OF PLATE XXXIX

(Slightly larger than natural size)

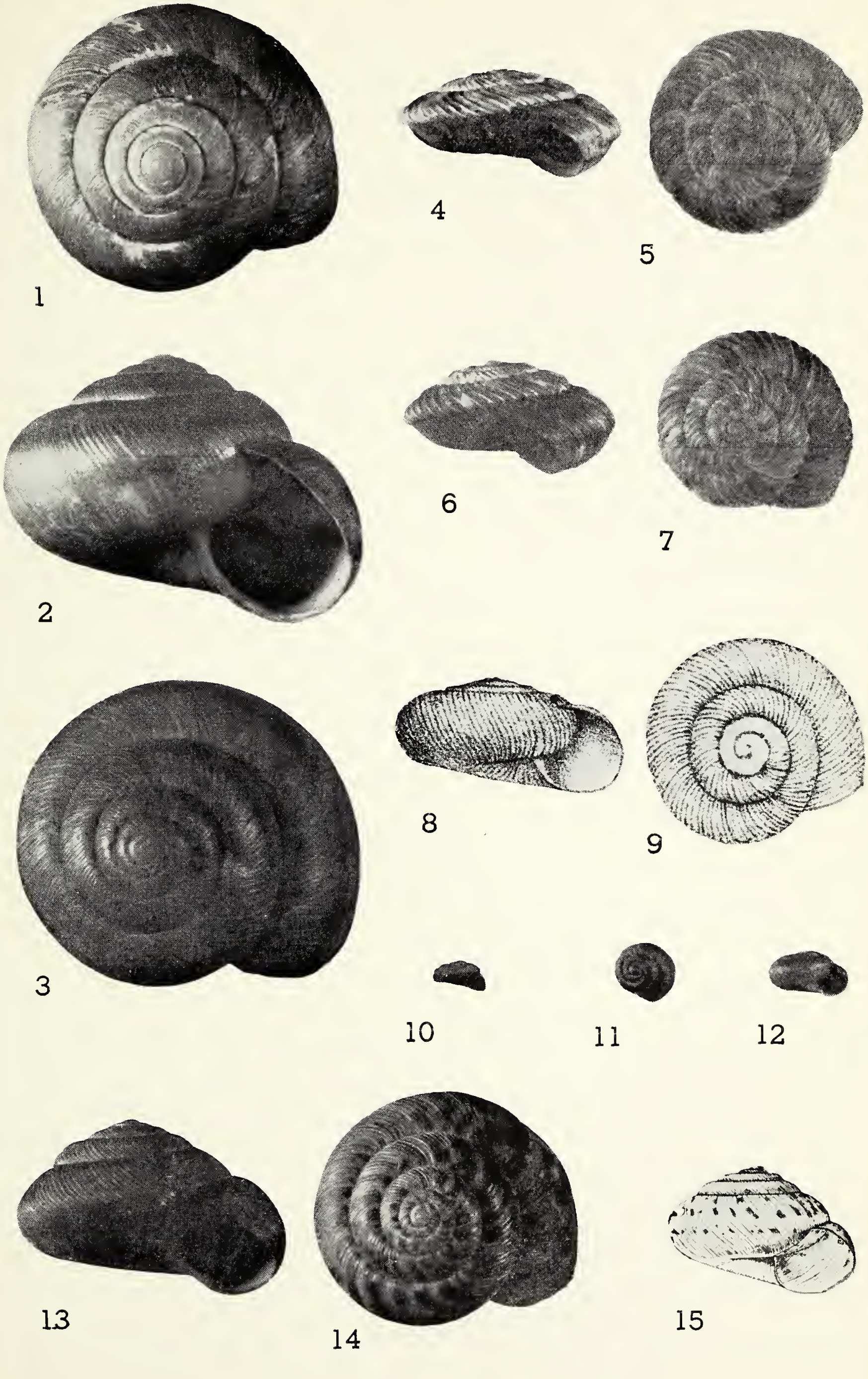
FIG. 1.	*Anguispira alternata jessica* Kutchka.
FIGS. 2, 3.	*Anguispira alternata knoxensis* (Pilsbry).
FIGS. 4, 5.	*Anguispira kochi roseo-apicata* (Clapp).
FIGS. 6, 7.	*Anguispira alternata eriensis* (Clapp).
FIG. 8.	*Anguispira kochi strontiana* (Clapp).
FIGS. 9, 10.	*Anguispira cumberlandiana* (Lea).
FIGS. 11, 12.	*Anguispira alternata macneilli* Walker.
FIGS. 13, 14.	*Discus marmorensis* H. B. Baker.
FIGS. 15, 16.	*Discus cronkhitei* (Newcomb).
FIGS. 17, 18.	*Discus cronkhitei catskillensis* (Pilsbry).


1
2
9
3
4
10
5
6
11
7
8
12
13
14
15
16
17
18

EXPLANATION OF PLATE XL

(Slightly larger than natural size except when so designated)

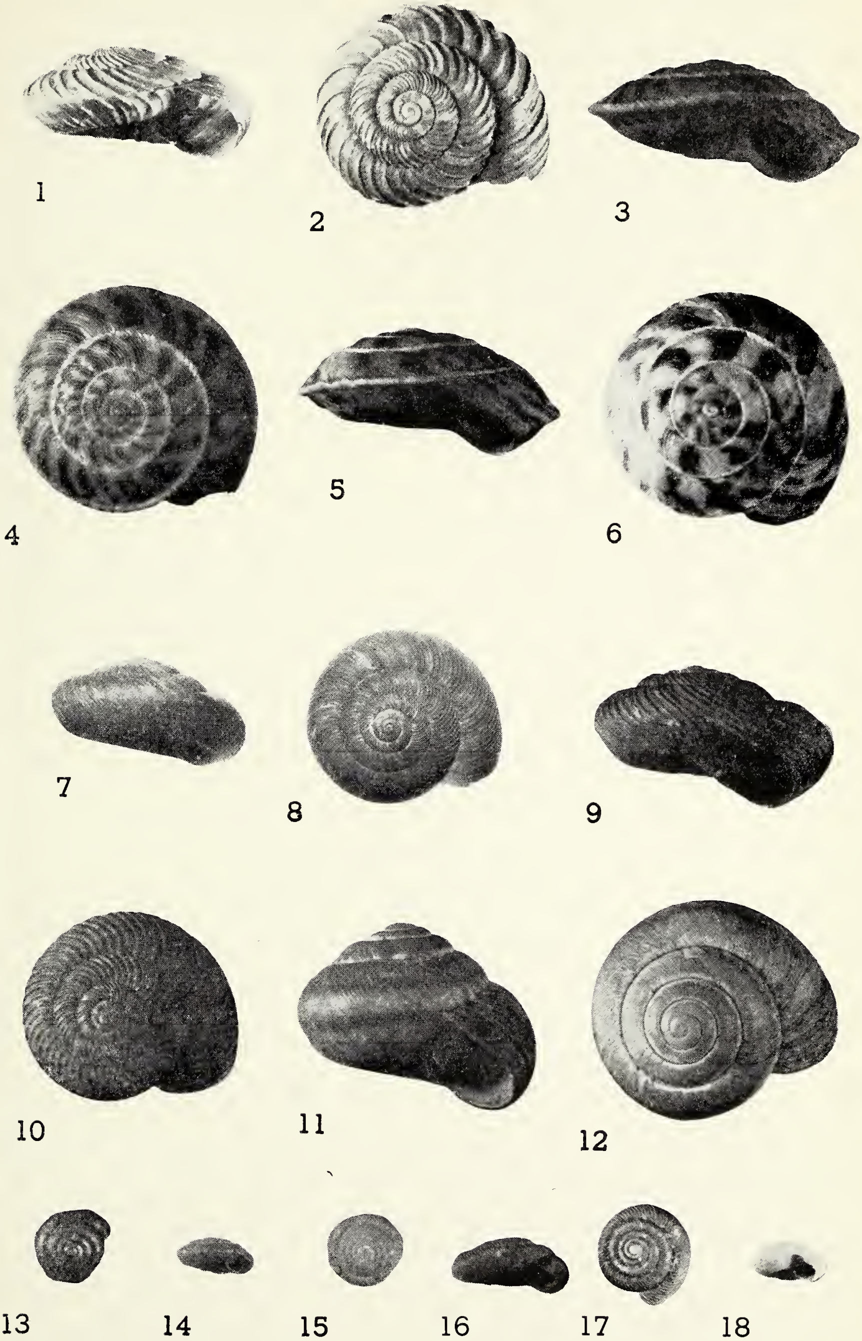
FIG. 1. *Anguispira kochi strontiana* (Clapp).
FIGS. 2, 3. *Anguispira kochi* (Pfeiffer).
FIGS. 4, 5. *Anguispira cumberlandiana columba* (Clapp).
FIGS. 6, 7. *Anguispira alternata smithi* Walker.
FIGS. 8, 9. *Discus selenitoides* (Pilsbry) 10 ×.
FIGS. 10, 11. *Discus cronkhitei anthonyi* (Pilsbry).
FIG. 12. *Discus shimekii cockerelli* (Pilsbry).
FIGS. 13, 14. *Anguispira alternata palustris* Clapp.
FIG. 15. *Anguispira clarki* Vanatta ⅓ nat. size.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

EXPLANATION OF PLATE XLI

(Slightly larger than natural size)

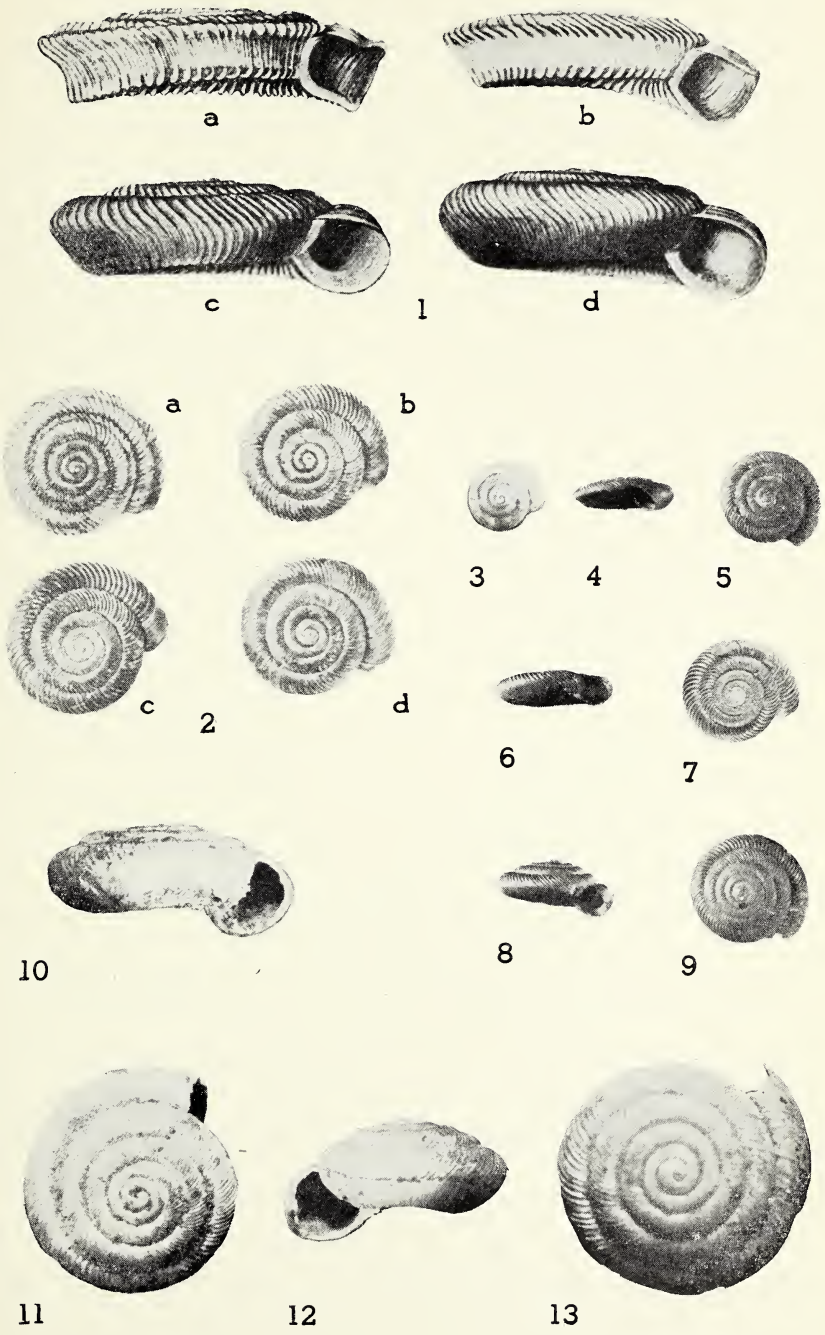
Figs. 1, 2. *Anguispira alternata paucicostata* Kutchka.
Figs. 3, 4. *Anguispira cumberlandiana alabama* (Clapp).
Figs. 5, 6. *Anguispira cumberlandiana picta* (Clapp).
Figs. 7, 8. *Anguispira alternata rugoderma* Hubricht.
Figs. 9, 10. *Auguispira alternata crassa* Clapp.
Figs. 11, 12. *Anguispira kochi mynesites* (Clapp).
Fig. 13. *Discus shimekii cockerelli* (Pilsbry).
Figs. 14, 15. *Discus rotundatus* (Mueller).
Figs. 16, 17. *Discus patulus* (Deshayes).
Fig. 18. *Discus shimekii* (Pilsbry).


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

EXPLANATION OF PLATE XLII

(Slightly larger than natural size except when so designated)

FIGS. 1a, 2a. *Discus clappi* (Pilsbry) 6 × & 3 ×.
FIGS. 1b, 2b. *Discus bryanti* (Harper) 7 × & 3 ×.
FIGS. 1c, 2c. *Discus bryanti nigromontanus* (Pilsbry) 6× & 3 ×.
FIGS. 1d, 2d. *Discus bryantwalkeri* (Pilsbry) 6 × & 3 ×.
FIG. 3. *Discus shimekii* (Pilsbry).
FIGS. 4, 5. *Discus bryanti tuberculatus* Kutchka.
FIGS. 6, 7. *Discus patulus brooksi* Kutchka.
FIGS. 8, 9. *Discus patulus angulatus* Kutchka.
FIGS. 10, 11. *Discus macclintocki* (F. C. Baker) 5 ×.
FIGS. 12, 13. *Discus macclintocki angulatus* (F. C. Baker) 4.5 ×.


a
b
c
1
d
a
b
3
4
5
c
2
d
6
7
10
8
9
11
12
13

INDEX