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Museum of Comparative Zoology

Cambridge, Mass. January 31, 1957 Number 67

NOTES ON CERTAIN SPECIES OF TETRAGNATHA (ARANEAE, ARGIOPIDAE) IN CENTRAL AMERICA AND MEXICO

By Arthur M. Chickering

Albion College, Albion, Michigan

In connection with my study of the genus *Tetragnatha* Latreille, 1804 in Panama and the West Indies I have also had occasion to examine a number of species from parts of Central America north of Panama, and also from Mexico, types of which are in the Museum of Comparative Zoology at Harvard College. The following notes are offered as a contribution to the further clarification of the genus.

Tetragnatha versicolor Walckenaer, 1841

T. convexa Banks, 1898
T. convexa Petrunkevitch, 1911
T. convexa Roewer, 1942

A vial labelled *T. convexa* Banks and marked "cotypes" now contains one male and three females all from San Jose del Cabo, Baja California. The chelicerae, palp, and other characters make it certain that the male belongs to *T. versicolor* Walckenaer. The females are always more difficult to place with accuracy but I feel certain that these belong in the same species with the male. There is another male in the collection from Sierra Laguna, Baja California, originally identified as a *T. convexa* Banks but this is also clearly a *T. versicolor* Walckenaer.

Tetragnatha guatemalensis O. P. Cambridge, 1889

T. fraterna Banks, 1898
T. mandibulata Banks, 1898

T. fraterna Petrunkevitch, 1911
T. fraterna Roewer, 1942

The characteristics of the male palp and the male chelicerae definitely identify the males collected at San Jose del Cabo, Baja California and described as *T. fraterna*, and I feel confident that we may be certain of the correct placement of the females as well. Banks identified both sexes collected at Tepic and San Jose del Cabo as specimens of *T. mandibulata* Walckenaer, 1841, known at present only from Ceylon, India, Australia, and Polynesia. Re-examination of these shows clearly that they belong to *T. guatemalensis* O. P. Cambridge.

TETRAGNATHA TRISTANI Banks, 1909

(Figures 1-5)

There is only a single specimen to represent this species so far as I have been able to determine. This is the holotype very briefly described by its author. I have carefully searched through my collections of *Tetragnatha* from the regions of Panama closely contiguous to Costa Rica, from which country the original was collected, without discovering any additional specimens. I have also compared the holotype with all other species known to me, with the result that I am compelled to regard it as a valid species.

External Anatomy of *Tetragnatha tristani* Banks

Figures 1, 2. Cheliceral teeth along the fang groove; promarginal and retromarginal teeth, respectively.

Figures 3, 4. Distal ends of cymbium, embolus, and conductor from two different views.

Figure 5. Paracymbium.

Since the original description was so brief I have thought it desirable to furnish a detailed treatment in accord with my usual procedure.

Male holotype. Total length including the chelicerae 4.55 mm.; exclusive of the chelicerae 4.16 mm. Carapace 1.495 mm. long, .97 mm. wide opposite second coxae where it is widest; other features as usual in the genus.

Eyes. Eight in two rows as usual in the genus; viewed from above, both rows moderately recurved; viewed from in front, both rows slightly procurved, both measured by centers. Central ocular quadrangle wider behind than in front in ratio of about 14 : 11, slightly wider behind than long. Ratio of eyes AME : ALE : PME : PLE = 7 : 5.5 : 8 : 6.5. AME separated from one another by 1.5 times their diameter, from ALE by a little more than twice their diameter. PME separated from one another by 1.7 times their diameter, from PLE by slightly more than this distance. Laterals separated from one another by the diameter of PLE; AME separated from PME by nearly 1.5 times as far. Height of clypeus equal to a little more than the diameter of AME.

Chelicerae. Moderately well developed, porrect and divergent; basal segment .78 mm. long and, therefore, about half as long as the carapace; the prolateral spur is simple, rather poorly developed, and not distally bifid; the fang is moderately sinuous and distinctly bent posteriorly in distal half; the promargin of the fang groove has seven teeth but the last three are minute denticles and would probably be subject to much variation in a large population; the retromargin also has seven teeth with the last two very small (Figs. 1-2).

Maxillae. Nearly parallel; somewhat concave along outer border; about three times as long as wide at narrowest level.

Lip. Wider at base than long in ratio of about 15 : 11; less than one-half as long as maxillae; sternal suture gently procurved; sternal tubercles well developed and robust at ends of sternal suture.

Sternum. As usual in the genus; with fourth coxae separated by about one-half their width.

Legs. 1243. Width of first patella at "knee" .162 mm., tibial index of first leg 4. Width of fourth patella at "knee" .152 mm., tibial index of fourth leg 7.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
			(All measurements in millimeters)			
1.	2.990	.650	3.250	3.380	.975	11.245
2.	2.080	.552	1.755	1.885	.700	6.972
3.	1.105	.390	.617	.845	.325	3.282
4.	2.210	.390	1.625	1.950	.520	6.695
Palp	.660	.154	.176	——	.970	1.960

All legs with moderately coarse spines and the normal coating of hair.

Palp. Both tibia and patella are short with the former only slightly longer than the latter; the paracymbium is very transparent but appears to have the shape shown in Figure 5; the cymbium is long and slender; the conductor and embolus are also long, slender, and gently curved (Figs. 3-4).

Abdomen. Not prolonged posterior to spinnerets; only slightly swollen in anterior half; slightly notched dorsally at base; 2.73 mm. long; .95 mm. wide about one-third of its length from base where it is widest.

Color in alcohol. Color apparently well preserved. Legs, mouth parts and cephalothorax with various shades of yellowish to light reddish brown. Abdomen with a well defined folium and many closely placed yellowish white silvery spangles on dorsum and along lateral sides. Venter plain yellowish.

There is only one specimen known at present and that was collected by Prof. J. Fid. Tristan of San Jose, Costa Rica, in his home city with no date recorded.

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1909. Arachnida from Costa Rica. Proc. Acad. Nat. Sci. Philadelphia, April, 1909: 194-234, 2 pls.

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Museum of Comparative Zoology

CAMBRIDGE, MASS. January 31, 1957 NUMBER 68

THE GENUS TETRAGNATHA (ARANEAE, ARGIOPIDAE) IN JAMAICA, B.W.I., AND OTHER NEIGHBORING ISLANDS

ARTHUR M. CHICKERING

Albion College, Albion, Michigan

For several years before her death in 1953 Miss Elizabeth B. Bryant, Museum of Comparative Zoology at Harvard College, had been engaged in a comprehensive study of a collection of spiders from Jamaica, B. W. I. This collection had come from several sources but it had been assembled largely through the interest of Mr. C. Bernard Lewis, Director and Curator, Science Museum, Institute of Jamaica, Kingston, Jamaica. After Miss Bryant's death this collection was placed in my possession for continued study. On my way to Panama in June, 1954, I was able to stop in Jamaica for a reconnaissance of the island preparatory to what may be a more or less extensive study of the spiders of that country.

As an extension of my study of the genus *Tetragnatha* Latreille, 1804 in Panama, I have been much interested in examining the genus in Jamaica and in comparing the species found there with the tetragnathids in several of the larger islands of that general region. This paper is a result of that study, and types of the new species named here are deposited in the Museum of Comparative Zoology.

It is again a pleasure to acknowledge my indebtedness to the following persons for their continued encouragement in the pursuit of my studies: Dr. A. S. Romer and Dr. P. J. Darlington, Jr., Director, and Curator of Insects, respectively, in the Museum of Comparative Zoology at Harvard College, and Miss Nelda E. Wright, Editor of Publications in the same institution. Without the privileges which have been extended to me

for many years in this museum the continued progress of my studies would have been much more difficult.

Genus TETRAGNATHA Latreille, 1804

The genus has been well defined by Seeley (1928) and is, in general, well understood by araneologists. There are, however, certain characteristics of the genus which have in the past made it difficult to identify the species correctly and numerous errors must eventually be eliminated. It is also my opinion that sufficient attention has not usually been given to the question of variation within species in respect to several of the most important structural features used by taxonomists for identification. F. P. Cambridge (1897-1905) emphasized the value of the characteristics of the male palp such as the form of the paracymbium, shape and course of the conductor and embolus as well as the features of the eyes, chelicerae, and legs. Petrunkevitch (1930) and Wiehle (1939) were the first to appreciate the value of the genital area, which lacks an epigynum, in identifying females which are often exceedingly difficult to place with certainty. Color has been shown to be extremely variable and nearly worthless as a means of identification. Cheliceral teeth are often quite variable in number, degree of development, and relative position. Size, when mature, is also subject to great variation in several species. I have tried to take account of all of these salient features in making my determinations.

THE GENUS IN JAMAICA

Only the bibliographical references considered essential are given in this paper. Extensive bibliographies may be found in several sources.

TETRAGNATHA ANTILLANA Simon, 1897

T. antillana Petrunkevitch, 1930
T. antillana Bryant, 1940
T. antillana Bryant, 1942
T. festina Bryant, 1945 (male only)
T. haitiensis Bryant, 1945

This species appears to be common in Jamaica. It was found abundant at Mavis Bank over water by R. P. Bengry. Collection records: One male from the Blue Mts., southwest side of Main Range, between 3000-4000 ft. elevation, August, 1934 (P. J. Darlington, Jr.); both sexes from Mavis Bank, over water, March, 1953 (R. P. Bengry); one female from Rio Cobre, June, 1954.

TETRAGNATHA CAUDATA EMERTON, 1884

Eucta caudata Petrunkevitch, 1911
T. caudata Seeley, 1928
T. caudata Bryant, 1940

Miss Bryant had a single female from Cuba. The species appears but once in the collection from Jamaica placed at my disposal; Papine, five miles north of Kingston, April, 1937.

TETRAGNATHA EXIGUA sp. nov.

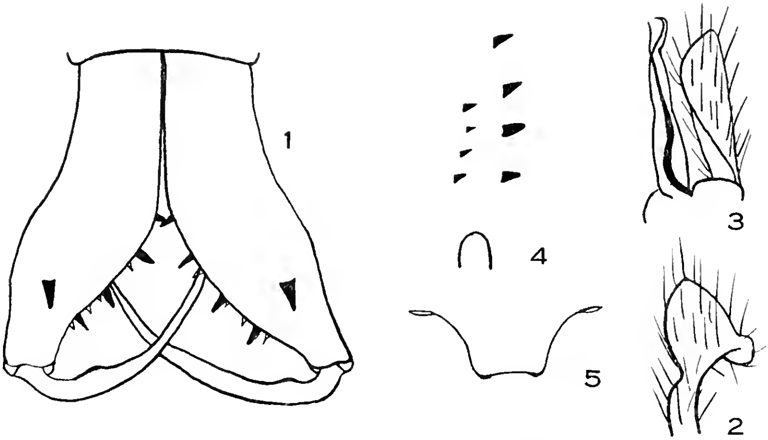
(Figures 1-5)

Male holotype. Total length including chelicerae 2.795 mm., without chelicerae 2.34 mm. Carapace 1.04 mm. long; .67 mm. wide opposite second coxae where it is widest; with the usual general form of the genus; .209 mm. tall at about the middle; nearly level from PE to posterior declivity; median depression very shallow, opposite interval between second and third coxae.

Eyes. Eight in two rows as usual; lateral ocular tubercles rather prominent; viewed from above, both rows moderately recurved; viewed from in front, anterior row slightly recurved and posterior row slightly procurved, both measured by centers; central ocular quadrangle wider behind than in front in ratio of about 4 : 3, wider behind than long in about the same ratio. Ratio of eyes AME : ALE : PME : PLE = 5.5 : 4 : 5 : 4. AME separated from one another by about 1.2 times their diameter, from ALE by about the same distance. PME separated from one another by a little less than twice their diameter, from PLE by about two thirds as far. Laterals separated from one another by about 1.25 times their diameter. AME separated from PME by a little more than the diameter of AME, hence further from one another than laterals are from one another in ratio of about 6 : 5. Height of clypeus equal to nearly 1.5 times the diameter of AME.

Chelicerae. Well developed, moderately porrect, quite divergent in distal two thirds, somewhat swollen in middle; prolateral spur a simple spine not bifid distally; fang slender, slightly sinuate, with a blunt tubercle on inner margin about one-fifth of its length from base; promargin of fang groove with four teeth, retromargin with four smaller teeth; with no "large tooth" on the promargin (Fig. 1).

Maxillae. Nearly parallel; slightly concave in middle of lateral border; somewhat more than twice as long as lip; three times as long as wide in middle.



External Anatomy of *Tetragnatha exigua* sp. nov.

Fig. 1. Chelicerae of male from in front.
Fig. 2. Paracymbium of male palp.
Fig. 3. Distal end of cymbium, conductor, and embolus.
Fig. 4. Cheliceral teeth of female.
Fig. 5. Genital fold of female.

Lip. Much widened in basal third where it is wider than long in ratio of 22 : 14; sternal suture only slightly procurved; with the usual sternal tubercles well developed at ends of sternal suture.

Sternum. Quite convex; surface finely pitted and granulated; with the usual form; continued laterally and posteriorly between all coxae; only a little longer than wide; posterior coxae separated by a little more than their width.

Legs. 1243. Width of first patella at "knee" .1083 mm., tibial index of first leg 4. Width of fourth patella at "knee" .0758 mm., tibial index of fourth leg 5.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	2.275	.390	2.275	1.755	.718	7.413
2.	1.625	.325	1.430	1.380	.580	5.340
3.	.910	.198	.445	.550	.308	2.411
4.	1.430	.260	1.170	1.235	.455	4.550
Palp	.440	.120	.176	——	.396	1.132

Spines. True spines appear to be entirely lacking in this species (a very unusual feature); hair and bristles are sparsely present. Trichobothria are present but have not been accurately observed.

Palp. Both tibia and patella are short with tibia longer than patella in ratio of about 3 : 2. The paracymbium is unusually broad. The conductor and embolus are shaped and related essentially as shown in Figures 2 and 3.

Abdomen. Slender; broadest near base and gradually tapered to a blunt point posteriorly; bluntly truncated at base which is not notched; 1.495 mm. long; longer than wide in ratio of about 23 : 9; not continued posterior to spinnerets. Other features as usual in the genus.

Color in alcohol. First and second femora yellowish; all other segments of legs a dusky yellowish. Palps light yellowish except the reddish brown tarsi. Chelicerae: basal segment a deep reddish brown; fang yellowish. Lip a deep reddish brown, lighter along distal border. Maxillae yellowish in medial third and brown elsewhere. Carapace a deep reddish brown, darker along the margins; median region with a narrow dark stripe posteriorly and widening at the median depression and extending to PLE; all eyes except AME surrounded by black pigment. Sternum: a deep reddish brown. Abdomen: nearly white dorsally with a few silvery spangles; in the posterior third there are very poorly outlined median gray spots with a series of very narrow black transverse lines; a fairly broad gray stripe extends along each lateral side; the venter is generally white with a little gray around the genital area and spinnerets.

Female allotype. Total length including nearly vertical chelicerae 3.12 mm. Carapace 1.28 mm. long; .715 mm. wide opposite second coxae where it is widest; otherwise essentially as in male.

Eyes. Central ocular quadrangle wider behind than in front in ratio of 5 : 4, wider behind than long in ratio of 5 : 4. Ratio of eyes AME : ALE : PME : PLE = 6 : 4.5 : 5.5 : 5. AME separated from one another by five-sixths of their diameter, from ALE by 1.5 times their diameter. PME separated from one another by slightly more than 1.6 times their diameter, from PLE by the same distance. Laterals separated from one another by the diameter of PLE. AME separated from PME by the diameter of PLE, hence as far from one another as the laterals are from one another. Height of clypeus equal to about two-thirds of the diameter of AME.

Chelicerae. Moderately well developed; nearly vertical and parallel; basal segment .454 mm. long and, therefore, about one-third as long as cephalothorax; fang slender and evenly curved; promargin of fang groove with four well-developed teeth fairly evenly spaced; retromargin with four smaller and fairly evenly spaced teeth (delicacy of the specimen makes it difficult to observe teeth accurately).

Maxillae, Lip, and *Sternum.* Essentially as in male.

Legs. 1243. Width of first patella at "knee" .119 mm., tibial index of first leg 5. Width of fourth patella at "knee" .097 mm., tibial index of fourth leg 7.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	2.210	.378	2.015	2.015	.716	7.334
2.	1.625	.330	1.170	1.430	.585	5.140
3.	.845	.200	.520	.550	.396	2.511
4.	1.495	.265	1.105	1.170	.401	4.436

Spines, hairs, and trichobothria essentially as in male.

Abdomen. 1.95 mm. long; broadest near middle where it is .910 mm. wide; slightly notched at base; genital area essentially as shown in Figure 5. Otherwise essentially as in male.

Color in alcohol. Abdomen: dorsally the cardiac area is nearly colorless; there are numerous silvery spangles and a vaguely outlined folium; the venter has a central slightly grayish stripe with a stripe on each side outlined by silvery spangles. Otherwise essentially as in male.

Type locality. Holotype male, allotype female, and three paratype males from Hanover, Askenish, Trail to Dolphin Head, Jamaica, June 24, 1954.

TETRAGNATHA PALLESCENS F. P. Cambridge, 1903

Eugnatha pallescens Petrunkevitch, 1911
T. pallescens Petrunkevitch, 1930
T. pallescens Bryant, 1940
T. pallescens Bryant, 1945

Collection records: A male and a female from Ocho Rios, January 1929 (W. S. Brooks); several of both sexes from St. Catherine, Port Henderson, Salina, November, 1949 (Bengry, Lewis, Wiles); both sexes from St. Thomas, Lysson, June, 1954.

TETRAGNATHA TENUISSIMA O. P. Cambridge, 1889

T. tenuissima Petrunkevitch, 1930
T. tenuissima Bryant, 1940
T. tenuissima Bryant, 1945

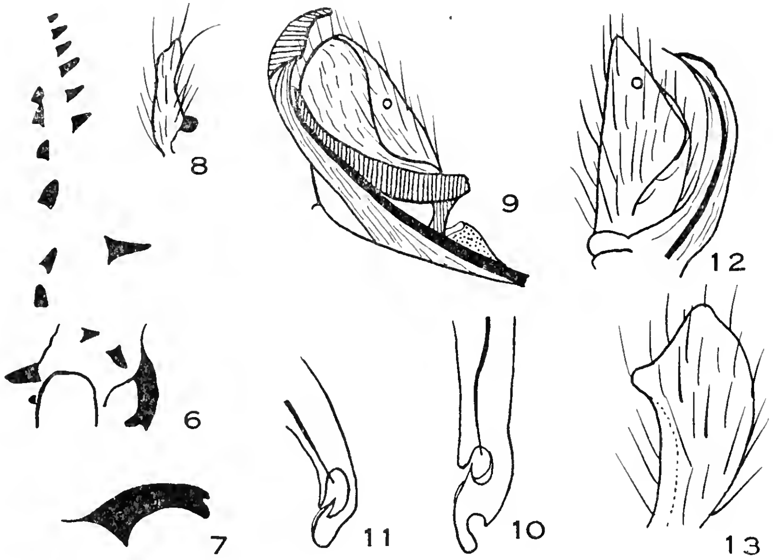
Only one specimen, a male, has appeared in the collection available to me; St. Elizabeth, Magotty, May, 1953 (G. R. Proctor).

TETRAGNATHA VISENDA sp. nov.

(Figures 6-9)

Male holotype. Total length including chelicerae 8.58 mm.; without chelicerae total length 7.475 mm. Carapace 2.60 mm. long; 1.495 mm. wide opposite second coxae where it is widest; with the usual general form of the genus; .66 mm. tall opposite third coxae just anterior to posterior declivity.

Eyes. Eight in two rows as usual; lateral ocular tubercles only moderately prominent; viewed from above, posterior row moderately recurved, anterior row strongly recurved; viewed from in front, anterior row moderately recurved, posterior row slightly procurved, all measured by centers; central ocular quadrangle wider behind than in front in ratio of 6 : 5, wider behind than long in ratio of 9 : 8. Ratio of eyes AME : ALE : PME : PLE = 11 : 5.5 : 8 : 7.5. AME separated from one another by slightly more than their diameter, from ALE by nearly twice their diameter. PME separated from one another by 2.5 times their diameter, from PLE by slightly more than this. Laterals separated from one another by slightly more than the diameter of PLE. AME separated from PME by slightly



External Anatomy of *Tetragnatha*

Fig. 6. *T. visenda* sp. nov.; cheliceral teeth of male from below.
Fig. 7. *Idem;* the prolateral spur of male.
Fig. 8. *Idem;* the male paracymbium.
Fig. 9. *Idem;* distal end of male tarsus.
Figs. 10-11. *T. versicolor* Walck.; distal ends of conductors and emboli from Cuba and Michigan, respectively.
Figs. 12-13. *T. parva* Bryant; distal end of male tarsus and paracymbium, respectively.

more than the diameter of AME, thus are farther from one another than laterals are from one another in ratio of about 12 : 7.5. Height of clypeus equal to a little more than two-thirds the diameter of AME.

Chelicerae. Well developed; moderately porrect; quite divergent in distal two-thirds of basal segment; somewhat swollen in distal half; prolateral spur well developed and clearly bifid with the larger lobe directed inward (Fig. 6); the fang is long, slender, only slightly sinuate; the fang groove has the so-called "large tooth" with eight others on the promargin and eight on the retromargin (Fig. 6).

Maxillae. Slender; considerably divergent in distal halves; a little more than twice as long as lip; longer than wide in middle in ratio of 4 : 1.

Lip. Only slightly wider at base than long; sternal suture clearly procurved; with the usual sternal tubercles well developed at ends of sternal suture.

Sternum. Only slightly convex; somewhat swollen opposite second coxae; with the usual general form; longer than wide in ratio of 12 : 7; continued laterally and posteriorly between all coxae; posterior coxae separated by about one-fourth their width.

Legs. 1243. Width of first patella at "knee" .395 mm., tibial index of first leg 5. Width of fourth patella at "knee" .260 mm., tibial index of fourth leg 6.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	6.500	1.105	6.890	7.475	1.560	23.530
2.	4.680	.910	4.225	4.420	.975	15.210
3.	2.340	.550	1.397	1.755	.600	6.642
4.	4.940	.715	3.835	4.420	.845	14.755
Palp	1.560	.370	.520	——	.850	3.300

Spines. All legs with spines of moderate size and length; a sparse coating of hair is also present. Trichobothria are present on femora and probably other segments of legs but their position has not been accurately observed.

Palp. Tibia and patella both short with tibia longer than patella in ratio of about 3 : 2. The paracymbium is rather long and slender with the chitinous knob about one-third of length of the structure from base (Fig. 8). The conductor terminates in a characteristic manner best shown in Figure 9.

Abdomen. Slender; only slightly concave at base; widest near middle; 5.07 mm. long and about 1.43 mm. wide in broadest region; not continued posterior to spinnerets; other features as usual in the genus.

Color in alcohol. All legs light yellowish brown, lighter below; first and second somewhat dusky dorsally and dorsolaterally with occasional grayish patches; third and fourth mostly lacking the dusky coloring and grayish patches. Chelicerae reddish brown, grayish along lateral surfaces. Lip dark brown with yellowish distal border. Maxillae yellowish in medial halves, darker along lateral halves. Carapace reddish brown with darker radiating streaks and an irregular granular border. Sternum reddish brown with darker irregularly grouped fine dots. Abdomen: dorsum light yellowish because of presence of numerous irregular subchitinous yellowish white deposits making this region very granular in appearance; there are also many short irregular grayish lines which become more longitudinal in position and prominent along the lateral sides; the venter has a median grayish stripe with a broader granular yellowish stripe on each side together with a white spot just lateral to each anterior spinneret and a smaller white spot just dorsal to the larger one.

Type locality. The male holotype was taken at St. Catherine, Port Henderson, June 20, 1954. One male paratype is in the collection from a house in St. Andrew, August, 1955 (G. R. Proctor).

THE GENUS IN CUBA

TETRAGNATHA ANTILLANA Simon, 1897

There is but one specimen, a male, in the collection in the Museum of Comparative Zoology but the species has been recorded from several localities.

TETRAGNATHA CAUDATA Emerton, 1884

Two females are in the collection in the Museum of Comparative Zoology, both taken at different times in Soledad gardens.

TETRAGNATHA ELONGATA Walckenaer, 1805

This species is well represented by both sexes in the collection and appears to be the most common of all of the eight species recorded from the island.

TETRAGNATHA GUATEMALENSIS O. P. Cambridge, 1889

T. banksi McCook, 1893
T. seneca Seeley, 1928
T. banksi Levi and Field, 1954

Drs. Gertsch and Levi have apparently agreed that *T. seneca* Seeley is the same as *T. banksi* McCook. I have made careful comparisons of the specimens from Cuba identified as *T. seneca* Seeley with my numerous specimens of *T. guatemalensis* O. P. Cambridge from Panama and other parts of Central America with the result that I am convinced that here we have another case of synonymy. The characteristics of eyes, several features of the male palps such as vermiform distal end of the paracymbium and course and shape of both conductor and embolus together with the general characters of the chelicerae all point toward this conclusion. Some may object that I am taking too much liberty with the cheliceral teeth because the "large tooth" is absent in *T. seneca* Seeley. This "large tooth" is not well developed in *T. guatemalensis* O. P. Cambridge and could very well have been reduced to the condition found in *T. seneca* Seeley. The specimens in the Museum of Comparative Zoology identified as *T. banksi* McCook also agree well with *T. seneca* Seeley as concluded by Levi and Field (1954).

TETRAGNATHA ORIZABA Banks, 1898

There are several specimens of both sexes from several localities in Cuba. Also recorded from Hispaniola but from no other place in the West Indies so far as known to the author of this paper.

TETRAGNATHA PALLESCENS F. P. Cambridge, 1903

Both sexes are represented in the collection from Havana and Soledad.

TETRAGNATHA TENUISSIMA O. P. Cambridge, 1889

Both sexes have been recorded from several localities.

TETRAGNATHA VERSICOLOR Walckenaer, 1841

T. extensa Emerton, 1884
T. dentigera F. P. Cambridge, 1903
T. extensa Seeley, 1928

The specimens from Soledad identified as *T. dentigera* F. P. Cambridge are, I believe, correctly recognized. These are especially interesting because of the fact that I have been forced to the conclusion that *T. dentigera* F. P. Cambridge is a synonym for *T. versicolor* Walck. I have examined a large number of specimens assigned to the latter species and as many as possible of the former. The cheliceral teeth, several features of the male palps (paracymbium, conductor, embolus) and the eyes all point rather decisively toward the synonymy which I have indicated. The tip of the conductor is like nothing else in the genus so far as I have seen. I have provided a drawing of the tip of the conductor from a specimen collected in Cuba and another from a specimen of *T. versicolor* taken in Michigan. There are slight differences but the basic plan is the same and the differences are well within the normal variation of a species (Figs. 10, 11).

THE GENUS IN HISPANIOLA

TETRAGNATHA ANTILLANA Simon, 1897

T. festina Bryant, 1945 (male only)
T. haitiensis Bryant, 1945 (females)

The males of *T. festina* Bryant have the bifid paracymbium, other features of the male palpi, eyes, and general cheliceral characters associated with *T. antillana* Simon. *T. haitiensis* Bryant has the general form, cheliceral characters, and genital area characteristic of females of *T. antillana*. The small differences noted by Miss Bryant and myself are all, I believe, within the normal variation for a species ranging over a wide area.

TETRAGNATHA CONFRATERNA Banks, 1909

T. elongata Bryant, 1945

One female from Puerta Plata, Dominican Republic, was identified as *T. elongata* Walck., 1805. I have examined this specimen very carefully and I am convinced that it has been misidentified. Its slightly extended abdomen, cheliceral characters, eyes, and genital area seem to place it in the species *T. confraterna* Banks where it is provisionally left.

TETRAGNATHA ORIZABA Banks, 1898

T. orizaba Bryant, 1945

The specimens of both sexes from the Dominican Republic seem to agree well with our current understanding of this species.

TETRAGNATHA PALLESCENS F. P. Cambridge, 1903

T. pallescens Bryant, 1945

Numerous specimens of both sexes from Haiti seem to indicate that this may be the most common species in Hispaniola.

TETRAGNATHA TENUISSIMA O. P. Cambridge, 1889

T. tenuissima Bryant, 1945
T. festina Bryant, 1945 (females only)

The cheliceral teeth, eyes, general form, lack of leg spines, and the genital area all indicate that *T. festina* females belong with *T. tenuissima* O. P. Cambridge.

THE GENUS IN PORTO RICO

I have had very little opportunity to study the species of *Tetragnatha* from Porto Rico. Petrunkevitch (1930) listed the following species from this island: *T. antillana* Simon; *T. elyunquensis* Petrunkevitch; *T. laboriosa* Hentz; *T. pallescens* F. P. Cambridge; *T. piscatoria* Simon; *T. subextensa* Petrunkevitch; *T. tenuissima* O. P. Cambridge; *T. vicina* Simon. There appears to be considerable doubt about the occurrence of *T. vicina* in Porto Rico. In 1947 Miss Bryant described *T. parva* from the Luquillo Mountains thus bringing the total number of recorded species in this island to nine. Two figures of the tip of the conductor and closely related structures have been prepared to supplement those provided by the author of the species (Figs. 12, 13).

THE GENUS IN THE VIRGIN ISLANDS

Very little opportunity has been afforded me to study the spiders of these small islands. I have carefully examined all specimens, however, now in the collection of the Museum of Comparative Zoology and am prepared to summarize my findings as follows: The vial labelled *T. antillana* Simon contains specimens belonging to this species but it also contains two females which I am tentatively assigning to *T. confraterna* Banks. The same vial contains a male palp which I believe was derived from this same species. Perhaps we may at least tentatively regard this species as being in the West Indies. The single male assigned to *T. piscatoria* Simon is, in my judgment, not this species but a specimen belonging to *T. visenda* sp. nov.

GENERAL SUMMARY

At the present time it seems that either fifteen or sixteen species of *Tetragnatha* may be considered to be known from the West Indies under consideration here. *T. elyunquensis* Petrunkevitch, *T. exigua* sp. nov., *T. parva* Bryant, *T. subextensa* Petrunkevitch, and *T. visenda* sp. nov. are known only from the islands from which they were described. *T. antillana* Simon has been recorded from all islands mentioned here. *T. caudata* Emerton has been recorded from Cuba and Jamaica. *T. confraterna* Banks is probably to be regarded as present in both Hispaniola and the Virgin Islands. *T. elongata* Walck. is only certainly known from Cuba. *T. guatemalensis* O. P. Cambridge is now known only from Cuba. *T. laboriosa* Hentz is, apparently, present only in Porto Rico. *T. orizaba* Banks appears to be in Cuba and Hispaniola. *T. pallescens* F. P. Cambridge has been recorded from all islands considered here except the Virgin Islands. *T. piscatoria* Simon is known only from Porto Rico among the islands considered here but it was described from St. Vincent. *T. tenuissima* O. P. Cambridge is known from all of these islands except the Virgin Islands. *T. vicina* Simon has been recorded from Porto Rico but its presence there appears doubtful.

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B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. January 31, 1957 Number 69

A NEW ZODARIID SPIDER FROM PANAMA

By Arthur M. Chickering

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Until the discovery of the species described in this paper only one zodariid spider was known from Panama, although a few others had been reported from Guatemala and Mexico. The single species hitherto known from Panama is *Storena barroana* (Chamberlin), 1925.

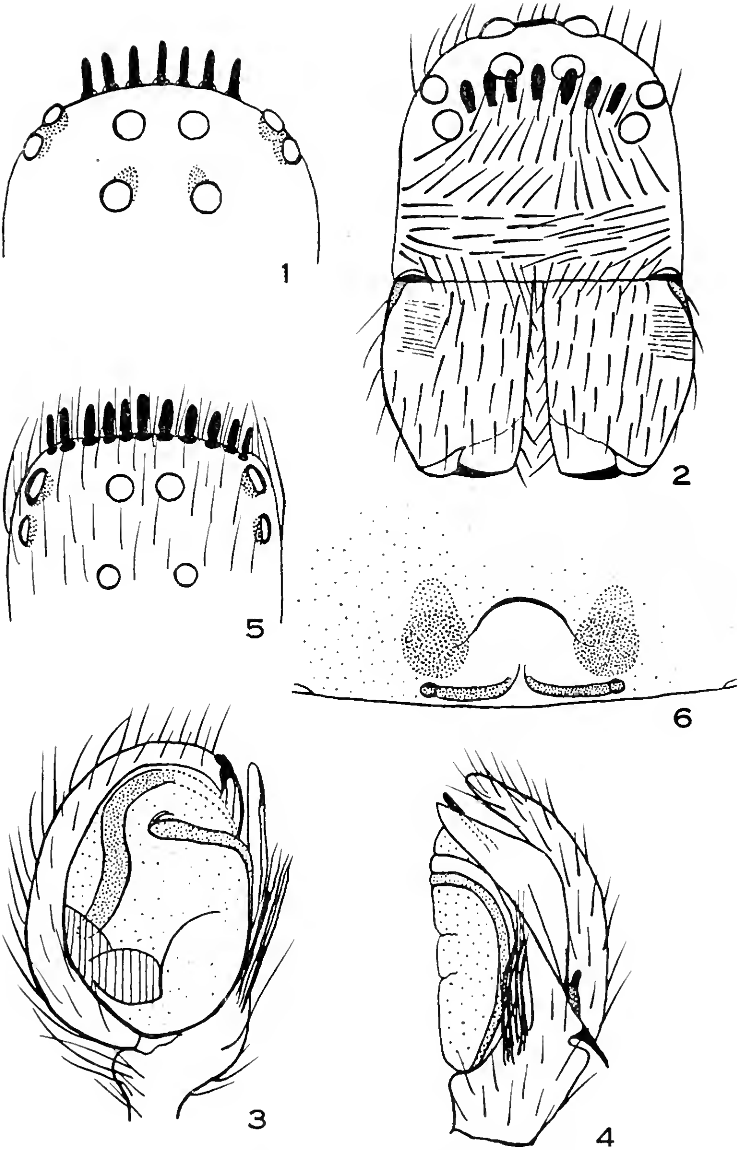
During the summer of 1954, while sifting decaying hay along the roadside near Corozal, Canal Zone, I discovered one immature and two mature males together with one mature and three immature females all belonging to what I regard as a new species referred to the genus *Leprolochus* Simon, 1892. So far as I know, only two species in this genus have been previously reported. The genotype of this rather remarkable genus, *Leprolochus spinifrons* Simon, was from Brazil and *L. parahybae* Mello-Leitao, 1917 was from Venezuela. The latter is known only from females. The description of this new species of *Leprolochus* is given in this brief paper in accord with my usual descriptive formula, and the types have been deposited in the Museum of Comparative Zoology.

Genus Leprolochus Simon, 1892

Leprolochus decoratus sp. nov.

(Figures 1-6)

Male holotype. Total length 2.21 mm., including spines projecting from head region. Carapace 1.235 mm. long, .770 mm. wide opposite second coxae where it is widest; bluntly rounded in front and with seven robust and bluntly pointed black spines



External Anatomy of *Leprolochus decoratus*

Fig. 1. Anterior cephalic region of male from above.

Fig. 2. Chelicerae, eyes, and special spines of male from in front.

Figs. 3-4. Tarsus and tibia of male palp; ventral and retrolateral views, respectively.

Fig. 5. Anterior cephalic region of female from above.

Fig. 6. Ventral view of epigynum.

projecting forward somewhat below AME (Figs. 1-2); the paratype male has nine of these spines; with a short and shallow median longitudinal thoracic groove opposite the third coxae; finely granulated, especially over pars thoracica; gently arched from PME to posterior border with highest part shortly behind these eyes.

Eyes. Eight in two rows; posterior row only slightly longer than anterior row; anterior medians dark, all others light. Viewed from above, posterior row strongly procurved, anterior row moderately so. Viewed from in front, both rows strongly procurved. Ratio of eyes AME : ALE : PME : PLE = 5.5 : 5.25 : 5 : 5. AME separated from one another by about 4/5 of their diameter, from ALE by about 8/5 of their diameter. PME separated from one another by about 9/5 of their diameter, from PLE by nearly twice their diameter. Laterals separated from one another by about 7/10 of the diameter of PLE. Central ocular quadrangle wider behind than in front in ratio of about 9 : 7, only slightly longer than wide behind. Height of clypeus equal to somewhat more than six times the diameter of AME.

Chelicerae. Stout, vertical, parallel; basal segment .352 mm. long; with moderately distinct basal boss and fine striations anterior to boss; the fang is weak, short, and apparently evenly curved; fang groove obscure and with no teeth observed; the pro-margin has a fleshy ridge with a row of stiff bristles.

Maxillae. Distinctly convergent; tapered distally and nearly meeting beyond lip.

Lip. Nearly triangular; wider at base than long in ratio of about 3 : 2; reaches about 2/5 of the length of the maxillae. Sternal suture straight.

Sternum. Cordiform; widest between first and second coxae where it is wider than long in ratio of 25 : 23; anterior border nearly twice as wide as base of lip; very convex; sharply pointed at posterior end but not extended between fourth coxae which are separated by 4/5 of their greatest width. All coxae moderately elongated.

Legs. 4312. Width of first patella at "knee" .108 mm., tibial index of first leg 15. Width of fourth patella at "knee" .130 mm., tibial index of fourth leg 15.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	.660	.264	.462	.660	.528	2.574
2.	.638	.250	.440	.660	.506	2.494
3.	.638	.275	.450	.748	.484	2.595
4.	.811	.275	.660	.990	.690	3.426
Palp	.330	.110	*.443	——	.374	1.257

*Including much extended apophysis.

Spines. All legs with inconspicuous spines difficult in some instances to distinguish from coarse bristles. First leg: femur dorsal 1-1-1-2, prolateral 1 distal, retrolateral and ventral 1 weak proximal; patella with numerous coarse bristles but probably only prolateral 0-1-1-0 spines; tibia dorsal 1-1-1 (all weak), prolateral 0-1-0-1, retrolateral 0, ventral only 2 distal; metatarsus 0. Second leg: essentially as in first except metatarsus which has a tuft of ventral bristles at distal end together with four spines on ventral and lateral sides. Third leg: femur apparently only dorsal 1-0-1-2, patella dorsal 1-1, prolateral 0 1-1-0, retrolateral 0-1-0, tibia dorsal 1-1-1, prolateral apparently 0-1-0-0 and with a group of distal bristles forming a comb-like structure, retrolateral 1 distal, ventral only distal 2; metatarsus only with distal spines essentially as in second. Fourth leg: essentially as in third.

Trichobothria. Observed as follows: tarsi with a row of two or three with the most distal very long; metatarsi the same; tibiae apparently with two rows of two each in dorsolateral positions; palpal tibia with two dorsal in a row with distal one very long.

Claws. Two claws throughout, each pectinate in a single row; with no claw tufts.

Palp. Patella very short; tibia with a short body but with a lateral apophysis which extends nearly the full length of the tarsus; also with a pair of retrolateral spines as shown in Figures 3 and 4.

Abdomen. Regularly ovoid; longer than wide in ratio of 17 : 13; overlaps cephalothorax only slightly; widest slightly behind the middle; provided with a moderately well developed scutum; well supplied with short appressed and recurved stiff bristles both black and transparent; postabdomen and anal tubercle project posterior to scutum; venter well chitinized; with a short, recurved lip just anterior to genital groove; tracheal spiracle obscure but apparently just anterior to base of spinnerets and appears to be marked by a row of relatively long stiff bristles; position of probable vestigial colulus obscure. With six pairs of spinnerets partly obscured by a group of bristles.

Color in alcohol. Carapace: cephalic parts a light brown; remainder a medium brown with darker streaks. Chelicerae light brown with other mouth parts and sternum yellowish brown. Legs: all coxae nearly white; femora brown, lighter beneath; other segments light brown. Abdomen: dorsally light brown with three irregularly dark reddish brown cross bars in the posterior two thirds and an irregular central stripe reaching to base from first cross bar; the posterior end of the abdomen behind the scutum and the postabdomen are white; the venter is yellow with varying shades.

Female allotype. Total length 3.90 mm. Carapace 1.625 mm. long; 1.105 mm. wide opposite interval between second and third coxae where it is widest; gently arched from PME to median, short, longitudinal thoracic groove from which it descends rather gradually to posterior border; cephalic portion well separated from thoracic part; with eleven robust black spines in the position of the seven similar spines in the male (Fig. 5).

Eyes. Ratio of eyes AME : ALE : PME : PLE = 6.5 : 5.3 : 6 : 6. AME separated from one another by about their diameter, from ALE by twice their diameter. PME separated from one another by 13/6 of their diameter, from PLE by 17/6 of their diameter. Laterals separated from one another by nearly the diameter of ALE. Central ocular quadrangle wider behind than in front in ratio of 4 : 3, longer than wide behind in ratio of 7 : 6. Height of clypeus equal to about eight times the diameter of AME.

Chelicerae, Maxillae, Lip, and *Sternum.* Essentially as in male.

Legs. 4321. Width of first patella at "knee" .16245 mm., tibial index of first leg 15. Width of fourth patella at "knee" .2166 mm., tibial index of fourth leg 15.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	.975	.390	.682	.715	.650	3.412
2.	.975	.390	.650	.975	.650	3.640
3.	1.040	.455	.780	1.235	.780	4.290
4.	1.170	.455	1.000	1.625	1.040	5.290

Spines. First leg: femur dorsal 1-0-1-2, probably prolateral and retrolateral only distal 1 or 2, ventral 1r (weak) near middle; patella only prolateral 0-1-1-0; tibia dorsal 1-1-1, prolateral 1-1-1, retrolateral 0-1-0-1, ventral 0-1r-0-2; metatarsus apparently with only two distal but with many spiniform bristles. Second leg: femur probably as in first; patella dorsal 1-1, prolateral 0-1-1-0, retrolateral 0-1-0; tibia probably as in first; metatarsus as in first except with a distal ventral brush of bristles and probably a group of 3 or 4 weak spines. Third leg: femur, patella, and tibia essentially as in second; metatarsus prolateral 0-1-0, retrolateral 0-1-0-1, ventral with brush of bristles as in second and with five clear distal spines on ventral and both lateral surfaces. Fourth leg: essentially as in third except brush is absent but the spines are retained. Palp: with numerous spines on femur, patella, tibia, and tarsus; tarsal claw finely pectinate with about ten slender teeth; claw is opposed to a chitinous tubercle. Trichobothria essentially as in male so far as observed.

Abdomen. Well rounded, oviform; 2.405 mm. long, 1.95 mm. wide near middle; without scutum such as that possessed by male; with six spinnerets, the anterior pair quite robust and somewhat the longest; without definite colulus; tracheal spiracle close to base of the anterior spinnerets.

Epigynum. Simple but well developed. There is a central shallow depression bordered anteriorly by a strongly chitinized recurved border. Two internal tubules occur at the posterior boundary and on each side there is a relatively large spermatheca (Fig. 6).

Color in alcohol. Carapace essentially as in male except that at the base of pars cephalica there is a dorsal, somewhat oval brown spot on each side from which a thin irregular line extends forward to PLE. The dorsal abdominal region is also very similar to that of male except that the reddish brown markings are broader and more united. Otherwise essentially as in male.

Type locality. The male holotype, female allotype, one mature male paratype together with four immature specimens from Corozal, C. Z., July 10, 1954.

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. January 31, 1957 Number 70

"ANGUIMORPH" TOOTH REPLACEMENT IN *AMPHISBAENA ALBA* LINNAEUS, 1758, AND *A. FULIGINOSA* LINNAEUS, 1758 (REPTILIA: AMPHISBAENIDAE)

By Carl Gans

In the course of an investigation into the status of the acrodont amphisbaenids it proved necessary to prepare the skulls of some related forms. When cleaning the mandible of a female specimen of *Amphisbaena alba* Linnaeus, 1758, it was noted that six to eight teeth were in the process of being replaced, while two or three others had only recently moved into position, and were as yet but imperfectly fused to the dentaries. The replacement teeth appeared to lie interdentally, between, rather than below, their predecessors.

McDowell and Bogert, in their recent revision of the anguimorph lizards (1954, pp. 102, 104, fig. 30), have stated that "alternate" tooth replacement was restricted to this group, all other lizards possessing "vertical" replacement. The amphisbaenids are generally considered to be Scincomorpha (Camp, 1923, p. 296) and if the distinction between an anguimorph and non-anguimorph pattern is as clearcut as McDowell and Bogert suppose, the occurrence of a pattern descriptively alternate would thus be unexpected here. For this reason and because certain other aspects of dental replacement in these forms seem worthy of special attention, it appears desirable to describe the female specimen mentioned above, as well as two specimens of *A. fuliginosa* Linnaeus, 1758, in which a similar replacement pattern was noted, in the hope of stimulating further research into these matters.

The mandibular dentition of *Amphisbaena alba*

Figures 1 to 5 show labial and lingual views of the mandible of an adult (body length 440 mm.; length of mandibular ramus 15 mm.[1]) female specimen (MCZ 54299) from "Brazil." This had been cleaned by dissection following controlled applications of full strength commercial bleach to selected portions of the soft parts.

Fig. 1. (Upper) *Amphisbaena alba.* Lingual view of right mandibular ramus of MCZ 54299.

Fig. 2. (Lower) *Amphisbaena alba.* Labial view of same mandibular ramus as Figure 1.

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[1] The length of the mandibular ramus has been selected as a convenient indicator of the total length of the specimen and is hence abbreviated as lmr.

The first part of this description covers the general aspect of the dentition and applies equally well to the female cited and to larger specimens listed below. The description of the replacement pattern and of individual or possibly ontogenetic variation follows upon this.

The dentition is weakly pleurodont, the height of the dorsal margin above the lingual shelf on which the teeth rest barely equaling the width of the tooth base. There are eight teeth on each side; the third is largest, the fourth, fifth, sixth, and seventh are slightly smaller, while the second, eighth, and first are progressively smaller in that order. All of the teeth are curved, this being most noticeable near the tip, and the curvature is directed medially and slightly caudad. There is a rotation in the tooth alignment so that the planes of curvature of the individual teeth do not lie parallel to one another. The teeth are of oval cross-section with the long axis lying in the plane of curvature.

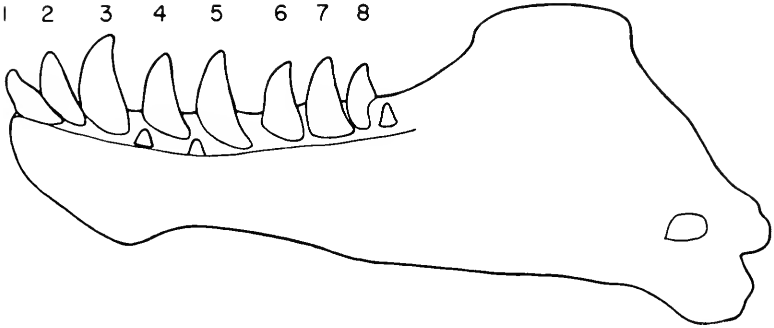

Fig. 3. *Amphisbaena alba.* (MCZ 54299) Sketch of lingual view of right mandibular ramus showing location of the replacement teeth.

The base of the fully formed tooth is hollow, the pulp cavity extending two-thirds of the total height of the tooth. About midway up the tooth the diameter of the cavity contracts so as to continue upwards as a thin cylindrical tube.

There is no tooth-bearing shelf as in a typical pleurodont dentition; instead, a ridge of bone (Fig. 6) rises to the projecting dorsal margin of the dentary between each two adjacent teeth (where replacement teeth are present this ridge is hollowed out to afford lodgement for the pit of the new tooth). Consequently the base of each tooth is almost entirely surrounded by bone, to which it is ankylosed by a ring of cement. The lowest exposed point lies on the lingual aspect and careful, but thorough, preparation shows here a single round foramen.[1] The foramen leads into the pulp cavity and presumably carries its vascular and nerve supply. A line extending to the level of the tip of the interior cavity is visible on the lingual side. Inspection along the lingual aspect of even the smallest cap-shaped tooth germs reveals a slight scalloping so that this line may be formed during tooth development by the fusion of the anterior and posterior portions. Several of the skulls showed longitudinal cleavage of the teeth along this line, which coincides with the long axis of the oval tooth cross-section.

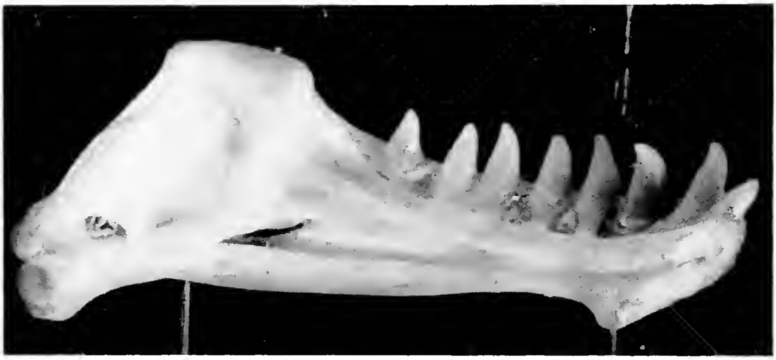

Fig. 4. *Amphisbaena alba.* Lingual view of the left mandibular ramus of MCZ 54299.

Various stages of tooth replacement are shown in MCZ 54299. In the subsequent description of it and other specimens, L and R will stand for left and right mandibular ramus, and the number following this for the particular tooth or alveolus counting from front to back.

At L-7, R-3 and R-4 the replacement tooth is but a small hollow conical shell, thicker at the top than at the sides, its lower edge somewhat excavated on the lingual side. It lies in a small and deep depression in the dentary in line with the posterior edge

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[1] These foramina, as shown in Figure 6, are of a larger specimen, which could be cleaned completely without danger of dislodging the firmly fused teeth.

of the tooth it is replacing. As a result, this pit lies on the ascending ridge directly between the tooth to be replaced and the one posterior to it. Even at this stage there is already some erosion into the base of the tooth being replaced.

L-4 and L-5 show a slightly more advanced stage with progressive erosion into the precursor and an increase in size of the enamel cap of the new tooth.

In R-8 the replacement tooth has reached approximately one-third of its final height, though its tip is still below the level of the projecting dorsal margin of the dentary. It has, however, destroyed almost half of the base of the tooth lying above it.

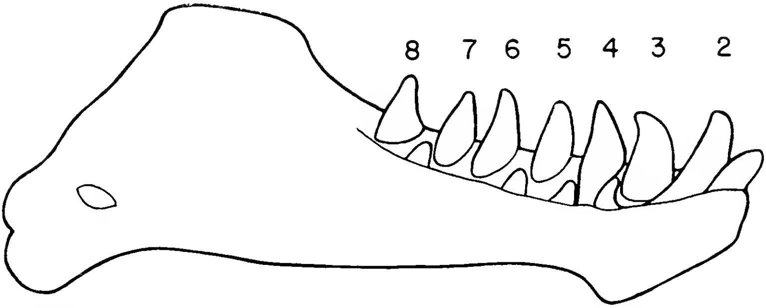

Fig. 5. *Amphisbaena alba.* (MCZ 54299) Sketch of lingual view of left mandibular ramus showing location of the replacement teeth.

At R-6 the tooth has just moved into its final position, its predecessor having been pushed out at some prior stage. It is still only loosely held in place by struts of cement, and appears slightly smaller, and thinner-walled than its neighbors. Its dark appearance is due to the contents of the large, soft-tissue-filled pulp cavity being visible through the translucent walls. This may indicate that the build up of the internal dentine layers is not completed until after the tooth is finally cemented into place.

The heavier enamel and more opaque, shell-like appearance of L-3 may indicate a more advanced stage of development. It is, however, still darker than its neighbors, and its base is still far from fused to the dentary. Its slightly cocked position seems to indicate that it is not fully aligned as yet.

All of the replacement teeth except the last two lie freely in the soft tissues and show no fusion to the dentaries.

Another interesting point is that the alveolus formation appears to start in the interdental ridge and only begins to extend into the base of the precursor tooth as growth takes place. No pits or alveoli were found at the base of any tooth that was not undergoing replacement.

Though the replacement pattern is interdental it differs from that described by Camp (1923, p. 329, fig. II) for *Gerrhonotus s. scincicauda* (Skilton), 1849 (and from that seen in a skull of the same form in the MCZ). In this specimen there is no trace of cavity or alveolus formation and the replacement tooth appears to lie always in the layer of tissue next to the bone. *Gerrhonotus s. scincicauda* is also definitely pleurodont and does not possess the interdental ridge that produces what is almost a sub-thecodont condition in *Amphisbaena alba*.

Fig. 6. *Amphisbaena alba.* (MCZ 32257) Dorsal view of tip of mandible, to show interdental bone ridges, basal foramina, and fusion lines.

The pattern in *alba* is actually closest to that of the snakes (Bogert, 1943, p. 327 ff.). Here the replacement occurs in pairs, alternate teeth being replaced, while those between them are functional. This results in the characteristic tooth – alveolus –

tooth – alveolus succession of the prepared dentate bones of the snake skull. *Amphisbaena alba* differs from this in that at each locus only one replacement tooth appears to be present at a time, and that this erodes its own pocket into the interdental ridge.

Four *Amphisbaena alba* skulls and mandibles from museum collections were available for comparison (MCZ 4031 — Brazil, lmr = 23.5 mm; MCZ 32256 — Surinam, lmr = 20 mm; MCZ 32257 — Brazil, lmr = 22.5 mm; AMNH 73233 — no data, lmr = 17 mm). In only one of these was any soft tissue still present along the lingual aspect of the dentary, but in this as in the others there was not the slightest indication either of replacement teeth or of eroded areas in the interdental ridges which might have lodged replacement teeth. This lack of evidence of tooth replacement may perhaps be related to the fact that all of the skulls were larger (see lmr above), and hence probably belonged to older specimens. The tip of one of these lower jaws is figured (Fig. 6) and illustrates not only the basal foramina previously referred to, but also the interdental bone ridges and the strong cementing of the tooth bases. The complete absence of evidence of replacement activity in these adult specimens, contrasted with the large number of teeth undergoing almost simultaneous replacement in the above described smaller specimen, may indicate that the ability to replace the teeth is lost in the adults.

It is interesting to observe that there is no evidence for the replacement of maxillary or premaxillary teeth in any of the skulls of *A. alba* examined.

The mandibular dentition of *Amphisbaena fuliginosa*

All available dried amphisbaenid skulls were examined for evidence of tooth replacement. Only two medium-sized specimens of *Amphisbaena fuliginosa* (MCZ 2154 — South America, lmr–8mm; MCZ 7799 — Riobamba, Ecuador, lmr–8 mm; listed by Zangerl 1944, p. 426 as specimens A and B) demonstrated a discernible tooth replacement pattern.[1]

Figures 7-10 show lingual views of two of the mandibles of

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[1] A very clean skull of *Rhineura floridana* Baird, (1858) (Gainesville, Florida) from the collection of Walter Auffenberg also reveals that some sort of tooth replacement occurs in this form. Since there are many reasons such as over-cleaning, etc., which might explain the absence of tooth replacement evidence in any given specimen, no useful purpose would be served by listing the names or numbers of specimens examined with negative results.

A. fuliginosa. The dentition is again pleurodont, with the lateral shelf slightly higher than the width of the tooth base. The teeth appear to lie in a slight trench formed between the lingual shelf and the ascending face of the dentary. This trench is crossed by only faint and occasional ridges.

There are seven teeth or large alveoli in each of the four

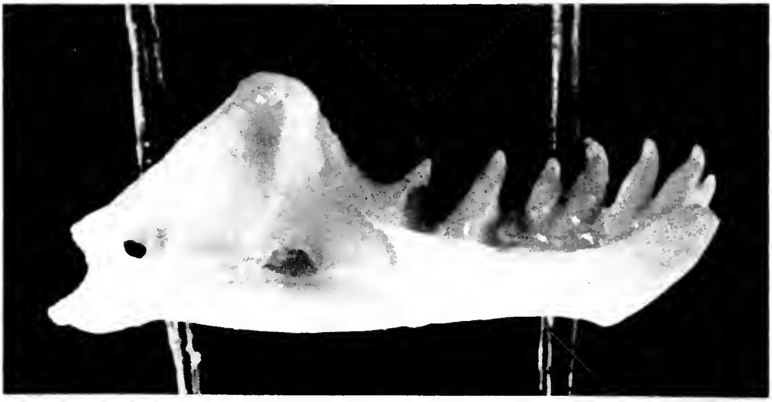
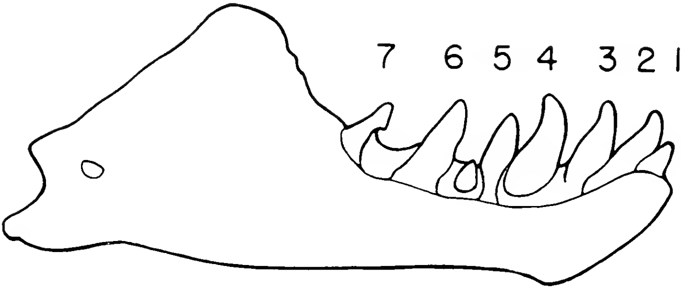


Fig. 7. (Upper) *Amphisbaena fuliginosa.* (MCZ 2154) Lingual view of left mandibular ramus.

Fig. 8. (Lower) *Amphisbaena fuliginosa.* (MCZ 7799) Lingual view of right mandibular ramus.

mandibular rami. However, the broken tooth spacing of the somewhat macerated mandible of one of the specimens (MCZ 7799) (Figures 8, 10) leads one to suspect that we are dealing with a row of eight teeth. The third and fourth teeth are again the largest, with numbers five, six and two equal to each other and slightly smaller, while seven and one are smallest. In other aspects the mandibles closely resemble those of *A. alba* though the cementing of the teeth is not quite as solid.

Three replacement teeth are visible in each of the mandibular rami of MCZ 2154 and two or three in each of MCZ 7799. These



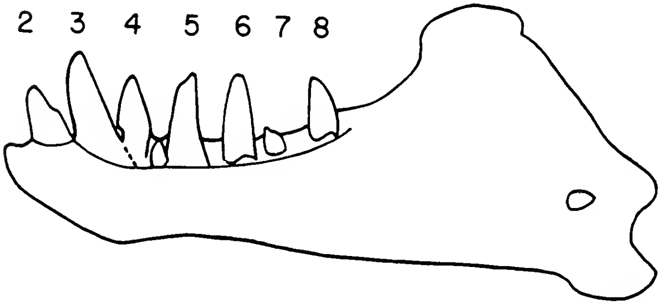


Fig. 9. (Upper) *Amphisbaena fuliginosa*. Sketch of mandibular ramus shown in Figure 7 to show locations of replacement teeth.

Fig. 10. (Lower) *Amphisbaena fuliginosa*. Sketch of mandibular ramus shown in Figure 8 to show locations of replacement teeth.

again lie clearly interdentally and the general pattern of the dentition is very similar to that previously described for *A. alba*. The largest replacement tooth, the precursor of which is still in position, is but slightly higher than the dorsal margin.

However, there is one item apparent in these jaws that cannot be seen in the specimen of *A. alba*, where the erosion always takes place on the posterior edge of the tooth undergoing replacement. In *A. fuliginosa* there are several instances of teeth eroded on the front only or on both front and rear. This is the case in R-5 and L-7 of MCZ 2154, as well as in R-3 and R-4, and possibly L-4 of MCZ 7799. Both in R-5 of MCZ 2154 and in R-3 of MCZ 7799 the developing anterior replacement tooth is considerably larger than the tooth that is eroded. The anterior tooth has thus eroded itself an alveolus wider than that of its precursor. The general spacing indicates that what is involved here is a rearrangement, respacing or perhaps a change in the tooth number, possibly due to the growth of the mandible.

Both sets of upper jaws show evidence of tooth replacement, with alveoli present above both maxillary and premaxillary teeth. As far as can be seen from the skulls, which are somewhat overcleaned for this purpose, the replacement proceeds alternately as described above. The only complications are due to the different alignment of the various teeth which make terms like "alternate" and "vertical" very difficult to apply here.

Discussion and Summary

In *Amphisbaena alba* and *A. fuliginosa:*

The teeth are pleurodont in that they lie against the lingual side of the dentary on a low shelf.

A ridge rises between each two teeth. This character, which gives the dentition a sub-thecodont appearance, is most strongly expressed in older or larger individuals.

The teeth when fully grown have a pulp cavity extending through more than two-thirds of their total height, and are fused to the dentary by a heavy layer of cement around their base. Vascular supply reaches the pulp cavity by a foramen located on the ventral edge of the tooth's lingual aspect.

Tooth replacement is alternate, with the developing tooth lying in a deep pit close to the posterior edge of its precursor. During growth it erodes away the posterior aspect of its precursor and sometimes the anterior face of the tooth next in line. The latter feature may provide for rearrangement or change in number of teeth. As the mandible lengthens and the individual teeth increase in size, it becomes possible for the replacement teeth to realign themselves (thus extending the length of the tooth row, and maintaining or increasing the interdental gap), rather than being restricted to entering the exact alveolus vacated by their precursor. Shortly after the new tooth extends higher than the dorsal margin it either displaces the tooth above it or the latter breaks away due to the dissolving of its base.

When initially entering the alveolus the new tooth is dark and has but a thin coating of enamel. Internal dentine deposition appears to continue until the tooth is well cemented into place.

In *Amphisbaena alba* there is evidence that tooth replacement either becomes rare or stops altogether beyond a certain size. If the function of the replacement were related to the provision of larger teeth, this phenomenon might result from a flattening of the growth curve with age.

None of the skulls of *A. alba* examined showed any evidence of tooth replacement on maxillaries or premaxillaries.

Both taxonomically and in a descriptive sense these results modify the simple picture presented by McDowell and Bogert. It is hoped that this brief note will stimulate supplementary investigation of this problem in every family and genus of the Squamata. This seems particularly desirable since even a cursory inspection of the lizard skeletons in the MCZ shows such divergence in the patterns[1] of tooth replacement that clearly they cannot be described in terms of just two categories — anguimorph or non-anguimorph.

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[1] Some of these patterns have previously been referred to in the literature (e.g. Camp 1923, p. 329, fig. H).

I wish to acknowledge the aid of the following friends, who read the manuscript and commented thereon: Walter Auffenberg, Charles M. Bogert, Tilly Edinger, Gordon Edmund, Richard van Frank, Arthur Loveridge, Samuel B. McDowell Jr., M. Graham Netting, Neil D. Richmond, and Ernest E. Williams.

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TAXONOMIC NOTES ON THE NEW WORLD FORMS OF *TROGLODYTES*

By RAYMOND A. PAYNTER, JR.

While preparing a list of the Troglodytidae, for the continuation of the "Check-list of Birds of the World," it became evident that my taxonomic treatment of the family diverged in a number of respects from the classification employed by Hellmayr (1934), the current standard reference to the New World wrens. It seems advisable, therefore, to present, in more detail than possible in the Check-list, the reasons which have instigated these changes. This paper will be concerned with the New World forms of *Troglodytes*.

I am greatly indebted to Dr. Dean Amadon of the American Museum of Natural History and to Dr. Herbert Friedmann of the United States National Museum for loaning me specimens under their care, and to Dr. Ira N. Gabrielson for very generously allowing me to borrow critical specimens from his private collection.

TROGLODYTES TROGLODYTES

It has been nearly 40 years since the New World forms of *Troglodytes troglodytes* were last revised. At that time, Oberholser (1919) recognized nine races, three of which he described in the course of his study. Four races have been designated subsequently. After examining nearly 450 specimens of the species from North America, I find that I cannot recognize five of the 13 races proposed. A synopsis of the races is presented below.

One of the puzzling features exposed in this review is that the number of male specimens outnumbers that of females by almost two to one. An unbalanced sex ratio does not seem to occur in the wild, at least in the European races (Armstrong, 1955). I suspect that collecting bias is involved in the museum material, perhaps caused by the greater ease with which the vociferous males may be found. Bias created by careless sexing of specimens is also a strong possibility and suggested by the fact that the non-breeding specimens display a greater disparity in the sex ratio than birds taken during the nesting season. Were accurately sexed material available, sexual dimorphism in size might be more pronounced than now evident and some of the apparent interracial overlap in size might be diminished.

TROGLODYTES TROGLODYTES HIEMALIS Vieillot

Troglodytes hiemalis Vieillot, 1819, Nouv. Dict. d'Hist. Nat., nouv. ed., **34,** p. 514 — Nova Scotia and New York; restricted to Nova Scotia by Oberholser, 1902, Auk, **13,** p. 178.

Troglodytes troglodytes aquilonaris Burleigh and Peters, 1948, Proc. Biol. Soc. Washington, **61,** p. 116 — Tompkins, Newfoundland.

T. t. hiemalis is the lightest colored of the continental forms. The Newfoundland population was named *aquilonaris* and was described as differing from *hiemalis* in being darker and less rufescent dorsally, and paler and more heavily squamated ventrally — characters which are notoriously variable throughout the species. A series of 36 specimens from Newfoundland, including part of the type series, has been examined. Some birds possess the characters ascribed to the race, but these individuals fall well within the range of variability of *hiemalis* and occur with the same frequency. *T. t. aquilonaris* is considered to be untenable.

The race breeds from the southern part of the District of Mackenzie and southern Newfoundland south to Pennsylvania, Minnesota, and Alberta. It winters in the southeastern half of the United States.

TROGLODYTES TROGLODYTES PULLUS (Burleigh)

Nannus hiemalis pullus Burleigh, 1935, Proc. Biol. Soc. Washington, **48,** p. 61 — Mount Mitchell (alt. 6,500 ft.), North Carolina.

This race, which breeds in the Appalachians, is barely distinguishable from *hiemalis*, but a series of 13 breeding specimens from Tennessee, Virginia, and North Carolina shows that

TABLE 1

Comparative Measurements (in mm.) of Adult *T. troglodytes*

Race		Wing (flat)				Tail				Culmen (base)				Remarks
		M	σm	Range	No.	M	σm	Range	No.	M	σm	Range	No.	
hiemalis	♂	49.30	.16	45.5—52.0	65	30.16	.15	27.0—33.5	71	14.27	.07	13.0—15.5	70	Eastern N. Amer.
″	♀	46.57	.28	44.0—50.0	30	29.03	.29	25.5—32.5	30	13.67	.13	12.0—15.0	29	″ ″ ″
pullus	♂	49.94	.56	48.0—52.0	8	30.31	.42	29.0—32.0	8	14.00	.57	12.5—15.0	8	Va., Tenn., N. C.
″	♀	45.30	.32	44.0—46.0	5	27.66	.28	26.5—28.0	4	14.00	—	14.0	3	″ ″ ″ ″
pacificus	♂	47.38	.16	44.0—51.0	78	29.96	.18	25.5—33.0	74	14.24	.07	13.0—16.0	74	Western N. Amer.
″	♀	45.58	.23	42.5—48.0	42	28.82	.25	26.0—32.0	40	14.14	.08	13.0—15.0	40	″ ″ ″
helleri	♂	48.50	.28	47.0—49.0	6	30.10	.40	29.0—31.0	5	15.12	.03	15.0—15.5	4	Kodiak and Afognak Ids.
″	♀	46.25	—	46.0—46.5	2	29.50	—	29.0—30.0	2	14.25	—	14.0—14.5	2	Kodiak Id.
semidiensis	♂	53.33	.19	53.0—54.0	3	35.25	—	34.5—36.0	3	19.66	.19	19.0—20.0	3	Chowiet and N. Semidi Ids.
″	♀	48.62	1.11	46.5—50.0	4	30.50	1.30	29.0—32.0	3	17.75	.25	17.0—18.0	4	Chowiet Id.
kiskensis (pt.)	♂	53.50	—	52.0—55.0	2	32.0	—	32.0	2	17.50	.14	17.0—18.0	3	Amak and Amagat Ids. (“*stevensoni*”)
″ ″	♀	—	—	51.0	1	—	—	31.0	1	—	—	17.5	1	Amak Id. (“*stevensoni*”)
″ ″	♂	53.15	.24	52.0—55.0	10	33.25	.70	31.0—35.0	8	18.16	.14	17.0—19.0	9	Fox Ids. (“*petrophilus*”)
″ ″	♀	51.00	.45	50.0—52.0	5	32.30	.29	31.0—33.0	5	17.00	1.00	15.0—18.0	4	Fox Ids. (“*petrophilus*”)
″ ″	♂	52.75	—	51.5—54.0	2	—	—	33.0	1	19.00	—	19.0	2	Yunaska and Carlisle Ids. (“*seguamensis*”)
″ ″	♀	49.10	.24	48.0—50.0	5	29.87	1.03	28.0—31.0	4	18.30	.09	18.0—19.0	5	Seguam, Amkuta, Yunaska, and Carlisle Ids. (“*seguamensis*”)
″ ″	♂	54.19	.37	52.5—55.5	8	32.50	1.14	30.0—33.5	6	19.05	.22	18.0—20.0	9	Andreanof Ids. (“*tanagensis*”)
″ ″	♀	50.60	1.64	49.5—54.0	5	31.80	1.04	29.5—33.0	5	18 60	.08	18.0—19.0	5	Andreanof Ids. (“*tanagensis*”)
″ ″	♂	53.21	.40	51.5—54.5	7	33.00	.25	31.5—34.0	7	18.75	.23	18.0—20.5	10	Buldir and Rat Ids.
″ ″	♀	50.06	.36	49.0—51.5	8	30.20	1.15	27.5—31.5	5	18.31	.09	17.5—19.0	8	″ ″ ″ ″
″ (all)	♂	53.45	.20	51.5—55.1	29	32.87	.25	30.0—35.0	24	18.57	.14	17.0—20.5	33	Aleutians west to Buldir Id.
″ ″	♀	50.21	.26	48.0—54.0	24	31.07	.34	27.5—33.0	20	18.11	.17	15.0—19.0	23	Aleutians west to Buldir Id.
meligerus	♂	55.50	.72	53.5—57.0	5	35.30	.65	34.0—36.5	5	18.62	.28	18.0—19.5	4	Attu Id.
″	♀	—	—	53.0	1	—	—	33.5	1	—	—	19.0	1	″ ″
alascensis	♂	—	—	55.0	1	—	—	37.0	1	—	—	17.5	1	St. George Id.
″	♀	52.17	.62	51.0—53.0	3	32.83	.62	32.0—34.0	3	17.50	.14	17.0—18.0	3	″ ″ ″

dorsally it is, almost constantly, slightly darker than birds of the northern race collected in the same season. A shorter wing and smaller bill were also attributed to *pullus*. However, 21 adult males collected between late May and early August in Newfoundland, New Brunswick, Quebec, Alberta, Maine, New Hampshire, New York, and Michigan had a mean wing length of 49.38±.28 mm., and 20 of the same series had a mean culmen length of 14.25±.15 mm., dimensions which do not differ significantly from those of breeding males from the Appalachians (Table 1).

The race breeds in the mountains from Virginia to Georgia. It is absent from its breeding grounds during the winter and presumably mingles with *hiemalis* in the southeastern United States. Differentiation of the two races in the winter is uncertain. The post-nuptial plumage of the species is considerably darker than the breeding plumage and although one might assume that in this dress *pullus* remains slightly darker than *hiemalis*, there is no evidence that this is true.

TROGLODYTES TROGLODYTES PACIFICUS Baird

Troglodytes hiemalis var. *pacificus* Baird, 1864, Rev. Amer. Birds, 1, (1864-1873), p. 145 — Simiahmoo, Puget Sound, Washington.

The western continental race is much more richly colored throughout than *hiemalis* and *pullus* and somewhat more frequently lacks dorsal barring. Ridgway (1904) stated that the bill of *pacificus* is more slender and less curved, but I cannot confirm this. The mean wing length of males of *pacificus* is substantially shorter than that of the males of the eastern races (Table 1), although the overlap in measurements is almost complete, rendering the character of little taxonomic value. Females of *pacificus* also have shorter wings than their eastern counterparts, but the difference is less pronounced than in the males.

The breeding range is from southeastern Alaska and the southern Yukon southward through the mountains to Idaho and central California. In the winter the race moves to lower elevations and occurs casually south to Arizona and New Mexico.

Troglodytes troglodytes helleri (Osgood)

Anorthura hiemalis helleri Osgood, 1901, Auk, **18**, p. 181 — English Bay, Kodiak Island, Alaska.

Kodiak and Afognak Islands are occupied by a nonmigratory race which is most similar to *pacificus*, but distinguished by its less rich coloration, reduced abdominal vermiculations, and slightly larger average size.

Troglodytes troglodytes semidiensis (Brooks)

Nannus hiemalis semidiensis Brooks, 1915, Bull. Mus. Comp. Zool., **59**, p. 400 — Chowiet Island, Semidi Islands, Alaska.

It is with reluctance that this form is accepted. It appears to be distinguished from *kiskensis* only by the greater average length of the bill of the males (19.66±.19 mm. *vs.* 18.57±.14 mm.; $0.05>P>0.02$). However, there are only three males in the sample from the Semidi Islands, and their bill measurements (19.0, 20.0 and 20.0 mm.) fall within the upper range of males of *kiskensis* (17.0 to 20.5 mm.). Under many conditions one might ascribe the observed difference to chance and with little hesitancy consider the two populations unworthy of separate designation. However, it is obvious that the birds are markedly different from *helleri* of the Kodiak region, which is about 100 miles away, and resemble the Aleutian form, from which they are isolated by roughly 400 miles. The extent of isolation makes it appear probable that the observed differences are indicative of two populations which are morphologically distinct. It is for this reason that it seems best to accept the data at face value and maintain *semidiensis*.

Specimens have been taken on Chowiet, Aghiyuk, and North Semidi Islands.

Troglodytes troglodytes kiskensis (Oberholser)

Nannus troglodytes kiskensis Oberholser, 1919, Proc. U.S. Nat. Mus., **55**. p. 228 — Kiska Harbor, Kiska Island, Aleutian Islands, Alaska.

Nannus troglodytes tanagensis Oberholser, 1919, Proc. U.S. Nat. Mus., **55**. p. 230 — Tanaga Bay, Tanaga Island, Aleutian Islands, Alaska.

Nannus troglodytes petrophilus Oberholser, 1919, Proc. U.S. Nat. Mus., **55**. p. 232 — Unalaska, Unalaska Island, Aleutian Islands, Alaska.

Nannus troglodytes stevensoni Oberholser, 1930, Proc. Biol. Soc. Washington, **43**, p. 151 — Amak Island, Alaska.

Troglodytes troglodytes seguamensis Gabrielson and Lincoln, 1951, Proc. Biol. Soc. Washington, **64**, p. 73 — Seguam Island, Aleutian Islands, Alaska.

The wrens of the Aleutian Islands present a number of problems, the most difficult of which is the condition of the available specimens. Almost all collecting has been done during the late spring and the summer, when the birds are in their most worn plumage, or are immature. Of 110 Aleutian specimens examined, only 15 were taken between the months of October and April. The condition of wear is frequently variable; even birds from the same island, collected on the same day, may exhibit marked differences. The poor condition of the specimens seems to have been the main reason for the description of six races from the region, although only two stand up under critical examination.

On the basis of five adult males and ten young birds, the population of Amak and Amagat Islands was named "*stevensoni.*" It was defined as differing from "*petrophilus,*" of the Fox Islands, in being more gray in both adult and juvenal plumages, in having fewer vermiculations below in adult plumage, and in having a slightly shorter bill in the adult. I cannot appreciate any of the supposed color characters. The difference between the mean length of the bills of three males from Amak and Amagat Islands (17.50±.14 mm.) and that of nine males from the Fox Islands (18.16±.14 mm.) is without question insignificant. ($P > .10$).

In the original description, "*petrophilus*" was compared with *alascensis*, of the Pribilofs, even though the describer (Oberholser, 1919) admitted that his new race was nearest to "*tanagensis,*" a form from the Andrean Islands which he described in the same paper. The race "*petrophilus*" was then casually mentioned as differing from "*tanagensis*" (*op. cit.*, p. 233) in having a shorter bill, shorter wing, more rufescent dorsum, and more ochraceous ventral surface. The series available to Oberholser, as well as material collected since that time, has been examined but not even a trend toward the characters described can be noted. The series is, of course, distinct from the Pribilof population, but a sample from anywhere in the Aleutians would have shown the same thing.

The most recently named Aleutian subspecies is "*seguamensis*," which was restricted to Seguam, Amutka, and Yunaska Islands, with intermediates occurring on the Islands of the Four Mountains. It was described, from badly-worn breeding specimens, as being the palest and grayest of the Aleutian races. Reduced barring on the flanks was another supposed character and it was indirectly suggested that the race has a longer culmen than that of "*petrophilus*."

The type series of "*seguamensis*" is rather lighter, on the whole, than the material from the eastern Aleutians. However, the series of "*seguamensis*" is extremely worn and comparable coloration may be found among equally-worn specimens from anywhere in the Aleutians. The tips of the ventral feathers are abraded, resulting in the apparent reduction of barring. As may be seen from Table 1, no significant difference in the length of the bill is evident.

As has been shown, "*tanagensis*" is indistinguishable from "*petrophilus*." This leaves only *kiskensis*, to which all of the birds of the Aleutians, east of the Near Islands, are referred. It is a large race, with only a few of its smallest examples overlapping the largest found on the mainland. It is rather richly colored and reminiscent of *helleri*, although lighter brown dorsally. It most nearly resembles *meligerus*, which is considered below.

The range may be defined as extending from Amak and Amagat Islands, off the western side of the tip of the Alaskan Peninsula, west through the Aleutians to Buldir Island. There are no records from the Alaskan Peninsula or Unimak Island. This may be due to the absence of collectors, since the climate (presumably the limiting factor on the mainland) at the end of the peninsula and on Unimak is probably not markedly different from that slightly farther out on the Aleutians or on Amak and Amagat.

TROGLODYTES TROGLODYTES MELIGERUS (Oberholser)

Anorthura meligera Oberholser, 1900, Auk, **17**, p. 25 — Attu Island, Aleutian Islands, Alaska.

T. t. meligerus differs from *kiskensis* in its generally longer wing and tail, and in having more and darker vermiculations on the flanks. It is a fairly well-defined race.

It has been recorded from the Near Islands (Attu and Agattu Islands).

TROGLODYTES TROGLODYTES ALASCENSIS Baird

Troglodytes alascensis Baird, 1869, Trans. Chicago Acad. Sci., 1, p. 315, pl. 30, fig. 3 — Saint George Island, Pribilof Islands, Alaska.

The race differs from *kiskensis* and *meligerus* in being darker dorsally and in having lighter and fewer vermiculations on the flanks. Although the data are scant, it would seem to have a somewhat shorter bill and longer wing and tail than either of these races. With the limited material at hand, the darker dorsal color appears to be the most distinctive character.

It occurs on the Pribilofs, on Saint George, Saint Paul and Otter Islands.

TROGLODYTES AËDON COMPLEX

Many taxonomists (e.g., Chapman and Griscom, 1924; Hellmayr, 1934; Sutton, 1951; Bond, 1956) have noted the close physical and behavorial resemblances between *T. aëdon* of the United States and Canada, *T. brunneicollis* of the mountains of Mexico, and *T. musculus* of Central and South America and the Lesser Antilles. The slight differences between the taxa involve such characters as the amount of barring on the flanks, minor variations in wing-tail proportions, and differences in the general shade of the plumage. The groups replace one another geographically, with only minor discontinuities in their ranges. Because of their allopatric, orderly distribution, they would seem to have arisen as isolates of a common progenitor and later expanded their range to form the present pattern. In spite of their obvious close affinities, there has been reluctance to consider them as racial groups of a common species because evidence of interbreeding or of bridging forms, has been lacking. Recent studies (Marshall, 1956) however, have shown that *aëdon* and *brunneicollis* do interbreed and this evidence, plus previously known facts, does much toward forming a convincing argument for considering *musculus* conspecific with the other groups.

The *brunneicollis* group, consisting of montane forms which range from southernmost Arizona through Oaxaca, may be distinguished from the *aëdon* group, which occurs from southern Canada to northern Baja California, by its more heavily barred flanks and browner coloration. Ridgway (1904) chose to consider the more pronounced superciliary stripe an additional character, but in reality the stripe is merely accentuated by the darker color of the surrounding plumage. These characters readily differentiate the birds of southern Mexico from the *aëdon* group, but the northern birds are not so distinct, for there is a south to north cline toward lighter color and reduced barring, or in other words an approach toward *aëdon*, until in Sonora, for example, the brown of the ventral surface is restricted to a buffy chest band and the barring of the flanks becomes no heavier than that which is found in extreme examples within the *aëdon* group. The converging of characters is in itself an indication that the groups are not specifically distinct, but convincing proof has been found by Marshall (1956) in southern Arizona, where both types of birds were discovered interbreeding and specimens were collected from a population which is intermediate between the already only slightly differentiated groups. Marshall also noted that the song of the more brownish form does not differ appreciably from that of the *T. a. parkmanii*, the house wren of the western United States. Thus, there can be no doubt that *brunneicollis* should be merged with *aëdon*.

The problem of the relationship between *aëdon* (now including *brunneicollis*) and *musculus* cannot be resolved so simply and conclusively. *T. musculus* is distributed from sea level to high altitudes over much of South and Central America and in the Lesser Antilles. A moderately dark race (*intermedius*) with barred under-tail coverts and faintly marked flanks extends north to Tabasco and to lower elevations in southeastern Oaxaca.[1] *T. a. brunneicollis*, a richly colored, heavily vermiculated form, is found at high elevations in Oaxaca. No indication of intergradation or sympatry between the groups has been noted, but the area is ornithologically poorly known and the evidence must be considered inconclusive.

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[1] Chapman and Griscom (1924), on the basis of two males from Manuel and Río Pilon, included Tamaulipas within the range. The wing-tail ratios of these birds, which I have examined, clearly indicate that they are wintering examples of *parkmanii*. The confusion of the two forms emphasizes their similarity.

Ridgway (1904) distinguished the Middle American forms of *T. musculus* from *T. aëdon* by the difference in the relative lengths of their wings and tails, the tail of *musculus* being less than five-sixths (83 per cent) the length of the wing and that of *aëdon* being five-sixths, or more, the length of the wing. The ratios have been recalculated, using more material than available to Ridgway, and the distinction between the two groups is still maintained (Table 2). But, when the races of *musculus* from South America (which undeniably are representatives of the Middle American forms) are considered, the clear-cut difference between the two "species" breaks down, although the majority of races are separable. For example, the wing-tail ratios of *musculus, bonaire,* and *chilensis* are roughly 84.5, 87.5 and 89.0 per cent; the remaining races range between 69.0 (*albicans*) and 82.0 (*rex*) per cent. When the *brunneicollis* group is included with *aëdon,* the overlap becomes more nearly complete, for these are short-tailed forms with *cahooni, brunneicollis,* and *compositus,* for example, having wing-tail ratios of about 75, 78, and 78 per cent respectively. It is evident, therefore, that the wing-tail ratio cannot serve to distinguish the two "species."

TABLE 2

Wing-tail Ratios of Males of the Northern Mainland Races of *T. aëdon*

Race	Character	M	σ_m	Range	N	Ratio
aëdon	wing	51.74 mm.	.29 mm.	49.0—55.0 mm.	25	82.1%
	tail	42.48	.30	39.0—46.5	26	
parkmanii	wing	52.26	.21	49.0—56.0	53	83.8
	tail	43.82	.28	38.0—47.0	48	
intermedius	wing	50.64	.28	43.0—55.0	55	72.7
	tail	36.83	.25	31.0—42.0	53	
inquietus	wing	55.00	.33	53.0—57.5	17	69.8
	tail	38.41	.41	36.5—40.0	17	

The absence of ventral barring is useful in distinguishing about half of the *musculus* groups from *aëdon* but within the remaining forms there is a range from the faintly barred crissum of *musculus* to the fairly heavily barred flanks and under-tail coverts of *inquietus.*

Other characters, such as the dorsal and ventral coloration, might be cited, but none is more useful in distinguishing the groups than those already mentioned. Taken collectively these distinguish each taxon from every other taxon, but no single feature, or assemblage of features, can be found which will fully separate the *aëdon* group from the *musculus* group.

Without a mutually exclusive character, or group of characters, it is difficult to justify considering *musculus* and *aëdon* distinct species. When this fact is coupled with what is known of the similarity in behavior of the two groups (*vide* Chapman and Griscom, 1924, in particular), with the evidence that the groups are allopatric, and with the knowledge that the generally more distinct *brunneicollis* group has been found conspecific with *aëdon*, the case for considering *musculus* and *aëdon* to be conspecific becomes as strong as that which can be made for many polytypic species. Although indisputable evidence of conspecificity is lacking, it seems far better to accept the evidence as it stands than to defer to conservative tradition and the philosophy that no change is better than change based on less than inviolable proof.

Twenty-nine subspecies have been recognized. This is three less than the number recognized by Hellmayr (1934). An additional form (*baldwini*) was described after Hellmayr's synopsis, and this is considered to be a synonym.

T. a. baldwini was described as being darker and grayer than the nominate form, with its breeding range in the central northern United States and adjacent parts of southeastern Canada (Oberholser, 1934). Although a large series was examined, including many of the specimens utilized by the describer, not even a trend toward the ascribed characters could be discerned. It appears that the author failed to take into account the postmortem color changes usually associated with wrens, as well as the heterogeneity in color found even in fresh material from a given locality. The race is synonymized with *T. a. aëdon*.

The race *intermedius* is now considered to range from southern Mexico through Costa Rica, although Nelson (1901) named *peninsularis* from the tip of the Yucatán Peninsula, and Chapman and Griscom (1924) named *oreopolus* from the highlands of Nicaragua.

Paynter (1955) accepted *peninsularis,* with reluctance, and stated that it could be distinguished from *intermedius* only by its slightly longer bill. An examination of 54 males from throughout the range of *intermedius* shows them to have a mean bill length of 16.16±.08 mm., with a range from 15.0 to 18.0 mm. Only one specimen, a bird from Costa Rica which approaches *inquietus,* has a bill as long as 18.00 mm.; the remainder fall between 15.0 and 17.0 mm. Six males of *peninsularis* from the type locality at Progreso and from nearby Santa Clara, Yucatán, have a mean culmen length of 16.83±.02 mm. (not ±.20 mm. as published by Paynter, 1955), and range from 16.5 to 17.0 mm. While the difference between the two samples is "statistically significant," the overlap is much too great to warrant recognition of two races.

Hellmayr (1934) doubted the validity of *oreopolus,* described by Chapman and Griscom (1924) as being a montane race slightly darker than *intermedius.* I cannot recognize the form and consider it to be synonymous with *intermedius.*

T. a. clarus, of the Guianas, Trinidad, northern Brazil, and adjacent parts of Venezuela, Colombia, and Peru, was considered by Chapman and Griscom (1924) to be indistinguishable from *albicans* of southwestern Colombia and western Ecuador. Nevertheless, Hellmayr (1934) chose to recognize the two forms, even though he admitted that individual variation frequently bridged the slight gap he believed to exist. Approximately 50 specimens from the range of each race have been examined and it is concluded with Chapman and Griscom (1924) that *clarus* cannot be separated from *albicans.*

TROGLODYTES SOLSTITIALIS COMPLEX

At high altitudes from southern Mexico through Central and South America, there is a series of isolated populations of short-tailed, short-billed wrens of rich, brown coloration, with broad, tawny superciliaries, tawny auriculars, and pronounced, dark post-ocular stripes. These have been treated as three species. The first is *T. rufociliatus,* a form with four isolated races ranging from Chiapas, Mexico, through El Salvador, which is characterized by heavy barring on the abdomen and under-tail coverts, concealed (or obsolete) small, white spots on upper-tail coverts, and a few white spots on the wing coverts. The second species is *T. solstitialis* (a group of seven or eight subspecies, most of which are isolated from one another) which is distributed from Costa Rica through the Andes to Venezuela and Argentina. It may be distinguished from *T. rufociliatus* by its less saturated color, lack (or nearly so) of abdominal vermiculation, and absence of spots on both the upper tail and wing coverts. The third species is *T. monticola* a monotypic form isolated near the top of the Sierra Nevada de Santa Marta, Colombia, which is much larger than the other two forms. It resembles *T. solstitialis* in that it is not deeply colored and has no spotting on the rump or wings, and is similar to *T. rufociliatus* in that it is heavily barred below.

Hellmayr (1934) saw no specimens of *rufociliatus,* but thought that it was intermediate between *brunneicollis* and *solstitialis,* and that eventually it might seem advisable to unite the three forms under one species. *T. rufociliatus* and *solstitialis* are morphologically quite distinct from *T. a. brunneicollis,* with only their rich coloration a point in common. In El Salvador *T. a. intermedius* and *rufociliatus* occur sympatrically (Dickey and van Rossem, 1938) and, as it has been shown, *intermedius* is conspecific with *brunneicollis.* Therefore, it is impossible to consider *rufociliatus* to be a member of the *aëdon-brunneicollis-musculus* complex, even if one ignores their morphological distinctiveness. Although *brunneicollis* is not the link between *rufociliatus* and *solstitialis,* the two groups are very similar, with only the presence or absence of abdominal barring a conspicuous difference. Even this difference is bridged, somewhat, by the nominate form of *solstitialis,* since mature specimens occasionally are distinctly, and quite extensively, barred on the flanks. The spotting on the wing and upper-tail coverts of *rufociliatus* is not a good distinguishing character either, because within a given population there are some individuals lacking these markings.

The two groups would seem to have arisen from a progenial population which at some time became divided into two isolated populations and thereupon became somewhat differentiated. Further division and isolation within the groups then gave rise to the various subspecies now recognized. It may be postulated that the primary division occurred during the Cenozoic when

Middle America was divided by various seaways. One population (*solstitialis*) may have been isolated in South America and southern Central America while the other population (*rufociliatus*) was isolated in northern Central America and southern Mexico. Even if the groups did not have their origin precisely in this manner, or at this period, the almost certain fact remains that they arose from a common ancestral stock which became split into two geographically isolated units.

Since the two groups are so slightly differentiated, there is little doubt that their relationship is best expressed by treating them as conspecific forms, uniting them under the older name of *solstitialis*.

T. monticola, the large, heavily barred form of Santa Marta, was believed by Hellmayr (1934) to be reminiscent of *brunneicollis*. He thought it a specialized offshoot of *solstitialis* but a possible link between *solstitialis* and *brunneicollis*. The resemblance between these two forms is superficial. *T. monticola* has the short tail, short bill, and facial pattern of *solstitialis*. Its large size and barred underparts are the only features which are similar to *brunneicollis*, and even the barred underparts are shared by some races of *solstitialis*. While I do not agree that *monticola* is a link between *brunneicollis and solstitialis,* I do think that Hellmayr (*op. cit.*) was correct in believing it to be an offshoot of *solstitialis*. The only character which distinguishes it from all of the forms of *solstitialis* is its large size. Being confined to a small area on the top of a mountain, it is analogous to an insular population, in which situation a race often is larger than its congeners. It would seem best to consider *monticola* as merely another race of *solstitialis*.

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IS THE ANT GENUS *TETRAMORIUM* NATIVE IN NORTH AMERICA?

BY W. L. BROWN, JR.

For some years, a controversy has continued concerning the distribution in North America of the ant genus *Tetramorium* Mayr. On opposite sides in this argument have been Dr. M. R. Smith (1943), who believes that all five of the *Tetramorium* species reported from North America have been introduced by man from overseas, and Dr. W. S. Creighton (1950), who thinks that the evidence points to prehistoric endemicity in the continent for at least two of the species mentioned; *T. caespitum* (Linnaeus) and *T. rugiventris* M. R. Smith. Apparently there is no serious disagreement about the origin abroad of *T. guineense* (Fabricius), *T. simillimum* (F. Smith) and *T. pacificum* Mayr. The first two of these are very likely African in origin, since they occur in wild parts of Africa and have their closest relatives among the species of that continent. *T. pacificum* is apparently from the Indo-Australian area, although its exact source has never been seriously tracked down. Certainly, it is Old World in origin.

The two species *caespitum* and *rugiventris* are therefore the central elements in the discussion, and it seems appropriate at this time to review the important facts in connection with these two forms and to add whatever significant observations are now available.

TETRAMORIUM CAESPITUM

This species is widespread in the Palaearctic region and in Africa, where it is extremely variable, as attested by an almost endless list of infraspecific variants. In terms of modern taxonomic practice, many of these entities would be considered good sibling species, as indeed some of them already have been treated by various European authors. Many others are mere synonyms of *caespitum* — individual or nest variants that do not represent natural, self-maintaining populations. No one has challenged the placement of the North American populations with the more nearly "typical" *caespitum* variants.

Creighton's assertion that *caespitum* is a native Nearctic ant rests on two principal pieces of evidence: first, the species was known at a very early date, i.e., 1895, from states as remote as Tennessee and Nebraska; second, there is present in North America, at least in the eastern states, a workerless parasite of *caespitum,* the aberrant species *Anergates atratulus* (Schenck), the transport and establishment of which would seem to present special difficulties.

The difficulty with the first piece of evidence is that the exact situation of the collections made in Tennessee, Nebraska and elsewhere in the "interior" of North America was never specified. All of these collections may have been, and probably were, made in or near "culture areas," that is, regions strongly disturbed by the presence of man. The experience of several practiced myrmecological field workers, including that of Dr. Creighton (personal communication) and myself, indicates that so far as known, *caespitum* in North America is known *only* from rather heavily disturbed localities, such as cities, towns, roadsides, farmyards, picnic areas and the like. I have been able to gather no records at all to show the existence of the species in places remote from the works of man in North America.

This situation contrasts with that holding in the Old World, at least so far as my own personal experience goes, and judging also from what I have been able to glean from various publications dealing with the species, and from personal communications with European myrmecologists. To sum up this information, it can be stated that *T. caespitum* in Europe and (although given various infraspecific names) in China is often abundant in and around human habitations, just as in North America. However, it is also to be found, often in abundance, in localities that show little or no trace of human disturbance, and that are far from the nearest humanly-occupied places. The contrast is very marked if one collects, as I have, at intermediate altitudes in

West China, in pine-oak forest, and then compares the collections of *Tetramorium* obtained with the results of a deliberate search for *Tetramorium* in similar vegetational zones in Pennsylvania, New Jersey or Massachusetts. In West China, *T. caespitum* tends to occur uniformly throughout the pine-oak forest, regardless of roads, villages, etc., which are very sparsely distributed in the areas I am recalling. In ecologically equivalent areas in the eastern United States, I have found the same species established only on or near the sites of more or less actively maintained human works. Clearly, the density of nests and individuals seen in North America is in large part proportional to the degree of urbanization of the area occupied, although the real extremes of urbanization, where almost all space is covered by concrete or asphalt, are certainly not favorable locales for colonization by this or any other ant species that lives largely in the open. In my opinion, the local, detailed distribution of *T. caespitum* in North America is that expected of an historically introduced, not a native ant.

The second point of evidence, that concerning the presence of the workerless, and therefore obligatory parasite, *Anergates atratulus*, certainly seems on the face of it a real sign of long occupancy of North America by both host and parasite. Creighton emphasizes the difficulties facing trial colonists of the parasite species: first, the species seems to be relatively rare in Europe; second, it is unlikely that the parasite female could survive a long trip; third, a female arriving in North America would be hard put to find a suitable nest of the host species to enter. To take these difficulties one at a time, we should first recognize that, while *Anergates* is not the commonest of ants in collections, it is nevertheless likely to be locally very common in restricted localities. Even in Europe, host populations are normally concentrated in gardens and waste places within towns and cities, including seaports, and these are accordingly very likely places for *Anergates* to occur unnoticed by primarily country-searching myrmecologists. In the United States, *Anergates* is known chiefly from East Coast localities in urban areas near the sea — exactly the kind of place from which colonists might be expected to be exported most easily. It should be added that *Anergates* females may be produced in very large numbers from a single nest, so that a given locality may be heavily saturated with them during the period of nuptial flights.

The difficulty of transport of live *Anergates* propagules is real, but far from insurmountable. Females can be carried either as individuals carrying the necessary sperm, or as established inquilines in a *Tetramorium* colony. There is no reason why such a voyage might not be successfully made by a parasite queen, especially when one considers the evidence of Lindroth (ms., personal communication) for transport of faunal fragments to North America in ballast originating in Europe. Furthermore, there is no reason to believe that *Tetramorium* nests, with or without *Anergates*, cannot flourish on shipboard for at least the normal span of these species as colonies, a span which seems to be sufficient even for a long voyage under sail.

The third objection is the least difficult one, for there apparently has been no shortage of suitable host nests at close proximity to the waterfront in at least some of the major western Atlantic ports, perhaps as far back as colonial times. If a colony of the host parasitized by *Anergates* arrived in ballast or otherwise stowed-away, it had only to release its flight of fertile female imagines on the new shore to create a high probability of successful establishment.

A similar series of events may have led to the establishment of the workerless parasite *Xenometra monilicornis* Emery in the West Indies, together with or following the establishment of its host, *Cardiocondyla emeryi* Forel. A *Xenometra* of the same or a very closely allied species lives with *C. elegans* Emery in Italy; Menozzi (1919) thought this was the male of *elegans*, but specimens from his collection indicate instead its affinity with *X. monilicornis*. *Cardiocondyla* is a primarily littoral and riparian genus from the warmer parts of the Old World; records of several species from the New World seem to indicate rather clearly that it has been introduced by man on many separate occasions (M. R. Smith, 1944).

To conclude the discussion of the bearing of parasites on the distribution of *Tetramorium*, I think we may safely consider that introduction of an obligatory parasite, while less probable than the establishment of the host, is nonetheless entirely possible if the opportunities exist for a long enough time, and if a dense host population is available to the immigrant parasite.

TETRAMORIUM RUGIVENTRIS

The type series and only recorded sample of *T. rugiventris* was obtained from an upland ponderosa pine stand about ten miles south of Prescott, Arizona, and about one mile off the highway. In emphasizing his difficulty in accepting Smith's hypothesis, namely, that the ant was introduced with camel food or stores at the time when camels were imported from North Africa during the last century, Creighton wrote: "Entomologists frequently strain at gnats but it is seldom that they are asked to swallow a camel."

I have checked with care a syntype of *T. rugiventris* kindly sent by Dr. Smith. As a result of this examination, I can agree with Dr. Creighton that the ant in question is almost unquestionably endemic to the locality where it was found. However, I cannot agree with either Smith or Creighton that the species *rugiventris* belongs to the genus *Tetramorium* as it is now constituted. Instead, the type I have examined seems to me to be a clearcut, if somewhat aberrant, member of the genus *Myrmica,* closely allied to *M. striolagaster* Cole. *M. striolagaster* is recorded from several localities in Arizona and New Mexico, and I have specimens collected by E. O. Wilson at or near the type locality of *rugiventris,* in the vicinity of Prescott. Although the two species are separated by the extent and strength of the gastric sculpturing and by other characters as well, it seems clear that they are congeneric, and also that they run rather close to the *M. punctiventris* group of *Myrmica.*

The *rugiventris* type actually possesses minute barbulation on the posterior tibial spurs, as can be seen at magnifications of 90 × and better, so that in this character, the species would key to *Myrmica,* rather than *Tetramorium,* in the standard keys to tribes and genera of Formicidae. Actually, however, this spur barbulation is not worth much as a tribal character within the Myrmicinae, despite the faith that key-makers have placed in it. The false distinction between *Hylomyrma* Forel (tribe Myrmicini) and *Lundella* (tribe Tetramoriini) appears to have been based partly on this character (Brown, 1953), and the same may hold true of the supposed difference between *Cratomyrmex* Santschi, purportedly a member of tribe Myrmicini, and *Messor* Forel, of tribe Pheidolini.

Dr. Smith is fortified in his opinion that *rugiventris* belongs to *Tetramorium* by the presence in his species of raised cariniform lateral wings of the clypeus that border the antennal fossae in front, as in *Tetramorium;* but this character is shown with varying degrees of clearness in other, undoubted *Myrmica* species, both in North America and in southern Asia, so that it cannot be used as a point of separation between the two genera. The question comes to mind, of course, as to whether *Myrmica* and *Tetramorium* really are separate genera after all, and this is precisely the kind of question that most needs asking in ant taxonomy these days. In deciding this particular question, further study must be made of the males, since tetramoriine males (with the exception of a couple of African forms that require closer study) have several funicular segments fused in such a way as to reduce the number of antennal segments to ten in this sex.

Unfortunately, the males of *rugiventris* remain unknown at present, so that it is not known whether they meet the strong criteria of this caste. From the habitus and lesser details of the worker, however, I consider the relationship with *Myrmica* is close enough to call for a **new combination:** *Myrmica rugiventris.* Whether or not this combination finally proves to be the valid one, it at least helps to establish strong doubts as to the pre-Columbian existence of *Tetramorium* in North America.

In fact, were it not for *Tetramorium lucayanum* Forel and the *Xiphomyrmex spinosus* complex, the New World could be considered free of endemic members of tribe Tetramoriini. With the synonymy of *Lundella* under *Hylomyrma* (Brown, 1953), the New World lost its one endemic tetramoriine genus. *T. lucayanum* presents no special difficulty, because its distribution (Bahamas, Puerto Rico, etc.) is highly suggestive of introduced status. In its morphological characteristics, *lucayanum* seems closest to an African group of species, but the species itself has not been identified with any particular continental African population. However, our knowledge of African *Tetramorium* is in a very imperfect state, and it seems to me likely that *lucayanum* must have come from the Dark Continent, even though it may be rare there. A parallel case involving *Strumigenys rogeri* Emery has turned out to follow exactly this pattern (Brown, 1954).

The *Xiphomyrmex spinosus* complex (which may represent a single variable species) is the one example that cannot be explained away, and it is all the more remarkable, considering its isolated position in southwestern United States and through much of Mexico, far away from the remainder of the generic range, which is entirely Old World tropical and warm-temperate. Preliminary examination reveals no reason to consider this complex as other than bona fide *Xiphomyrmex*, and its distribution is almost certainly that of a long-established endemic group of populations, surely pre-Columbian in North America. *Xiphomyrmex* is separated from *Tetramorium* by a very minor character, 11 antennal segments in place of the 12 of *Tetramorium*. Future revisers could well fail to be impressed by the soundness of the generic split based on this difference, so that we may eventually see a systematic technicality bring back *Tetramorium* as a native American genus.

SUMMARY

Of the five species of *Tetramorium* so far reported as occurring in North America, only two are under dispute as possibly having existed on this continent prior to the advent of European colonists; these are the species heretofore known as *T. caespitum* and *T. rugiventris*. Evidence is presented to show that *T. caespitum* almost certainly was introduced by man from Europe, this evidence consisting primarily of the demonstration that *T. caespitum* in North America, unlike the Eurasian populations, is distributed exclusively in the manner of a man-accompanying "tramp" species. The species *rugiventris*, on the other hand, is removed from *Tetramorium*, where it does not fit well, and is transferred to *Myrmica*. The number of *Tetramorium* species occurring in North America is thus reduced to four, all of them likely introductions from the Old World within historical times. The only member of tribe Tetramoriini that can safely be considered as endemic to the New World at the present time is the *Xiphomyrmex spinosus* complex, widespread in southwestern U. S. and Mexico.

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B R E V I O R A

Museum of Comparative Zoology

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ADDITIONS TO THE MAMMALIAN FAUNA OF PERU AND NOTES ON SOME OTHER PERUVIAN MAMMALS

By Oliver P. Pearson

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An earlier report discussed the mammals of the highlands, or altiplano, of southern Peru (Pearson, 1951). Subsequent collecting has revealed important additions to the fauna of this area as well as considerable extensions of the range of certain species. I am indebted to Dr. Carl B. Koford, who collected several of the specimens mentioned, for permission to report upon them and to draw upon information in his field notes. All specimens are in the Museum of Vertebrate Zoology, Berkeley.

Hesperomys sorella (Thomas). This species was not listed in the previous report on mammals of the altiplano. Eleven specimens have now been taken in the Department of Puno in bunchgrass terrain at 3 mi. NE Arapa, 12,600 ft., 5 mi. S Asillo, 13,000 ft. and at Hacienda Calacala, 13,000 ft., which is 7 mi. SW Putina. They are longer-tailed, longer-eared, and tawnier than *H. lepidus ducilla*, which also lives in this region, and have shorter, more slanting zygomatic plates. The range of measurements (in mm.) is: total length, 128-147; tail, 60-71; hind foot, 17-19; ear from notch, 18-19; and greatest length of skull, 21.5-23.2. They do not match the type of *sorella* perfectly but seem to be more closely related to that form than to *callosus, carillus,* or *frida*.

Since publishing the earlier report in which I used the name *Hesperomys ducilla* for the short-tailed species in southern Peru, I have examined the types of *H. lepidus* (Thomas) and *H. ducilla* (Thomas) and find that despite great difference in age of the individuals they are quite similar and can easily be included in the same species, characterized by short tails and tall zygomatic plates. Sanborn (1950) also considered *ducilla* to be a subspecies of *lepidus*.

Eligmodontia puerulus puerulus (Philippi). Four specimens of this desert mouse have been reported from Peru (Pearson, 1951), all from Santa Rosa de Juli, Department of Puno, and were listed as *E. p. hirtipes*, the type locality of which is Lake Poopo in Bolivia. Our recent collections included 11 specimens taken in Peru between 13,000 and 15,300 ft. in the Departments of Moquegua, Puno, and Tacna. These specimens have now been compared with topotypes, in the Chicago Natural History Museum, of *E. p. puerulus* from northern Chile and are indistinguishable. *E. p. tarapacensis* Mann has also been described from northern Chile, but the new material reveals that the shape of the zygomatic plate and the bicolored nature of the tail, features on which *tarapacensis* was based primarily, are unreliable. The Peruvian *Eligmodontia* therefore should be *E. p. puerulus*.

Phyllotis (*Galenomys*) *garleppi* Thomas. Two specimens of this rare mouse were taken in southern Peru, one at Pichupichuni, 12,600 ft., 5 mi. NW Huacullani, and another at Pampa de Ancomarca, 13,700 ft., 76 mi. S Ilave, both in the Department of Puno. These are the first records of this species from Peru. Since no field measurements have been published and the type specimen has a smashed skull, we record measurements (in mm.) of our two specimens and photographs of one of the skulls (Fig. 1).

	MVZ 115903	MVZ 115907
Total length	129	132
Tail	32	30
Hind foot	23	24
Ear	19	19
Skull greatest length	26.7	27.0
Zygomatic breadth	15.0	15.0
Width of braincase	12.8	13.0
Maxillary toothrow	5.3	5.2

Compared with the type and another Bolivian specimen in the British Museum of Natural History, and one in the Chicago Natural History Museum, the Peruvian specimens are smaller, have much shorter fur, color much less bright, and shorter ears. Unfortunately both Peruvian specimens are younger, although one was old enough to be pregnant (April 10) and the other estrous (February 1). The Peruvian specimens agree with the type in these diagnostic features: incisors slender and markedly proodont, anterior border of zygomatic plate distinctly convex and extending almost to the top of the rostrum, and dorsal profile of the skull strongly convex.

Fig. 1 (above). *Phyllotis (Galenomys) garleppi*: 2.3 x.
Fig. 2 (below). *Felis jacobita*: 0.6 x.

One of the specimens was caught in front of a burrow of *Ctenomys peruanus* on a heavily grazed pampa of dwarf grass and prostrate forbs. The other was taken near a stone wall on a similar, grazed pampa on which were also growing scattered thornbushes about one foot tall. *Ctenomys opimus* was living about 100 yards away. Other mammalian associates were *Galea musteloides, Akodon jelskii, Phyllotis darwini, Ph. sublimis*, and *Hesperomys lepidus ducilla*. The last two of these are surprisingly similar in appearance to *garleppi*. *Ph. garleppi* is larger than *ducilla* (total length of *garleppi* more than 120 mm., foot more than 20 mm.) and smaller than most *sublimis* with tail usually shorter (less than 46 mm.) and not bicolor, soles of hind feet more hairy than in *sublimis*. Using Pearson's (1951) key to the rodents of the altiplano west of Lake Titicaca, *Galenomys* keys out as either *Phyllotis osilae, Ph. darwini*, or *Akodon amoenus*. All of these have much longer tails than does *garleppi*.

Punomys lemminus Osgood. The range of this rare mouse has been extended considerably by its capture 55 mi. ENE Arequipa. 15,300 ft., Department of Arequipa, and 12 mi. NE Tarata. 14,600 ft., Department of Tacna. These new specimens agree well with those from Caccachara (Pearson, 1951) and with the type.

In addition, nine specimens were taken 8 mi. SSW Limbani, 15,000 ft., Department of Puno. This is 130 miles north of the type locality and separated from it by the grassland of the Titicaca basin. A circuitous strip of more favorable habitat may connect the two regions by way of the mountains to the west and northwest, but no specimens have been taken there. The specimens from near Limbani, like so many forms from this more humid region of the Andes, are distinctly and consistently darker than those from farther south or west. Compared with the type and with the specimens mentioned in the preceding paragraph, the Limbani *Punomys* are greyer and darker on the back, the feet and hands duskier above, ears darker, tail less distinctly bicolor, and belly considerably darker grey with a distinct buffy wash.

The Limbani specimens, as well as those from near Arequipa and Tarata, were captured in barren, broken rock areas and, as at Caccachara, were near fleshy-leaved, pungent *Senecio* plants or piles of *Senecio* cuttings.

Cavia tschudii osgoodi Sanborn. Two species of guinea pigs live on the altiplano of Peru and at some localities probably occur together. *Cavia* (*Galea*) *musteloides* is diurnal (Pearson, 1951) and prefers rather open habitat with good visibility. At Hacienda Calacala the much darker colored *Cavia* (*Cavia*) *tschudii* lived in thick grass where it made distinct runways and was crepuscular. Steel traps set in the runways failed to catch any during the day, but numerous individuals were seen and collected in the evening after sunset and in the early morning.

Lagidium peruanum Meyen. In Peru mountain viscachas have been considered to live only at high altitude. It was a surprise, therefore, to find a small population living in the fog belt, or lomas, at only 2200 ft. at Naña, Department of Lima. The hilltops at Naña support scattered clumps of fog-nourished *Tillandsia* (Bromeliaceae). On the lower slopes there is no vegetation, but there are irrigated fields on the floor of the valley. Among rocks on one of the hilltops were many viscacha scats, which probably accumulate for years in the absence of rain, a few viscacha bones, and at least one living viscacha. This individual was seen at a distance of only 6 feet and appeared to be similar to the mountain viscachas of southern Peru but with more than average buffy color. A maxillary toothrow picked up nearby agrees well with specimens of *Lagidium peruanum*.

This population living more than 6000 ft. lower than any other viscacha population known to me in Peru is isolated by several thousand feet of brushy and weedy terrain unsuitable for viscachas.

Mustela frenata Lichtenstein. Weasels have long been thought to live on the altiplano of Peru but have been inadequately represented by specimens. A mounted skin is now available, taken in the spring of 1951 at Hacienda Calacala, 13,000 ft., 7 mi. SW Putina, Department of Puno.

Grison (*Grisonella*) *cuja* (Molina). The presence of this mustelid on the altiplano of Peru has heretofore been inadequately documented. We now have the skin and skull of an adult male from Hacienda Pairumani, 13,000 ft., 24 mi. S Ilave, Department of Puno. Measurements (in mm.) are: total length, 570; tail, 145; foot, 70; weight, 1700 grams. This specimen was shot at 4 p.m. with its stomach crammed with at least three mice and a lizard, indicating diurnal feeding.

Felis jacobita Cornalia. The complex taxonomic history of this wildcat (see Osgood, 1943) has been based on a half-dozen skins, many of them without adequate locality information, and on drawings of a single skull (Philippi, 1873). No previous specimens are known from Peru. We now have a skin and skull of a male, trapped March 30, 1952, among rock outcrops at 15,500 ft., 57 mi. ENE Arequipa, Department of Arequipa. This is a barren region of rocks and bare ground with scattered clumps of bunchgrass (*Festuca orthophylla*) and small tola bushes. Other steel traps nearby caught a fox (*Dusicyon culpaeus*) and a mountain caracara (*Phalcoboenus megalopterus*). A mountain lion passed close by several times. Probable prey items in addition to small rodents and small birds were mountain viscachas (*Lagidium*), tinamous (*Tinamotis*), and seed snipe (*Attagis*, *Thinocorus*). Vicuñas, the young of which might be killed by *jacobita*, were abundant.

The skin matches well the various published descriptions, but several features of the skull, some of them previously considered to be diagnostic, do not match the illustrations in Philippi's report. The audital bullae of our specimen are not bisected by a deep sulcus; in fact, scarcely a trace of the sulcus shows. Compared to four *Felis pajeros* from southern Peru and northern Chile, the nasals of our *jacobita* are only slightly larger and the incisors not more proodont. The skull of our *jacobita* is slightly flatter and more robust than in *pajeros*, and has larger teeth, but skulls of the two species are not as different in appearance as are those shown in Philippi's illustrations. A possible diagnostic character is the orientation of the upper premolars. In *pajeros* these two teeth on each side, when viewed from below, lie in a straight line. In *jacobita* the anterior premolar toes in abruptly in front. Since no other skulls seem to be available and since our specimen differs considerably from the one seen by Philippi, two photographs are presented in Figure 2. Measurements (in mm.) are: total length, 990; tail, 413; foot, 133; ear, 63; weight, 4.0 kg.; condylobasal length, 96; greatest length of skull, 100; zygomatic breadth, 69.5; greatest length of upper carnassial, 14.0.

The pelage is fluffier and greyer than that of *F. pajeros* and is without a spinal crest of long hairs; the ears are rounded without tufts, and the tail is non-tapering, much longer, and more conspicuously ringed than in *pajeros*.

In southern Peru *Felis jacobita* seems to be much less abundant than *F. pajeros* and probably prefers higher elevations.

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BREVIORA

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THE DISCOVERY OF CERAPACHYINE ANTS ON NEW CALEDONIA, WITH THE DESCRIPTION OF NEW SPECIES OF *PHYRACACES* AND *SPHINCTOMYRMEX*

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During December, 1954, and January, 1955, the author was fortunate in being able to spend an uninterrupted five-week period on New Caledonia, studying the ant fauna of the island.[1] During this time three species of *Phyracaces* and *Sphinctomyrmex* were collected, all undescribed and representing the first cerapachyine ants ever found on New Caledonia. Their presence is of some zoogeographic importance, in that they appear to ally the ant fauna of New Caledonia more closely with that of eastern Australia, as opposed to the remainder of Melanesia. *Phyracaces* and *Sphinctomyrmex* are strongly developed both in species and in individual numbers in Australia, but are known from only three rather rare species (two *Phyracaces* and one *Sphinctomyrmex*) on New Guinea, and are unknown from the rest of northern and central Melanesia. In an obverse relationship, *Cerapachys* (*s. str.*), is the predominant cerapachyine genus on New Guinea and the Fijis, but has never been collected in either Australia or New Caledonia. Finally, the New Caledonian *Phyracaces* and *Sphinctomyrmex* are most closely allied to eastern Australian species, as indicated in the descriptions to follow.

PHYRACACES COHICI Wilson, new species

Diagnosis. A shining, black, medium-sized species closely related to the *turneri* group of species of eastern Australia. *P.*

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[1] Field research was supported by grants from the Society of Fellows, Harvard University, and the Museum of Comparative Zoology.

cohici can be easily distinguished from the latter group, which includes *turneri* Forel, *adamus* Forel, and *larvatus* Wheeler, by its more obtuse and rounded dorsal propodeal corners. In *cohici* these corners form an angle of more than 110° when viewed from the side, while in the *turneri* group of species they form an angle of 90° or less. *P. cohici* also bears a fair resemblance to the Australian *P. senescens* Wheeler, but can be separated from this species by its longer, flatter petiolar node and straighter and more horizontally aligned posterior petiolar teeth.

Holotype worker. Head width[1] 0.99 mm, head length 1.05 mm, scape length 0.63 mm, cephalic index 94, scape index 64, exposed length of mandibles 0.21 mm, eye length 0.26 mm, pronotal width 0.79 mm, petiole width 0.83 mm, petiole length (measured from the midpoint of the anterior border of the node to the midpoint of the posterior border of the posterior peduncle) 0.63 mm, postpetiole width 0.83 mm, postpetiole length 0.67 mm, width of next gastric segment 1.00 mm. Occipital border very feebly convex in full-face view. Alitrunk viewed from above moderately constricted medially, marginate along the entire dorsolateral border except for an interval of about 0.20 mm in the region of the mesothorax. Petiolar node viewed from directly above with strongly concave anterior border, and evenly convex lateral borders, its widest point being about in the middle (see accompanying figure). In the same view the posterolateral teeth extend well beyond the posteriormost point of the posterior node border. Seen from directly above, the postpetiole is widest in the anterior half and is laterally marginate only in the anterior half.

Entire body covered by scattered piligerous punctures spaced on an average of 0.03 to 0.06 mm apart, the interspaces completely smooth and shining. On the sides of the alitrunk the punctures are unusually small, being barely visible at 40X magnification.

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[1] Head width and other body measurements were made in the standard fashion employed by W. L. Brown in his published serial studies of the dacetine ants and by myself in my recent revision of the ant genus *Lasius* (1955, Bull. Mus. Comp. Zool. Harv., 113: 1-200). In the past, Brown and I have differed slightly in our definitions of head length, but in the present paper I have decided for the purposes of uniformity to follow Brown's original definition, which was given as follows: "critical maximum length of the head, measuring from a transverse through the posteriormost point or points along the occipital border to a transverse through the anteriormost point or points on the anterior clypeal border" (1953, Amer. Midl. Nat., 50: 11). With this change I believe that our *standardized* measurements now all agree in every detail.

Entire body deep blackish brown to jet black, except for the mandibles and gastric apex, which are dark reddish brown. Appendages variably dark reddish brown.

Worker variation. Maximum head width of type series (all shown by a single colony, acc. no. 190): 0.88-1.01 mm. The worker type series shows very little variation in other external characters.

Male. Head width (across and including compound eyes) 1.10-1.14 mm. Antenna 13-segmented. Mandible well developed, narrowly subtriangular, its masticatory border bearing a large, blunt apical tooth followed basally by an indeterminate number of serial denticulae; the masticatory and basal borders joining through an even, convex curve. Clypeus narrow, its dorsal surface gently convex, its anterior border seen from directly above moderately and evenly convex.

Parapsidal furrows well developed, parallel with each other, and extending anteriorly for about half the length of the scutum. Notaulices absent. Median notal suture present and extending posteriorly for slightly more than one-third the length of the scutum. Wing venation generalized, essentially similar to that of *Cerapachys* (see Brown and Nutting, 1950, Trans. Amer. Ent. Soc., 75: 132, pl. VIII), differing primarily as follows: *Rsf2·3* is lacking, and the second radial crossvein and *Rsf5* form a single unit coming off the stigma. The crossvein "*x*" indicated by Brown and Nutting in the basal cubital-anal region of *Cerapachys manni* is missing in *Phyracaces cohici*.

Petiole completely lacking the lateral margination that characterizes the *Phyracaces* worker caste. Seen from above, the node is widest in its anterior half, and its anterior and posterior corners are gently rounded; seen from the side, the node forms a single, even, strong convexity only weakly demarcated from the peduncles. Genitalia completely retractile. Subgenital plate relatively large (exposed length about 0.35 mm), sclerotized, tapering posteriorly to end in a pair of sharp, upward curving hooks each about 0.06 mm in straight length. Parameres short, broadly rounded apically.

Pilosity, sculpturing, and color essentially as in the worker.

Types. Described from a long series of workers and four males collected by the author at Ciu, near Canala, at 300 meters, and from two kilometers southwest of Ciu, at 500 meters, New Caledonia. The following accessions are included: 190, 246, 263 (holotype nest series), 267, 275, 278, 298. Each represents a separate nest series with the exception of numbers 246 and 275, which are from the same nest. All of the collections were made in the period from December 21, 1954, to January 2, 1955.

This species is named for Mr. François Cohic, of the Institut Français d'Océanie, an able and enthusiastic student of New Caledonian entomology.

Ecological notes. All of the collections were made in the rich subtropical evergreen forest clothing the hills that extend from the south bank of the Canala River in the vicinity of the Ciu Falls. The holotype colony was found under a rock in a densely shaded part of the forest, and was occupying a single cavity and adjacent short vertical gallery in the soil. The males were very active and attempted to fly when the nest was exposed. Another colony (acc. no. 246-275) was nesting in open soil at the side of one of the forest trails. The nest entrance consisted of a single five-millimeter-wide opening surrounded by a low, indistinct turret of excavated earth. Lateral excavation revealed three or four galleries leading down from the entrance hole and into soil packed between several buried rocks. At about ten centimeters down two small adjacent chambers had been excavated in the soil against the vertical face of one of the rocks. In these were massed all of the brood and most of the workers. The following rough population estimate was made at the time of collection: 80-100 workers, 40 pupae (in cocoons), 30-40 half-grown to fully grown larvae, and 30 eggs. The reproductive of this colony was unfortunately not found.

Workers belonging to colony no. 246-275 and other colonies were encountered on several occasions foraging during the day, always in file, over the surface of the ground, and on one occasion (no. 190) workers were discovered in the upper layers of a moist rotting log. Twice, workers were observed in the act of raiding colonies of the ant genus *Pheidole.* The foraging and raiding behavior of this species will be described in greater detail in a later paper on the general subject of cerapachyine behavior.

PHYRACACES DUMBLETONI Wilson, new species

Diagnosis. Distinguished from all other species of the genus known to me by the following combination of characters: moderately large size (head width of type series 1.16-1.25 mm), antennal scapes unusually long, sides of alitrunk non-marginate, body surface smooth and shining to shagreened and subopaque, body color deep blackish brown to jet black.

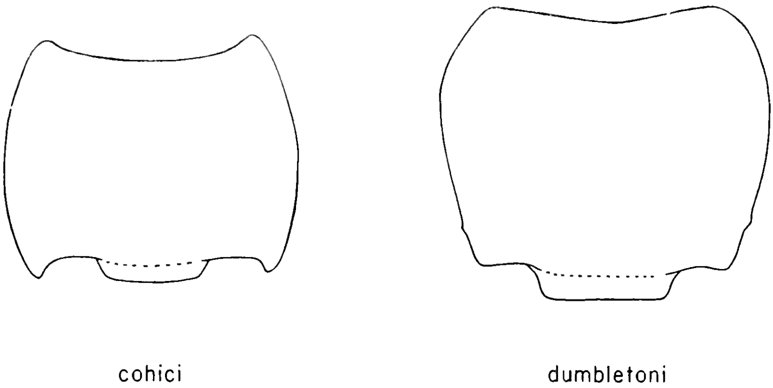
The only other Indo-Australian *Phyracaces* lacking marginations along the sides of the alitrunk are *aberrans* Clark and *pygmaeus* Clark of northern Queensland and *hewitti* Wheeler of Borneo. These species are easily distinguished from *dumbletoni* by their much shorter scapes, which reach only to about the posterior margins of the compound eyes when the head is viewed in full face — in *dumbletoni* the scapes extend beyond the eyes by about their own maximum width. Of the three species, *dumbletoni* most resembles *aberrans* Clark, being very close in both size and sculpturing.

Holotype worker. Head width 1.17 mm, head length 1.30 mm, scape length 1.08 mm, cephalic index 90, scape index 92, exposed length of mandibles 0.29 mm, eye length 0.33 mm, pronotal width 1.03 mm, petiole width 0.95 mm, petiole length 0.76 mm, postpetiole width 1.09 mm, width of next gastric segment 1.26 mm. Occipital border in full-face view very feebly convex. Alitrunk viewed from above only feebly constricted medially, its dorsolateral area evenly rounded and lacking any trace of margination. Petiolar node seen from directly above with moderately concave anterior border and evenly convex lateral borders, its greatest width located in the anterior half.

Puncturation as described for *P. cohici*, except that anterior to the postpetiole the punctures are more scattered, the majority being 0.09 to 0.12 mm apart. On the postpetiole and anterior to this segment the interspaces are for the most part "shagreened," the shagreening in this case in reality consisting of regular, minute, contiguous foveolae each about 0.01 mm in diameter. The foveolae are deepest on the dorsal surface of the head and alitrunk, and render most of the cuticular surface there subopaque. They are absent posterior to the postpetiole.

Color as described for *P. cohici*.

Worker variation. Maximum head width range, Chapeau Gendarme and Mt. Mou series: 1.16-1.25 mm (all shown by acc. no. 65, the holotype nest series). Maximum head width range, Ciu series: 1.11-1.20 mm (all shown by acc. no. 245). The Ciu workers differ significantly from the Chapeau Gendarme and Mt. Mou workers in the intensity of the foveolar "shagreening." The latter approach the condition described in the holotype, with little deviation. The Ciu specimens have the same basic form of sculpturing, but on the head and alitruncal dorsum the foveolae are much shallower, so that the surface is strongly shining under ordinary reflected light.



Dorsal view of the petioles of the two New Caledonian species of *Phyracaces;* outlines drawn to scale from the holotypes.

Ergatogyne. Head width 1.14 mm, head length 1.26 mm, scape length 0.76 mm, cephalic index 90, scape index 67, exposed length of mandibles 0.22 mm, eye length 0.30 mm, pronotal width 1.00 mm, petiole width 0.95 mm, petiole length 0.62 mm, postpetiole width 1.32 mm, width of next gastric segment 1.55 mm. Ocelli lacking. More similar to the worker caste than to the queen caste of other *Phyracaces* species, differing primarily in the following external features. (1) The alitrunk is very worker-like, apparently differing only in the somewhat stronger pleural suturation. The posterior metapleural suture, which is absent in the *dumbletoni* worker, is present although feebly developed in the ergatogyne. (2) The petiole is relatively shorter in the ergatogyne. (3) The postpetiole and gaster are much more massive and more poorly demarcated from each other than are the same structures in the worker.

Types. Described from a long series of workers from Chapeau Gendarme (Yahoué), Mt. Mou, and Ciu, and a single ergatogyne from Ciu. The following accessions are included, each representing a separate nest series: Chapeau Gendarme, no. 65 (holotype nest series); Mt. Mou, single worker; Ciu, no. 245 and "observation colony."

This species is named after Mr. L. J. Dumbleton, formerly economic entomologist for the South Pacific Commission, and an expert student of the New Caledonian insect fauna.

Ecological notes. P. dumbletoni was collected at Chapeau Gendarme and Mt. Mou in dry, semi-deciduous "valley-pocket" forest and at Ciu in moist broadleaf evergreen forest. In all three localities it was limited primarily to the least disturbed portions of the forest, and was never encountered in the adjacent open *Melaleuca* woodland.

At Chapeau Gendarme a large colony (no. 65) was found nesting in several spacious galleries and chambers in the upper layers of a large, moist, fern-covered log. It contained at least 200 workers, a single ergatogyne (later lost), over 100 cocoons and larger larvae, and an undetermined number of eggs. Among the brood were found the hollowed-out propodeum of a worker of an undescribed species of *Lordomyrma* and the mangled remains of the larva of an undetermined ant genus. These insects appeared to be the prey of the *Phyracaces,* but of course this cannot be proven.

When first disturbed, many of the *Phyracaces* workers sallied out with a display of aggressiveness unusual for cerapachyines, and one succeeded in stinging me on the forearm. I think it is worth mentioning that this is the only time I have ever been stung by a cerapachyine ant, despite the fact that I have excavated many nests of *Phyracaces* and other genera without making any effort to protect myself from the workers. The sting caused a prominent welt about six millimeters wide surrounded by an erythema about twenty-five millimeters wide. There was a persistent, dull, throbbing pain of the sort commonly resulting from the stings of ponerine ants.

SPHINCTOMYRMEX CALEDONICUS Wilson, new species

Diagnosis. Closely resembling *S. steinheili* Forel of eastern Australia, from which it can be distinguished by the following two characters. (1) Sculpturing, which is dominated by puncturation, is overall denser in *caledonicus.* In *steinheili,* the interspace distances over the genal surface are mainly as great as the adjacent puncture diameters or greater, while in *caledonicus* the genal punctures are contiguous and their borders form an even rugoreticulum. In *steinheili,* the lateral surfaces of the alitrunk are in large part feebly shining, while in *caledonicus* these surfaces are entirely opaque. (2) In side view, the dorsal posterior corners of the propodeum form a distinct angle of about 110° in *steinheili,* but are evenly rounded in *caledonicus.*

Holotype worker. Head width 0.56 mm, head length 0.71 mm, scape length 0.41 mm, cephalic index 79, scape index 73, exposed length of mandibles 0.06 mm, pronotal width 0.42 mm, petiole width 0.35 mm, petiole length (including peduncles) 0.38 mm, postpetiole width 0.47 mm, width of next gastric segment 0.60 mm, length of gaster posterior to postpetiole (measured in a straight line) 1.35 mm.

Worker variation. Maximum head width range (internidal) 0.50-0.57 mm; (intranidal; acc. no. 195) 0.50-0.56 mm. In size as well as other external characters the worker type series is remarkably uniform.

Ergatogyne. Head width 0.62 mm, head length 0.76 mm, scape length 0.42 mm, cephalic index 82, scape index 68, exposed length of mandibles 0.09 mm, pronotal width 0.44 mm, petiole width 0.42 mm, petiole length 0.41 mm, postpetiole width 0.60 mm, length of gaster posterior to postpetiole 1.96 mm. This specimen is very worker-like, and can be distinguished only by its slightly larger size, proportionately shorter head and scapes, broader petiole, and larger postpetiole and gaster. In addition the postpetiolar-gastric constriction is somewhat weaker than in the worker. Compound eyes and ocelli are completely lacking, as in the worker, and the structure of the alitrunk is essentially the same.

Types. Described from a long series of workers and a single ergatogyne from Ciu, 300 meters, New Caledonia. The following two accessions, representing separate nest series, are included:

no. 195, no. 225. The holotype was chosen from no. 225.

Ecological notes. The two type colonies were found in a small, isolated patch of broadleaf evergreen forest on the farm of Mr. D. Fèrè, about half a kilometer northwest of the Ciu Falls. This little woodlot did not exceed two acres in extent, and its floor had been badly disturbed by cattle. Most of the ants present, including the *Sphinctomyrmex,* were found underneath rocks embedded in the soil. It is curious that the *Sphinctomyrmex* was not found in the undisturbed forest on the south bank of the Canala River a short distance away, despite intensive collecting there.

Both colonies were quite large, one containing over 500 workers and the other over a thousand. That the colonies may have been in migration is suggested by the fact that they occupied poorly defined galleries in the soil which bore no sign of lengthy occupation. The brood of colony no. 195, collected on December 21, consisted of large numbers of mature larvae; two days later, about three-quarters of a sample of these larvae kept alive in a bottle had spun cocoons. The brood of colony no. 229, collected on December 31, consisted of large numbers of cocoons, all of which contained prepupae of indeterminate caste. These data suggest a high degree of synchronization of brood development, a condition usually associated in ants with a nomadic way of life. An account of the behavior of the workers of this species will be given in a later paper.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. MAY 1, 1957 NUMBER 75

ON A NEW OCTOCHAETINE EARTHWORM SUPPOSEDLY FROM GUATEMALA

By G. E. GATES

INTRODUCTION

Twenty-four species of earthworms have been reported from Guatemala. One of them is widely distributed in North America where it presumably originated. Another, "pantropical," may have come from the south. Four are obviously exotic, probably introduced accidentally by man since 1500 A.D. The eighteen supposed endemics are known only from the original material.

As a result of one of those accidents that occasionally advance our knowledge of an infrequently collected group of animals, another presumed endemic now can be added to the list of species known only from a single specimen.

The author's thanks are extended to Dr. P. W. Oman for providing the present specimen and for assistance rendered in connection with problems arising from the study of various other species.

Family MEGASCOLECIDAE

Subfamily OCTOCHAETINAE

Genus RAMIELLA Stephenson 1921

RAMIELLA AMERICANA n. sp.

Guatemala. In soil with *Ceiba pentandra* in cargo on plane arriving at San Pedro, November 25, 1955, 0-0-1. U. S. Bureau of Plant Quarantine.

External characteristics. Length, 133 mm. Diameter, 8 mm. (through elitellum). Segments, 217 (+? possibly a recent posterior amputee). Body slightly compressed dorsoventrally and transversely elliptical in cross section behind clitellum. Unpigmented (formalin preservation). Prostomium, prolobous. First two segments with numerous fine longitudinal grooves in both ventrum and dorsum. Secondary annulation, one presetal furrow each on iv-xii, one postsetal each on vi-xii, first presetal furrows deep but from ix less marked and like the postsetal; secondary furrows lacking behind the clitellum. Setae small, closely paired, only very slightly or not at all protuberant from epidermis, unrecognizable (lacking?) anteriorly; ventral couples first visible on vi, the lateral on xi, $CD<AB$, $AA<BC$, DD ca.$=\frac{1}{2}C$, both *a* and *b* present on left side of xviii, *b* only on right side, ventral couples of xvii and xix penial. Follicles of ventral couples larger than the others, ventral setae probably also larger. Nephropores unrecognizable. First dorsal pore on 11/12.

Clitellum reddish brown, saddle-shaped, reaching ventrally about to *B*, intersegmental furrows obliterated, dorsal pores occluded, setae retained, on xiii-xx. Epidermis 3-4 times as thick as rest of the body wall, cracking into blocks on slight tension.

Spermathecal pores transverse slits of about the same width as *AB*, centered at *A*, on 7/8-8/9. Female pore in a transverse groove in *AA* just in front of eq/xiv. Male pores minute, about half way between *B* and a furrow circumscribing a male field, at 17/18. Prostatic pores minute, on lateral wall of a common lumen containing both *a* and *b* penial setae, on xvii and xix.

Male field longitudinally and broadly elliptical, demarcated by a distinct circumferential furrow somewhat lateral to *B* and just behind eq/xvi but less obvious in front of eq/xx. Two small but conspicuous conical protuberances on each of xvii and xix, about in region of *AB*, might be either localized temporary elevations or eversions of slight parietal invaginations. The large aperture at the tip of each is filled by two penial setae. No other genital markings.

Internal anatomy. Septum 4/5 membranous and transparent: 5/6-9/10 thickly muscular, funnel-shaped, posteriorly directed; 10/11 and 11/12 much thinner though slightly strengthened, apposed at parietes laterally and ventrally but easily separable till just lateral to hearts of xi and there strongly adherent, apparently united dorsally and without insertion on body wall so that gut, dorsal trunk and hearts of xi are invisible at first. Septum 12/13 and those following all membranous.

Pregizzard portion of gut *ca.* 10 mm. long, the thin-walled oesophagus sigmoid. Gizzard large, in v. Gut in vi-xiv slender; calciferous glands and lamellae unrecognizable. Intestinal origin in xv. Caeca vertically placed, 2.5-3 mm. long (high), slightly narrower dorsally, protuberant above dorsal face of gut so that the large dorsal trunk at first glance appears to be within a depression of intestinal roof, nine pairs in xxi-xxix. Typhlosole begins in xix-xx though a much lower ridge extends forward into xvi, reaching a height of 2 mm., lamelliform, anteriorly for a short distance with vertically lamellar lateral protuberances, ending abruptly in clxii. A fairly high and rather thick longitudinal ridge on each side in xxi-xxviii, between apertures into caeca and the median typhlosole, appears to be a lateral typhlosole. It probably does not function as a valve to close off lumen of gut from the caeca as the latter are filled with soil. (No supra-intestinal glands.)

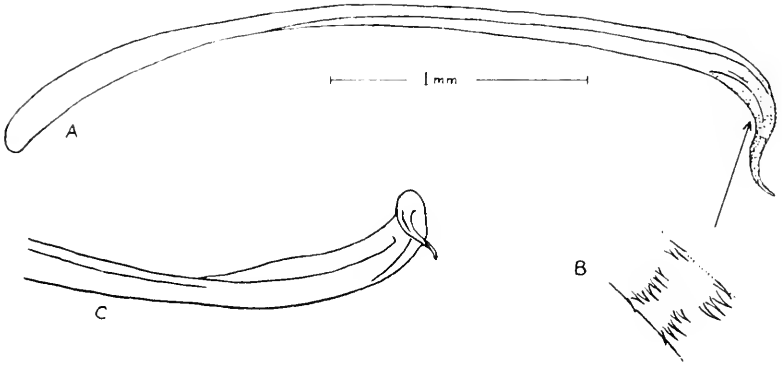
Dorsal blood vessel single throughout, large, gradually dwindling anteriorly and disappearing into tissues of pharyngeal bulb. Supra-oesophageal vessel recognizable only in xi-xii. Ventral trunk unrecognizable anterior to viii. Subneural unrecognizable (lacking?). Extra-oesophageals or other longitudinal vessels not found. Hearts of xi-xii large, latero-oesophageal though presumed bifurcations to dorsal trunk have no blood. Hearts of x somewhat narrower and lateral, those of ix-viii still slenderer and also lateral. Paired vessels from dorsal trunk in vii-v cannot be traced to the ventral trunk. ("Lymph glands" lacking.)

Nephridia of iv represented by a large cluster of looped slender tubules on each side of anterior face of 4/5 (ducts not found nor any funnels, possibly closed, enteronephric and opening into pharynx). Paired, smaller clusters of similar slender tubules present on anterior faces of septa ventrally in v-xi, in viii-ix also attached to posterior faces of spermathecal ducts (ducts and funnels not found). Nephridia, from xii posteriorly on the parietes, on each side one transverse row of short loops from *A* nearly to mD. Nephridial tubules are as slender as anteriorly in xii-xvi but from xvii much thickened and flattened without marked increase in length. The thickening appears to be due to presence of the same sort of tissue as conceals the slender tubules of the micronephridia in certain species of *Dichogaster*. Individual loops, 9-10 on each side in each segment, are connected by a slender transverse cord (blood vessel? or?) but similar cords may be recognizable passing from the loop into the parietes or to the gut. Nephrostomes apparently are lacking until well posteriorly. From the medianmost loop on each side, beginning about at cxxv, a slender cord passes anteromesially to and through the anterior septum, the anterior free end median to *A* very slightly widened. This cord and its slight terminal thickening presumably are neck and funnel respectively but even under highest power of the binocular definite funnel characters cannot be distinguished. Posteriorly the medianmost component of each transverse series becomes somewhat larger and of more than a single loop, and the larger widening of the free anterior end of the cord (neck) becomes definitely funnel-like. Typical, stomate exonephric holonephridia certainly are lacking throughout the entire length. Brain and circumpharyngeal connectives well anteriorly in iii.

Metandric (no funnels in x). Male funnels large, plicate. Male deferent ducts large (with muscular sheath?), with large lumen, on parietes in *BC*, passing into body wall about at level of 17/18, slightly narrowed in xvii and still more so within the body wall. Seminal vesicles, in xii, medium-sized, cut up into very many fine lobes. Prostates tubular, looped and coiled, *ca.* 20 mm. long, lumen central and recognizable clear to ental end, in xvii-xviii and xix-xx. Ducts 3+ mm. long, slightly narrower than gland, with smooth surface, muscular sheen, slit-shaped lumen, muscular layer much thicker than the lining epithelium. Penisetal follicles at first separated from prostatic duct in body wall by a thin vertical sheet of longitudinal muscle, united more deeply.

Penial setae have been studied by Mrs. Dorothy McKey-Fender. Her description is as follows:

"Penial setae (Fig. A) curved, especially proximally and distally, flattened in the plane of curvature and somewhat twisted, the apical, more strongly curved portion somewhat widened, forming an asymmetrical, spoon-shaped blade (Fig. C) with attenuate, often spirally twisted, tip. Distal seventh of shaft, including tip, sculptured on sides and both faces. Sculpture (Fig. B), of interrupted rows of fine teeth that become slightly longer and fewer per group toward the apex of the shaft. Setae *a* and *b* of both xvii and xix alike, except that the tip of the *b* setae may be more strongly twisted. An apparently mature, unworn seta is 3.2 mm. long (disregarding curvature), 0.1 mm. wide and (being rectangular in section) 0.05 mm. thick."



Penial setae of *Ramiella americana*.

A. Camera lucida drawing of an entire seta.
Arrow indicates location of detail shown in B.
B. Detail of edge of blade of same seta, showing character of sculpture (More highly magnified.)
C. Face view of distal portion of a *b* seta from segment xix (sculpture omitted).

Drawings by Mrs. Dorothy McKey-Fender.

Spermathecae adiverticulate, *ca.* 5 mm. long, a band of connective tissue passing from each duct to the septum just in front. Ampulla narrowing somewhat entally, with several annular constrictions externally, ridging of inner wall and large lumen. Duct *ca.* 1½ mm. long, thicker than ampulla but asymmetrical, somewhat and gradually narrowed in parietes, lumen slit-like, wall thick, muscular. Seminal chambers, seven or eight on the bulged side, one or two smaller on the other side, communicate narrowly with duct lumen. Ovaries very small. (No ovisacs found.)

Reproduction. Testis sac with little coagulum and that within a forward pocket-like, median bulge of 10/11. Male funnels with iridescence recognizable only at margins of the folds. Flecks of red iridescence recognizable in each lobule of the seminal vesicles (sheen of muscles in connective tissue binding lobules together, green-red-orange). Clitellum probably at or near maximal tumescence. However, seminal chambers in spermathecal duct and the ampullae are empty. Iridescence is unrecognizable terminally in male deferent ducts. Obviously copulation had not taken place. Accumulation of mature sperm on male funnels presumably had begun only fairly recently though the clitellum appears to be already at maximal development. Sexual, and biparental, reproduction is anticipated.

Remarks. The gut, through xiii-xiv where coelomic cavities were filled with coagulum, is macerated but probably not enough so that intramural calciferous lamellae would have become unrecognizable. Extramural glands, since the intestine begins in xv, would have to be in xiii-xiv. In those segments, small slenderly-stalked glands, judging from experience with poorly preserved material of other species, could have been lost in washing out the coagulum, if disintegration had not been previously completed. Site of stalk-gut junction, in either case, probably would be indistinguishable. As there is no reason for believing that extramural glands had been present in the holotype, absence in the species must, for the present, be assumed.

The excretory system obviously is meronephric.

DISCUSSION

Absence of calciferous glands in ix-x, location of the male pores on xviii at some distance from external apertures of all prostatic ducts, and the meronephry require (cf. key in Pickford, 1937, p. 98) the Guatemalan species to go into the Octochaetinae. In that subfamily, only two genera now appear to require consideration.

The genus *Ramiella,* hitherto recorded only from India and Burma, is defined by its author (Stephenson, 1930, p. 845) as follows: "Setal arrangement lumbricine. All septa present (behind their commencement). One oesophageal gizzard in one simple segment. No calciferous glands. Excretory system purely micronephridial, the micronephridia relatively large and few in number, from seven to one pair per segment. Sexual apparatus purely acanthodriline."

The phrase "purely micronephridial" was intended to convey the idea that holonephridia are lacking from one end of the body to the other. One word, meronephric, is sufficient for that purpose. Further characterization of the excretory system is not warranted at present[1] any more than previously, the supposed reduction of meronephry to a single pair of nephridia per segment being based, in one species at least, on the number of opaque white masses that were externally recognizable through a semi-transparent body wall. The definition accordingly should read, in part, only as follows: Excretory system meronephric.

Ramiellona Michaelsen 1935, also meronephric, differs from *Ramiella* only in having calciferous glands. The latter are characterized (p. 53) as follows: "segmental Erweiterungen des Ösophagus mit blutreichen Falten der Wandung im 12 Segment und einigen vorhergehenden." The small vascular folds on the inner wall of the oesophagus in *Ramiellona stadelmanni* Michaelsen 1935 (the only species) are not known to differ from similarly located ridges in *Ramiella bishambari* (Stephenson, 1914) and *R. nainiana* Gates 1945. As *Ramiellona* is not distinguishable morphologically, the Honduran *stadelmanni,* as well as the Guatemalan *americana,* must go into *Ramiella.*

The huge distributional discontinuity thus established is not exceptional in a system with geographical ranges such as the following: South India-Ceylon and Australia-New Zealand (*Notoscolex* and *Megascolex*), Australia-New Zealand and the Pacific coastal strip of the United States (*Plutellus* and *Megascolides*), temperate-zone North America and peninsular India (*Diplocardia*).

The two Central American species of *Ramiella* do not appear to be more closely related to each other, than to any of their

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[1] Specimens of *Ramiella nainiana* Gates 1945, fixed and preserved in accordance with his instructions, were forwarded, along with other material, to K. N. Bahl for study of the nephridia. If his failure to publish thereon had been anticipated, some data would have been included in the original description while the worms were still available. Ever since, live individuals of any species of *Ramiella* have been unavailable.

oriental congeners. The anatomy, as known, lacks the uniformity one should expect in a good genus. *Ramiella* thus provides one more illustration of the inadequacy of the classical system and the futility of patchwork changes in generic definitions .

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B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. June 18, 1957 Number 76

TWO NEW LAND AND FRESHWATER MOLLUSKS FROM NEW GUINEA

By William J. Clench

The first species was received from Mr. James Poling of New York City, the second from Mrs. Marjorie Kleckham of Daru, Papua, New Guinea.

Mr. Poling purchased all of the remaining stock of the land and marine mollusks from Ward's Natural Science Establishment in Rochester, New York, after the death of Mr. F. H. Ward. Contained in this miscellaneous material were a few lots of land shells, originally obtained from some collector in New Guinea. Subsequent correspondence by Mr. Poling with Ward's has failed to add to the meager data accompanying the specimens. Just who the collector was or the exact locality in New Guinea still remains unknown. The locality is somewhere in western New Guinea, to judge by the associated specimens from the same collector.

Verdichloritis new subgenus

This subgenus differs from all other species in the subfamily Chloritinae by being a dull jade green. All other species, now numbering over 200, are uniformly brown, red-brown, or banded with some shade of brown or red-brown. The usual arrangement of the periostracal "hairs" is in staggered or offset rows; in this subgenus the rows are regular.

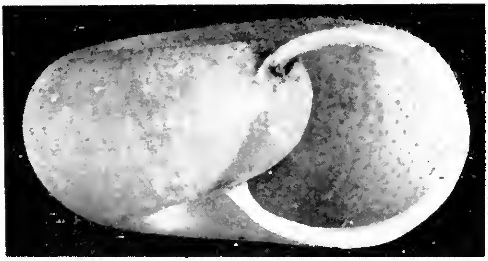
Type species. Eustomopsis (Verdichloritis) polingi Clench.

Eustomopsis (Verdichloritis) polingi, new species

Figure 1

Description. Shell small, reaching 15 mm. in greatest diameter.

planorboid in shape, thin, fragile and minutely hirsute. Color a uniform and dull jade green. Whorls 3½, convex, and coiled in a single plane. Spire depressed below the body whorl. Aperture subcircular. Outer lip thin and very narrowly reflected.



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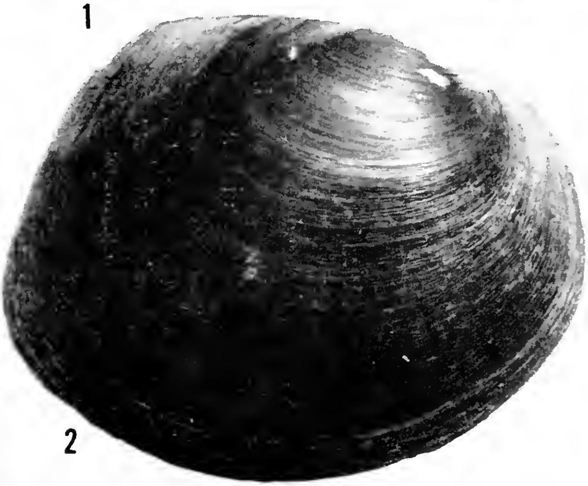

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Fig. 1. *Eustomopsis (Verdichloritis) polingi* Clench (Holotype, 4X).
Fig. 2. *Westralunio albertisi* Clench (Holotype, 1.5X).

Parietal area covered with a very thin glaze. Sculpture consisting of numerous rows of very short, gold-colored periostracal "hairs" which are arranged axially and slightly diagonally.

following the lines of growth. These rows are regular and not staggered or offset as in other species of *Eustomopsis*. Umbilicus narrow but deep, the nuclear whorl being visible. Periostracum jade green overlaying a nearly glass-like shell.

Height	Gt. diameter	Less. diameter	
7.5 mm.	15 mm.	11.5 mm.	Holotype

Type. The holotype is in the Museum of Comparative Zoology, No. 212319, from western New Guinea.

Remarks. This new species is quite remarkable. The dull jade green color sets it well apart from all other species in the subfamily Chloritinae. So far as I am aware, all other species in the Chloritinae are uniform brown, red-brown, chocolate brown, or light brown to yellowish and banded with brown. Many species are hirsute, that is, the periostracum forms little "hairs" in regular or offset rows, such "hairs" emanating from small pits impressed in the calcium of the shell.

It is quite possible that this species is arboreal and, as in many other groups, the species which become arboreal also become somewhat brightly colored, as, for example, species in *Liguus*, *Polymita*, *Placostylus*, *Helicostyla*, *Amphidromus* and many other genera.

A factor of considerable interest is the green color, a rare color even in arboreal mollusks. A few species are banded with green, such as *Liguus* and *Amphidromus* but nearly solid green is exceedingly rare. *Helicina viridis* Lamarck and *H. castilloi* Clench from Hispaniola, *Papustyla pulcherrima* Rensch from the Admiralty Islands, two or three species of *Helicostyla* and *Chloraea* from the Philippines are about all the known species to possess this color predominantly.

WESTRALUNIO ALBERTISI, new species
Figure 2

Description. Shell inequilateral, subcircular in outline, rounded anteriorly, subtruncate posteriorly and reaching 53 mm. in length. Umbos rather small, slightly elevated above the dorsal margin and anterior to the center. Shell moderately compressed and rather light in structure. Color a dark blackish brown. Posterior slope fairly well marked and slightly concave. Posterior ridge not well defined. Ligament long and very narrow. Periostracum shining on the disc but somewhat scaly and dull on the posterior slope.

Nacre white, shining and slightly iridescent posteriorly. Muscle scars well outlined. Hinge plate long and narrow. Right valve with two pseudocardinal teeth, the innermost being the larger. In addition, there is a single and long, narrow, lateral tooth. Left valve with a single pseudocardinal tooth and two long and narrow lateral teeth.

Length	Height	Width	
53 mm.	42 mm.	20 mm.	Holotype
51	44.5	22.5	Paratype
57	50.0	25	Paratype, Lake Murray, Fly River

Types. The holotype is in the Museum of Comparative Zoology, No. 212908, inland from Daru, Western Division, Papua, New Guinea. A single paratype from the same locality is in the Australian Museum, Sydney. An additional paratype is from Lake Murray, Herbert River, Fly River System. All specimens were collected by Mr. Kleckham of the Department of Agriculture, Papua.

This new species is related to *Westralunio flyensis* Tapparone Canefri from the upper Fly River, Papua. It differs from *W. flyensis* by being far more circular in outline and in being proportionately somewhat greater in width. In addition, the ventral margin is rounded, the posterior portion of the dorsal margin is somewhat wing-like and the posterior ridge is well defined.

This species is named for L. M. d'Albertis, a naturalist-explorer who was in New Guinea in 1872-73 and again in 1875. Much of the mollusk work accomplished by Tapparone Canefri was based upon material collected by d'Albertis.

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. June 21, 1957 Number 77

DACETINOPS, A NEW ANT GENUS FROM NEW GUINEA

By W. L. Brown, Jr.
and
E. O. Wilson

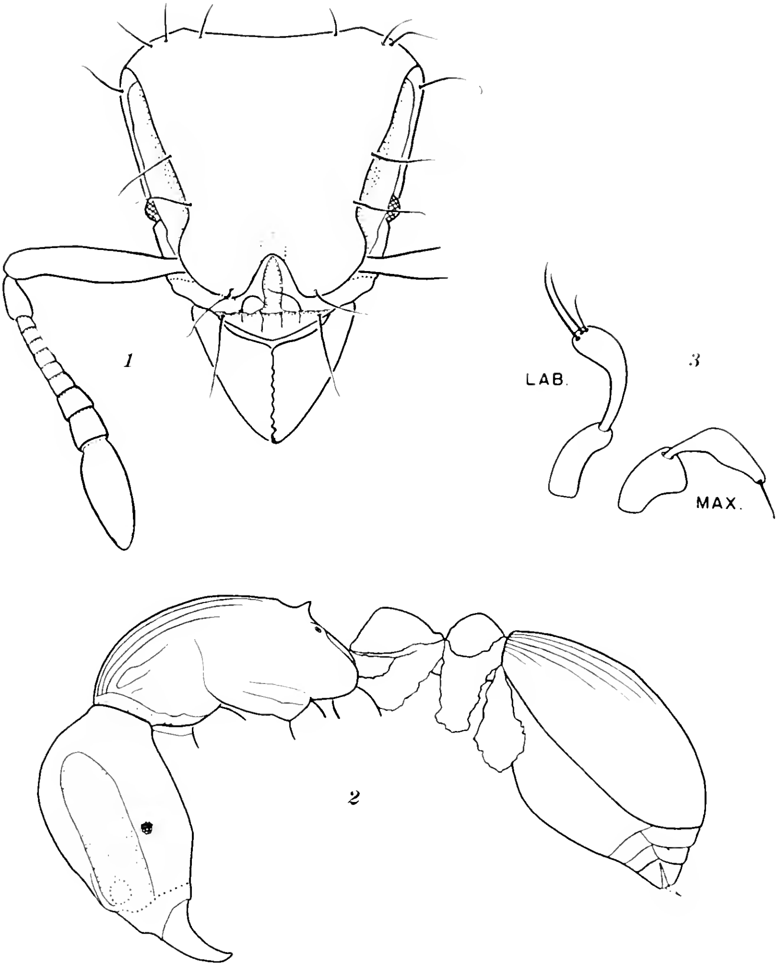
In the course of an extended field trip to the southwestern Pacific area during 1954-1955 (supported by the Museum of Comparative Zoology and the Society of Fellows of Harvard University), one of us (Wilson) was able to collect in the rich tract of rain forest at the Busu River, near Lae, Australian Mandated Territory of New Guinea. Among the samples obtained here were several of a small myrmicine ant with the habitus, both in life and in preservation, of certain short-mandibulate members of tribe Dacetini. However, further examination revealed that this species could not be a member of the Dacetini, even though it possessed certain features, especially the spongiform appendages of the petiole, postpetiole and gaster, not otherwise known among ants outside the Dacetini. This remarkable pseudo-dacetine is described below and its affinities discussed.

Dacetinops gen. nov.

Diagnosis, worker. Small myrmicine ant, apparently closest to *Lachnomyrmex* Wheeler of the American tropics. Body compact, integument hard and thick. Head subtriangular (with mandibles triangular), widest across occipital region, tapering toward mandibles. Antennal scrobes present, deep and distinctly bounded; compound eyes moderate in size, situated ventrad of scrobes near midlength of head. Antennae 11-segmented, with a fairly distinct 3-segmented club. Both sets of palpi 2-segmented. Clypeus convex, obscurely bicarinate, its anterior border forming a broadly rounded translucent apron. Mandibles triangular, broad, with straight, crenulate masticatory margins. Alitrunk compact, arched and sutureless dorsally; propodeal dorsum and declivity almost continuous; a pair of small but distinct propodeal teeth present. Petiolar node sessile (a small condylar extension is visible from above), rounded above, and sloping from a median summit; postpetiole transversely ellipsoidal, rounded above. Gaster broad and somewhat depressed; first segment taking up nearly all the length, nearly circular in outline as seen from above, bluntly margined along the sides in front; remaining segments small, retracted. Sting sclerotized, acute, exsertile. The lower halves of the petiole, postpetiole and anterior part of the first gastric segment bearing and covered by bulky festoons of whitish spongiform tissue. Sculpture consisting predominantly of very coarse longitudinal costation, becoming more reticulate on head, nodes and sides of alitrunk; posterior half of gaster smooth and shining, as is also the propodeal declivity. Mandibles striate. Legs and antennal scrobes finely and densely punctulate. Pilosity consisting of sparse, long, flexuous tapered hairs, mostly situated at definite bilateral positions over the body. Pubescence forming a thin cover mostly only on appendages. Color deep brownish red.

Female. Dealate, but with thoracic flight segments well developed, as usual for winged myrmicines of small size; wing stumps present. Size only slightly larger than worker; form, except as mentioned, similar to that of worker, with only the usual slight differences of caste. The compound eyes are larger than in the worker, but are still modest in size. Scutum and scutellum forming together a nearly plane platform, crossed by the distinct transscutal suture; prescutellum reduced to two small lobes, one on each side of the suture, so that the scutum and scutellum meet at the suture. Scuto-scutellar platform evenly costate longitudinally.

Type of genus: *Dacetinops cibdela* sp. nov.



Dacetinops cibdela, gen. et sp. nov., worker. Fig. 1, holotype, head in full-face view; most of sculpture omitted, and only the hairs nearest the periphery shown. Fig. 2, holotype, body in lateral view; hairs and all sculpture except the prominent dorsal costation omitted. Fig. 3, paratype, detail of maxillary and labial palpi. Drawings by Nancy Buffler.

DACETINOPS CIBDELA sp. nov.

Holotype worker. TL 2.7, HL 0.64, HW 0.59 (CI 91), ML 0.16 (M25), WL 0.76, petiole L 0.22 mm. Index of cephalic depression (ICD) is about 62. Measurements and indices are the ones used in recent works on Dacetini by Brown (see especially Brown, 1953, Amer. Midl. Nat., 50: 7-15).

Form of head and mandibles as shown in Figures 1 and 2. Scrobes sharply defined, each divided partially by a fine anterior carina, and able to receive the entire antenna except the apical part of the club; upper scrobe margins narrowly lamellate. Pronotum margined in front, submarginate along the sides; humeral angles obtuse, but distinct, subtuberculate. Propodeal region of alitrunk short, tapering rapidly behind promesonotum; propodeal declivity weakly concave from side to side, bounded above by an ogival margin, and marginate laterally. Propodeal teeth acute, feebly downcurved toward their apices, their bases separated by about 4 times their length. Propodeal spiracles not far under the teeth on the lateral margins of the declivity, facing posterolaterad. Petiolar node seen from above approximately as broad as long, with strongly rounded sides, widest near midlength. Postpetiole about half again as broad as long, ellipsoidal or subreniform as seen from above, the more strongly rounded margin posterior. Gaster with a short, straight anterior margin opposite the postpetiole, the sides rounded away on each side.

Spongiform appendages of petiole, postpetiole and gaster finely areolate, apparently composed of cuticular material, not arranged in distinct lobes like those of the dacetines, but narrowed medially below, where masses of opposite sides are joined (Fig. 2).

About 10 coarse, fairly distinct longitudinal costae across the head between the ends of the scrobes, these converging and anastomosing anteriad between the frontal lobes, and joined by short transverse ridges to form a coarse reticulum (not shown in the figures). The bottoms of the large pits or foveolae thus enclosed are sculptured finely and are subopaque. Disposition of costulae on clypeus shown in Figure 1; interspaces here finely sculptured and subopaque. Underside of head coarsely rugoreticulate. Mandibles coarsely striate at base, becoming smooth and shining apicad, with scattered punctures. Dorsum of alitrunk with smooth, straight, heavy longitudinal costae running from anterior pronotal margin to the beginning of the propodeal declivity (10 costae across pronotal dorsum), shining and with more or less shining interspaces. Sides of alitrunk and dorsal surface of petiolar node coarsely rugo-reticulate. Basal half of postpetiole and of gaster with coarse longitudinal costae (9-10 across gastric base), remainder of gaster, postpetiole, declivity and concave lateral faces of propodeum smooth and shining, often with scattered punctures. Legs, antennae, scrobes and a band along each side of the first gastric sternum densely punctulate, opaque.

Long, fine, tapered hairs scattered over dorsum of head (those nearest the cephalic borders are shown in Figure 1), alitrunk, both nodes and gaster as well as a few on the gular surface of the head, on the coxae and on the underside of the femora; length ranging about 0.12-0.19 mm. Short, fine, appressed to decumbent hairs forming a pubescence on the legs, antennae and sternum and apex of gaster; similar hairs are sparsely distributed over both surfaces of head, mostly one hair to a foveola, and over mandibles.

Basic body color deep brownish red; mandibles, legs and antennae, especially the club and the first funicular segment, more yellowish.

Holotype worker (deposited in the Museum of Comparative Zoology) taken in rain forest at the lower Busu River, near Lae, New Guinea (E. O. Wilson leg., No. 1058), May 17, 1955, either as a stray or in berlesate from under bark of a large Zoraptera-stage log. Three additional workers (paratypes) were taken in this collection and bear the same number.

Paratypes, workers. 9 mounted dry, 3 in alcohol, all collected in the same tract of forest as the holotype (Wilson Nos. 899, 942, 978, 1052, 1058, 1113). Deposited in Museum of Comparative Zoology, U. S. National Museum, Coll. G. C. Wheeler, and one or more each in Australian and European collections as yet unselected. Total maximum variation for all series: TL 2.2-2.6, HL 0.54-0.63, HW 0.50-0.57 (CI 91-93), ML 0.15-0.16 (MI 24-27), WL 0.65-0.76, petiole L 0.18-0.22 mm. Greatest intranidal variation occurs in series No. 1052: TL 2.2-2.5, HL 0.54-0.62, HW

0.50-0.56 (CI 91-92), ML 0.15 (MI 25-27), WL 0.65-0.75 mm. Very little variation among the workers of these lots. Sculpture, particularly of cephalic dorsum, varies in minor details; spongiform appendages a trifle more voluminous in some specimens than in others.

Paratypes, dealate females. 3 specimens, taken with workers (Nos. 942, 1052, 1113, the last in alcohol, not measured). Deposited in the Museum of Comparative Zoology and elsewhere with the workers. Queen variation (Nos. 942 and 1052): TL 2.6-2.8, HL 0.58-0.62, HW 0.56-0.60 (CI 96-97), ML 0.17-0.19 (MI 29-30), WL 0.79-0.85 mm.

Larva. A single medium larva was preserved in alcohol. This specimen is short and thick, with head turned ventrad. Without proper preparation, none of the details of this larva can be made out, except that the hairs are varied in length, with some of the longer dorsal ones anchor-tipped. This larva has been sent to Dr. G. C. Wheeler for expert study (See Breviora No. 78).

Biology. The six collections were all made on the forest floor in heavy to medium rain forest. Nos. 978 and 1052 were strays taken from soil-leaf litter berlesates. No. 899 was a stray sample from the forest floor, beneath a log. No. 942 was a small nest in a cavity under the bark of a Zoraptera-stage branch about 6 cm. in diameter, buried in the leaf litter; the queen and two workers were taken. No. 1113 is a queen with one worker, originally taken with a few larvae and two eggs in a small cavity in the middle of a small piece of rotten wood buried in the leaf litter. This apparently incipient colony was kept in an artificial nest for 10 days, but showed no signs of predatory or nest-founding behavior during that time. All of the collections were made during the first three weeks in May, 1955.

From these observations, we may perhaps conclude that *D. cibdela* is normally a dweller in the leaf litter of the rain forest floor, where it frequently, perhaps usually, nests in or beneath the bark of rotting logs or other large or small masses of rotting wood. Apparently the nests are small in volume and in population, like those of other specialized small myrmicines with similarly slight differences separating the female and worker castes. Wilson noted that the workers of this species walk in a slow, deliberate fashion reminiscent of dacetines and basicerotines.

Relationships. Although from its general habitus this species seems to belong to the Dacetini, a closer look does not bear out placement with that tribe. In the first place, its resemblance is general, and not particular to any one dacetine genus or subtribe. The shape of the head and mandibles are fundamentally different from those of any dacetine, as is also the arrangement of the spongiform appendages, which at first sight are so dacetine-like. The antennae are 11-segmented, like those of the primitive dacetines, but the distinct club is not a dacetine feature; the palpi of *Dacetinops* are segmented 2, 2, against 5, 3 for the primitive dacetines and 1, 1 for the higher dacetines. The details of structure of the alitrunk and petiolar node are also not like those of any dacetine, and the sculpture recalls that of the dacetines only at the gastric base, but even here, the costulae are of a basically different type. Ties with the Basicerotini are even fewer, the position of the eyes being one important difference; there seems to be no need to compare further with basicerotines.

As already mentioned, the closest similarity holds with the neotropical genus *Lachnomyrmex* Wheeler (with three described species). The best account of *Lachnomyrmex* is that of M. R. Smith (1944, Proc. Ent. Soc. Washington, 46:225), which gives excellent figures of the genus. *Lachnomyrmex* also has an 11-segmented antenna, but the club is 2-segmented. This difference in club segmentation is really not a very important character, since only a slight change in size of the antepenultimate segment would be needed to make the *Lachnomyrmex* club 3-segmented. *Lachnomyrmex* has no posterior expansion of the head. as in *Dacetinops*, and the form of the node is somewhat different, as well as the proportions of the parts of the alitrunk, but the differences here are not as serious as those between *Dacetinops* and the dacetines. *Dacetinops* appears to belong, with *Lachnomyrmex*, to a group of small myrmicines that includes also the New World *Rogeria* Emery (the so-called *Rogeria* from the *Melanesian* area are not true members of the genus, but are closer to *Lordomyrma*), *Apsychomyrmex* Wheeler, and *Adelomyrmex* Emery, as well as the primitive *Agroecomyrmex* Wheeler of the Baltic Amber. Apparently these are specialized relicts of an ancient and widespread myrmicine fauna that still retain some marks of their ectatommine ancestry.

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. June 21, 1957 Number 78

THE LARVA OF THE ANT GENUS DACETINOPS BROWN AND WILSON

By George C. Wheeler and Jeanette Wheeler

Department of Biology
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Genus Dacetinops Brown and Wilson

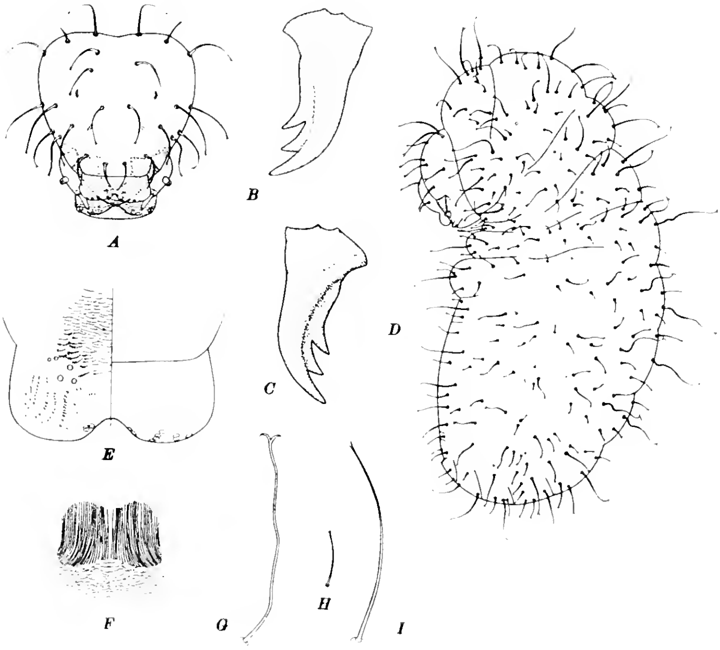
LARVA

Body hairs sparse, of two types: (1) with short-bifid tip and (2) anchor-tipped, with sinuate shaft. Cranium subcordate. Antennae minute. Head hairs few (about 26), with short-bifid tip. Posterior surface of labrum with numerous spinules. Mandibles long and slender; apex forming a long sharp-pointed tooth which is curved medially; with a narrow blade projecting medially from the anterior surface and bearing two long coarse medial teeth. Maxillae small, with the apex paraboloidal; palp a stout peg; galea digitiform. Anterior surface of labium with numerous spinules. Hypopharynx spinulose and with numerous longitudinal ridges near the pharynx.

Dacetinops cibdela Brown and Wilson

(Text figure 1)

Immature Larva. Length through spiracles about 1.25 mm. Short and stout; prothorax directed ventrally; head ventral; anterior end formed from the dorsum of the mesothorax; dorsal profile C-shaped; abdominal somites II and III produced ventrally into rounded transverse welts. Anus ventral, with a small posterior lip. Spiracles small, mesothoracic slightly larger than the rest. Integument apparently without spinules. Body hairs sparse and uniformly distributed, of two types: (1) 0.036-0.15 mm. long, slightly curved, with short-bifid tip, some on each somite, longest on the thorax and ventral surface; (2) anchor-tipped, with sinuate shaft, about 0.16 mm. long, four in a row across the dorsum of each abdominal somite II-V. Cranium subcordate in anterior view, clypeus bulging. Antennae minute.



Text figure 1. *Dacetinops cibdela* Brown and Wilson, larva. A, head in anterior view, X93; B, left mandible in anterior view (stippled to show thickness), X271; C, left mandible in posterior view (shaded to show contours), X271; D, immature larva in side view, X54; E, labrum (left half of drawing in posterior view, right half in anterior view), X271; F, hypopharynx in anterior view, X271; G, anchor-tipped body hair, X185; H and I, two bifid-tipped body hairs, X185.

each with three sensilla, each of which bears a minute spinule. Head hairs few, 0.036-0.09 mm. long, slightly curved, with short-bifid tip. Labrum short, wide and bilobed; each lobe with about 13 sensilla on and near the ventral border; posterior surface of each lobe with a central cluster of 4 or 5 sensilla, lateral to which the spinules are large, isolated and sparse, but medially and dorsally the spinules are much more numerous, smaller and arranged in short transverse rows which are grouped into longer rows. Mandibles heavily sclerotized, rather narrow and elongate, subtriangular in anterior view; with one large apical tooth which is curved medially and posteriorly; with a median blade arising from the anterior surface and bearing two large medial teeth. Maxillae small, apex with a few short encircling rows of minute spinules; palp a stout peg with five apical sensilla (three minute and bearing a spinule each, two larger and encapsulated); galea digitiform, with two apical sensilla. Anterior surface of labium spinulose, the spinules numerous and in short arcuate rows, the rows arranged in a longer subtransverse pattern, the spinules longer ventrally; palp a low knob with five apical sensilla (three minute and bearing a spinule each, two larger and encapsulated); opening of sericteries in a wide depression on the anteroventral surface of the labium. Hypopharynx spinulose, the spinules numerous, minute and arranged in subtransverse rows; numerous longitudinal ridges near the pharynx. (Material studied: one damaged larva from New Guinea, collected by E. O. Wilson; courtesy of W. L. Brown.)

A single damaged immature larva is a frail foundation on which to base the taxonomic relationships of a genus. Nevertheless we must hazard a few guesses, for that is all the material we have. Such guesses are the more difficult because of the nearly diagrammatic structure of this larva. If only it had a few (or even one) striking peculiarity — something overdeveloped or something lacking. If we extrapolate the mature body shape, enlarge the antennae to normal size, inflate the bases of the mandibles a little and reduce somewhat the size of the medial mandibular teeth, the result might be considered the synthetic type for the subfamily Myrmicinae.

We are now in the process of synthesizing our studies of the larvae of the Myrmicinae. Consequently we do not yet have clear ideas as to what characters are phylogenetically basic. However, we do feel that a few provisional opinions about the relationships are not out of order.

The larva of *Dacetinops* resembles the larva of *Rogeria* so closely that the same generic description would apply to either — *except* for the hairs: *Rogeria* lacks the anchor-tipped hairs which we suspect will prove to be of basic phylogenetic importance. The larva of *Dacetinops* also resembles the larvae of the tribe Basicerotini but differs in having anchor-tipped hairs and by lacking spinules on the mandibles. The worker of *Dacetinops* is convergently similar to the Dacetini, but its larva is not. In fact, the larva of *Dacetinops* shows no close affinity with any known genus.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. AUGUST 9, 1957 NUMBER 79

DASYPELTIS MEDICI LAMUENSIS, A NEW RACE OF EGG-EATING SNAKE (OPHIDIA, REPTILIA) FROM COASTAL EAST AFRICA

By CARL GANS

Museum of Comparative Zoology and Carnegie Museum, Pittsburgh, Pa.

Some time ago an analysis of the African egg-eating snakes of the genus *Dasypeltis* indicated the presence of an undescribed race from coastal East Africa. However, as the entire revision of this genus will not be published for several months, I am describing the new race here in order that Mr. Arthur Loveridge may include it in his checklist of the reptiles and amphibians of East Africa, which is now in press.

In 1942, Loveridge revived *Dasypeltis medici* as a subspecies of the wide-ranging *D. scabra*. Examination of additional specimens from supplementary localities convinced me that two forms are involved, and furthermore that *D. scabra* and *medici*, though sympatric in many areas, are distinct species which, besides their color patterns, show differences in a number of other characters. Among these are ventral and caudal counts of both male and female species, body proportions, etc.

In his 1942 paper Loveridge mentioned in passing that northern specimens of *medici* were unicolored and did not possess the characteristic color pattern upon the basis of which this species was initially described by Bianconi. The "uniform" coloration has been found to be associated with significantly lower ventral counts and the northern specimens are here recognized as a distinct race.

The detailed acknowledgments to the many who helped with the analysis will be given in the main paper. Here I restrict myself to thanking Ernest E. Williams and Arthur Loveridge

of the Museum of Comparative Zoology (MCZ) for checking this paper, the John Simon Guggenheim and National Science Foundations for supporting the research upon which this paper

Figure 1. *Dasypeltis medici.* Dorsal views showing pattern atop head. *Top. D. m. medici* — BM 12-1-30-6 from Matemo, Mozambique. *Bottom. D. m. lamuensis* — BM 51-1-3-73 from Kilifi, Kenya. Note that the pattern is almost completely faded out on the parietal scales of *lamuensis*, and has disappeared in the nuchal region. The pustulosity or pitting on the head shields and the dark pigmentation of the pits is clearly apparent.

is based, and Mr. J. C. Battersby of the British Museum (Natural History), London (BM), as well as Dr. Heinz Wermuth of the Zoologischen Museums der Universität, Berlin (ZMU), for the loan of paratype material.

DASYPELTIS MEDICI (Bianconi), 1859

1. Pattern, consisting of narrow lateral bars (of which at least the first three to eight fuse to form narrow Vs on the nape), extends the entire length of snake from the head on to the tail; ventrals more than 229 in males, more than 236 in females. .... *D. m. medici.*
2. Pattern, if present, restricted to top of head (see Fig. 1); ventrals 229 or less in males, less than 233 in females. .... *D. m. lamuensis.*

DASYPELTIS MEDICI MEDICI (Bianconi), 1859

Dipsas Medici Bianconi, 1859, p. 277. No locality designated, but Mozambique by inference. Type in Bologna Museum.

Dasypeltis scaber var. *fasciolata* Peters, 1868, p. 451. Type (ZMU 5737) from "Angeblich aus Zanzibar".

Dasypeltis elongata Mocquard, 1888, p. 131. Type locality: Zanzibar. Type in Museum d'Histoire Naturelle, Paris.

Diagnosis. Three to eight narrow Vs commencing on the nape, followed by a series of narrow, lateral, dark red-brown bars. These bars will encircle a pink to silvery-white vertebral dot, if they coalesce with their fellows from the opposite flank. In some specimens the posterior bands are situated between more or less clearly expressed oval dorsal saddles, while various intermediate patterns (see Fig. 2) have also been observed. The dorsum is a light reddish-brown, which shows a considerable amount of mottling under the binocular microscope. The apical scale pits, as well as those of the head region, are a dark brown, this pigmentation being found on all scales and very sharply set off. The ventrum is a clear pink, more or less regularly stippled with grey. Beneath the tail of many specimens, particularly in males, this stippling is arranged in two to four lines. In other individuals, however, the distribution of the stippling appears to be haphazard. Three lateral scale rows are definitely reduced and inclined, and they, as well as some of the adjacent rows, generally have strongly serrated keels. The frontals show pitting or pustulosity over their entire surface as do most of the other cephalic scales (see Fig. 1). The inter-prefrontal suture is not depressed. Ventrals in males 235-253, in females 237-259; caudals 82-109 and 71-80, respectively.

Range. Coastal East Africa. Extreme southern Kenya, Tanganyika, northern and central Mozambique; inland to Nyasaland.

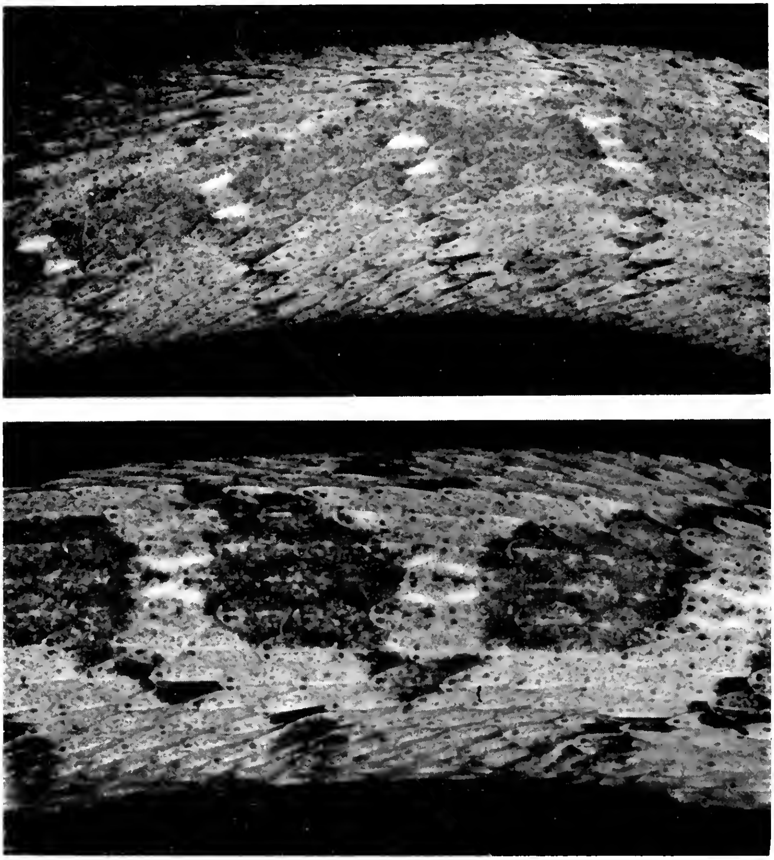


Figure 2. *Dasypeltis m. medici.* Dorsal views at midbody showing color pattern variants of this race. *Top.* BM 12-1-30-6 from Matemo, Mozambique. *Bottom.* BM 97-6-9-106 from between Nkata Bay and Ruarwe, Nyasaland. Note lighter middorsal spots between the saddles, the regular pigmentation of the apical scale pits, and the general speckling of the ground color.

Distribution records. (Map 1 shows the relation of these localities to each other. Records from the literature are starred.) KENYA: Takaungu. Between Voi and Ndi, Taita. TANGANYIKA: Zanzibar Coast. Kibongoto' Kilimanjaro (Intergrade? specimen[1]). Amani, Usambara Mts. Usambara. Makindu River. Morogoro. Nyange, Uluguru Mts. Northern Ukutu (Kuthu) Steppe. Tendaguru. Mikindani. Nchingidi. Liwale. ZANZIBAR. MAFIA. MOZAMBIQUE: Matemo. Ribáuè, Nyassa Prov. NYASALAND: Between Nkata Bay and Ruarwe. Zomba. Cholo Mtn.

DASYPELTIS MEDICI LAMUENSIS Subsp. nov.

Dasypeltis palmarum Peters (not of Leach), 1878, p. 206. 1 ex. Taita, Kenya (J. M. Hildebrandt): ZMU.

Dasypeltis scabra var. F (part), Boulenger, 1894, p. 356. 1 ex. Mt. Kilimanjaro, Tanganyika (F. J. Jackson): BM.

Dasypeltis scaber Uthmöller (part), 1934, p. 113. 1 ex. nr. Gomberi, Kilimanjaro, Tanganyika (Uthmöller): Zool. Staatssammlung, München.

Dasypeltis scaber Loveridge (part), 1936, p. 256. 1 ex. Mt. Mbololo; 2 ex. Lamu Island, Kenya (Loveridge): MCZ.

Dasypeltis scaber Scortecci (part), 1939, p. 276. 1 ex. Belet Amin, Ital. Somaliland = Somalia (S. Patrizi): Genoa Civ. Mus. Stated to be uniform grey dorsally.

Dasypeltis scaber medici Loveridge (part), 1942, p. 283. Mention of uniformly colored northeastern material: MCZ.

Diagnosis. Uniform reddish-brown dorsally, fading to buff in some specimens after preservation (Loveridge). Pink ventrally with a fine speckle of a slightly darker pinkish-brown denser on the sides (Fig. 4, bottom). Some specimens are a uniform olive grey, fading to a plumbeous grey after preservation. These have a light grey ventrum, minutely flecked with white. A vague or distinct mottling of the ground color may be seen under the binocular microscope (see Fig. 4, top). Apical pits of body and marginal pits of head scales distinctly pigmented with a darker reddish-brown (see Fig. 1). With proper illumination faint to clear V-shaped markings can be discerned on the parietal scales of some specimens. Three lateral scale rows are distinctly reduced and inclined, and they, as well as several of the adjacent rows,

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[1] The status of this specimen is discussed below and its data are not included in the above ranges for this subspecies.

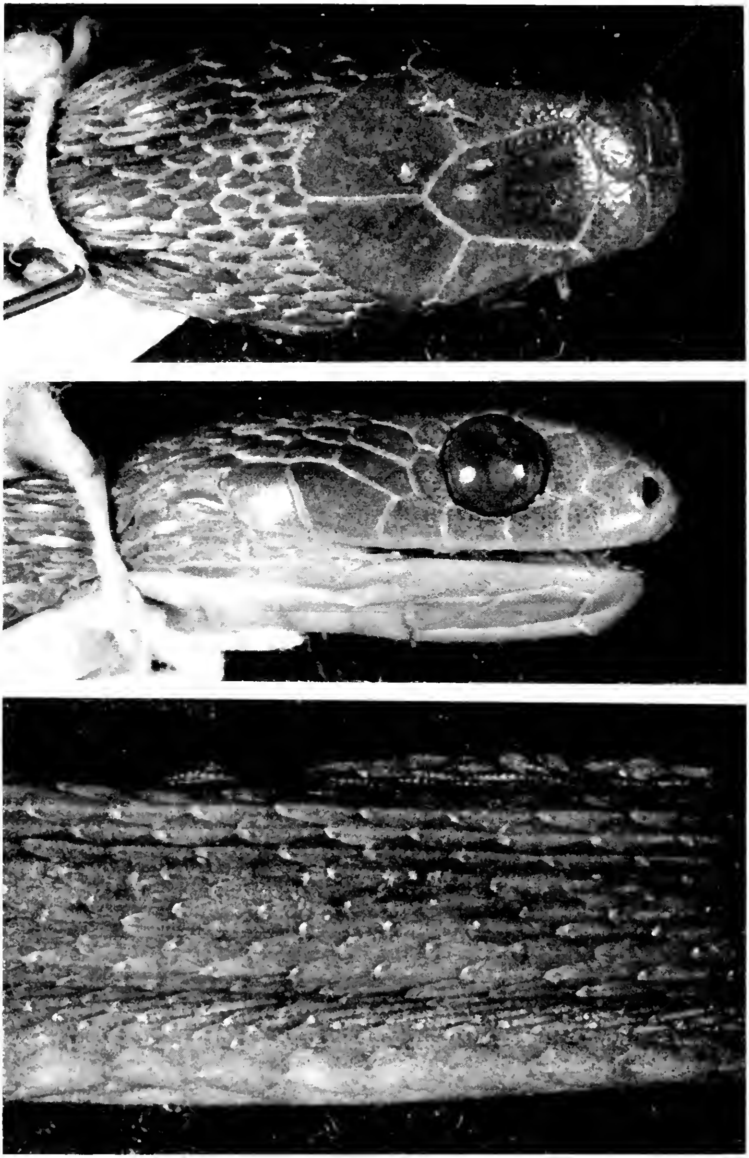

Figure 3

generally have strongly serrated keels. Each frontal scale shows pustulosity or pitting around the periphery and in the center. The suture between the prefrontals is not depressed. Ventrals in males 226-229, in females 226-232; caudals 84-94 and 72-84, respectively.

Holotype. Museum of Comparative Zoology No. 40582, an adult male from Lamu Island, Kenya, collected by Arthur Loveridge 12 May 1934.

Allotype. Museum of Comparative Zoology No. 40583, an adult female collected with the type.

Paratypes. British Museum (Natural History) Nos. 51-1-3-72 and 51-1-3-73 from Kilifi, north of Mombasa, Kenya. Also British Museum (Natural History) No. 98-1-8-15 from Maungu, near Voi, Kenya; Museum of Comparative Zoology No. 40580 from Mt. Mbololo. Kenya; Zoologisches Museum der Universität (Berlin) No. 9244 from Taita (region), Kenya; and British Museum (Natural History) No. 87-11-3-31 from Mt. Kilimanjaro, Tanganyika.

Description. Both the Lamu holotype and allotype are a uniform brownish-red dorsally, and a speckled pink on the venter. Under proper illumination a very faint, posteriorly-directed V may be discerned on the parietal scales (see Fig. 3, top). Scale pits on head and body with sharply defined darker brown pigmentation, though this is only slightly darker than the dorsal color (Fig. 3, bottom) and not as clearly visible as on lighter specimens (Fig. 4, middle). The frontals are pitted around their margins and pustules are also present in their centers, with the other head shields showing a similar pattern. The suture between the prefrontals is not depressed, the ocular-temporal formula is 1+2+2+3, and the upper labials and eye contact are 7(34). Counts of ventrals are 226 for both type and allotype, caudals are 94 and 84, dorsals 23 and 24 at midbody respectively. The third, fourth and fifth rows of dorsal scales from each side are reduced, inclined and serrated, and the keels of the dorsal

Figure 3. *Dasypeltis m. lamuensis.* Views of the holotype (MCZ 40582). *Top.* Dorsal view of head. *Middle.* Lateral view of head. *Bottom.* Dorsolateral view of specimen in the midbody region. Note the very faint pattern on the parietals, and the fact that the prefrontals, oculars, anterior labials, etc. are covered with pigmented pits.

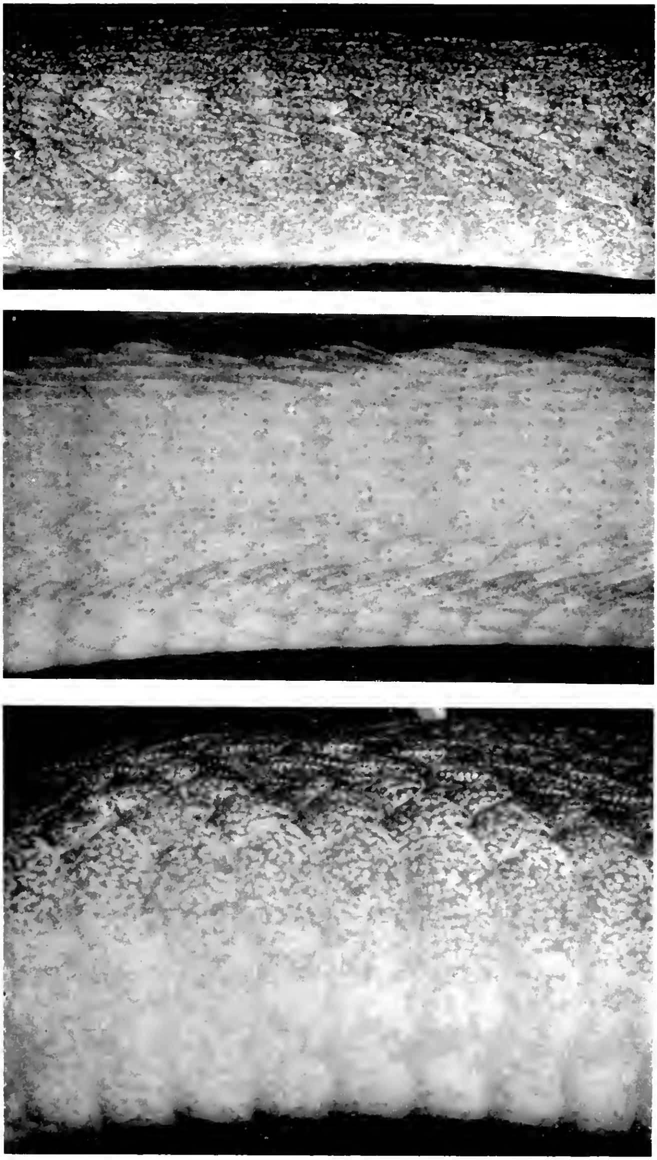

Figure 4

scales are serrated around the body in the anal region of the type, but not of the paratype. Body and tail lengths are 493+132 mm. and 570+128 mm. respectively.

Range. Coastal East Africa from Somalia south to the Kenya-Tanganyika frontier.

Distribution records. SOMALIA: Belet Amin (Scortecci, 1939). KENYA: Lamu Island (Loveridge, 1936); MCZ 40582, 40583. Kilifi, north of Mombasa. BM 51-1-3-72, 51-1-3-73. Maungu near Voi. BM 98-1-8-15. Mt. Mbololo (Loveridge, 1936); MCZ 40580. Taita (Peters, 1878); ZMU 9244. TANGANYIKA: Mt. Kilimanjaro (Boulenger, 1894); BM 87-11-3-31. Near Gomberi, Mt. Kilimanjaro (Uthmöller, 1934).

Discussion. The map shows the relative position of collecting localities for both patterned and unicolored forms of *D. medici*. The species appears to be restricted to the coastal regions below 1000 meters, generally characterized by their reddish laterite soils (Loveridge, 1942). As may be seen from the map, all but two of the Kenya specimens are definitely unicolored. Pattern is present in the Voi-Ndi juvenile, but the Takaungu individual is an almost completely faded adult, which lacks even the pigmentation of the apical pits so characteristic of the species. Two of the three specimens from the vicinity of Mt. Kilimanjaro (seen, or reported on in the literature) were unicolored, while the dorsal pattern of the third is faded out posteriorly. All other specimens and records from Tanganyika have, or are said to have, a color pattern.

Of the other characters examined only ventral counts show clinal variation. Figure 5 demonstrates these counts for male and female specimens of the two color phases, showing the sharply

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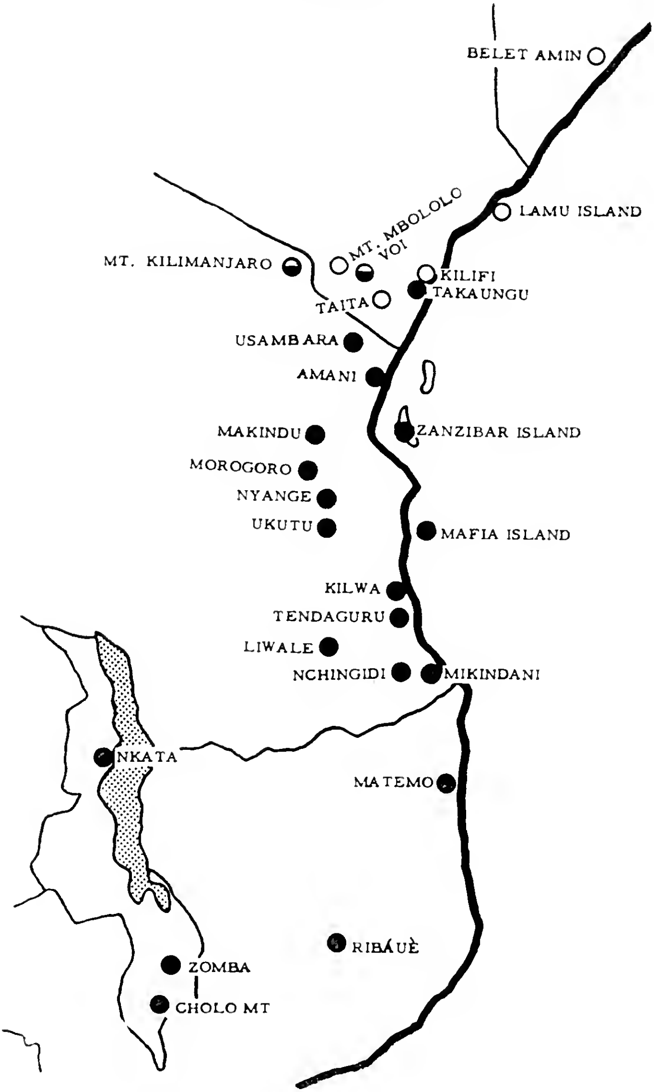
Figure 4. *Dasypeltis m. lamuensis.* Views of the midbody region of different specimens to demonstrate certain characteristics of the pigmentation. *Top.* BM 51-1-3-73 from Kilifi, Kenya. Lateral view of dark grey specimen, showing the extensive speckling of the ground color, which almost masks the pigmentation of the apical pits. *Middle.* BM 98-1-8-15 from Maungu, Kenya. Lateral view of light colored specimen which clearly shows both pigmentation of apical pits and lateral scale arrangement. Note that the ground color is still speckled. *Bottom.* BM 51-1-3-72 from Kilifi, Kenya. Ventrolateral view of specimen showing color invasion and speckling of light colored ventrum.



Dasypeltis medici. Map showing localities for all specimens actually examined as well as for the literature record from Belet Amin. Solid dots stand for records of *m. medici*, open circles for records of *m. lamuensis*. Divided circles refer to the pairs of immediately adjacent records discussed in the text.

distinct ranges. The only exception is furnished by the faintly patterned specimen from Kibongoto' Kilimanjaro. This has a ventral count of 218, i.e. 8 less than the lowest count for a unicolored specimen and 19 less than the lowest count for a patterned specimen.

In view of the fact that the two populations replace each other geographically, that they differ in two characters which break in the same zone, and that there exists a possibly intermediate specimen from a geographically intermediate region, they are here considered to be subspecifically distinct. This decision has been

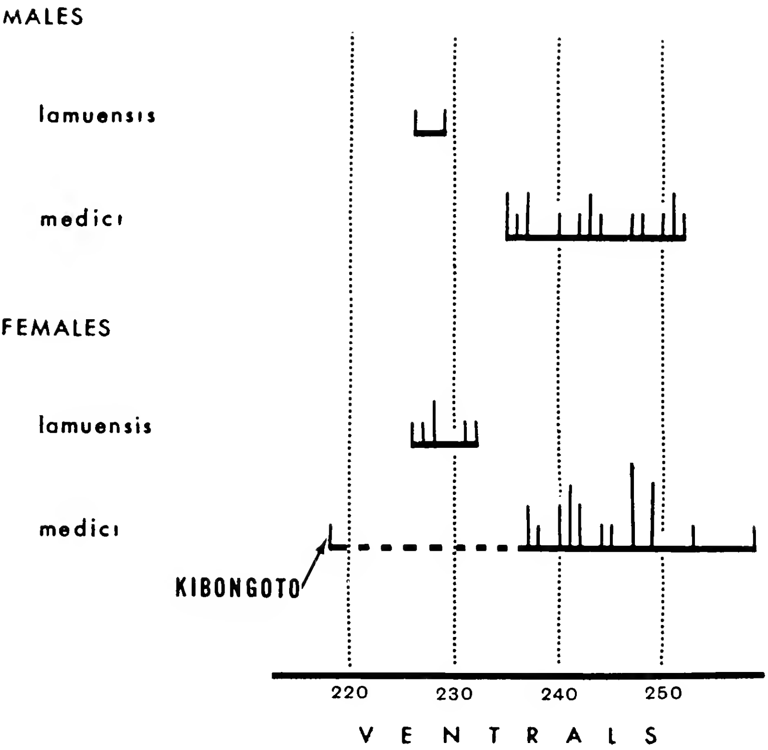


Figure 5. *Dasypeltis medici.* Graph showing ventral counts of all specimens of the two races actually examined. Note the anomalous count of the Kibongoto specimen.

consciously influenced by a desire to focus attention upon this population in the hope that this will permit re-examination of the matter on the basis of more nearly adequate collections.

It has been suggested that this situation represents two adjacent species and that the patterned Kilimanjaro specimen is a hybrid. While the material is insufficient to decide the point, there is some evidence against this idea. Thus both of these color patterns feature a sharply defined pigmentation of the apical scale pits and are the only forms within the genus that have this characteristic. Besides which, 45 out of 46 specimens of the combined sample have frontals that are entirely, rather than marginally, pustulated or pitted, a frequency not approached by any other population, with the exception of *Dasypeltis scabra* from South Africa. In view of these facts and in the absence of more detailed data, the two forms are considered to belong to a single polytypic species.

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. September 30, 1957 Number 80

A COLLECTION OF DRAWINGS OF FISHES ASCRIBED TO J. P. KIRTLAND (1793-1877), IN THE LIBRARY OF BOWDOIN COLLEGE

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During the latter part of 1956, a pamphlet box removed from the shelves of the Bowdoin College Library was found to contain 61 uncatalogued drawings of fishes, nearly all bearing the signature "J. P. Kirtland, del." Of the drawings, all of which are in good condition, 57 appear to be originals of various of the illustrations accompanying a series of articles by Jared Potter Kirtland on the fishes of Ohio, which appeared in the Boston Journal of Natural History from 1840 to 1846. Most of the drawings are in pencil; a few are finished in watercolors; all appear to have been drawn by the same hand. Of the 69 figures accompanying Kirtland's articles, corresponding drawings are lacking for but 11 which constituted 4 of the 26 plates and 2 of the 3 figures of a fifth plate. Various bits of evidence indicate that these drawings were executed by Kirtland for his article. How might they have come to Bowdoin College? Probably through Dr. D. H. Storer.

David Humphreys Storer (1804-1891) and Jared Potter Kirtland had much in common: New Englanders by birth, educated for the medical profession, eminent teachers and practitioners of medicine, among the founders of medical schools and active civic leaders, prolific authors in diverse fields, both had a lifelong interest in natural history and especially in ichthyology. Storer was a native of Maine and a graduate in 1822 of Bowdoin College;

he moved to Boston to begin his medical education at Harvard University where he later taught for many years. Kirtland moved to Ohio in 1823 from New Haven where he had graduated from Yale Medical School in 1815.

Gehr's (1952) biography of Kirtland states that he was a member of the first class to matriculate in the medical school of Yale University, and that he pursued a long career as a physician and teacher of medicine. He was a founder of, and a proponent of legislative action which established the medical school of Western Reserve University. He was for most of his life a contributing student of natural history — of mollusks, insects, fishes and birds. He was the author of many publications and articles on subjects as diverse as medicine and horticulture. He was a correspondent of Professor Louis Agassiz and collected Ohio fishes for him. He was a frequent lecturer in many areas of knowledge, and included the duties of an editorship among his other responsibilities. He was elected a member of the American Philosophical Society at the age of 82. Legislator, teacher, physician, biologist, noted naturalist, Jared Potter Kirtland led a full and most productive life.

Indicative of their stature as naturalists is the fact that Kirtland and Storer were each appointed in 1837 by the government of their respective states (Storer by Massachusetts and Kirtland by Ohio) to assume an important role in natural history surveys of those states. Storer's report on the fishes and reptiles of Massachusetts was published in 1839 by the Commissioners on the Zoological and Botanical Survey of the State. Of his report, Storer wrote to Nehemiah Cleaveland of Bowdoin College probably sometime between 1855 and 1867, in a letter preserved by the College, "In 1837, Commissioners were appointed by the Governor and Council to prosecute the Botanical and Zoological Survey of the Commonwealth. The departments of ichthyology and herpetology were entrusted to me. I concluded my report in 1839 . . . In 1842, Dr. DeKay published his 'Zoology of the State of New York.' You will excuse me for copying from that report the following: 'In 1839, Dr. D. H. Storer, who had previously furnished several valuable papers on ichthyology in the Boston Journal of Natural History, published a masterly report on the fishes of Massachusetts. In this report, the author has enumerated one hundred and nine species, of which one hundred and four are accompanied by original and carefully drawn up descriptions. This report is an invaluable document to the American ichthyologist and in every way worthy of its eminent author."

The Ohio survey was abandoned in 1839, after submission of the second annual report to the legislature. This report, which contained Kirtland's descriptions of the fishes of Ohio, was not published by the legislature.

Storer had been an active member of the Boston Society of Natural History for nearly a decade when the Journal of that Society began in 1840 the publication of Kirtland's (1840, 1841, 1842a, b, 1843, 1845a, b, 1846) descriptions of Ohio fishes. It was perhaps during the period of publication from 1840 to 1846 that Kirtland and Storer became acquainted; their friendship is indicated by Kirtland's (1845a, p. 32) description of *Leuciscus Storerianus:* "It affords me pleasure to dedicate it to my friend, D. Humphreys Storer, M. D., to whom I am indebted for essential aid, and many important suggestions, in arranging and describing our western fishes."

Storer's connection with the Boston Society of Natural History, and his own interest in fishes, would certainly have made him cognizant of Kirtland's work on the fishes of Ohio, and possibly it was through an earlier acquaintance with Storer that Kirtland decided to publish in the Journal of the Society. Kirtland's figures would presumably have accompanied his manuscripts to Boston, where Storer might well have received them, after publication, as a gift from Dr. Kirtland. Gehr (1952, p. 17) indicates that Kirtland's figures for the Ohio report were drawn by himself, and indeed that he learned to draw for the express purpose of illustrating his work on fishes.

Dr. Storer maintained a lifelong interest in Bowdoin College. As late as the year of his death in 1891 he contributed money and pamphlets to the College, and at various times submitted information requested for alumni records of the College. After his death in 1891, his daughter sent to the College several items in the form of books, journals and miscellaneous pamphlets which had been in her father's library. The box in which the drawings were found contained several pamphlets inscribed to Dr. Storer by various authors. It is not improbable that the drawings executed by Kirtland came to Bowdoin College with material donated after Dr. Storer's death.

In view of their historical significance, I have felt it worthwhile to inform ichthyologists of the location of drawings which I ascribe to Dr. Jared Potter Kirtland, early describer of the fishes of Ohio.

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FIGURES

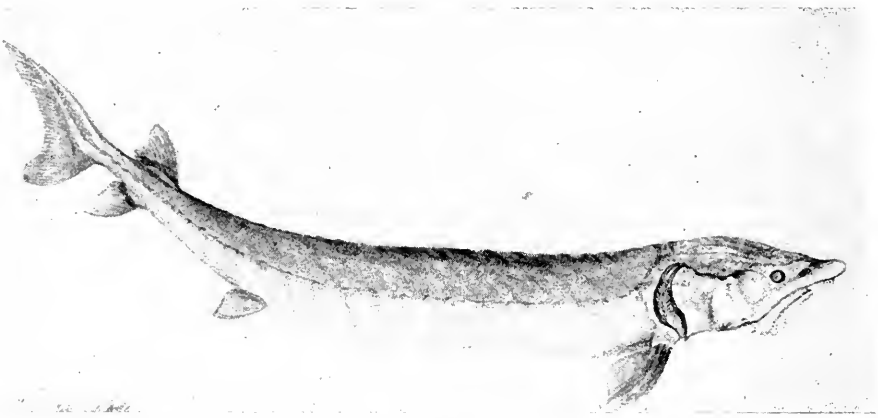

Figure 1. Probably *Acipenser fulvescens* Rafinesque, named *A. nudus* by Kirtland due to loss of the bony plates with age. The pencilled signature on this figure, lacking in the Boston Society article, was retouched by the photographer.

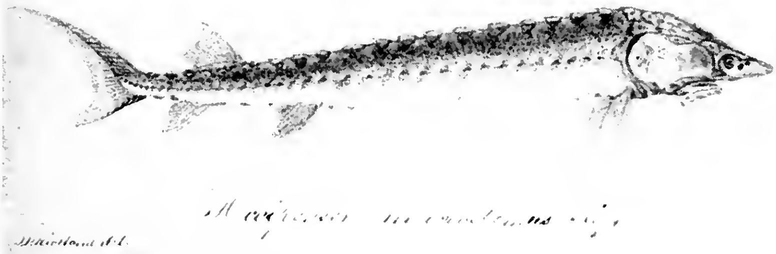

Figure 2. A second figure of *Acipenser fulvescens* Rafinesque, designated by Kirtland *Accipenser macrostomus* Rafinesque. This figure, also unpublished in the Boston Society article, was signed in ink.

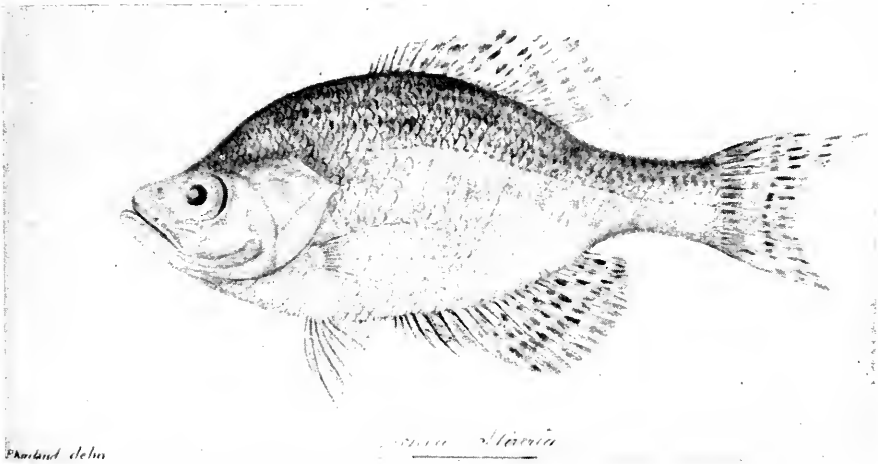

Figure 3. Kirtland's drawing of *Pomoxis annularis* Rafinesque, apparently intended to be named after Storer, *Cichla Storeria*. The signature is printed, unlike other signatures in the collection. The drawing was not included in the article of the Boston Society of Natural History.

B R E V I O R A

Museum of Comparative Zoology

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CONTRIBUTIONS TO A REVISION OF THE EARTHWORM FAMILY LUMBRICIDAE. I. ALLOLOBOPHORA LIMICOLA

By G. E. Gates

INTRODUCTION

External characteristics and the internal anatomy of many earthworm species are known only from the original descriptions, all too often based on a single specimen. Hence little information as to variation, even in common forms, is available. Such records as have been provided usually are for the genital system. More necessary at present are data for somatic systems that are now being found to be phylogenetically more conservative.

This contribution is the first of a series that will provide, insofar as circumstances permit and from lumbricid material preserved in the field without benefit of special techniques, information as to characters used in the obsolescent taxonomy of the past as well as those that may be employed in the more natural classification of the future.

The author's thanks are extended to Harold Davies for providing three of his New Jersey specimens.

Family LUMBRICIDAE

Genus ALLOLOBOPHORA Eisen 1874

ALLOLOBOPHORA LIMICOLA Michaelsen, 1890

Allolobophora limicola Michaelsen, 1890, Jahrb. Hamburg. Wiss. Anst., 7, p. 10 (Type locality, Rolfshagen, Hamburg, Germany. Types probably in the Hamburg Museum.)

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Allolobophora limicola, Satchell, 1955, Ann. Mag. Nat. Hist., (12) 8, p. 224. (England)

Material examined

Massachusetts

Boston. Arnold Arboretum, peat bog, May 18, 1956. 1-10-62-1.

New Jersey

(Three specimens supplied by Harold Davies. *Vide*, Davies, 1954, p. 3.)

External characteristics. Segments (*cf.* Table 1), of worms that are not obviously recent amputees, 83-136.

Setae begin on ii where all usually are present. Ventral setae larger, slightly more protuberant than lateral ones, more closely paired on xv. Apertures of follicles are very slightly farther apart than elsewhere in the genital tumescences. Intersetal intervals vary in absolute width from one region of the body to another as well as on the same segment in individuals of different sizes. Relative widths of the intervals are as previously indicated (Gates, 1953).

Table 1

Segment number in *A. limicola*

Segment Number	Number of specimens from Mass. 1956	1952 (b)	N. J. (a)	Totals
83	1			1
95	1			1
98		1		1
104			2	2
105	1			1
107		1		1
108	3*			3
110	1			1
111			1	1
112	1		1	2
113	2	1	1	4
114			3	3
115	2*			2
117				2
118	2	2		4
119	1*			1
120	3	2		5
121	4		2	6
122	4	1	1	6
123	8	5	2	15
124	8	3	1	12
125	6	1		7
126	2	1		3
127	1	1		2
128	4			4
129		1	1	2
136	1			1

(a) Cited from Davies (1954)
(b) Cited from Gates (1953)

Nephropores usually closed and not certainly recognizable even after softening, treatment with picric acid, or use of other techniques, but probably so situated as to permit the following characterization. Nephropores alternating irregularly, with frequent asymmetry, between two levels, one well above *D*, the other somewhat above *B*, pores of xiv usually in *DD*, of xv-xvi usually at the lower level.

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* One of the worms, in each case, may be a posterior amputee.

Clefts in male tumescences, though obvious, go down only slightly, if at all, below general level of outer surface of the body.

The clitellum always covers xxx-xxxv, occasionally extending into xxix (sometimes to the equator but never in front of it), and/or into xxxvi or even to 36/37. The clitellum reaches slightly farther posteriorly, in variant specimens, on that side which has the longer tuberculum. Tubercula pubertatis have a distinct margin, after appearance of clitellum, only on the median side and occasionally are unrecognizable even under optimal illumination. The median margin is concave or incised at 33/34 (also at 34/35, 35/36, in variant specimens). Tubercula usually are in xxxiii-xxxiv (57 specimens) but on some of the variant worms are also in xxxv as follows: on the left side (5), and right side (2), on both sides (8). Locations in the remaining specimens are: on left sides of xxxiii-xxxv and right sides of xxxiii-xxxvi (1), on left sides of xxxiv-xxxvi and right sides of xxxiii-xxxv (1), in xxxiv-xxxvi on both sides (2). Incidence of worms with variant tubercula in previous lots (of 129 aclitellate and clitellate specimens), 14.7 per cent; in present lots (of 73 specimens), 26 per cent.

Genital tumescences (cf. Table 2) may be present on any of segments ix-xiii, xvi-xvii, xxvi-xxxii, xxxv-xxxviii. Locations, behind xv, on the 19 variant specimens (as regards tubercula), are as follows: on xxix-xxxii, xxxv-xxxvi (1), on xxix, xxxi-xxxii, xxxv-xxxvii (1), xxx-xxxii, xxxv (3), xxx-xxxii, xxxv-xxxvi (2), xxx-xxxii, xxxv-xxxvii (2), xxx-xxxii, xxxvi (2), xxx, xxxii, xxxv (2), xxxi-xxxii, xxxv (2), xxxi-xxxii, xxxv-xxxvi (2), xxxii, xxxv (2).

Internal anatomy. Septa 6/7-9/10 muscular, 5/6 and 10/11-11/12 or 12/13 slightly muscular. Pigment unrecognizable in longitudinal muscle strip at mD and in sections of body wall, also in circular muscles after stripping off longitudinal layer. Epidermis thickened two to three times in male tumescences, less so in genital tumescences.

Oesophagus widest in x, narrowing gradually through xiv, constricted fairly deeply at insertions of 10/11-11/12 so that portions in xi and xii appear subspheroidal. Additional but slighter constrictions, at 12/13-13/14, occasionally are recognizable. Lumen vertically slit-like in xi-xii or widened in middle of xii (internal constriction of gut wall). An internal constriction in xii usually is confined to one side but in xiii usually is on both sides. Oesophageal wall much thinner in xiii-xiv than in xi-xii, calciferous lamellae recognizable only in xii-xi and the posterior half of x. In x the dorsal blood vessel at first appears to be within a groove in dorsal face of gut but this appearance results from presence of two rounded protuberances (77 specimens) which, with a similar pair on the ventral face, provide the only evidence, in these strongly contracted worms, for existence of calciferous sacs. Intestinal origin in xv (77). Gizzard in xvii (77), the layer with brilliant muscular sheen in horizontal section abruptly narrowing and ending shortly behind insertion of 17/18. Posteriorly the gut wall is much thinner, weaker, breaking most easily in both wet and dry material just behind 17/18. Gut narrowing slightly through xix, rather valvular in region of insertion of 19/20. The typhlosole, shortly after its beginning,

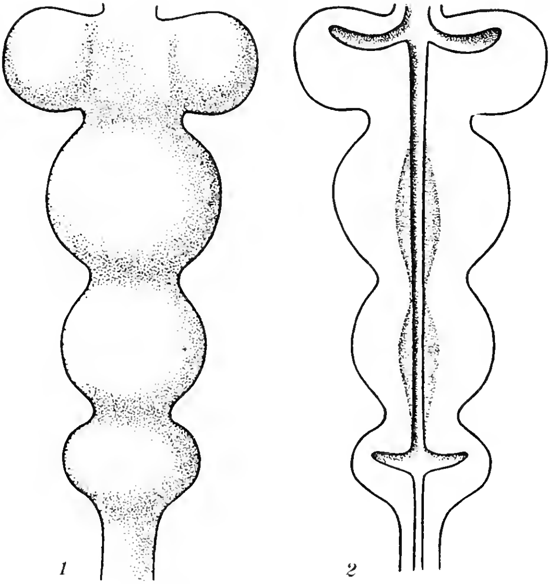
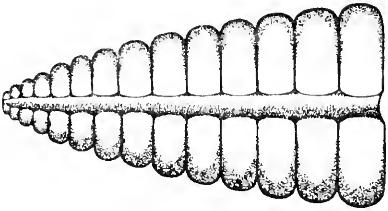


Fig. 1. Oesophagus in segments x-xiv, dorsal view.
Fig. 2. Oesophagus in segments x-xiv, horizontal section.

is nearly circular in transverse section and deeply grooved on each side clear to level of the small median ridge on the ventral face. The grooves appear to be exactly opposite each other (not alternate) and produce, on each side, a series of laterally directed, halfmoon-shaped leaflets. Superficially, as previously suggested, the appearance suggests a stack of coins with a cord running along it. Behind the clitellum the lateral grooving gradually disappears and the typhlosole becomes more nearly thickly lamelliform. The grooving is typical, characterizing each of the 77 worms of the 1956 series. The typhlosole ends in front of the 119th segment as shown in Table 3.

Dorsal and ventral blood vessels have not been traceable anterior to 5/6, probably because they are empty. Extra-oesophageals, median to the hearts and in contact with the gut only in regions of some septal insertions, pass up to the dorsal trunk in xii (77). Hearts present in vi-xi (35), usually slenderer in vi and there often empty or nearly so. Inability to see hearts in vi of the other 42 worms probably not due to absence but to difficulty of distinguishing the vessels, when empty, from nephridial and other tissues with which they are associated. Last hearts in xi (77). Nephridia, behind xiv and except in clitellar region, large, back from xix reaching up to dorsal blood vessel. A bladder is present but its condition (not improved by various attempts to render nephropores visible) obviates accurate characterization, possibly U-shaped. The supposed duct, slender and very fragile, always seems to pass into parietes close to *B*.



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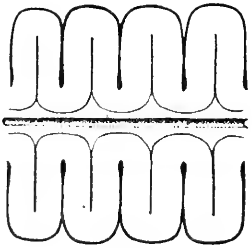

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Fig. 3. Typhlosole. Anterior end from ventral side.

Fig. 4. Typhlosole. Horizontal section slightly posterior to level shown in Figure 3.

Brain, left by a transverse section exactly along 3/4, in iii. Usually all of each circumpharyngeal commissure also is left in iii, at most only very short stubs remain in iv.

Holandric (77). Seminal vesicles, four pairs, in ix-xii (77). Male deferent ducts, just behind funnel septum, variously looped, the loops (epididymis) or all but one of them bound together in a disc (77) often of about the same size as a testis. Ducts of a side come into contact posteriorly in xii but may not unite until into xiv. They disappear into longitudinal musculature about at eq/xv.

Ovaries, each with a single distal egg-string containing one to three ova, erect discs with shape approximating to vertically oblong. Oviducts pass under a muscle inserted on *b* follicle of xiv and then into parietes just lateral to *B*. Ovisacs always present (77) and in the usual positions on posterior face of 13/14. Spermathecae, two pairs, always in ix-x (77) and opening to exterior posteriorly.

Atrial, TP and supraparietal GS glands are lacking in the coelom (77) and no special glands are recognizable (in unstained free-hand sections) within the muscular layers. Follicles of ventral setae, from xv into postclitellar region at least, with two exceptions, much larger and more protuberant into the coelom than those of the lateral pair in the same segment. Exceptions are provided by segments xxxiii-xxxiv where the ventral follicles usually appear to be little if any larger than the lateral ones. Ventral follicles of xv usually appear to be little if any larger than in xvi. Follicles opening through genital tumescences always (77 specimens) are especially enlarged and unusually protuberant into coelomic cavities. Setae in all examined follicles have been genital (GS) and may be 1+ mm. long.

Reproduction. Spermatophores were not found on any of the 1956 series. Iridescence of male funnels more or less brilliant in each worm except the juvenile and one of the aclitellates, localized in a few small spots in several aclitellates, more general in others and most brilliant in those worms with clitellar tumescence nearer the maximum (which probably had not been reached by any of the present lot). Iridescence in the contents of some or all of the spermathecae (both spermathecae of a side empty in several worms) of 26 clitellate specimens shows that sperm are present there too and hence that copulation had taken place. As sperm had been, or were being, matured so generally, and as they are exchanged during copulation, reproduction can be assumed to be biparental.

Regeneration. A tail regenerate at 78/79 has *ca.* seven segments but the metamerism is quite abnormal.

Abnormality. No. 1. Extra male tumescences, with equatorial cleft, present on left side of xvi. No pore is recognizable in that cleft and both male gonoducts of the left side apparently pass down through the muscular layers in xv.

No. 2. Left anterior spermatheca bifid down to parietes. Both ampullae preseptal, filled with sperm.

No. 3. Eight segments in front of anal region are involved in a complicated spiral metamerism.

Nos. 4-6. One helicometamere, in the postclitellar region of each of two worms, was observed while counting segments. Two spirals were noticed in the same region of another worm.

Table 2

Genital tumescences in Massachusetts collections of *A. limicola*

	Number of specimens in		
In segment	previous lots	present lot	Totals
9	100	74	174
10		5	5
11	97	68	165
12	112	74	186
13		3	3
16		2	2
17		1	1
26		1	1
27		2	2
28		6	6
29	31	23	54
30	83	58	141
31	81	51	132
32	118	72	190
35	98	71	169
36	39	25	64
37	18	6	24
38		1	1

The present lot is from the very same spot at which a majority of the previous specimens were obtained.

Table 3
Typhlosole termination and segment number in American collections of *A. limicola.*

Serial number	Typhlosole ends in segment	Atyphlosolate segments	Number of segments		
1	76	7	83	S	
2	85	10	95	S	
3	86	19	105	S	
4	94	14	108	S	
5	95	18	113	V	
6	96	12	108	V	
7	96	14	110		
8	99	16	115		
9	100	8	108	V	Old posterior amputee?
10	102	19	121	V	
11	103	18	121	V	
12	103	19	122	V	
13	103	21	124	V	
14	104	14	118		New Jersey
15	104	16	120		
16-17	104	18	122	V (1)	
18	104	19	123	S	
19	104	21	125		
20	105	13	118	S	
21	105	17	122		
22-24	105	18	123	S (1)	
25	105	19	124	S	
26	105	20	125		
27	106	13	119	V	Old posterior amputee?
28	106	17	123		
29	106	18	124	V	
30	106	19	125		
31-32	107	17	124	V (1)	Other from New Jersey.
33-34	108	17	125	V (1)	
35	108	20	128		
36	110	18	128		
37	118	18	136		

S Small specimen, not obviously a recent posterior amputee. Nos. 1, 2, 9, may be old posterior amputees, also No. 26.

V Variant specimens, *i.e.*, with tubercula pubertatis extending beyond xxxiii-xxxiv.

(1) One specimen only.

Except as otherwise indicated all specimens are from the same spot in the Arnold Arboretum.

Table 4
Individual patterns of genital-tumescence location in 1956 series of *A. limicola*.

Segments												Other segments	Number of specimens
9	10	11	12	29	30	31	32	35	36	37	38		
*	*	*	*	*			*	*	*				1
*	*	*	*	*	*	*	*	*					2
*	*	*	*			*	*	*					1
*	*		*		*	*	*	*	*				1
*		*	*		*		*	*				16	1
*		*	*		*		*	*	*	*	*	16	1
*		*	*	*	*	*	*	*				26-28	1
*		*	*	*	*	*	*	*				27-28	1
*		*	*	*	*		*	*				28	1
*		*	*	*	*	*	*	*					4
*		*	*	*	*	*	*	*	*				4
*		*	*	*			*	*					1
*		*	*	*			*	*	*				1
*		*	*	*	*		*	*					3
*		*	*	*	*		*						1
*		*	*	*		*	*	*	*				1
*		*	*	*		*	*	*	*	*			1
*		*	*		*								1
*		*	*		*			*	*				1
*		*	*		*	*	*	*					17
*		*	*		*	*	*	*	*				5
*		*	*		*	*	*	*	*	*			4
*		*	*		*		*	*					2
*		*	*		*		*		*				1
*		*	*			*	*	*					2
*		*	*			*	*	*	*				2
*		*	*				*	*					5
*		*	*	*	*	*	*	*				13, 17, 27, 28	1
*		*	*	*		*	*	*				13 28	1
*		*	*		*	*	*	*				13	1
*			*		*		*	*				28	1
*			*	*	*	*	*	*					1
*			*		*	*	*		*				1
*			*		*		*	*					1
*			*		*		*	*	*				1

* Genital tumescences present in the segment thus indicated, but disregarding asymmetry, *i.e.*, absence on one side.

Remarks. A dark coloration with a bluish metallic lustre in the body wall of the New Jersey worms is an artifact that results, in appropriate conditions, when formalin around the worms has remained for some time in contact with cork.

Precis. Clitellum, saddle-shaped, on 5½-8½ segments, xxviii/2, xxix, xxix/n, xxx, xxx/2-xxxv, xxxvi/n, xxxvi. Tubercula pubertatis with median margin concave or incised at 33/34, in xxxiii-xxxiv (xxxv, xxxvi), rarely lacking on xxxiii. Genital tumescences around apertures of ventral follicles only, usually in ix, xi, xii, xxx-xxxii, xxxv, occasionally in one or more of x, xiii, xvi-xvii, xxvi-xxix, xxxvi-xxxviii. Male pores equatorial on xv, in *BC*, within transverse clefts in tumescences that obliterate 14/15-15/16. Female pores just lateral to *B*, equatorial on xiv. Quadrithecal, pores at *C*, on 9/10-10/11. Setae, closely paired, more so laterally, ventral setae larger (?), $CD < AB$, $BC < AA$, DD ca. = ½C. Nephropores inconspicuous, irregularly alternating, with asymmetry, between a level somewhat above *B* and another well above *D* (usually at upper level on xiv but at lower level on xv-xvi?). First dorsal pore at 4/5 or 5/6. Prostomium epilobous, tongue usually open. Unpigmented. Segments, 80-136. Size, 60-100 x 3-5 mm.

Calciferous sacs of x lateral and vertical, opening widely into oesophagus but reaching slightly below and above it. Calciferous gland more or less constricted at insertions of 10/11-12/13 so that gut in xi-xii or xiii may be rather moniliform. Intestinal origin in xv. Gizzard mostly in xvii. Typhlosole deeply incised anteriorly, by opposite lateral grooves, into half-moon shaped leaflets, ending in the region between 95th and 118th segments so as to leave 14-21 segments atyphlosolate. Extra-oesophageal trunks, median to hearts, pass up into dorsal trunk in xii. Hearts in vi-xi. (Nephridial bladders U-shaped, ducts passing into parietes near *B*?) Holandric. Male deferent ducts with discoidal epididymis. Seminal vesicles four pairs, in ix-xii. (Atrial, TP and coelomic GS glands lacking.) Genital setae in enlarged follicles opening through genital tumescences.

Reproduction. Presumably sexual and biparental.

Distribution. Germany (Hamburg, Steinweiler, Wörth/Rhein, Bienwald). Switzerland (Zürich). Belgium (Bouge, Esneux, Bastogne, Comblains-la Tour). England (Grange-over-Sands, N.

Lancashire). Massachusetts (Boston). New Jersey (Morristown, Dover, Beatystown).

Presence in America certainly is due to transportation, presumably by man. The same agent may well be responsible for presence in England.

Habitats. Marshes, marshy places, meadows, peat bogs, very damp and loamy soil, mud. In soils with pH of 4.5-6.6.

The specimen found in an English pasture on glacial drift, away from water, presumably was a stray.

The Boston peat bog supports a population that certainly can be called dense.

Associated earthworm species. Seven species, in previous samplings of the Boston peat bog, were found along with the dominant *limicola*. Five of those seven again were obtained, in 1956, from the few shovels-full of earth that provided the above-described series of *limicola*. The species and numbers obtained are as follows:

Allolobophora limicola	1-10-62-1.
tuberculata	0-0-4.
turgida	0-0-1.
Lumbricus rubellus	6-0-1.
terrestris	0-0-1.
Octolasium lacteum	1-0-3.

Individuals of species of *Lumbricus* are of about average size. Individuals of *tuberculata*, *turgida* and *lacteum* are all smaller than average and, indeed, smaller than many of the individuals of *limicola*.

DISCUSSION

Only one specimen of *A. limicola* has been reported from England, and one from Switzerland. How many worms from Belgium and Germany have been identified is not known but if lack of data as to differences from the type is any clue, the number is small. Paucity of records may be due, at least in part, to failure to collect in the proper habitats where dense populations can be expected.

A clitellum, of 5½ segments, shorter than on the types (where it was of 7½-8½ segments) was noted by Cernosvitov for his Belgian specimen. Otherwise, nothing of importance is known as to the variability of European material. In contrast, records now have been published of the variation in 270 individuals from four American localities. Those records make possible for the first time in the Lumbricidae, an examination of the taxonomic value of somatic versus sexual characters.

In the genital system of a species presumably with obligatory biparental reproduction, no variation whatever was found as to number and location of: gonads, gonoducts, seminal vesicles, spermathecae, ovisacs, male and female as well as spermathecal pores. An epididymis always was present. Each ovary had but one egg-string. Certain structures that have been neglected in the past, atrial, TP and supraparietal GS glands, always were absent. Exceptions to that invariability can of course be expected, more or less rarely, when hypo- or hypermeric cephalic regeneration has taken place or when embryonic development has been prevented from proceeding normally. Development of an extra area of male tumescence on a single individual is a mutational aberration that may have more importance in other circumstances (to be considered subsequently) than in *limicola*.

Variability worthy of note was found only in three portions of the reproductive system, the genital tumescences, the tubercula pubertatis, and the clitellum. Those are the very structures that have furnished the characters most used for distinguishing and defining lumbricid species. So much importance has been attached to one of the organs that "variant," in a previous communication, was unwittingly restricted to mean divergent with respect to tubercula. In *limicola*, the tubercula usually are confined to xxxiii-xxxiv but there is enough individual deviation therefrom to require mention in a specific definition, if for no other reason than to obviate needless erection of species. A species norm as to number of segments covered by the clitellum and as to its location remains to be determined. Accordingly, all that can now be provided in a precis (p. 11) is a list of variations as hitherto recorded.

Genital tumescences appear to provide a still more complicated problem in *limicola*. The number of individual patterns of tumescence location (Table 4) in the Massachusetts material seems large in view of a possibility that the colony may be highly inbred (descendant from a single importation of a few individuals?). Only seven of the patterns were found in more than two individuals and just one in more than five individuals. Although a species pattern has not been recognized for *limicola* the data of Tables 3 and 4 show that tumescences usually can be expected in certain segments as listed in the precis. Those metameres, with the exception of xi, are the ones also mentioned in the original description of the species.

In the somatic systems no variability whatever was found (in dissections of 100+ specimens) as to location of calciferous gland, gizzard, intestinal origin, last pair of hearts, and junction of extra-oesophageal trunks with the dorsal vessel, as to presence of calciferous sacs in x, and presence of an intestinal typhlosole. Especially noteworthy is the invariability of the sculpturing (into leaflets) at the anterior end of the typhlosole (Fig. 3) and the invariability in structure of the calciferous sacs (Figs. 1-2). Deviations from conditions described above for any of those organs can be expected only rarely and then as a result of some aberration of embryonic development.

SUMMARY

Variability of somatic as well as of genital structure has been recorded from an American colony of a lumbricid species, presumably with obligatory biparental reproduction. Variation in the genital system was found only with respect to those characters most used hitherto in identification and definition of species.

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THE TRUNK MUSCULATURE OF *SANZINA* AND ITS BEARING ON CERTAIN ASPECTS OF THE MYOLOGICAL EVOLUTION OF SNAKES

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Since Mosauer's paper in 1935,[1] very little has been published concerning the myology of the trunk region in snakes. In that paper he outlined three myological types on the basis of an examination of a number of species[2] from several distinctly related groups. These types were described as characteristic of (1) the Boidae, (2) the Colubridae and (3) the Viperidae, and were distinguished on the basis of several correlated peculiarities in muscle arrangement. These arrangements were, according to Mosauer "surprisingly constant" within each group.

As a contribution to a much needed wider survey of snake myology, the body musculature of *Sanzina* (a boid genus rarely available for this type of study) is described in this paper. It is shown that, at least in this genus, there is considerable departure from the basic boid pattern described by Mosauer. More important, this departure embodies some aspects of myological arrangement previously considered to be characteristic of the Viperidae or Colubridae.

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[1] Walter Mosauer (1935) Univ. Calif., Los Angeles. Publ. Biol. Sci., Vol. 1. No. 6, pp. 81-120.

[2] In addition to *Constrictor constrictor,* Mosauer examined the following boid genera and species: *Python molurus, Calabaria reinhardti, Epicrates striatus, Lichanura roseofusca* and *Charina bottae.*

I wish to thank Dr. Ernest E. Williams, Museum of Comparative Zoology, who made the specimen of *Sanzina* available for study. Dr. William Riemer, Florida State Museum, made it possible to study the musculature of a large specimen of *Ophiophagus hannah* in the University of Florida collections, for which I am very grateful.

The description below is based on a single adult specimen of *Sanzina madagascarensis*, approximately four and a half feet long (M.C.Z. 8002). In addition, the musculature of one specimen each of *Crotalus durissus terrificus, Ophiophagus hannah* and *Coluber constrictor* was studied. No differences were found from the descriptions of these or similar forms given by Mosauer. The myological description of *Sanzina* is meant to supplement that given by Mosauer, and follows, for the most part, his outline of presentation to facilitate comparison.

M. Semispinalis et spinalis
(Figs. 1, 4, *SSP.SP.*)

As in *Constrictor constrictor*, this muscle arises from a tendinous arch, stretching between the neural spine and postzygapophysis of a single vertebra, with the concavity directed caudally. From this arch the muscle extends as a flat ribbon, directed forward, medially and dorsally. It is inserted by a tendon into the caudodorsal edge of the neural spine of a more anterior vertebra. From origin to insertion the muscle and its tendons cover ten segments.

As in the typical boid arrangement, the medial portion of the muscle seems to represent the spinalis and the lateral part the semispinalis fused and inserted by means of a common terminal tendon.

M. Longissimus dorsi
(Figs. 1, 2, 3, 4, *ML*)

This muscle is also similar to that in *Constrictor*, with the origin at the craniolateral portion of a prezygapophysis. At about the level of the thirteenth vertebra cranial to its origin the muscle is replaced by a flat tendon, which divides in two. The medial division inserts on the posterolateral portion of the four-

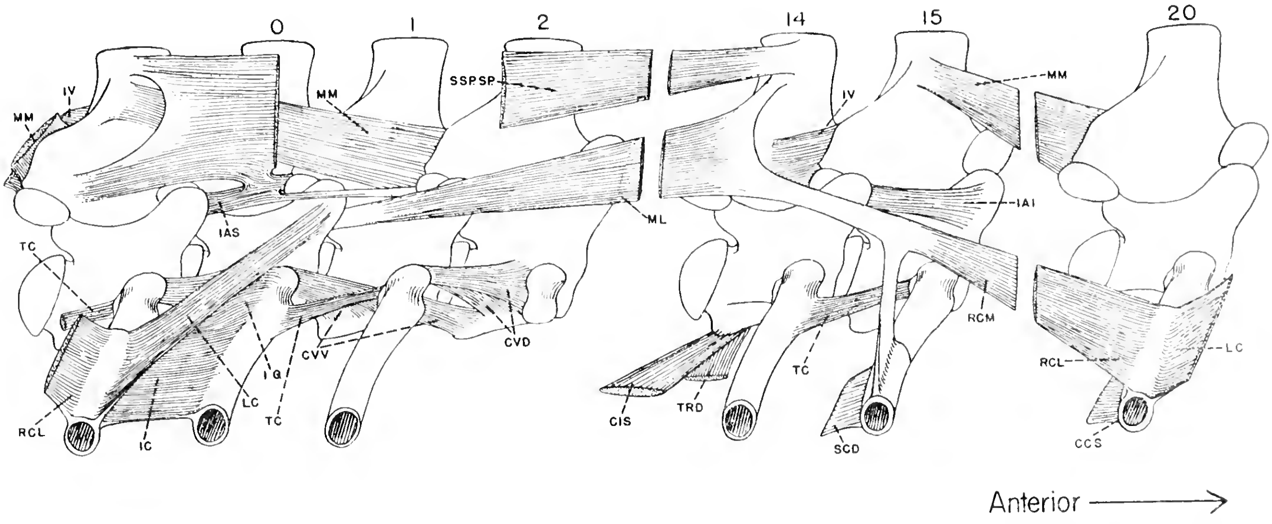


Fig. 1. Diagrammatic lateral view of the musculature of the middle thoracic region in *Sanzina*. Gaps in the column represent missing portions and numbers over the vertebrae indicate vertebral position. Thus the longissimus passes over thirteen vertebrae to insert on the fourteenth cranial to its origin. Abbreviations: *CCS*, costocutanus superior; *CIS*, costalis internus superior; *CVD*, dorsal head of the costovertebrocostalis; *CVV*, ventral head of the costovertebrocostalis; *IAI*, interarticularis inferior; *IAS*, interarticularis superior; *IC*, intercostalis proprius; *IQ*, intercostalis quadrangularis; *IV*, intervertebralis; *LC*, levator costae; *ML*, longissimus; *MM*, multifidus; *RCL*, lateral belly of the retractor costae biceps; *RCM*, medial belly of the retractor costae biceps; *SCD*, supracostalis dorsalis; *SSP.SP.*, semispinalis et spinalis; *TC*, tuberculocostalis; *TRD*, transversus dorsalis.

teenth neural spine anterior to the origin of the muscle. The lower division of the tendon extends cranially for an additional vertebra, where it sends a small thin tendinous slip to the rib of the fifteenth vertebra, closely associated with the origin of the supracostalis dorsalis and the insertion of the medial belly of the retractor costae biceps. Anterior to the fifteenth vertebra, the aponeurosis of the longissimus gives rise to the slender, band-like

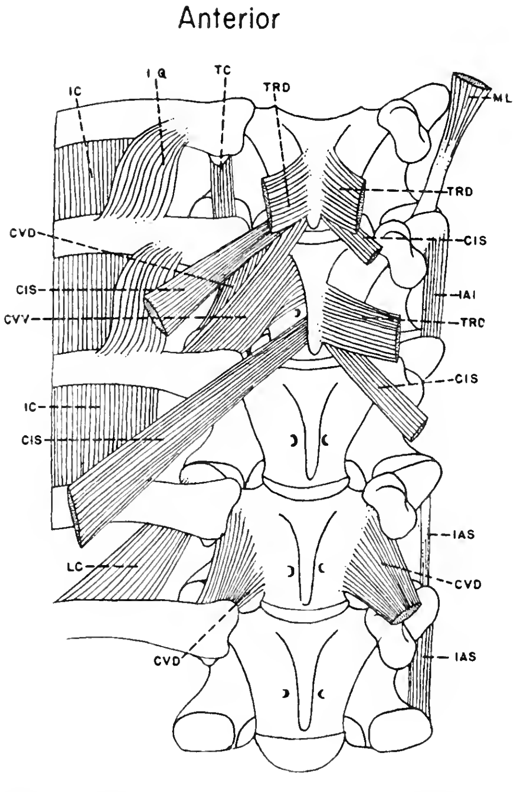


Fig. 2. Diagrammatic ventral view of the musculature of the middle thoracic region in *Sanzina*. Abbreviations: *CIS*, costalis internus superior; *CVD*, dorsal head of the costovertebrocostalis; *CVV*, ventral head of the costovertebrocostalis; *IAI*, interarticularis inferior; *IAS*, interarticularis superior; *IC*, intercostalis proprius; *IQ*, intercostalis quadrangularis; *LC*, levator costae; *ML*, longissimus; *TC*, tuberculocostalis; *TRD*, transversus dorsalis.

medial belly of the retractor costae, which in turn gives rise to the more anterior lateral belly, inserting on the twentieth vertebra cranial to the primary origin of the entire complex.

The main differences between this series of muscles and tendons in *Sanzina* and *Constrictor* lie in the lengths of the myological segments. In the former the medial tendinous insertion of the longissimus is on the fourteenth neural spine. In the latter it is on the ninth. In *Sanzina* the tendinous slip from the aponeurosis of the longissimus inserts on the fifteenth rib; in *Constrictor* it inserts on the fifth. The entire complex, including the lateral head of the retractor costae includes twenty vertebrae in *Sanzina,* and eighteen in *Constrictor.* Thus, the longissimus is five segments longer in *Sanzina,* and the retractor costae biceps complex seven segments shorter.

M. Multifidus

(Figs. 1, 4, *MM*)

In *Constrictor* this muscle originates from the ventral surface of the tendinous arch forming the origin of the semispinalis et spinalis. It extends four to five segments, inserting into the caudal border of the laminae of the neural arch. In *Sanzina,* as in most Colubridae and Viperidae studied by Mosauer, the muscle arises from the craniodorsal edge of the neural spine, and as in *Crotalus* extends anteriorly for only three to four vertebrae.

M. Interarticularis superior

(Figs. 1, 2, 3, 4, *IAS*)

In *Constrictor* this muscle arises from the lateral tendon of the tendinous arch of the semispinalis et spinalis. It then extends anteriorly for four vertebrae, where it inserts on the posterior lateral border of the postzygapophysis of several successive vertebrae. In *Sanzina* the muscle originates on the craniodorsal border of the postzygapophysis and extends cranially for one vertebra, inserting on the same region as in *Constrictor.* The muscle is thus considerably shorter in *Sanzina,* being similar to that in the Viperidae. In addition, its origin on the postzygapophysis, rather than on the tendinous arch suggests the condition Mosauer found in most colubrids and viperids. On the other hand, the muscle is joined by a slip from the lateral portion of the fused semispinalis et spinalis, suggesting the origin for the interarticularis superior found in most boids (Fig. 4, A, B).

Mosauer takes the medial head of the digastricus dorsalis of Colubridae to be homologous with the interarticularis superior of the Boidae. In all of the colubrid genera which he studied the medial head of the digastricus arises from the superior surface of the postzygapophysis and inserts by a thin tendon into the caudal border of a postzygapophysis several vertebrae cranially. It is joined by the lateral head of the digastricus, which arises from the accessory process of the next vertebra posterior to the one which forms the origin of the medial head. It is also joined by a small raphe of the longissimus (Fig. 4, D).

In *Sanzina* the main body of the interarticularis superior inserts on the cranial border of the postzygapophysis of the preceding vertebrae as in other boids, but a small tendinous slip passes cranially to a slightly more lateral insertion on the postzygapophysis of the second preceding vertebra. This tendon is so similar to the anterior tendon of the digastricus in most colubrids that there can be little doubt as to homology.

In the Anilidae, according to Mosauer, the medial head of the digastricus arises on the tendinous arch of the semispinalis et spinalis. It joins the lateral head, which covers one vertebra, and is apparently homologous to the interarticularis superior of *Sanzina*.

Mosauer states that in the colubrid snakes the lateral head of the digastricus has apparently migrated posteriorly to the accessory process of the succeeding vertebra, and has also become associated by means of a small raphe with the longissimus of the succeeding vertebra. That such migration is possible in the Colubridae seems reasonable in view of the fact that in at least the single specimen of *Coluber* which I have examined the lateral head of the digastricus is provided with a very thin tendon connecting that muscle with the superior surface of the postzygapophysis; probably this tendon represents the caudal end of the interarticularis superior of the Boidae. The caudal tendon of the medial head of the digastricus thus seems to represent, at least in part, the original semispinalis et spinalis of the tendinous arch.

It seems reasonable to assume that the semispinalis has migrated posteriorly along the medial tendon of the longissimus. The Anilidae apparently represent an intermediate condition (Fig. 4).

In the Viperidae the interarticularis superior is said by Mosauer to be very similar to that in the Boidae, except that a few fibers originate on the postzygapophysis. I have checked this in *Crotalus durissus terrificus*. The muscle extends for only one vertebra, as the main portion does in *Sanzina*. However, in *C.d. terrificus* and in the other viperids examined by Mosauer there is no anteriorly directed tendon, and the muscle originates mainly on the semispinalis et spinalis.

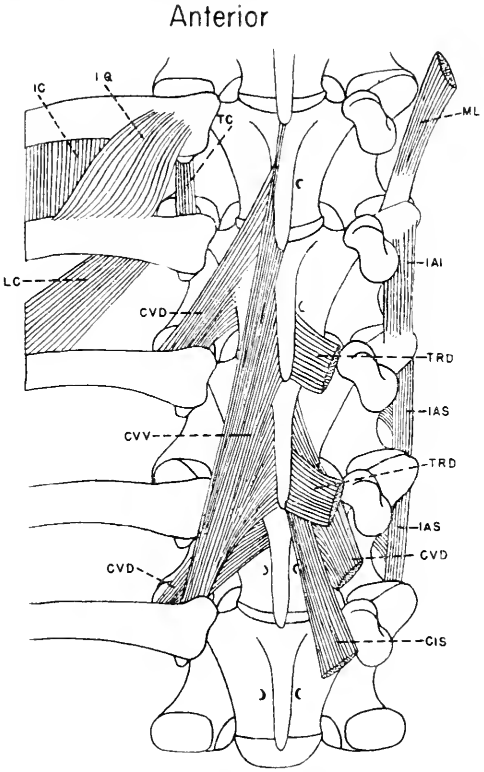


Fig. 3. Diagrammatic ventral view of the musculature of the anterior thoracic region in *Sanzina*. Abbreviations as in Figure 2.

M. COSTOVERTEBROCOSTALIS
(Figs. 1, 2, 3, *CVD, CVV*)

As in *Constrictor*, this muscle is composed of two heads. The medioventral head arises from the lateral surface of the haemal keel and from the caudoventral parapophysial portion of the paradiapophysis. It extends caudally and laterally, inserting on the costal tubercle and neck of the succeeding rib. The dorsal head arises from the cranioventral portion of the diapophysial portion of the paradiapophysis and unites with the ventral head caudally.

M. INTERCOSTALIS QUADRANGULARIS
(Figs. 1, 2, 3, *IQ*)

This small muscle is not mentioned by Mosauer in his description of the typical musculature of the Boidae, but only in the description of the arrangement found in the Colubridae. It is, however, well developed in *Sanzina*. As in the Colubridae and Viperidae, it arises from the caudal surface of the capitulum costae, just lateral to the articular head of the rib, running caudally and laterally to be inserted on the inferior cranial border of the following rib. The identity of this muscle in *Sanzina* is so obvious that homology to the similar muscle mass in the Colubridae is hardly to be questioned.

M. TUBERCULOCOSTALIS
(Figs. 1, 2, 3, *TC*)

Mosauer describes this muscle as being found only in the Colubridae. However, it is present in *Sanzina*, originating, as it does in colubrid snakes, from the laterocaudal circumference of the dorsocaudal costal tubercle, running obliquely to insert on the cranial border of the neck of the following rib.

OTHER MUSCLES

In addition to the muscles described above, the remaining units described by Mosauer as being found in the Boidae have all been located in *Sanzina*. Some of these differ in a very minor fashion from those found in *Constrictor*. The retractor costae biceps is somewhat shorter, as pointed out above. The costalis interni superior covers eight vertebrae in *Sanzina* and nine in *Constrictor*. The following muscles were found to be the same in both *Constrictor* and *Sanzina:* Intervertebralis, levator costae, transversus dorsalis, interarticularis inferior, supracostalis dorsalis,

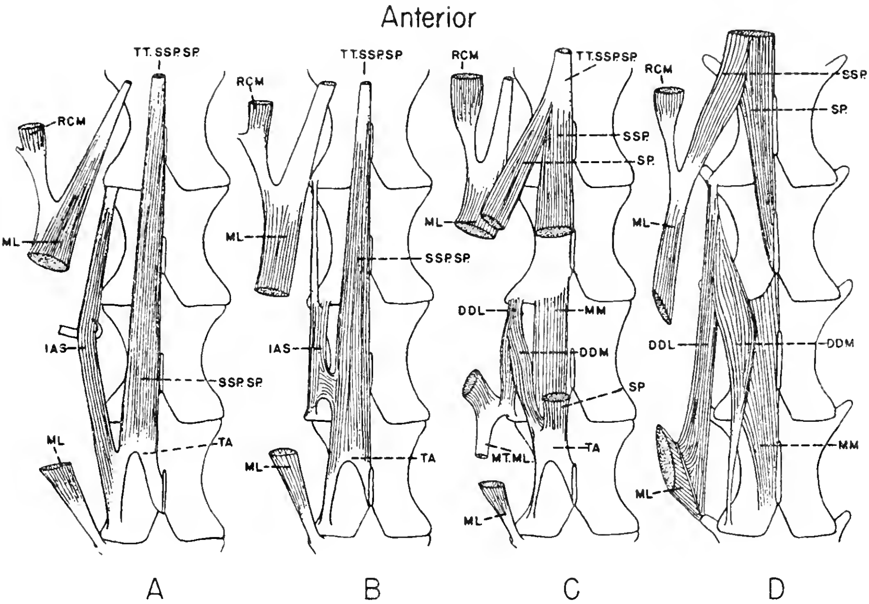


Fig. 4. Diagrammatic representations of the dorsal musculature of (A) *Constrictor*, (B) *Sanzina*, (C) *Anilius* and (D) *Coluber* illustrating the apparent evolution of the semispinalis et spinalis and the interarticularis superior to form the digastricus and the highly modified semispinalis in the Colubridae. Abbreviations: *DDL,* digastricus, lateral head; *DDM,* digastricus, medial head; *IAS,* interarticularis superior; *ML,* longissimus; *MM.* multifidus; *MT. ML.,* median tendon of the longissimus; *RCM,* retractor costae biceps, medial belly; *SP,* spinalis; *SSP,* semispinalis; *SSP.SP.,* semispinalis et spinalis; *TA,* tendinous arch; *TT. SSP.SP,* terminal tendon of the semispinalis et spinalis.

supracostalis lateralis superior, supracostalis lateralis inferior, intercostalis proprius, intercartilaginosus, costalis inferior, transversus abdominus, obliquus abdominis internus, costocutanus superior and costocutanus inferior.

COLUMNAR VARIATION

Little work has been done regarding the change in position and shape of muscles from the middle to the anterior or posterior portion of the vertebral column in snakes. Considerable structural changes take place along the length of the column. The most important of these is the presence of well-developed hypapophyses anteriorly. Such changes would be expected to influence arrangement of at least some myological elements in the anterior part of the column. Mosauer made only a few comments concerning this variation.

For the most part, myological changes correlated with intercolumnar morphological variability involve shortened or lengthened muscle segments, so that fewer or additional vertebrae are covered in the anterior part of the column than in the middle or posterior portions. However, some of the changes involve more than mere variability in muscle length, and these are of considerable interest (*cf.* Figs. 2 and 3).

As mentioned previously, and also by Mosauer, the transversus dorsalis is apparently absent in the anterior part of the column of most snakes. The costalis internis superior thus forms the inner muscular lining of the body cavity in this region. The latter muscle becomes progressively shorter and thicker cranially, so that each muscle covers only three segments instead of eight as in the mid-dorsal region. The insertion and origin, as well as relationship to other muscles, remain the same.

Of the deeper muscles the costovertebrocostalis becomes longer anteriorly, covering from one to four vertebrae, instead of only one to two. Occasional fibers may even extend to the fifth vertebra anteriorly. As in the middle thoracic region, the muscle is provided with two heads. The longer, thinner member inserts on the cranioventral portion of the hypapophysis of the fourth vertebra cranially. The shorter, thicker head inserts on the basal part of the hypapophysis and the ventrolateral portion of the body of the centrum, including the cranial border of the parapophysis. Of particular importance is the fact that in this area this muscle also originates in two heads, the larger on the neck of the rib, and the smaller on the cranial surface of the parapophysis. The fibers of both become interlaced before they divide into the two heads at their insertions described above (Fig. 3).

Mosauer described a muscle, the transversohypapophyseus, supposedly peculiar to the Colubridae, Elapidae and Viperidae, which originates on the cranial border of the parapophysis and extends to the caudolateroventral border of the hypapophysis. These fibers are also joined by others from deeper, shorter muscle segments. The muscle is quite distinct in the single specimens of *C. constrictor, Ophiophagus hannah* and *C. durissus terrificus* I have examined. It seems highly probable that the same muscle is represented in the anterior portion of the vertebral column of *Sanzina* as a second head of the costovertebrocostalis, not fully separated from a shorter head, which lies ventral to it (Figs. 2, 3), and which is found as a distinct unit in the anterior vertebrae of the Colubridae and all vertebrae of the Viperidae and Elapidae. Mosauer also reports the transversohypapophyseus as extending to the anus in colubrids in which hypapophyses are present throughout the column. Thus it seems apparent that the muscle cannot be considered characteristic of any particular family or families, but simply a development of the costovertebrocostalis found only in those regions of the column in which hypapophyses are well developed.

DISCUSSION

The exact phyletic position of *Sanzina* is not at all clear and the present myological study sheds little light on this problem. The genus is generally placed in the Boinae. Its zoogeographic isolation on Madagascar suggests that it may represent a very old stock.

Myologically *Sanzina* is not as much like *Constrictor* as one would suppose. Deviations in muscular arrangement are suggestive of intermediacy between typical boines, such as *Constrictor*, and the Anilidae, as represented by *Anilius*. The latter seems, in turn, intermediate between *Sanzina* and the Colubridae.

It is entirely possible that various members of the Boidae have independently evolved colubrid-like modifications several times in the past. These radiations may even be represented in rather extreme fashion by one or more of the Recent morphologically intermediate families (Anilidae, Xenopeltidae and Uropeltidae). *Sanzina*, as a slightly modified general boid type, may represent a single minor radiation paralleling the myo-evolutionary sequence leading to the Colubridae. There is, at least at present, little reason to suppose that *Sanzina* is on, or even close to, the line leading to the colubrids.

The musculature of relatively few snakes is known in detail. Before the full value of this tool in systematics can be realized, it is necessary to study the myology of many important Recent genera. Mosauer had intended that his observations would stimulate other workers to examine more closely the trunk musculature of snakes. However, the preliminary nature of his study has been largely overlooked by later writers. It is hoped that the present paper will re-awaken interest in comparative trunk musculature of reptiles if only by pointing out the inadequacy of Mosauer's system, which was intentionally over-simplified because of its admitted preliminary nature.

B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. January 29, 1958 Number 83

THAMNOPHIS BOVALLII DUNN REDISCOVERED (REPTILIA, SERPENTES)

By Benjamin Shreve and Carl Gans

In the course of a collecting trip by the junior author in Mexico and Central America, a garter snake (Museum of Comparative Zoology 54974) was secured at San Jorge, Lake Nicaragua, Nicaragua, on July 1, 1956.

This specimen was found to agree closely with E. R. Dunn's original description (1940, p. 190) of *Thamnophis bovallii* (type locality: Granada on Lake Nicaragua, somewhat farther north than San Jorge). The evidence of this additional specimen and certain other considerations led to the conclusion that Smith (1942, pp. 97 and 110) was wrong in synonymizing *bovallii* with *sumichrasti* Cope. Later examination of a specimen cited by Dunn (*loc. cit.* p. 192) as possibly *bovallii* — American Museum of Natural History 12439 from Colorado bar, Costa Rica — confirmed this conclusion and further extended the range of the form (map).

The table gives the scale counts for Dunn's two juvenile females (specimen A was expressly designated the type by him), and for the two specimens, both males, that we have added.

The color pattern of the MCZ specimen is well shown in Figures 1-3. There are a few differences from Dunn's specimens, as described. The American Museum specimen also differs slightly. Thus anteriorly, and probably posteriorly as well, the lateral bars are shorter (true also of the American Museum specimen) and two rows of alternating and sometimes coalescing spots occur throughout the vertebral region. In Dunn's two specimens the spots were separate only posteriorly. In the AMNH specimen the two rows of spots tend to coalesce into one row but in such a way that the identity of the two rows is not entirely lost over the whole length of the animal. The MCZ specimen lacks the light, black-edged spots on the parietals found by Dunn in his juveniles and present in the American Museum specimen. Both the MCZ and the AMNH specimens have seemingly a less clear delimitation of dorsal coloration on the side of the head, and neither

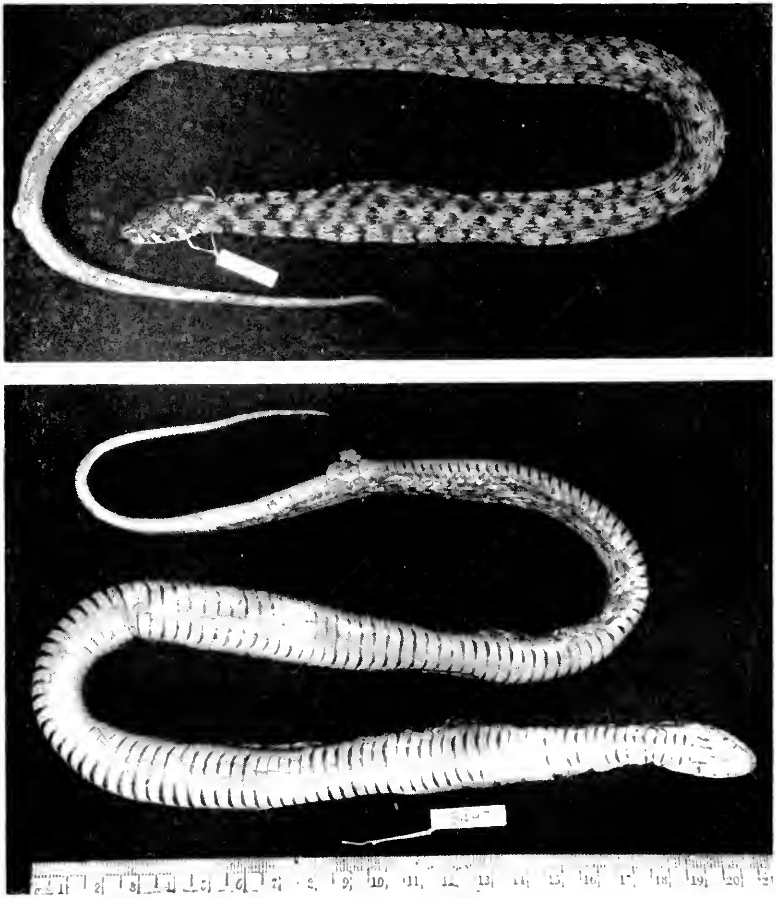


Figure 1. *Thamnophis bovallii.* Dorsal and ventral views of MCZ 54974 from San Jorge, Nicaragua.

shows the reddish in the dorsal coloration mentioned for the type series by Dunn. As the specimens before us are males and apparently adult, while both of Dunn's specimens were females and young enough to still show the "navel," it is suspected that some of the color differences are due to age or sex.

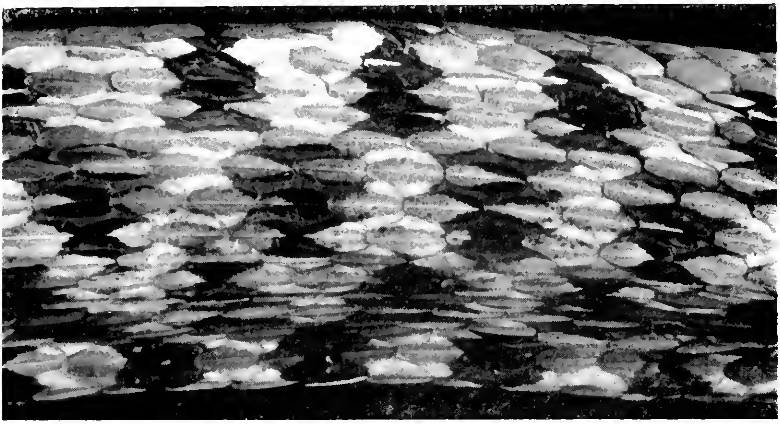


Figure 2. *Thamnophis bovallii.* Detail of middorsal color pattern of MCZ 54974 slightly posterior to midbody. Note that there exists a tendency for middorsal separation of the two rows of blotches which are partly fused in this region.

H. M. Smith (*loc. cit.*) was the first to regard *bovallii* as invalid (without, however, stating his reasons), placing it in the synonymy of the typical race of *T. sumichrasti.* The two cotypes of the latter were stated to have come from Orizaba, Vera Cruz, Mexico, but Smith thinks it more likely that they were collected on the Atlantic slope of the Isthmus of Tehuantepec.

TABLE

Specimen	Sex	Ventrals + Caudals	Dorsals	Dorsals drop to 19 at ventral number	Pre-ocular	Post-ocular	Upper Labials	Lower Labials	Body + Tail Length in mm.
Goteborg A	♀	140+70	21-19-17	11	1	¾	8(4,5)	10	180+60
Goteborg B	♀	144+71	21-19-17	15-17	1	⅔	8(4,5)	10	180+58
MCZ 54974	♂	148+79	21-19-17	7	2	3	8(4,5)	10	485+167
AMNH 12439	♂	148+x	21-19-17	8-9	1	3	8(4,5)	10	543+x

As *Thamnophis bovallii* Dunn is known only from southern Nicaragua and northern Costa Rica, it would be surprising if it

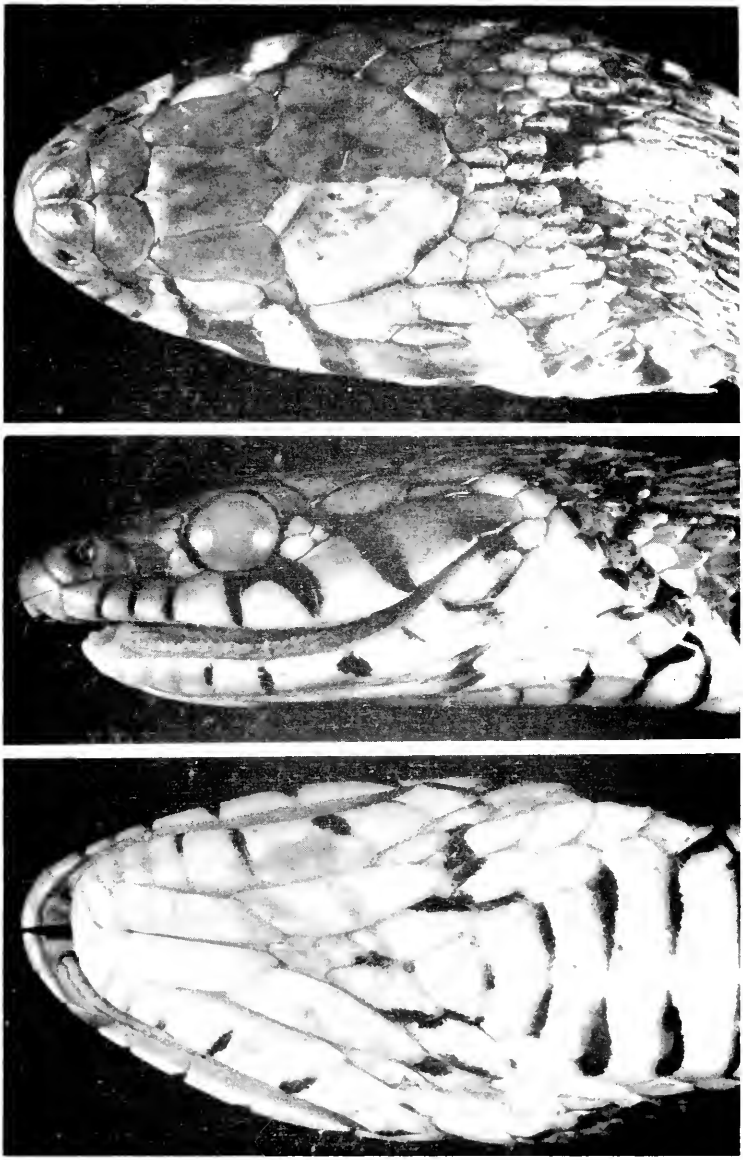


Figure 3. *Thamnophis bovallii.* Dorsal, lateral and ventral views of the head of MCZ 54974. Note the very irregular black flecks in the center of the parietals where the other specimens have the light, black-edged spot. The color difference between left and right sides is due to the shedding of the scales of the left side.

were quite identical with a form from eastern Mexico, the more so since two races (later three, Smith, Nixon, and Smith, 1950, p. 579) of the same species were recognized by Smith from intervening Guatemala, and since there appear to be no records at all for this group of garter snakes between Guatemala and southern Nicaragua.

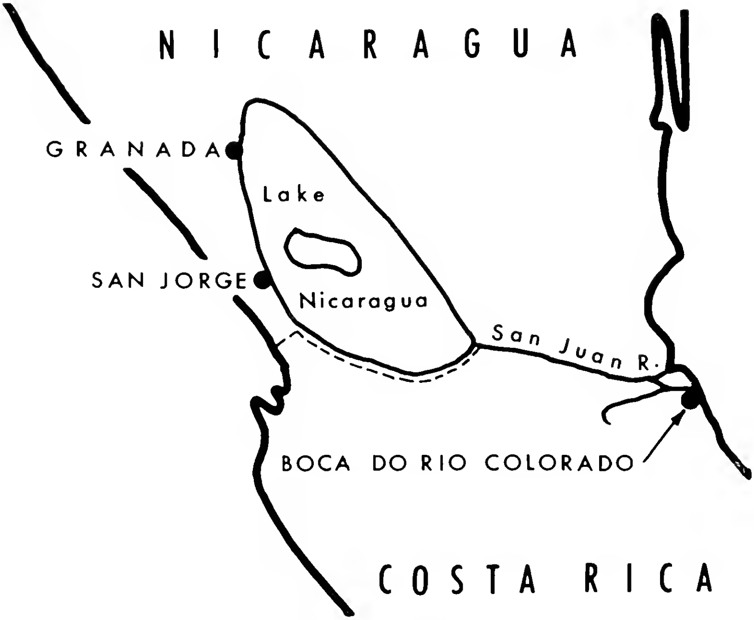
W. W. Milstead (1953) has treated this group of Mexican and Central American *Thamnophis* very differently than did Smith but has followed him in synonymizing *bovallii*, again without discussion. Milstead has made Smith's species, *sumichrasti*, a race of *cyrtopsis* (*eques* of authors), and has contributed to the understanding of the variational range of scale counts and color of the populations he treats. However, he is so far from giving serious attention to *bovallii* that after citing it in the synonymy of *T. cyrtopsis sumichrasti* he forgets to mention Nicaragua in the range of the subspecies in the section on "Subspecific Variation" (*loc. cit.*, p. 359), although he does include it later under the formal presentation of the range of *sumichrasti* (*loc. cit.*, p. 361).

Several characters persuade us not only to regard *bovallii* as valid, but even provisionally to retain it as a full species until the taxonomic uncertainties surrounding this section of *Thamnophis* are further clarified. In scale characters the most significant point is the presence of 21 rather than 19 scale rows at the nape, while in coloration the most striking feature is the dark anterior border (narrowed medially) of all the ventrals. Both these features serve to separate *T. bovallii* from all *T. cyrtopsis* as conceived by Milstead. The shortness of the lateral bars (in our two examples), and the presence always of two rows of spots in the vertebral region (even if partly coalesced) are additional characters.

ECOLOGY

The San Jorge specimen was collected by two boys under lakeshore debris, early on the morning of July 1, 1956. Just above the water line there is a windrow of vegetable debris, wood, coconut husks, etc. This and the small puddles of this zone were inhabited at dusk by large numbers of small toads and frogs. Series of *Leptodactylus melanonotus* (Hallowell), and *Bufo mari-*

nus (Linné), were collected during the visit. During the daytime the frogs appeared to hide away from the beach, but large numbers of lizards were found along the bluff beyond the beach (*Anolis achilles* Taylor?, *Sceloporus variabilis olloporus* Smith, and *Cnemidophorous d. deppii* Wiegmann were collected). In addition to the specimen of *borallii* the beach also yielded a specimen of *Thamnophis saurita chalceus* (Cope) and one of *Leptodeira rhombifera* Günther.



Map. *Thamnophis borallii.* Sketch map showing the relation of the three localities from which this species has been recorded.

Granada, the type locality of *borallii*, also lies on Lake Nicaragua (elev. 105 ft.) and the two specimens listed by Dunn (*loc. cit.*) probably came from a locality similar to that described. "Colorado Bar," on the other hand, refers to the mouth of the Colorado river (Boca do Rio Colorado on Costa Rican maps). While this lies on the Caribbean coast, it is part of the delta of the San Juan River which drains Lake Nicaragua and which has such a low gradient that it was used for navigation in historic times.

Thus all three localities at which *T. bovallii* has been taken are lowland. This is in strong contrast with Milstead's description of the situation in *T. cyrtopsis* which he regards as a species that does not descend below 1000 feet in altitude. He admits one exception, the Edwards Plateau of Texas (minimum altitude 700 feet), but ascribes this to the temperate, subhumid climate of the region. He doubts the records of *cyrtopsis* from British Honduras, Yucatan (Mexico), and Escuintla, Guatemala, which would bring the form into the tropical zone. Here again is evidence of his lack of attention to *bovallii* since he fails to mention it or Nicaragua at all in this discussion.

ACKNOWLEDGMENTS

The junior author welcomes this opportunity to thank those friends, whose unselfish and valuable assistance made this trip and the visit to Rivas and San Jorge both possible and successful. I should like to express my particular appreciation to Messrs. Julio César Moya, Inspector Forestal, and Gustavo Hernandez, Agrónomo, both of Rivas as well as to the municipal officials of this city, and in addition, to my companions Gerardo Budowski of the Instituto Interamericano de Ciencias Agricolas of Turrialba, and Phil Noyce.

We also wish to thank Arthur Loveridge for comments, and Ernest E. Williams for additions to and revision of the manuscript, and the staff of the Department of Amphibians and Reptiles of The American Museum of Natural History for loan of the Colorado-bar specimen.

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. January 30, 1958 Number 84

REDISCOVERY OF THE AUSTRALIAN CHELID GENUS *PSEUDEMYDURA* SIEBENROCK (CHELIDAE, TESTUDINES)

By Ernest E. Williams

In 1954, L. Glauert described a new species — *Emydura inspectata* — from western Australia, comparing his new form only with species of *Emydura*. A glance at his photograph revealed that the new form was congeneric with, and perhaps conspecific with, *Pseudemydura umbrina* described by Siebenrock from an unique type specimen in the Vienna Museum with no more precise locality than "Australia," and which had come into the possession of that museum in 1839.

Pseudemydura umbrina was named by Siebenrock in a preliminary note in 1901, but it was not figured nor fully described until 1907. The long interval between these two papers may, I think, be easily explained: The specimen was unique and without adequate locality, yet it was made the type of a genus. Only Siebenrock's wide knowledge of the order as a whole justified such a procedure, and even for him it was natural and desirable to wait for some years in the hope of procuring additional specimens the better to document his case.

Siebenrock never obtained any further specimens, but in default of them his 1907 paper compared *Pseudemydura* carefully and in a key with every other genus in the family.

Pseudemydura belongs to the group of short-necked chelids, and is peculiar among these in having a large intergular plastral scute that not only separates gulars and humerals but penetrates some distance between pectorals. A somewhat similar condition occurs in the long-necked chelid genus *Chelodina*, in which, however, the gulars usually meet in front of the intergular, separating the latter from the anterior plastral margin. Only in *Chelodina intergularis* (Fry, 1917) among Recent turtles is there any close parallel to the condition found in *Pseudemydura.* Among known fossil forms, however, a very similar intergular pattern occurs in some members of the related family Pelomedusidae — *Elochelys perfecta* Nopesa of the Cretaceous of Europe, and probably in some *Taphrosphys* (Cretaceous and Tertiary of North and South America).

The relationship of the intergular to the other anterior plastral scutes in *Pseudemydura umbrina* (clearly seen in Glauert's specimens) is thus striking enough among Recent members of the Chelidae and in particular the short-necked chelids to be by itself a feature permitting recognition at the generic level. However, the judgment that the specimens from Warbrook, 24 miles north of Perth, West Australia, described by Glauert as *Emydura inspectata* belong not to *Emydura* but to *Pseudemydura* does not rest only on this feature but also upon a similarity that in creatures so variable as turtles is surprisingly complete.

Neither the Vienna type nor any of Glauert's material has been available to me, but the similarity of the two described forms can be placed beyond all question merely by comparing in parallel columns a translation of Siebenrock's 1907 description and Glauert's 1954 account. I have given Siebenrock's description in full and rearranged Glauert's shorter description to make the parallels and differences more obvious:

Pseudemydura umbrina	*Emydura inspectata*
Carapace length: 106 mm	Carapace length (two specimens): 133 mm, 98 mm
Carapace breadth: 81 mm	Carapace breadth (two specimens): 103, 83 mm
Carapace height: 33 mm	
Carapace very strongly flattened with a definite vertebral furrow, most distinct on the middle three vertebrals.	Carapace slightly depressed with a distinct sulcus.

Pseudemydura umbrina	*Emydura inspectata*
The posterior carapace rim only slightly expanded so that the greatest breadth (between the eighth marginals) only slightly exceeds the breadth at the middle of the shell.	Slightly narrower in front (96 mm as compared with 103 mm); marginals 5-8 with a distinct flange.
Anterior carapace rim truncate and only insignificantly incurved.	
Posterior carapace rim projecting medially into a keel produced by the arching of the supracaudals and adjoining eleventh marginals. The supracaudals also forming ventrally an acute-angled notch, which, with the posterior end of the plastron, also angularly notched, forms a rhomboidal opening for the tail.	
First vertebral longest, broader anteriorly than posteriorly, narrower than the second and third, as broad as the fourth and fifth.	First vertebral largest, as wide as long, obtusely pointed in front, the second and third much wider than long, fourth and fifth slightly wider than long, longer than the second and third.
First costal as broad as, the remaining three costals narrower than, the corresponding vertebrals. Of these the second costal broadest, almost twice as broad as the fourth. All costals broader at the lateral margins than medially, and broader than the lateral margins of the corresponding vertebrals.	Second and third vertebrals shorter than the adjacent costals.
Carapacial shields leathery, finely wrinkled.	
Nuchal rather large, trapezoidal, broader in front than behind.	Nuchal very small (9 x 5 mm) entirely free below.

Pseudemydura umbrina	*Emydura inspectata*
Lateral marginals very narrow; the sixth narrowest, only about one-third as wide as the ninth. The form of the lateral marginals is correlated with the great size, especially breadth, of the second costal.	Fifth, sixth, seventh and eighth marginals with distinct flange, fourth to seventh narrowest.
Plastron flat, about as large as the shell opening, with a distinct angle at the bridge.	Plastron (124 x 95½ mm, measured to the edge of the bridge) flat, large, almost as wide as the carapace, bridge rounded.
Anterior lobe broader than posterior lobe, truncate.	Plastron narrower behind, semi-circular in front, posteriorly with a broad, straight-sided, anal notch.
Posterior lobe with an angular notch.	
The two corners of the anal notch are bent upward to make contact with the posterior rim of the shell, thus forming the rhomboidal opening before mentioned.	
Breadth of bridge one-third the length of plastron and one-half the width of the anterior lobe.	Bridge one-third the length of the plastron measured along the mid-line.
Intergular very large, heart-shaped, not much longer than broad, its broad anterior margin straight, weakly dentated, the pointed posterior end inserted between the pectorals, separating these in their anterior third.	Intergular very large (29.5 x 25.5 mm). Widely in contact with the pectorals.
Gulars very small, forming equilateral triangles, their medial sides scarcely one-third the adjacent lateral rim of the intergular.	Gulars very small, widely separated.
Humerals small, widely separated from one another, in form and size showing great similarity with those of *Chelodina*.	Humerals triangular slightly narrower than the intergular.

Pseudemydura umbrina	*Emydura inspectata*
Anal middle suture longer than the pectoral and significantly longer than the femoral.	Pectorals slightly shorter than the femorals which are shorter than the anals, the latter forming a broad shallow notch behind.
Intergular longer than the pectoral middle suture.	
Head broad and flat, the upper surface finely wrinkled.	Head broad and flat, rugulose above.
Parietals strongly expanded, covering the whole width of the head, their posterior margin not pointed but somewhat incurved.	
Snout short.	Snout projecting.
Interorbital space broad and concave, its breadth exceeding the transverse diameter of the orbits. Both jaws narrow; the breadth of the lower jaw at the symphysis not quite two-thirds the transverse diameter of the orbit.	Interorbital space twice the width of the symphysis, the latter equal to the vertical diameter of the orbit.
Two small chin barbels, widely separated.	Two small barbels.
Back of neck with numerous large erect conical tubercles.	Neck above and laterally with pronounced conical tubercles; temporal region, chin and throat reticulate.
Limbs with rather large flat scales. *Transverse lamellae such as occur on the anterior surface of the lower arm in Emydura entirely lacking.*	*Forelimbs with three series of transverse lamellae and a flap of three or four enlarged scales.*
Webbing well developed, extending to the claws. Fifth toe of hind foot clawless.	
Tail short, reaching scarcely to the posterior rim of the shell.	Tail very short, hardly projecting.

Pseudemydura umbrina	*Emydura inspectata*
Carapace and upper surfaces of head umbra brown.	Color of carapace bone brown. Young: brighter brown. Head above dark olive, sides of face, lower lip, chin and throat marguerite yellow, a few dark markings on the throat.
Plastron dirty yellowish green. All sutures of the shell brown.	Plastron buffy olive, over the sutures buff. Young: plastral plates edged with brown.
Limbs and back of neck dark brown, the jaws horn-colored.	Forelimbs olive black, hind limbs darker.

Siebenrock's type was intermediate in size between Glauert's type and the latter's young specimen, but closer to the young specimen. Careful comparison of the two descriptions discovers few differences that are not merely verbal, while there is agreement in all essentials even in color — the latter remarkable when it is realized that Glauert's fresh specimens are being compared with a specimen that had been in the Vienna Museum 62 years before it was first described.

Only one of the few described differences would seem possibly significant. Siebenrock makes a point of the absence in *umbrina* of transverse lamellae such as exist in the genus *Emydura*. Glauert specifies in *inspectata* "three series of transverse lamellae and a flap of three or four enlarged scales."

Glauert's photographs accompanying the type description of *inspectata*, however, while excellent for other aspects of the animal do not show this area. I have therefore obtained from Dr. Glauert two photographs of the forelimb in his type. These are reproduced in Plates 3 and 4 and show the flap or spur very well and in the ventral view exhibit also the three series of scales described as "transverse lamellae" by Glauert.

Siebenrock's 1907 figure (Plates 1 and 2) definitely does not show any flap or spur on this forelimb on the type of *Pseudemys umbrina* but does show in the ventral view several series of scales apparently less regular than those of Glauert's type but easily comparable to these. These scales are individually rather squarish, though arranged in transverse rows. In this respect the difference between Glauert's and Siebenrock's descriptions would seem to be primarily verbal. However, the absence of the flap would still remain as a serious difference between *Pseudemydura umbrina* and *Emydura inspectata.*

To check this final point I requested Dr. Eiselt of the Vienna Museum to re-examine Siebenrock's specimen. He reports: "The type of *Pseudemydura umbrina* is a stuffed and lacquered specimen. In correspondence with Siebenrock's figures it showed no spurs whatsoever. Being somewhat of a sceptic, I had the lac removed from the front legs and feet, and then soaked them in water. The effect was surprising: both lower front legs now show on their outer (hind) edges a series of three triangular scales which had, up to now, been glued firmly to the lower surface of the leg. Also the scales on the outer edge of the fifth toe (finger) show a tendency to form a flat and serrated lamella. As a whole the scalation of the legs shown in Siebenrock's figures is rather inaccurate and needs redescription or refiguring."

Dr. Eiselt has also provided a sketch of the flap, which appears to be not significantly different from that described and photographed by Glauert.

With this evidence the synonymizing of *Pseudemydura umbrina* and *Emydura inspectata* must be considered established.

Glauert's species name must thus disappear from the list, but his discovery is still important. A genus known from a single specimen without adequate provenance is an unhappy problem. The Glauert specimens provide an exact locality, confirmation of the characters described by Siebenrock, and knowledge of the peculiar spur-flap, a feature missed by Siebenrock and which, though approached in other chelids by a flap of scales along the whole external range of the forelimb, is in its peculiar spur-like development apparently peculiar to this genus.

Dr. Glauert has called to my attention that Western Australia was opened in 1829 and that the German collector Dr. L. Preiss collected there in the late 1830's and early 1840's. This accords very well with the date of arrival of the Vienna specimen at that museum, but Dr. Eiselt could supply me with no information about the collector.

Acknowledgements. My indebtedness to Dr. Eiselt and Dr. Glauert has been conspicuous throughout this paper. I want to

make, however, a very personal expression of thanks for their kindness and courtesy in answering my questions. The photographs of the forefoot of *Emydura inspectata* were furnished by Dr. Glauert; the reproduction of Siebenrock's figure is the work of Mr. Frank White.

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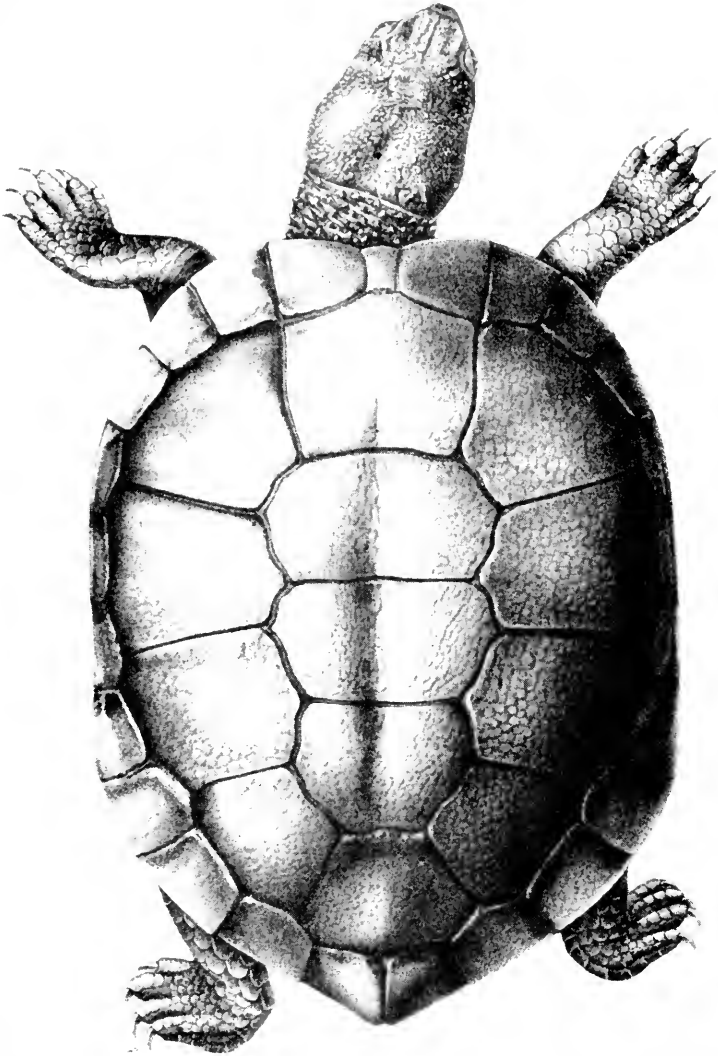

Plate 1. Type of *Pseudemydura umbrina*, dorsal view. From Siebenrock (1907).

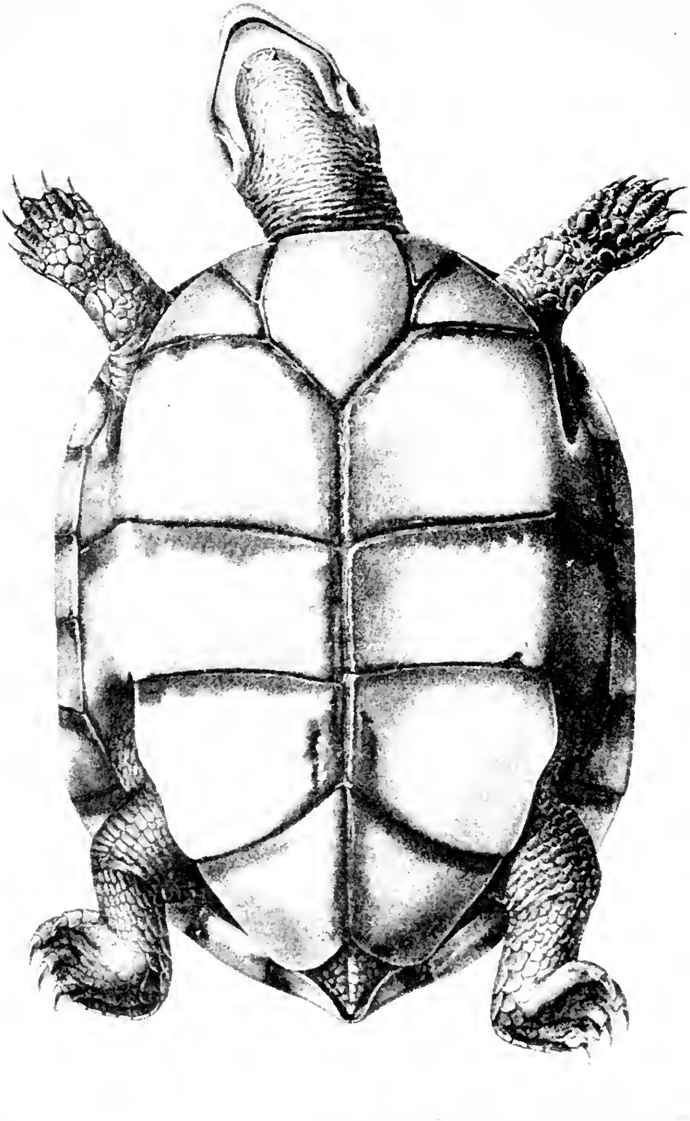

Plate 2. Type of *Pseudemydura umbrina*, ventral view. From Siebenrock (1907).

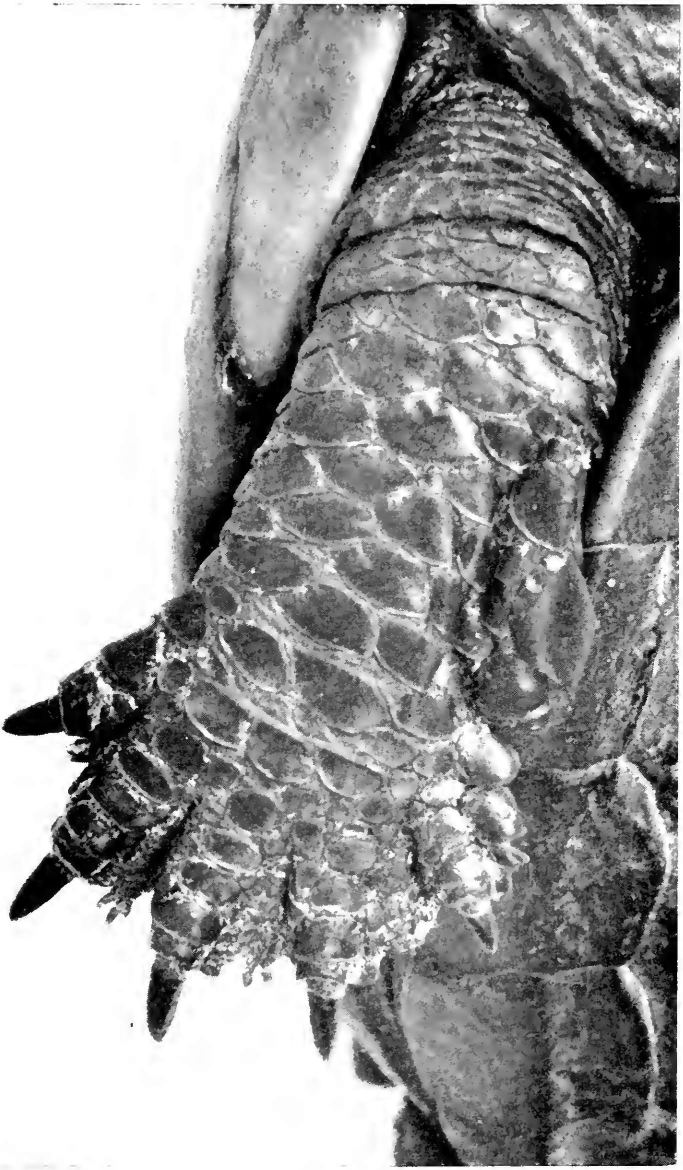

Plate 3. Dorsal view of forefoot of type of *Emydura inspectata* Glauert.

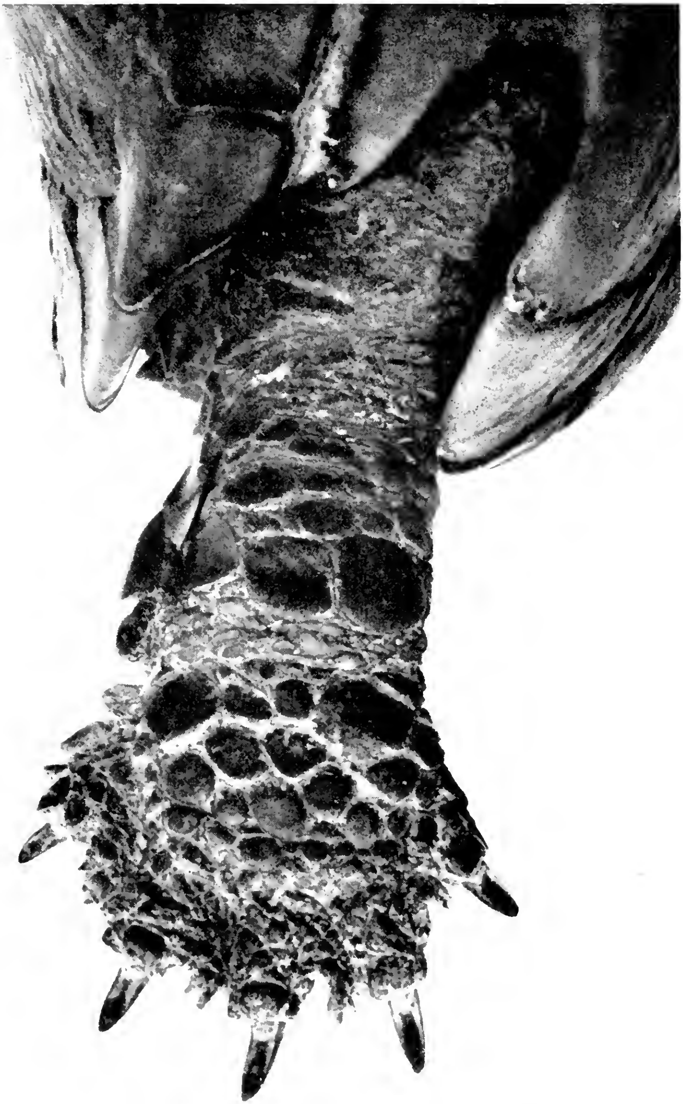

Plate 4. Ventral view of forefoot of type *Emydura inspectata* Glauert.

B R E V I O R A

Museum of Comparative Zoology

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THE CHOANAL PAPILLAE OF THE CHELONIIDAE

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INTRODUCTION

There appear to be no published descriptions of the papillae which are found along the lateral margin of the choanae or internal nares in the members of the Cheloniidae. They are mentioned in two papers, Deraniyagala (1939) and Carr (1942), but in each case only the number present is noted and given as a generic character.

The following note is based primarily on the study of two heads of *Chelonia mydas* which were obtained from the Carolina Biological Supply Company. Supplementary observations were made on specimens in the collections of the Museum of Comparative Zoology. Histological investigations were confined to *Chelonia mydas*. The specimens had been preserved in formalin and were stained with hematoxylin and eosin and by the Bielschowsky silver method. A third method, Mallory's triple connective tissue stain, was tried, but did not prove successful.

I am indebted to Dr. E. E. Williams for allowing me to examine the specimens in the Museum of Comparative Zoology, and for his advice throughout the course of this study. Thanks are also due to Dr. A. B. Dawson and Mrs. T. S. Parsons for advice and assistance in making the histological preparations.

CHELONIA MYDAS

In *Chelonia mydas* the papillae form a row along the entire lateral margin of the choana. They are long and narrow conical projections of irregular length, so that the row of papillae appears quite uneven. In the anterior two-thirds of the choana, they tend to be longer and more prominent, with approximately half of the width of the choana occupied by the papillae; farther posteriorly they do not extend out into the choana any great distance. Deraniyagala (1939) reports not only a lateral row, but also a single anteromedial papillary vestige. However no such vestige was seen in any of the specimens studied in the present investigation.

The number of papillae in the lateral row is not constant. Carr (1942) states only that they are numerous, and Deraniyagala (1939) that there are eight. Unfortunately the latter author does not mention the number of specimens which he examined. In the two adults dissected for the present study there were eleven to fourteen papillae on either side (one had thirteen on each side, the other eleven on the left and fourteen on the right). The only other adult specimen which was examined (MCZ 7150) possessed ten papillae on the right side and eleven on the left. Thus there are probably ten or more papillae along the lateral margin of each choana in most fully mature *Chelonia mydas;* however this is not true of juveniles. In three specimens under six inches in total length (MCZ 1413, 1414, and 29594) there was only a single, rather weakly developed papilla near the anterior end of the lateral margin of each choana. A larger juvenile (MCZ 3454) possessed two papillae on the right side and three on the left.

In section, each papilla can be seen to consist of two major histologic elements. First there is a thick, cornified, stratified squamous epithelial covering, and secondly a mass of dense connective tissue forming a central core. Plate II shows transverse sections of papillae. The upper section, stained with hematoxylin and eosin, was taken near the center of the papilla, while the lower one, stained by the Bielschowsky silver method, was taken near the base.

The epithelium closely resembles normal body epidermis. In some regions all four strata — germinativum, granulosum, lucidum, and corneum — are well developed. The first and last are present throughout, but the granulosum and lucidum are not always recognizable. There is a gradual increase in the thickness of the stratum corneum from a minimum at the base of the papilla to a maximum at its tip. The external surface of the epithelium is relatively even at the distal end of the papilla, but basally it becomes irregular with numerous small projections and, more rarely, indentations. As in typical epidermis, the boundary between the epithelium and the underlying connective tissue is generally a rather wavy line, although near the tip of the papilla it becomes far more even. No basement membrane could be seen; in fact the fibers of the connective tissue appear to continue into the basal epithelial cells. However in human epidermis, which appears similar when viewed through a light microscope, a thin basement membrane can be demonstrated by electron microscopy (Maximow and Bloom, 1957).

The core of the papilla is a mass of typical dense connective tissue. Irregularly arranged bundles of collagenous fibers occupy most of the space, but there are numerous included cells and small relatively clear areas. The cellular constituents of the connective tissue were not identified in the present study. Within the connective tissue there are quite numerous very small blood vessels; however only a single arteriole and venule could be found at the base of the papilla, and the tissue is not very heavily vascularized. No nerve fibers or endings could be recognized. However nerve fibers would resemble most closely the fibers of the connective tissue, and thus be very difficult to demonstrate. Presumably there are some nerves present; certainly the lining of the oral cavity is well innervated in most forms.

OTHER CHELONIIDS

Plate I, lower figure shows a specimen of *Caretta caretta.* In this specimen (MCZ 53133) there is a single choanal papilla located near the anterior end of the lateral margin of the choana. This is in agreement with the findings of both Deraniyagala (1939) and Carr (1942). The form of the papilla is essentially similar to that found in *Chelonia mydas*, but it appears to be slightly shorter and broader in *Caretta.*

The only specimen of *Chelonia depressa* which was examined (MCZ 54712) is a juvenile, and possesses a single choanal papilla exactly like that of *Chelonia mydas* juveniles.

In *Eretmochelys imbricata*, Deraniyagala (1939) found a single choanal papilla, and Carr (1942) reports one or two papillae. All seven specimens examined for the present study (MCZ 1138, 1141, 1416, 1418, 4049, 49406, and 49407) possess a single papilla exactly like that of *Caretta*.

No specimens of *Lepidochelys* were seen by me. Both Deraniyagala (1939) and Carr (1942) report a single choanal papilla like that found in *Caretta*.

FUNCTION OF THE PAPILLAE

In adult specimens of *Chelonia mydas* the form of the papillae suggests the possibility that their function is to prevent pieces of food from entering the nasal cavities. However the single choanal papilla of the other cheloniid genera and of juveniles of *Chelonia mydas* could not be very effective in this regard.

According to Deraniyagala (1939), all the cheloniids are omnivorous, preferring an animal diet but often subsisting on purely plant food. *Chelonia* in particular is primarily herbivorous. Its eating habits also differ slightly from the other members of the family in that its "stomach contents are never in a finely divided condition but appear to be 'bolted' entire" (Deraniyagala, 1939, p. 234); the other cheloniids tend to break up their food more. However it does not appear to me that an unchewed piece of alga would cause any more injury than a broken piece of mollusc shell if lodged in the choana or nasal cavity. Thus food habits do not seem to explain the differences between the genera.

Another possible function of the papillae is that they might bear some special sensory receptors. However the histological observations provide no evidence for such a theory, although they are not absolutely conclusive. As was noted above, no nerves or sensory endings were observed in the papillae of *Chelonia*. Since the material was not ideally preserved for histologic study and since nerve fibers would not be clearly differentiated from connective tissue fibers by the stains employed, their absence cannot be considered as proven; in fact, it appears highly probable that there is some sensory innervation of the papillae. However the absence of any conspicuous nerve trunk entering the base of the papilla and of any distinguishable receptors renders it most unlikely that the papillae function primarily in a sensory capacity. Furthermore, the thickness and high degree of cornification of the epithelium would be surprising, though not impossible, in a sensory structure.

Thus I am unable to suggest any function for the single papilla in *Caretta*, *Eretmochelys*, or *Lepidochelys*. In *Chelonia* (adults) they must serve to prevent the contents of the mouth from entering the nasal cavities; whether or not this is their primary function cannot be stated.

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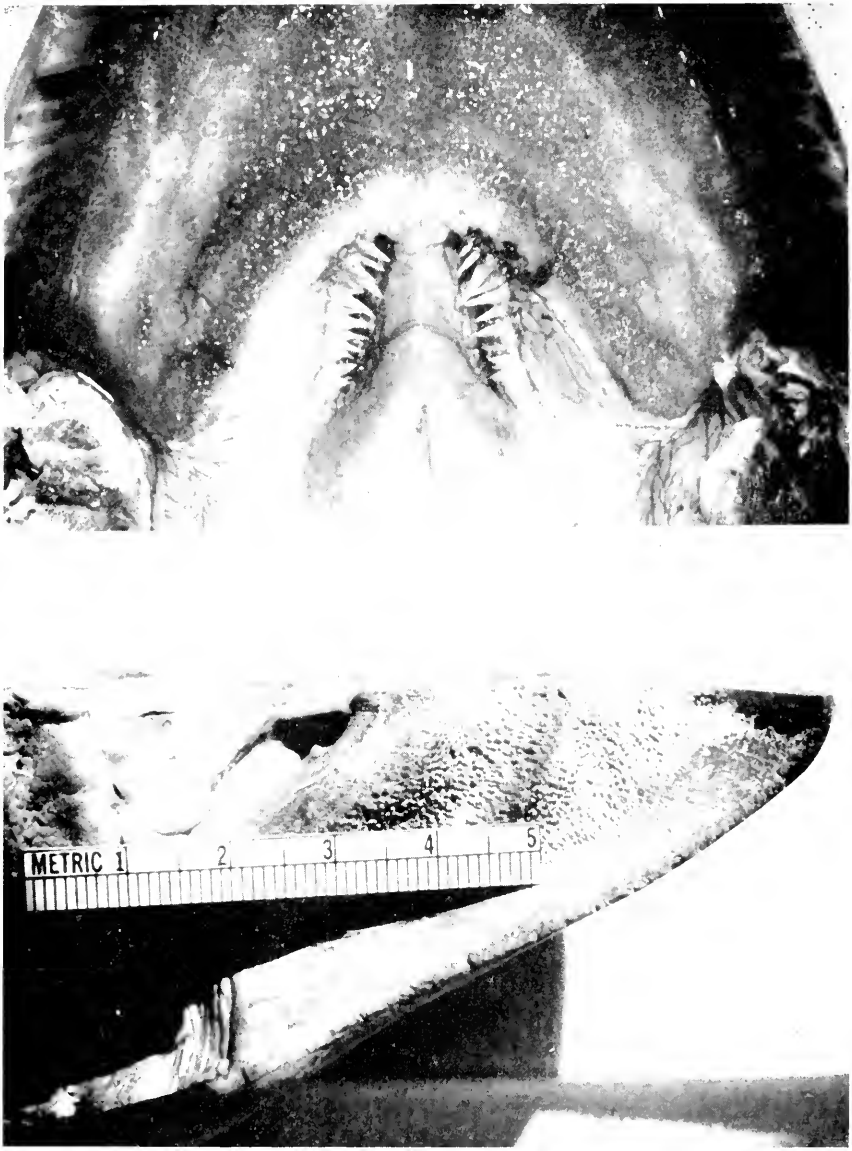
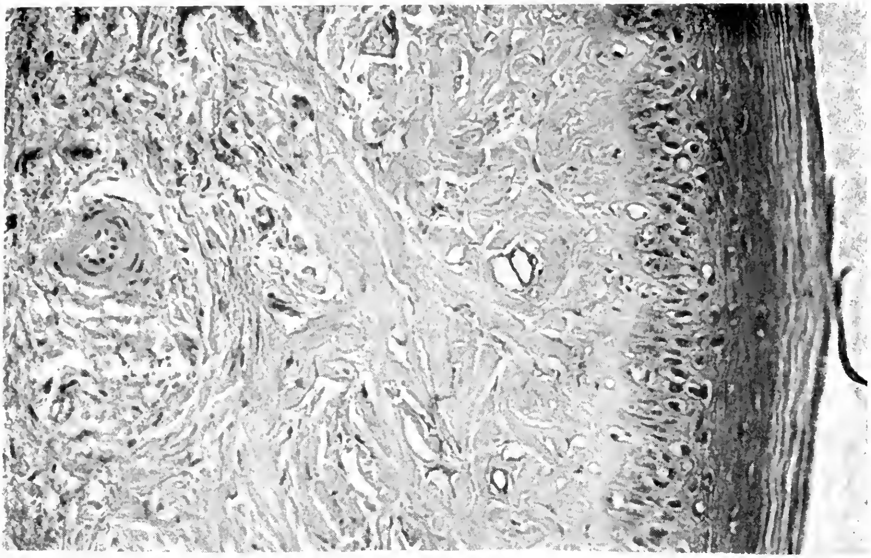


PLATE I

Upper, Chelonia mydas. View of part of the palate showing the choanal papillae.

Lower, Caretta caretta. View of the left side of the palate showing the single choanal papilla.



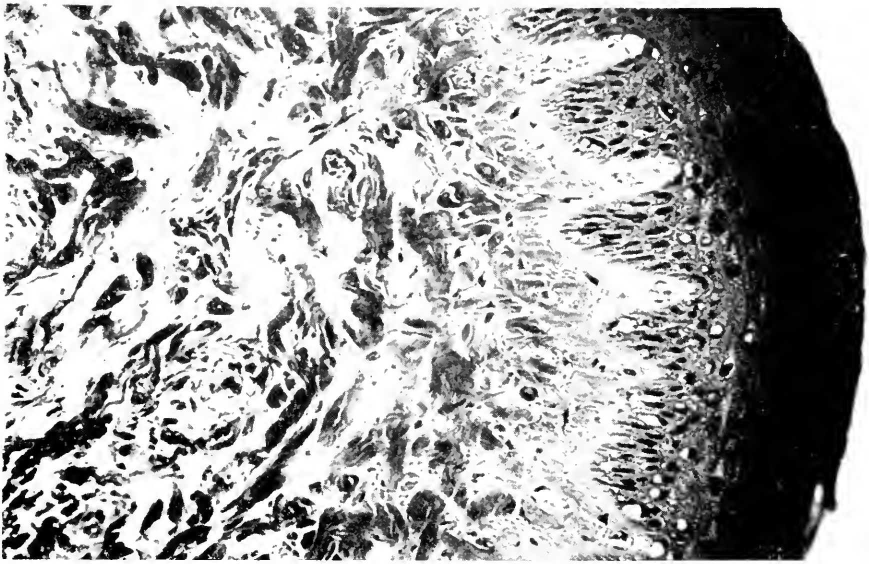


PLATE II

Upper. Chelonia mydas. Transverse section of a choanal papilla taken near its center and stained with hematoxylin and eosin. 250x.

Lower. Chelonia mydas. Transverse section of a choanal papilla taken near its base and stained by the Bielschowsky silver method. 250x.

BREVIORA

Museum of Comparative Zoology

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A NEW SICISTINE RODENT FROM THE MIOCENE OF WYOMING

By Craig C. Black[1]

During the course of a study of the Split Rock local fauna of Middle Miocene age, several isolated teeth, two partial maxillaries, and one fairly complete lower jaw of a new sicistine rodent were discovered. Because of the rather limited occurrence of this group in North America and the paucity of previous records, it is felt that this form should be described before the study of the fauna as a whole can be completed.

For the loan of material described below I am indebted to Drs. P. O. McGrew, Loris Russell and A. E. Wood and to the Chicago Natural History Museum. I would like to acknowledge the helpful assistance and suggestions of Professor A. E. Wood and Professor Bryan Patterson.

The following abbreviations are used throughout:

A.C. — Amherst College
C.N.H.M. — Chicago Natural History Museum
R.O.M. — Royal Ontario Museum of Zoology and Paleontology
U.W. — University of Wyoming

Family ZAPODIDAE
Subfamily SICISTINAE
SCHAUBEUMYS SABRAE,[2] n. sp.

Holotype. U. W. No. 1405, partial left mandible with the incisor, M_1, M_2, and the anterior roots of M_3.

Referred Specimens. Partial maxillaries with P^4-M^1 A.C.

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[1] This study was made while the author was Rufus B. Kellogg Fellow from Amherst College.

[2] The specific name is given in honor of my wife.

No. 10490, R.O.M. No. 1950; M^1 A.C. Nos. 10489, 10491, 10493, 10494, 11293, C.N.H.M. Nos. PM 2101, 2102, U.W. No. 1406; I^1 C.N.H.M. Nos. PM 2105, 2106; M_1 A.C. Nos. 10492, 11294; M_2 C.N.H.M. No. PM 2103; M_3 C.N.H.M. No. PM 2104.

Diagnosis. Intermediate in size between *Plesiosminthus? clivosus* (Galbreath, 1953, p. 99) and *Shaubeumys grangeri* (Wood, 1935b, p. 1); no anteroconid on M_1; mesostylid closely applied to metaconid on M_2; mesolophid connected to metaconid on M_2; hypoconulid well-developed on M_1-M_2.

Horizon and Locality. Middle Miocene. Vicinity of *Brachycrus* quarry "Exposure No. 2" (Schultz and Falkenbach, 1940, p. 251), seven miles by road northwest of Muddy Gap filling station, in a draw about ¼ mile south of U.S. Highway 280, Fremont County, Wyoming.

Description. The jaw (Fig. 1 H) is broken through the middle of the alveolus of M_3 and down the outer half of the body so that the incisor is revealed beneath M_2. The ridge marking the lower border of the masseteric scar is thick and prominent and extends forward to below the anterior root of M_1. The mental foramen lies almost immediately below the center of the diastema.

The upper teeth are associated in several cases with fragments of palate, the most complete of which is shown in Figure 1 A. The posterior boundary of the anterior palatine foramen is on a line with the anterior end of P^4. A small part of the zygomatic arch is preserved, arising somewhat anterior to P^4, with the ventral border of the infraorbital foramen preserved. However, only that portion of the foramen which transmits the infraorbital nerve is present so that no estimate of the size of the opening for the masseter can be made.

There are a number of isolated upper incisors (Fig. 1 F, G) which agree so closely with the description given by Schaub (1930, p. 621, Fig. 4) for those of the European sicistine, *Plesiosminthus schaubi* Viret, that they are here referred to the North American form, *Schaubeumys sabrae.* They are prominently grooved with the enamel extending 0.2 to 0.3 mm. over the medial side of the tooth. The pulp cavity is Y-shaped, the median arm of the Y being the longer.

The upper fourth premolars (Fig. 1 A, E) are bud-like in appearance with two small buccal cusps, a deep central pit, and a slight lingual swelling. The upper first molars (Fig. 1 A-E) are almost square. The paracone and metacone are higher than the other cusps. The anterocone and anterior cingulum are well developed with the latter sloping steeply buccally to join the paracone at its base. The paracone and protocone are usually connected through what is probably the protolophule II, either directly, or via the mesocone. In one specimen (Fig. 1 B),

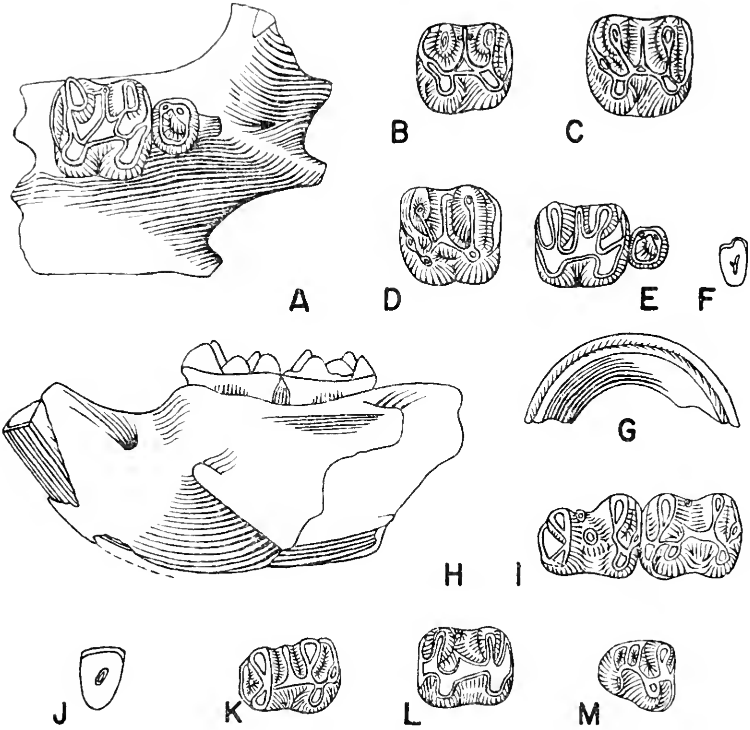

Figure 1. Teeth of *Schaubeumys sabrae*, all X 10 except for *F* and *G* X 5. *A*, R.O.M. No. 1950, part of palate with RP^4-M^1; *B*, A.C. No. 10491, LM^1; *C*, A.C. No. 10489, LM^1; *D*, A.C. No. 10494, LM^1; *E*, A.C. No. 10490, RP^4-M^1; *F*, C.N.H.M. No. PM 2105, I^1, lateral side to right; *G*, the same, lateral view; *H*, U. W. No. 1405, partial left mandible with I$_1$, M$_1$, and M$_2$ (type); *I*, U.W. No. 1405, LM$_1$-M$_2$; *J*, U.W. No. 1405, I$_1$, lateral side to right; *K*, A.C. No. 11294, LM$_1$; *L*, C.N.H.M. No. PM 2103, LM$_2$; *M*, C.N.H.M. No. PM 2104, RM$_3$. Anterior end to the left except for *A*, *E*, *G*, and *M* where it is to the right, and *F* and *J* where it is at the top.

however, there is no trace of the protoloph. The mesoloph extends to the buccal margin of the teeth and is occasionally connected to the paracone, metacone, or both, by low lateral ridges. The posterior cingulum lies below the level of the metaloph.

The lower incisors (Fig. 1 J) are triangular in outline with a flat anterior face and a small elliptical pulp cavity on the wear surface. The enamel extends slightly over the medial side of the tooth.

There is no anteroconid on the first lower molars (Fig. 1 I, K), but on A.C. No. 11293 (Fig. 1 K) there is a small distinct cuspule in the deep basin between the protoconid and the metaconid. This cuspule is not on the anterior cingulum, however, and there is no trace of such a cuspule on either of the other two first lower molars. In all the specimens there is a strong ridge or arm rising steeply from the anterior cingulum to the protoconid while lingually the cingulum abuts against the base of the metaconid with no indication of such a cingular arm. In two instances the mesolophid is well-developed in contrast to the distinct mesostylid and mesoconid of U.W. No. 1405 (Fig. 1 I). The hypoconulid is distinct in all cases and closely connected to the hypoconid. The posterior cingulum descends steeply from the hypoconulid and passes to the lingual edge of the tooth terminating well below the entoconid.

The second lower molars (Fig. 1 I, L) are in general similar to the first molars with the one exception that in the former the mesolophid has shifted anteriorly abutting against the metaconid. The mesostylid is thus distinct, lying half way down the steep metaconid slope. The protoconid and metaconid are connected, probably through the metalophulid II. The mesolophid and metalophulid II enclose a small pit between the protoconid and metaconid.

The third lower molar (Fig. 1 M) is proportionately smaller than any of the first or second molars so far encountered, but since so few specimens are available no dependable ranges for tooth size can be determined. The anteroconid is not distinct, but blends into the two cingulum arms, one of which passes to the lingual margin while the other slopes downwards to the base of the protoconid. The mesolophid passes anteriorly to unite with the metaconid at its base, forming a deep pit between the metalophid and mesolophid. The mesoconid and entoconid are not distinguishable within the crests. The hypoconid is large and is connected to the entoconid region through the posterior cingulum and the anterior hypoconid arm, the two isolating a posterior pit. There is also a central pit between the mesolophid and hypolophid.

Discussion. *Schaubeumys sabrae* is the third mid-Tertiary species of sicistine to be reported from North America. The species previously described are *Schaubeumys grangeri* (Wood, 1935b) from the Lower Rosebud, and *Plesiosminthus? clivosus* (Galbreath, 1953) from Quarry A in NE Colorado, of Middle Miocene age. I have assigned the present population to the North American genus, *Schaubeumys,* rather than to the European genus, *Plesiosminthus,* because I do not feel that at present there is enough evidence available to warrant considering the North American and European forms congeneric. Galbreath (1953, p. 99) was of the same opinion when, in his discussion of *P.? clivosus,* he stated, "It seems unlikely that this North American zapodid from the middle Miocene is congeneric with the lower Miocene zapodid of western Europe." I also feel that the three North American species are congeneric and that *P.? clivosus* should be referred to *Schaubeumys.*

The North American forms can be distinguished on the basis of size: *S. clivosus* is the smallest; *S. sabrae* is intermediate; and *S. grangeri* is the largest. *S. sabrae* is strikingly different from either of the others in the absence of the anteroconid on M_1 and in the fact that the mesolophid abuts against the metaconid and fails to reach the mesostylid on M_2. *S. clivosus* appears to have no distinct hypoconulid on any of the lower teeth whereas this cusp is relatively large in the other two species.

It is of interest to note that all three species occur in a relatively limited time span, no sicistines yet being known in North America from any deposits earlier than Miocene (I am excluding from the Zapodidae the peculiar *Simimys* from the Sespe Eocene), or later than Middle Miocene. This brings up the problem of where the North American sicistines came from. No definite answer is possible but some guesses may be hazarded.

All the North American species show a great many similarities to contemporaneous forms in Europe, and to forms known from the Oligocene of Europe and Mongolia. In fact, if it were not for the presence of grooved upper incisors, *S. sabrae* might be referred to the Mongolian genus *Parasminthus* described by Bohlin in 1946. *Parasminthus* in turn is equally close to the European *Plesiosminthus* (Bohlin, 1946, pp. 16-17), from which it is separated only on the basis of the non-grooved incisors.

Wood (1935a, pp. 225-226) has pointed out that it is quite possible that the presence or absence of a groove on rodent incisors may be controlled by a single gene. He goes on to state that if this is the case such grooving could be lost and regained within one lineage practically at will. In the case of the sicistines this would mean that the North American forms could be derived from the Mongolian complex and that the European forms could also be so derived, or vice versa. Bohlin (1946, p. 43) points out that the structural differences observed between species of *Parasminthus* are of the same kind as those found between the species of *Plesiosminthus*. This is also true when the North American complex is compared with either *Parasminthus* or *Plesiosminthus*. These complexes show the presence of the anteroconid in some species and its absence in others. The degree of development of the mesolophid and the position of the mesostylid vary in a similar manner in each group. The way in which the lophs are formed also shows the same variation, and, finally, the same size ranges occur in each group. This great morphological similarity would seem to indicate that these three complexes are basically similar genetically. (No attempt has been made here to determine generic limits within the Miocene sicistines.)

TABLE OF MEASUREMENTS[1]

	Number of Specimens	Mean	σ	C.V.
I^1				
anteroposterior	8	1.20	.10	8.3
transverse	8	.74	.05	6.8
P^4				
anteroposterior	2	.55		
transverse	2	.65		

[1] All measurements in mm. σ = Standard Deviation, C.V. = Coefficient of Variation.

M^1				
anteroposterior	10	1.32	.08	6.0
transverse	10	1.29	.10	7.8
I_1				
anteroposterior	1	.85		
transverse	1	.60		
M_1				
anteroposterior	3	1.32		
transverse	3	1.02		
M_2				
anteroposterior	2	1.28		
transverse	2	1.11		
M_3				
anteroposterior	1	1.03		
transverse	1	.91		

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. June 20, 1958 Number 87

AN EMBOLOMERE JAW FROM THE MID-CARBONIFEROUS OF NOVA SCOTIA

By Alfred Sherwood Romer

It is not always realized that our knowledge of Carboniferous tetrapods is almost entirely confined to forms of relatively late age. Apart from a meager fauna from Scotland (cf. Watson 1929) and a single specimen from England, all described Carboniferous amphibians are of Westphalian or later date — i.e., from Middle to Upper Pennsylvanian strata (Romer 1947, p. 322). The jaw here figured is the first specimen to be described from any American pre-Westphalian formation.[1]

In 1956 the Museum of Comparative Zoology undertook a summer's exploration of the Carboniferous deposits of Nova Scotia in search of vertebrate fossils. Some excellent material of Westphalian amphibians was obtained, and will be described later. The present specimen is the only pre-Westphalian amphibian identified in our collections.

It was derived from the Point Edwards formation (Hyde 1913, p. 252), considered by Bell (1938; 1944, pp. 11–12, 16) to belong to the Canso group. It is definitely earlier than the Riversdale series, with a flora of Westphalian A type, and younger than the Windsor series of the Mississippian. It thus appears to be equivalent to some horizon in the Namurian of European nomenclature and is currently considered as late Mississippian (Weller *et al.* 1948, p. 173, chart 6).

Exposures of the Point Edwards formation occur only in limited areas adjacent to Sydney Harbor in Cape Breton. They are well shown in the series of maps illustrating the geology of

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[1] I hope to describe at a later time remains from the Mississippian of West Virginia (cf. Romer 1941).

the Sydney Coalfield which were published by the Canadian Bureau of Geology and Topography in 1938. The best exposures are along the shores of Point Edward. A *Gyracanthus* spine was collected there many years ago. Our group in 1956 discovered a beach exposure containing dipnoan and other fish bones about one-half mile southwest of the point. The present specimen was found on the shore about 100 yards southeast of the tip of the point, on a detached slab of rock. An incomplete *Gyracanthus* spine and fragmentary fish remains were found nearby in the ledge from which the jaw slab was derived. On another loose slab was a crushed bone, about 50 mm. long and 29 mm. broad at one end, probably a *Sagenodus* quadrate. Intensive search of the area failed to produce further amphibian material.

The specimen consists of a slab of calciferous siltstone which, with its missing counterpart, had contained the greater part of the right lower jaw of a large labyrinthodont amphibian. Wave action had removed all the bone, leaving, however, an almost perfect mold of the outer surface, from which excellent casts have been made. The portion preserved extends from the symphysis to a diagonal line running down and forward from a point a short distance behind the termination of the tooth row; the greatest length as preserved, measured in a direct line, from the symphysis dorsally is 235 mm; the length of the tooth row is 191 mm. The shape of the jaw, as preserved, is that common to many early labyrinthodonts, particularly embolomeres; superposition of our fragment on an outline of such embolomeres as *Archeria* and *Pteroplax* suggests a total length of jaw — and hence, approximately, of skull — of about 365 mm. This indicates an animal of considerable size, this measurement being within 10–15 per cent of that of typical skulls of the familiar Permian labyrinthodont *Eryops*. If outlines of the jaws of such familiar embolomeres as *Pteroplax* and *Archeria* be superposed on that of our specimen by using as a common measurement the length of the tooth row, it will be found that the jaw ramus is intermediate in proportions between the long and slender *Archeria* jaw and the relatively deep and short ramus of *Pteroplax*. There are few non-embolomere jaws of Carboniferous age with which comparison can be made, and little reliance can be placed on proportions of the jaw ramus in attempts to determine relationships. If, however, a series of representative jaws of labyrinthodonts be examined (cf., for example, Romer 1947, figs. 9, 10), it will be seen that in general there is little tendency for the development of an "ascending ramus" in the surangular region in temnospondyls, but some trend in this direction in seymouriamorphs, and in embolomeres a strong development of depth posteriorly, with a notable up-swing of the dorsal margin of the jaw posteriorly. This last trend is obvious in the specimen as preserved, and the edge of the jaw back of the end of the tooth row shows a thin broken margin, indicating that in life the jaw curved upward posteriorly still more strongly. This posterior depth strongly suggests that the jaw is that of an anthracosaurian (as I have used that term) and probably an embolomere. It is regrettable that the inner surface, where positive embolomere features are to be found is not available.

When the cast is viewed dorsally, it is seen that although the mold is slightly incomplete in the symphysial region, the jaw was not widely bowed outward as in such a broad-snouted type as *Eryops*, but turns sharply backward to run a straight course for almost the entire length of the portion preserved.

The surface has an ornamentation of pits anteriorly and extending back along dorsal and ventral margins; dorsally, the pits give way posteriorly to deeply incised striations. Between dorsal and ventral margins the surface shows a lighter series of antero-posterior striations. At the posterior end of the ventral margin there is part of a deep groove carrying the mandibular lateral-line canal; farther forward the mold does not extend quite to the ventromedial line of the ramus and hence the anterior prolongation of the canal is not visible on the cast.

The jaw was crushed before fossilization. As is frequently the case in labyrinthodont specimens (and well shown in an *Archeria* jaw before me at the moment), the outer surface was crushed downward (i.e. medially) in the area between the thickened dorsal part of the jaw carrying the tooth sockets and the stout ventral margin. Sutures are, for the most part, not apparent and since we are dealing with a mold only, further development is impossible. It seems certain that the uncrushed upper margin is entirely, or almost entirely, included in the dentary, and it may be that the longitudinal line of breakage below this region is on or close to the suture between the dentary and the infra-dentary series. An area below this line of breakage, in which parallel striae extend forward and slightly downward, appears to be part of the surangular, which thus extends remarkably far forward (as in *Kotlassia*). Below this region, posteriorly, is one in which the striae extend diagonally anterodorsally; this seems surely part of the angular. The rugose ventral margin was surely occupied by postsplenial and splenial. The pertinence of the wedge-shaped anterior part of the finely striated area is uncertain.

A symphysial tooth pair is present, with both members developed and striated in labyrinthodont fashion. Much of the lateral tooth row is preserved. The most anterior teeth seen on the cast, lying close to the symphysis, appear to be somewhat crowded and irregularly placed. These are conical teeth of modest size, striated basally and slightly recurved at the tips. One complete tooth extends 8 mm. above the jaw margins; an adjacent incomplete tooth appears to have been several millimeters higher. For 5 cm. back of this region the teeth are broken off, but the alveolar surface of the dentary bone is preserved. Here there is seen a typical labyrinthodont arrangement of alternate teeth (broken) and empty alveoli; the interval between successive elements of the row is about 4 mm. The tooth bases suggest that the teeth are comparable in size to those seen at the anterior end, without the development of any large "fangs." For the next 10 cm. the mold does not extend inward beyond the outer rim of the dentary, so that the alveolar region is not visible and there are impressions of only 5 teeth in all, some of them obviously loose from their sockets. The most anterior of these teeth appears to be comparable to those seen near the symphysis; the others give the impression of greater slenderness, although this may be due to incompleteness of the mold. For the last 3 cm. of the series the alveolar surface is again visible, and 5 of the 6 most posterior teeth are present, although none is complete. Naturally these are smaller than the more anterior teeth, and the interval between successive elements is reduced to about 3 mm. There is little indication that the teeth were markedly recurved or had the chisel-like tips seen in *Archeria*. Calculation suggests that the total marginal row consisted of about 50 teeth, which were rather closely spaced and of modest size.

What are the relationships of this specimen? There are no described American pre-Westphalian amphibians with which comparison can be made. It was at one time believed that the older tetrapod faunas of Europe and North America were as radically distinct as are the reptile and amphibian faunas today, and that trans-Atlantic comparisons were invalid. However, such recent work as my study of the Kounova fauna (1945) and Baird's current (unpublished) studies of the Linton fauna indicate that eastern North America and western Europe were extremely similar in faunas in the Carboniferous, and that the supposed contrasts in genera present in the two areas are due in great measure to false assumptions as to faunal contrasts and lack of comparison of American and European materials.

But even so, the number of pre-Westphalian specimens from Europe, with which this jaw can be legitimately compared, are few (Watson 1929). There are several loxommids from the late Mississippian and early Pennsylvanian of Scotland, but this jaw is quite different from that of known loxommids, in which the jaw is shallow posteriorly, and in which the dentition consists of a smaller number of much more robust teeth. The straight ramus of the jaw indicates an animal with a more or less pointed snout (although the skull may have broadened posteriorly, with a triangular shape). This appears to eliminate from consideration *Otocrat'a* and *Palaeogyrinus* and perhaps *Crassigyrinus*. The massive upper teeth of *Anthracosaurus* (in the proper sense) make it improbable that our jaw is pertinent. Two Scottish forms remain — *Pholidogaster* from the Mississippian (Gilmerton Ironstone), and a skull attributed by Watson to *Pholiderpeton* from the Lanarkian of Airdrie. Both have a pointed snout and, appropriately, a marginal dentition including a long series of small teeth. Of *Pholidogaster*, the type skeleton (Huxley 1862; Watson 1929, pp. 230–233, figs. 7–9) is that of an animal much smaller than the present one; a skull from the same beds as the type, and which may be a specimen of the same form, is of somewhat larger size, with a length, measured to the quadrate of about 156 mm. The lower jaws are present of the type specimen; they do not appear to show the increasing depth posteriorly which is characteristic of this jaw, as of embolomeres (which *Pholidogaster* is not). Of *Pholiderpeton*, the type (Huxley 1869) is of Westphalian age, but Watson (1929, 223–224, pl. 1, fig. 2) assigned to this form a skull of earlier date. The latter skull appears to have had a length of approximately 405 mm., a length comparable to that estimated for our specimen. I have not seen the Manchester Museum slab containing part of this specimen but from Watson's description and the Museum of Practical Geology specimen it would appear that the jaw (definitely of embolomere type) is comparable to that described here. Hence, although the matter lies at two removes from certainty, our specimen may be provisionally assigned to *Pholiderpeton.* It may be reasonably questioned whether a fragment of this sort should receive a specific name. Since, however, it is of considerable interest from stratigraphic and topographic points of view, I will, nevertheless, describe it as *Pholiderpeton*(?) *bretonensis*, sp. nov. A specific diagnosis is, of course, valueless, but since this is required by the "règles," I will mention as a supposed specific character the observable gently striated nature of the external jaw sculpture between the coarser sculpture bands of dorsal and ventral borders. The holotype is M.C.Z. No. 2772.

Although it now seems probable that many of the Carboniferous labyrinthodonts once thought to be embolomeres are members of other groups — rhachitomes, ichthyostegalians, or pre-seymouriamorph anthracosaurians — there nevertheless remains a "hard core" of typical embolomeres which carry the story of the group downward through much of the Carboniferous. *Archeria* is the last survivor; *Pteroplax* ("*Eogyrinus*") is a typical Westphalian representative; the skull assigned to *Pholiderpeton* by Watson and the present jaw carry the story down to or across the Pennsylvanian-Mississippian boundary, and undescribed materials from West Virginia show the presence of a true embolomere in Upper Mississippian times. The trend within the group appears to be the development of persistently aquatic fish-eating amphibians with an elongated body and tail and short limbs, and, as in piscivorous vertebrates of many groups, a trend toward development of a long slender snout and a long row of relatively small marginal teeth.

In this first of several projected papers on our Nova Scotia materials, I wish to express our thanks to the National Science Foundation, whose grant for field expenses made the summer's

work possible, and, further, our gratitude to others who aided and facilitated our work. Dr. H. D. Smith, of the Nova Scotia Research Foundation, was most helpful, as was Mr. John Haslam of New Glasgow, in charge of mining operations at Stellarton and Springhill. Dr. W. A. Bell gave us the benefit of his expert knowledge of the Nova Scotia Carboniferous. To the Nova Scotia Bureau of Mines and the Massachusetts Institute of Technology we owe thanks for generous hospitality at the summer geological camp at Crystal Cliffs, conducted by Dr. Walter O. Whitehead.

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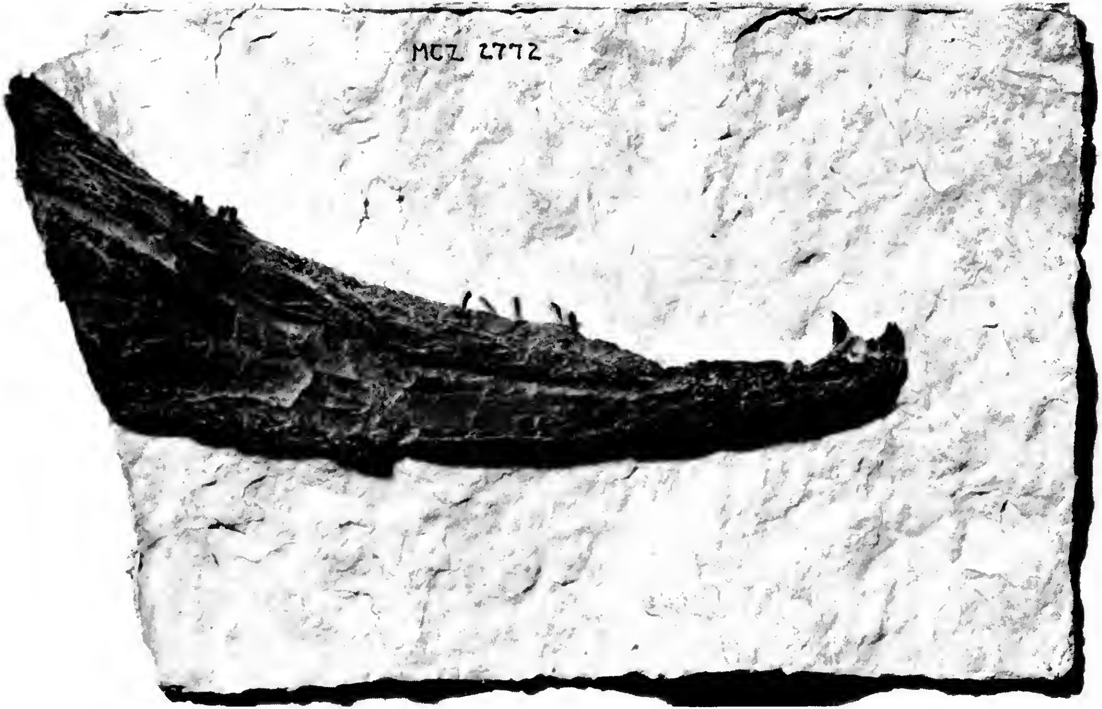

A cast from the type mold of *Pholiderpeton* (?) *bretonensis*, sp. nov.

B R E V I O R A

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A NEW SPECIES OF THE GENUS UROTHECA (SERPENTES: COLUBRIDAE) FROM VENEZUELA

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While touring several U. S. museums in 1957 I discovered among the Venezuelan herpetological material in the Museum of Comparative Zoology, Harvard University, a very peculiar undescribed species of the genus *Urotheca*. Later I found that the U. S. National Museum (USNM), the Carnegie Museum, Pittsburgh (CM), and Museo de Biología, Universidad Central de Venezuela (MBUCV) also have one specimen each of this form. I take the opportunity to describe this new species.

I express my appreciation to Dr. E. E. Williams, Dr. D. M. Cochran and Mr. N. D. Richmond, not only for permitting me to examine the collections at their museums, but also for other kindnesses I received during my stay in the United States.

I would also express due thanks to the Fundación Creole, Caracas, Venezuela, and to the Council Research Fund, American Museum of Natural History, whose help enabled me to take this study tour.

UROTHECA WILLIAMSI n. sp.

Leimadophis bimaculatus opisthotaenia, Marcuzzi, 1950, Nov. Cient. La Salle, Ser. Zool., No. 3, p. 8.

Holotype. ♀ MCZ No. 51329, collected by G. Marcuzzi in October, 1949.

Type locality. El Junquito, Distrito Federal, Venezuela, 1900 meters.

Paratypes. ♂ USNM No. 121206 collected in Colonia Tovar, estado Aragua, Venezuela, 1800 meters, by E. G. Holt on March 30, 1929; ♂ CM No. 7393, collected in Colonia Tovar, estado Aragua, Venezuela, 1800 meters, by E. G. Holt on April 30, 1929; ♀ MBUCV No. 3044, collected in Rancho Grande, estado Aragua, Venezuela, 1200 meters, by J. Racenis on August 23, 1949.

Distribution. The Central Cordillera de la Costa in northern Venezuela, between 1000 and 2000 meters. This zone is covered by typical cloud forest (high rain forest).

Diagnosis. Urotheca with one scale pit on the dorsals; 17–18+2 maxillary teeth; 146 to 158 ventrals; 53 to 61 subcaudals; 17–17 dorsals, without any reduction; 1 or 2 preoculars, and a *Leimadophis*-like coloration: dark longitudinal lateral lines beginning on the anterior part of the body and extending to the tip of the tail.

Description of the holotype. Maxillary teeth 17+2, the last two somewhat enlarged and separated from the rest by a gap. Mandibular teeth subequal. Head squamation that of *Urotheca*, rostral scarcely visible from above, nasals divided, the nostrils situated on the dividing suture. A pair of internasals and prefrontals, the latter a little broader than long and longer than the internasals. The frontal shield twice as long as the prefrontals and approximately as long as the parietals. A loreal shield, deeply penetrating the preocular, and reaching almost to the orbit. One preocular, trapezoidal, twice as wide above as below. Two postoculars, the upper much larger than the lower. Temporals 1+2 on both sides. Seven upper labials, the third and fourth entering the orbit. Nine infralabials, the first four in contact with the anterior pair of chin shields, of which the first pair is longer than the second. Ventrals 150, anal divided, and 53 pairs of subcaudals. The dorsal formula 17–17, without any reduction.

Coloration. Head and upper part of the body grey (brown in life?). Upper lip black, crossed by a white line, which begins on the rostral shield and disappears on the neck. Infralabials and other ventral shields white, heavily mottled with black. This mottling is present also on the ventrals, where it concentrates mainly along the borders of the ventral scales, but fades gradually posteriorly on body. On mid-line of the subcaudals the black coloration appears again as an irregular ill-defined dark line.

The black supralabial coloration continues on the neck as a series of black blotches, which on the anterior third of the body form a lateral black line, at first occupying the whole of the scales on the fourth dorsal row, but more posteriorly shifting to the lower part of the scales of the fourth and upper part of the scales of the third dorsal row.

Anteriorly on the mid-dorsum there are irregular black spots, which gradually unite to form two black lines on the eighth scale row on each side. These lines are well defined on the posterior part of the body, the zone between them being darker than the general coloration. On the tail the two middorsal lines fuse, so that there are only three black lines (one middorsal and two lateral) on the tail.

Total length: 420 mm., tail 85 mm.

Notes on the paratypes. The general characteristics are those of the holotype. The total variation of the scale counts in all specimens, including the holotype, is as follows: 146 to 158 ventrals (♂♂ 155–158; ♀♀: 146–150), 53 to 61 subcaudals (♂♂: 58–61; ♀♀: 53–59), anal always divided, dorsal formula 17–17. Supralabials 7 (3, 4), infralabials are 9 (4) or 10 (5). There is one preocular on both sides in one specimen, two preoculars on both sides in two specimens, and one specimen has one on the left and two on the right side. There are 1+2 or 1+1+2 temporals.

The coloration of the paratypes is similar to that of the holotype, with exception of the MBUCV No. 3044, which seems to be a somewhat more melanistic and aberrant specimen. It has the middorsal black line broader, covering the superior part of the seventh and the whole of the eighth and ninth rows, and the zone between the middorsal and lateral black lines is lighter (pale brown). The MBUCV specimen is darker in general: the mottling on the underside of the head being almost black and the dark streak on the middle line of the subcaudals being darker.

The CM specimen has the following hemipeneal characters: The sulcus spermaticus is bifurcated, the bifurcation taking place rather close to the base. At the base are several large spines or hooks. About 12 longitudinal rows of larger spines run from the base to the place where the bifurcation of the hemipenis occurs, each row containing 5 to 7 larger spines; among them are placed several smaller spines, which eventually may form additional longitudinal rows, between the big rows. At the apex, where the sulcus ends, there is a calyculated zone, formed by several larger and smaller calyces.

Generic position. This is one of the most complicated cases in the already sufficiently complicated *Leimadophis-Liophis-Urotheca*, etc. group of genera. This species has the following characteristics of the genus *Urotheca:*

1. Absence of any reduction in the dorsal squamation.
2. Calyculated and simple bifurcated sulcus of the hemipenis, as well as the presence of large spines or hooks at the base.
3. Dark lip coloration, with a white line crossing it.

It has, on the other hand, these characteristics of the genus *Leimadophis:*

1. The presence of one scale pit on dorsals.
2. The general coloration, i.e., a longitudinal dark lateral and dorsal line beginning to form at midbody, occupying all the posterior part of the body and the tail.

The maxillary dentition is in general intermediate between the two, although with a slight predominance of the *Urotheca*-like characteristics, i.e., there is a gap, but it is rather small, and also the two last teeth following the gap are somewhat smaller than usually is the case in *Leimadophis.*

The hemipenis and the dorsal scale formula were the characteristics which caused me to put this new species in the genus *Urotheca,* although the presence of one dorsal pit has been considered as a very decided *Leimadophis*-like character. However, on several occasions I have observed the absence of pits in specimens of several species of *Leimadophis* (*L. melanotus, L. reginae*), and I have found scale pits occasionally present in specimens of *Lygophis* and—more important—in *Liophis.* It seems that the presence or absence of scale pits in this group of genera and occasionally in others (cf. Amaral's genus *Barbourina!*) can be used only as an auxiliary generic character. Moreover, scale pits are present in practically all reptiles, although usually so small that they are not seen except under high magnification. The problem thus arises: when are they sufficiently visible to be useful as a character?

As to the question of *Urotheca* vs. *Rhadinaea*, there can be little doubt, as pointed out by Dunn, 1957, that the earlier name should be used. *Urotheca dumerilii*, the genotype, apparently is not a Cuban form, as originally presumed, but most probably a species from Central America (the description suggests this very strongly), described later as a species of *Rhadinaea* (*R. pachyura fulviceps*). On this view, the genus *Rhadinaea* Cope, 1863, is a synonym of *Urotheca* Bibron, 1843. To use *Urotheca* will certainly simplify the taxonomy greatly, since in the past various authors have distributed species to one or the other genus, without any clear concept of the differences between them.

The holotype and the MBUCV specimen have been reported by Marcuzzi, 1950, as *Leimadophis bimaculatus opisthotaenia*, but this is an error, since the latter species is a form from the Andes of Mérida, Venezuela, and is a true *Leimadophis* (I have seen several specimens of that form), and very distinct indeed from *U. williamsi*.

I take pleasure in naming this species for my friend and colleague, Dr. Ernest E. Williams, from whom I received much kind help and cooperation, while staying at the Museum of Comparative Zoology.

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B R E V I O R A

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REMARKS ON SOME FORMS OF *CINCLUS* (AVES)

By James C. Greenway, Jr.
and Charles Vaurie

The genus *Cinclus* was studied by us independently. Greenway studied the collections in the Museum of Comparative Zoology and in the American Museum of Natural History in preparation of a part of the Check-list of the Birds of the World. Vaurie studied the collection of the American Museum in preparation of a check-list of the Palearctic avifauna (1958, in press), and published some notes on this genus on two occasions (1951 and 1955). Greenway deferred publication. Later he sent the draft of his paper to Vaurie, who in 1957 examined the material in several European museums. We have decided to present our conclusions jointly.

Cinclus cinclus

Two main types are represented on the European continent: one which has a blackish breast, and the other in which the breast is several shades of brown. Some populations are constant or relatively constant, as in Scandinavia and northern Europe where the birds (nominate *cinclus*) are blackish but other populations vary individually. The latter may consist of individuals that are blackish and very similar, if not identical, with nominate *cinclus* or of individuals in which the color of the breast varies from dark and dull brown to rather bright rufous. In some regions, as in the Alps and to some extent in Spain, the birds inhabiting a watershed may be blackish, whereas in a contiguous watershed they are brown and these blackish, or brown, populations may resemble other populations from which they are widely separated. For instance, blackish birds inhabit Scandinavia and northwestern Spain and brown birds inhabit Germany and southern Spain. On the other hand, the populations may grade more or less smoothly into one another, as from southeastern Germany southeastward through central Europe.

These complicating factors render a division for nomenclatural purposes somewhat arbitrary and Vaurie was, at first, inclined not to recognize any subspecies. However, all the birds of Scandinavia and northern Europe are blackish and identifiable at a glance from the brown-breasted ones from farther south, and the geographical variation, though not constant in central and southern Europe, shows several trends. In the end, Vaurie (1955) recognized five subspecies. These five subspecies are also widely recognized by conservative authors and are as follows: nominate *cinclus* Linnaeus, 1758, type locality, Sweden; *aquaticus* Bechstein, 1803, type locality, Germany; *pyrenaicus* Dresser, 1892, type locality, Pyrenees; *meridionalis* Brehm, 1856, type locality, Carinthia, Austria; and *orientalis* Stresemann, 1919, type locality, Macedonia.

There is, however, little agreement about the limits of their ranges. Hartert (1910) stated that the range of nominate *cinclus* was Scandinavia and western Russia south to East Prussia; Witherby (1922, p. 341) added the Cantabrian Mountains of northwestern Spain, and in 1928 (pp. 618-620) the mountains of central Spain; while Vaurie (1955) referred all the birds of the Iberian Peninsula to *pyrenaicus* which Hartert had restricted only to the Pyrenees. Hartert (1910) stated that the birds of France were *aquaticus* (except in the Pyrenees and in the southwest where they are replaced by *meridionalis*) but Mayaud (1953, p. 49) includes Brittany and the Massif Central of France in the distribution of *pyrenaicus,* stating that in the southeast the populations show a tendency toward *meridionalis.* Hartert (1922) recognized *orientalis* for southeastern Europe, a region which he had formerly included in the range of *meridionalis*, while Rokitansky (1939) extended the range of *orientalis* westward to Moravia in central Europe. Finally, von Burg (1924) and Troller (1935) described six new forms from the

Alps, and Floericke (1926, Mitt. Vogelw., p. 78. Non vid.) one from northern Portugal which he named *atroventer*. The latter, the type locality of which is Serra do Gerez, is a very black form.

It is evident from the foregoing that students of this group have often disagreed (especially regarding the classification and distribution of the populations of France, the Alps, Balkans, and Iberian Peninsula), and Greenway came to the conclusion that it would be best to recognize only two subspecies: a blackish one (nominate *cinclus*), and a brown one (*aquaticus*). He was aware that the range of the black form is discontinuous, and also that a more realistic treatment might include but a single subspecies. Black and brown forms are, however, separable at a glance.

Vaurie, after studying the material in the European collections, now shares the opinion of Greenway. We consider that it is best to synonymize *pyrenaicus, sapsworthi, atroventer,* and *amphitryon* with nominate *cinclus,* and to synonymize *meridionalis, orientalis, olympicus,* and the forms described by von Burg and Troller, with *aquaticus. Sapsworthi* was described by Arrigoni in 1902 from Corsica but we find that good series in New York and Europe from Corsica and Sardinia are not separable from specimens from the Pyrenees. *Olympicus* Madarasz, 1903, type locality, Cyprus, and *amphitryon* Neumann and Paludan, 1937, type locality, Lasistan, northeastern Turkey, will be discussed below.

The populations of Austria and Italy (*meridionalis*), or from the Balkans (*orientalis*), vary too much individually to warrant nomenclatural recognition as about one third to one half or more of the specimens examined cannot be distinguished from typical *aquaticus* of Germany. Professor Stresemann, with whom Vaurie has discussed this question, is now also of the opinion that *orientalis* is not sufficiently constant and is best synonymized with *aquaticus.*

The subspecific status of the birds of the Iberian Peninsula and Pyrenees is the least clear and has been the subject of most comment. The result of Vaurie's examination of relevant material in European collections is set forth below; that in New York was discussed in 1955.

Eleven specimens from the Pyrenees support the statement made by Vaurie in 1955 after he had examined 25 birds that are virtual topotypes of *pyrenaicus*. As stated then, this population varies individually, but "in series . . . differs from nominate *cinclus* by being not so black, browner above and below including the crown and nape, which are distinctly paler, and in fresh plumage by having the gray edges of the feathers of the back better developed." Whistler and Harrison (1930, p. 467) stated that their three specimens from the Pyrenees "cannot be separated from Swedish topotypes," but much larger series show that Witherby (1928) is correct when he states that the birds of the Pyrenees though "very much like" nominate *cinclus* are "not quite so black." Witherby recognized *pyrenaicus* but we believe it is best to synonymize it with nominate *cinclus,* as it is impossible to separate the birds of the Pyrenees from specimens which, in series, are even more similar to nominate *cinclus.*

Nine specimens from the province of Santander are very similar above to the birds of the Pyrenees, including the prominent gray edges, but in series average a little more blackish, especially below. Three specimens from Riaño, northern León, are still blacker. These three match four from the Serra do Gerez in northern Portugal (topotypes of *atroventer*), one from Serra da Estrela, also in northern Portugal, three from Candeleda, Sierra de Gredos, Avila, and twelve from Lagunilla, Bejar, Salamanca. All these are very blackish below and similar to nominate *cinclus* but not quite identical. They average deeper black below but above they are more similar to the birds from Santander and the Pyrenees, the crown and nape averaging slightly more rufous and the gray edges of the feathers being, as a rule, better developed than in nominate *cinclus.*

However, individuals are found in northwestern or central Spain that are not similar to nominate *cinclus*. One specimen from Santo Domingo de Silos, Burgos, and also one from Candeleda are browner. Of three specimens from San Ildefonso la Granja on the northern side of the Sierra de Guadarrama, one is similar to the black birds from Riaño, though very slightly browner, and the other two are a little browner still. One from Cercedilla, on the southern side of the Sierra de Guadarrama, is distinctly browner than the foregoing and Witherby (1928) remarked that it is intermediate between nominate *cinclus* and *aquaticus,* adding that one from nearby Escorial ''is like *aquaticus.*''

This last specimen is now in the collection of the American Museum of Natural History and was examined by Vaurie in 1955 together with two from the Sierra Nevada in southern Spain. These three are identical and not separable from *aquaticus.* Five other skins, examined in 1957, from the Sierra Nevada are also very brown and identical with *aquaticus.*

In short, it appears that the population of southern Spain is constant and not separable from *aquaticus.* The birds of central Spain and the Pyrenees vary individually but, taken as a series, these populations are closer to nominate *cinclus* than they are to *aquaticus,* while in northwestern Spain and northern Portugal the populations seem constant again, and, though not quite identical, are best called nominate *cinclus* as they are so similar to it.

Two of the additional specimens from the Sierra Nevada were collected in 1955 by Dr. G. Niethammer and are in the collection of the Bonn Museum. This museum possesses also the type and paratypes of *amphitryon.* This series is identical with nominate *cinclus* in coloration, as stated by Neumann and Paludan (1937), who separated it from the latter on the basis that it had a ''somewhat shorter wing and an almost imperceptibly thinner bill'' (trans.). The bill shows a tendency to be more slender, but the difference is extremely slight and not of taxonomic importance, and the wing measurements show too much overlap to warrant the recognition of *amphitryon.* According to Vaurie, the wing length measures 93, 93, 94, 94 (+, molting), 95, 98, 98 (95) in the males from northeastern Turkey, as against 92, 94, 95, 95, 95, 96, 96, 97, 98, 98, 99, 100 (96.3) in males from Scandinavia.

Two other forms (*olympicus* from Cyprus, and *uralensis* Serebrovski, 1927, type locality, Urals) require brief comment though we are handicapped by the lack of adequate material.

The material that we have seen from Cyprus consists of three rather worn and not too well prepared specimens collected in the spring of 1906. Vaurie (1955) stated he could match them with specimens of *orientalis,* but in Greenway's opinion they resemble *caucasicus* rather than Macedonian birds. Hartert (1910), who had the same specimens, stated that he ''was not able'' to separate them from *caucasicus* but cautioned that more and better prepared material was necessary from Cyprus. Nevertheless, he synonymized *olympicus* with *caucasicus,* though with a query. The name *olympicus* has remained a synonym of *caucasicus* ever since but, unfortunately, *olympicus* was described in January 1903 as against December of the same year for *caucasicus;* it should replace the latter if indeed the populations of Cyprus and the Caucasus are not separable. Fresher and more abundant material from Cyprus is necessary, however, to establish beyond dispute that the two forms are not separable. We therefore recognize provisionally the validity of *olympicus.*

Serebrovski (1927) has separated the population of the Urals as *uralensis,* stating that it differs from nominate *cinclus* by being paler and more brownish above and below, but is darker above and less rufous below than *aquaticus.* The validity of *uralensis* has been recognized by Hartert and Steinbacher (1935), Dementiev (1935), and Portenko (1937), but Sudilovskaya (1954) considers that *uralensis* is a synonym of nominate *cinclus.* Her opinion, however, may be extreme as she also synonymizes *caucasicus* (which in our opinion is perfectly valid) with nominate *cinclus.* The only specimen of *uralensis* that we have seen is not fully adult but shows the differences mentioned by Serebrovski when compared to specimens in the same plumage. The population of the Urals is very widely isolated from all the other populations of the species and may well be distinct.

CINCLUS PALLASII

As Vaurie (1951) has remarked, there are four specimens of the Brown Dipper, in the collection of the American Museum of Natural History, having gray rumps contrasting with brown backs. These were taken in Amurland and near Mukden.

It would perhaps be possible to separate on the basis of such material the populations of extreme eastern Siberia and Japan, on the one hand, from those of China and Formosa, on the other. The probability is strong that this one difference in color of rump is due to a single gene, however, and a theory that a single population inhabits eastern Asia, Japan, Formosa, and northern Indochina is probably the most correct one. To be sure, there is a small size difference, as is shown in Table 1, below. That this is significant may be doubted. Of a series of 15 kinds, 6 are intermediate. Application of a coefficient of difference test shows a 20 per cent overlap.

TABLE 1
WING (in mm.)

Amurland	*China*	*Formosa*
94.0 1	104.0 1	96.0 1
102.0 1	105.0 1	102.0 1
103.0 1	106.0 1	103.0 1
106.0 1	107.0 1	105.0 1
	108.0 1	
	109.0 2	Ef x = 406.0
	110.0 3	n = 4
	111.0 1	m = 101.50
	114.0 1	= 3.87
	120.0 1	
	121.0 1	

Japanese populations are intermediate to some extent. Of a series of 13 specimens from Japan and Amurland, 5 are impossible to diagnose as belonging to one population or the other. In other words, only 62 per cent can be recognized on the character of the gray versus brown rump. Certain Japanese specimens have a somewhat more reddish tinge than those from the Asiatic mainland, but only 65 per cent of the series at hand can be distinguished by this character.

Vaurie (1955), recognized only two subspecies: nominate *pallasii* Temminck, 1820, type locality, "Crimea," but error for Okhota River, eastern Siberia, as shown by Stresemann (1948, pp. 115, 126); and *tenuirostris* Bonaparte, 1850, type locality, central Asia. Among the forms synonymized with nominate *pallasii* were *wilderi* La Touche, 1925, type locality, Hopeh, and *dorjei* Kinnear, 1937, type locality, eastern Bhutan.

The two co-types of *wilderi* from the Eastern Tombs near Peking have brown rumps and do not appear to differ in any way from birds of western and southern China (see above).

The affinities of *dorjei* were not made too clear by Kinnear (1937. p. 263), and Professor Stresemann kindly pointed out to Vaurie that the latter was probably wrong in considering that *dorjei* was not separable from nominate *pallasii*. In Stresemann's opinion *dorjei* was probably a valid race, or, if not, a synonym of *tenuirostris* rather than of nominate *pallasii*. Examination of the original series shows that Stresemann is correct and that *dorjei* is valid.

Its diagnosis and range, as given by Vaurie (1958) are: "Darker than *tenuirostris* in all plumages but paler than nominate *pallasii*. This race, though intermediate in coloration, is closer to *tenuirostris*. Range: Eastern Himalayas, east of *tenuirostris* [which ranges eastward about as far as northern Sikkim where it grades into *dorjei*], hills of Assam south of the Brahmaputra, and higher hills and mountains of Burma south to the Chin Hills in the west and the Shan States in the east, to northern Siam and probably to neighboring northern Yunnan though there are no records."

Cinclus schultzi

Cinclus schultzi Cabanis of the mountains of northwestern Argentina has been treated as a distinct species by all authors. In view of the intraspecific variation in other parts of the world it would appear to reflect the probable biological truth better to treat it as a subspecies of *leucocephalus*. Compare *Cinclus cinclus leucogaster* of Afghanistan with *caucasicus* and *cashmeriensis,* for example.

The brown breast of *schultzi* replaces the white of the more northern form (*leucocephalus*). The white wing bar of *schultzi* is not consistently of greater extent. It is a grayer bird and a very distinct subspecies.

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Vaurie received much friendly cooperation during his recent visit to Europe and takes pleasure in thanking the curators of the various museums and their staffs for much help. Professor Stresemann kindly discussed several of the forms mentioned in this paper, giving him the benefit of his great experience, and Mr. Macdonald of the British Museum sent to New York the specimens of *dorjei* for further study.

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A FOSSIL VAMPIRE BAT FROM CUBA

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Of the nine families of bats in the Western Hemisphere, all but three (Desmodontidae, Furipteridae, Thyropteridae) have been known from the West Indies for some time, although the Emballonuridae reach the West Indies only in Grenada. The precise ecology and food habits of the Thyropteridae and Furipteridae are poorly known so that no explanation for their absence other than the presence of water barriers is apparent. The Desmodontidae, on the other hand, are the vampire bats, whose blood diet is well known. The absence of this family from the West Indies might, therefore, be explained by the paucity of native, non-flying, land mammals of which in the Greater Antilles, only five genera are known, none larger than a cat. Chicken-sized or larger ground birds are also absent. Thus it is possible that at the time of arrival of man in the West Indies, there were no animals present which could support a population of vampire bats.

For a number of years, however, it has been known that during the late Pleistocene, several genera of large and medium-sized mammals existed in the Greater Antilles. Four genera of ground sloths are known from Cuba, while elsewhere in the Greater Antilles, both ground sloths and large rodents are known. It therefore appears that at this time a suitable habitat for vampire bats did exist. Until now, however, none of the fossil deposits in which these larger forms are found, at least in Cuba, has yielded bat remains.

During the past 18 years, the Speleological Society of Cuba has made extensive excavations in numerous caves, chiefly in western and central Cuba, uncovering abundant mammal remains, including a great deal of ground sloth material (Arredondo 1955). One of the richest series of fossil deposits was in the Lamas cave, a few miles west of Havana. The following statement was prepared for me by Sr. Oscar Arredondo of the Sociedad Espeleológica de Cuba, Havana, and Sr. Gilberto Silva Taboada, a student of recent bats, also of Havana.

"The Lamas Cave is merely a rocky shelter located in a land slope to the southwest of Santa Fé Beach, on the northern coast of Habana province. On January 21, 1951, an excavation was made at this cave by Oscar Arredondo, Director of the Paleontological Section of the Speleological Society of Cuba, together with Dr. Manuel Rivero de la Calle, from Las Villas Central University.

"According to the stratigraphical profile, the first level was a layer of very dark earth, 60 centimeters in depth, containing plenty of shells and human bones pertaining to the oldest Indian culture of Cuba (the Guanahatabeyes), together with skeletal remains of *Capromys*, *Geocapromys*, and *Boromys offella*. The second level, extending about 40 centimeters in depth, was composed of a red earth completely lacking any bones or archeological remains. The third level was a 30 centimeter deep layer of a light yellow colored earth, containing bones of small extinct rodents, like *Geocapromys*.

"The fourth level, having a depth of 1.40 meters and composed of a humid earth, reddish-yellow in color, was the richest fossil-bearing layer of the trench. Thousands of scattered fragmentary bones and skulls, representing almost all the known extinct Cuban fauna, were unearthed from this level. Here was found a fragmentary bat skull in association with the extinct rodents *Geocapromys columbianus* and *Boromys torrei*, the insectivore *Nesophontes micrus*, the ground sloths *Megalocnus rodens* and *Mesocnus torrei*, an unknown bird allied to the extinct *Phororacos*[1] of Argentina, and also *Testudo cubensis* and the living *Crocodylus rhombifer*."

[1] This identification may be erroneous.

We are here concerned with the richest, deepest, and therefore oldest, of the four layers. This, it may be noted, consists entirely of extinct species, at least as far as the mammals are concerned. I can verify the identity of at least the *Nesophontes*, *Boromys*, *Geocapromys*, and "*Testudo*" (*Geochelone*), since Sr. Arredondo has very generously turned over to me a small sample of the fossils from this layer. The assemblage probably indicates a truly Pleistocene level and the presence of ground sloths (*Megalocnus*, *Mesocnus*) and of large ground birds (whatever their affinities may be) indicate a very different habitat, in terms of ability to support vampire bats, from that which existed in late pre-Columbian times.

As mentioned above, among the numerous fossil bones of this deposit, there was found the rostral portion of a bat skull, which Sr. Gilberto Silva Taboada kindly presented to me. It is now No. 4737 in the Vertebrate Paleontology collection of the Museum of Comparative Zoology. In this specimen, the very characteristic vampire dentition is immediately apparent, together with the peculiar rhombic shape of the palate characteristic of this group of bats. Comparison with the three living species of the family Desmodontidae shows that the fossil is clearly referable to *Desmodus rotundus*, the commonest mainland species.

Unfortunately the condition of the skull permits few measurements to be made on it (Plate). The following are the only standard ones I was able to make. In each case, the figures in parentheses refer to a series of seven specimens of *Desmodus rotundus murinus* from El Pachon, Tamaulipas. Measurements are in millimeters.

Least interorbital width — 5.1 (4.5-5.5)
Length from anterior edge of incisor to posterior edge of canine — 4.9 (4.6-4.9)
Width across base of incisors — 3.9 (3.3-3.7)

Except for the slightly greater width across the incisors, the Cuban fossil appears to be indistinguishable from the Middle American subspecies, *Desmodus rotundus murinus*.

We may assume that *Desmodus* reached Cuba after prey was available in the form of ground sloths and large ground birds, and that when these forms became extinct and thus the ecological niche for vampires disappeared, the latter also died out in Cuba. The introduction of domesticated animals in post-Columbian times has presumably reopened the niche, but, at least so far, vampires have failed to get across the fairly wide water barriers and hence do not form part of the living bat fauna of Cuba.

In conclusion, I wish to acknowledge the help very graciously given me by the two above-mentioned Cuban naturalists, Sr. Oscar Arredondo and Sr. Gilberto Silva Taboada.

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Palatal views of *Desmodus* skulls. *Top*, the Cuban fossil, MCZ (Vertebrate Paleontology) 4737. *Bottom*, *D. rotundus* ♂, MCZ (Mammalogy) 10445 from Bogaba, Panama.

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CONTRIBUTION TO A REVISION OF THE EARTHWORM FAMILY LUMBRICIDAE. II. INDIAN SPECIES

By G. E. Gates

INTRODUCTION

The domain of the "recently evolved and dominant" lumbricid family, a group which has "almost completely conquered the Palaearctic" (Stephenson, 1930, p. 668), long has been thought to reach well into India. The southern boundary of that domain, on recent distributional maps (for example those of Tetry, 1938, and Julin, 1949), runs from the Mediterranean so as to include the Punjab portion of the Sind Valley and all of the Gangetic Valley to Calcutta from whence it is extrapolated, with question marks or predictions, across northern Burma and through China to the Pacific.

Two routes from European centers of lumbricid evolution to the vicinity of Calcutta could have been available to the advancing lumbricids: through the Himalayas in an easterly direction and then down to the plains, or south along the Indus River and thence easterly through the Gangetic Valley. In either case, lumbricids could be expected throughout an eastern portion of the Gangetic plain as well as in the western part of the Himalayas. A survey of the earthworm fauna of the Allahabad sector (Gates, 1945, 1947) and collecting in such Himalayan sites (Gates, 1951) as could be visited during wartime, provided data that made a review of the taxonomic status of the supposedly endemic species advisable.

The results of that study are presented herewith. The text of the present contribution, except for this paragraph, has been excised from a chapter of an unpublished manuscript written several years ago during tenure of a John Simon Guggenheim fellowship.

SYSTEMATICS

Genus ALLOLOBOPHORA Eisen, 1874

"ALLOLOBOPHORA CALIGINOSA (Savigny, 1826)"

A complex of four or more morphologically distinguishable species long has gone under Savigny's name. The data available in the literature rarely permit a decision as to which species was present in a particular collection. Indian localities from which "*caliginosa*" has been recorded are: Fern Hill and Ootacamund (at elevations of 6-8,000 feet in the Nilgiri Hills, South India), Mt. Abu (Rajputana), Lahore, Ferozepur, Kotla, Murree, Peshawar, Mardan, Chitral (Punjab and Northwestern Frontier Province), Gilgit, Gurez, Gundarbal, Anchar Lake (Kashmir), Almora, Mussoorie, Naini Tal, Simla, Kufri, Junga, Kasauli (western Himalayas). All except the Nilgiri localities are well within the temperate zone. None of the complex ever was found at Darjiling where exotic lumbricids now appear to be dominant (Gates, 1951). There are no records for Ceylon, Burma, the Andaman and Nicobar Islands, the Malay Peninsula, and other parts of southeast Asia, not even for hill stations where introduction might have been expected.

The characterization "cosmopolitan" so frequently applied to "*caliginosa*" obviously implies more than has been warranted by the facts, even if the complex had been but a single species.

ALLOLOBOPHORA JASSYENSIS Michaelsen 1891

This little known species has been reported from a single Indian locality well north of the thirty-second parallel in the Murree subdivision of the Punjab. Individuals of the *caliginosa* complex sometimes have been mistaken for *jassyensis*. Presence of the latter in India, if confirmed, presumably is due to importation by man.

ALLOLOBOPHORA TRAPEZOIDES (Dugès, 1828)

Helodrilus (*Helodrilus*) *mariensis* Stephenson 1917, Rec. Indian Mus., Calcutta, 13, p. 414, fig. 6. (Type locality, Murree. Types, several, presumably in the Indian Museum.)

Allolobophora (*Eophila*) *mariensis*, Stephenson, 1923, Oligochaeta, *in* Fauna of British India, Ceylon and Burma, London, p. 504.

Stephenson's species is known only from the original description. Subsequent collections at the type locality provided only specimens that have been referred to the *caliginosa* complex.

The types probably were brittle and strongly contracted, as female and spermathecal pores were unrecognizable. A number of differences, of a minor sort, apparently were thought to obviate consideration of *caliginosa*. The greenish coloration may have been an artifact. Shape of the posterior portion of the body (shown in fig. 6) may have resulted from unusually strong contraction at preservation and from dehydration in too strong alcohol. A similar condition of the posterior end has been seen in a number of specimens of *trapezoides* recently examined. Location of the first dorsal pore at 4/5 is of little importance taxonomically. A functional pore has been found in *trapezoides* as far forward as 6/7. Just which ones of a series of more or less pore-like markings at mD really are patent apertures through the body wall into the coelomic cavity often is undiscoverable in field-preserved material. Absence of mention of tubercula pubertatis in Stephenson's description presumably means that those structures (as often is the case in browned or other alcoholic museum material) were quite unrecognizable. The crypts or yellowish projections from the oesophagus in x, that were mentioned by Stephenson, are, of course, calciferous sacs. The supposed hearts of xii are only the vertical portions of the extra-oesophageal trunks (cf. *O. cyaneum* below).

Spermatophores have not been found externally nor spermatozoa in the spermathecae of any of a considerable number of specimens of *trapezoides* that have been available from various parts of the world. The male funnels usually have shown no indications of presence of mature sperm. Male sterility requires that reproduction be parthenogenetic and that permits reduction in number as well as in size of the seminal vesicles. Most liable to early elimination after reproduction becomes asexual are the vesicles of x and ix. Absence of those vesicles certainly is no justification for assigning a species to *Helodrilus* or to *Eophila,* whatever those two genera may prove to be. In *Allolobophora,* where the species undoubtedly belongs, there is no good reason for specific distinction from *trapezoides.*

ALLOLOBOPHORA TUBERCULATA Eisen 1874

Among specimens from Simla that were originally (Gates, 1951) referred to *caliginosa* are a number that can now be placed in Eisen's species. Synonyms are: *similis* Friend 1911, *arnoldi* Gates 1952, and *caliginosa* (various authors). Elsewhere, the species now can be recorded from the United States (northeastern portion), Canada, England, Chile, Denmark, Norway, Sweden and probably Germany. The distribution, even as now known, must have resulted in part from transportation. Obviously there can be no imputation of endemicity in India.

Genus BIMASTOS Moore, 1893

BIMASTOS PARVUS (Eisen, 1874)

Jalla, Patna, Bihar, March, 0-0-1, R. C. Lacy.
Rawalpindi, Punjab, May, 0-0-6. F. G. Dickason.

Forty-four specimens of this species were collected at Allahabad during a period of four years. More than half were found in dirt around roots of potted plants. The others were obtained from a single small area (*sansibaricus* habitat) by a drainage canal that was sampled at least once a month through most of the period (Gates, 1945, 1951). The *sansibaricus* habitats, in the region around Jubbulpore to the south of Allahabad were investigated (Gates, 1956) on several occasions during that same period but yielded no specimens of *parvus*.

Indian localities where *parvus* has been found are: Kodaikanal (Palni Hills, South India), Darjiling (eastern Himalayas), Patna (Bihar), Allahabad and Saharanpur (United Provinces), Partabgarh (Rajputana), Lahore, Lyallpur, Ferozepur, Peshawar, Mardan, Chitral (Punjab and Northwestern Frontier Province), Gorai, Srinagar (Kashmir), Kasauli, Barogh, Naini Tal (western Himalayas). All are in the temperate zone except Kodaikanal which is a summer resort where elevations are 6000-7000 feet. The species was found in Burma, during twenty years of intensive collecting, only at elevations of more than 4000 feet, in and around four hill stations where European cultivated plants had been introduced. A hill station also provided the only record for the Malay Peninsula. *B. parvus* obviously is more widely distributed in southeast Asia than the supposedly cosmopolitan "*caliginosa.*" The species usually is assumed to have originated in America from whence, or indirectly through Europe, it was brought by man to India.

The plants along with which *parvus* was brought to the orient were not taken only to the hill stations of Burma or to the Indian localities just mentioned. Such plants, potted or otherwise, are common throughout the Allahabad sector of the Gangetic Valley and also in the Jubbulpore region. The plants undoubtedly have been taken on innumerable occasions into the tropical lowlands of India, Burma and the Malay Peninsula. Absence in those lowlands after a hundred years and more of such introductions must have resulted from inherent inability of the species to adapt itself to a tropical climate.

BIMASTOS EISENI (Levinsen, 1883)

This peregrine species, which probably does not belong in *Bimastos,* is known in India only from the region of Naini Tal in the western Himalayas.

Genus DENDROBAENA Eisen 1874

DENDROBAENA OCTAEDRA (Savigny, 1826)

This species, hitherto unknown from India, is now recorded from Kodaikanal (Palni Hills, South India) where it appeared to be quite common. This is another form to which the characterization of cosmopolitan has been erroneously applied. South of Siberia, the species has been found only at the Kodaikanal summer resort. The species is also absent from almost all of South America.

D. octaedra is not usually geophagous and, accordingly, would not have been expected to be carried around the world as much as the earth-eating species. Nevertheless, specimens of this species have been intercepted at American ports during the last few years, in shipments of plants from Spain, Belgium, Holland, Germany, Denmark, Norway, Sweden, Italy, Czechoslovakia and Portugal. Importations into North America in days when quarantine restrictions were unenforced or lacking must have been much more numerous. The species obviously is exotic in India as well as in South and North America.

DENDROBAENA RUBIDA (Savigny, 1826)

Athecal Indian specimens that have been identified as *Bimastos constrictus* or *Bimastos tenuis* belong here. *D. subrubicunda* also is a synonym.

Indian localities from which the species is now known are: Kodaikanal, Fern Hill and Ootacamund (Palni and Nilgiri Hills of South India, at elevations of 6000-8000 feet), Darjiling (eastern Himalayas), Almora, Naini Tal, Simla and vicinity (western Himalayas).

Genus EISENIA Malm 1877

EISENIA FOETIDA (Savigny, 1826)

Indian localities from which the species has been recorded are: Ponmudi, Travancore; Kodaikanal and vicinity (Palni Hills) where it is very common; Fern Hill, Coonoor (Nilgiri Hills); Calcutta; Darjiling and vicinity (eastern Himalayas) where it is also very common; Simla, Kasauli, Dharmsala (western Himalayas). Absence of records for the Punjab, where Stephenson and his students worked, is noteworthy.

The Travancore and Calcutta records never have been confirmed. *E. foetida* was deliberately introduced, by the hundreds or thousands, on various occasions within the last twenty years, to lowland tropical areas of the Malayan and Indian peninsulas. All such introductions have been failures. Many more times the species must have been brought into the plains near the hill stations. Some such importation, most probably from Darjiling, may well have been responsible for the Calcutta record.

EISENIA HORTENSIS (Michaelsen, 1890)

Eisenia veneta f. *hortensis*, Gates, 1951, Proc. Nat. Acad. Sci. India, B, vol. 21, pp. 19, 21.

This peregrine species has been found, in India, only at two Himalayan localities, Darjiling and Simla.

EISENIA ROSEA (Savigny, 1826)

Helodrilus (Bimastus) indicus Michaelsen 1907, Mitt. Nat. Mus. Hamburg, vol. 24, p. 188. (Type locality, Calcutta. Types, five, presumably in the Indian Museum but probably valueless as they already were "weakened" from maceration in 1907.)

Helodrilus (*Allolobophora*) *prashadi* Stephenson 1922, Rec. Indian Mus., Calcutta, vol. 24, p. 440. (Type locality, Gundarbal, Kashmir. Types, several, in the British Museum.)

Allolobophora (*Allolobophora*) *prashadi* + *Allolobophora* (*Bimastus*) *indica*, Stephenson, 1923, Oligochaeta, *in* Fauna of British India, Ceylon and Burma, London, pp. 501 and 506.

Stephenson's species is known only from the original description. Insofar as can be determined from that description the types differed from Savigny's *rosea* only by the absence of spermathecae. As various strains of *rosea* are now known to be athecal there is no longer any reason for recognition of *prashadi.*

Michaelsen's species is known only from the types the descriptions of which contain no indications that external characteristics or internal anatomy warrant distinction from athecal, quadrivesiculate strains of *E. rosea.* Tubercula pubertatis, not mentioned, may have been unrecognizable because of poor condition or they may have been lacking — they are disappearing in some of the athecal strains. The diameter, 6 mm., is 2 mm. greater than the maximum usually mentioned for *rosea* but the types may have been bloated (as are some recently examined specimens where thickness in the clitellar region is about 7 mm.).

The types of *indicus* could have been collected at the Botanical Gardens in Sibpur where there were secured types of at least one other earthworm species erroneously thought to be endemic in Bengal. Indeed, in absence of subsequent records to confirm domicile in the area, it now seems possible that the specimens in question may have been secured directly from earth around roots of imported plants. Certainly, there is now not the slightest reason for believing that any lumbricid is endemic in Bengal.

All individuals of athecal strains of *rosea* that have been studied by the writer were male sterile. Two spermatophores, each containing "two oval sperm masses" were, however, present on one of the types of *indicus.* Acquisition of ability to reproduce asexually often precedes male sterilization. As soon as reproduction becomes parthenogenetic, important organs such as the spermathecae and male terminalia can be eliminated. In the genus *Pheretima,* for example, several instances are known in which extrusion to the exterior of sperm has become impossible though maturation still is profuse. Too little is known as yet about the consequences of becoming parthenogenetic, in the Lumbricidae, to permit attribution of much taxonomic value to the presence of spermatophores even if containing sperm.

Savigny's species obviously does not belong in the genus *Eisenia* but may as well remain there until lumbricid genera can be defined by reference to structures that are less liable to rapid evolutionary change than are the organs of the reproductive system.

E. rosea has been reported from Kashmir, Murree Subdivision of the Punjab, Chitral in the Northwestern Frontier Province, Simla (western Himalayas), Darjiling (eastern Himalayas), and to the south only from Kodaikanal (Palni Hills). The new synonymies require no additions to the distribution as domicile in the region of Calcutta is improbable.

Genus LUMBRICUS L.

L. rubellus Hoffmeister 1845 has been recorded from the Nicobar Islands. No confirmation has been provided in the last sixty years. Subsequent collections from those islands have contained no lumbricids and domicile is improbable. The specimens may have been found in imported earth.

L. terrestris L. This species has been found only once in India and then at Simla in the western Himalayas.

Genus OCTOLASIUM Orley 1885

OCTOLASIUM CYANEUM (Savigny, 1826)

Helodrilus (*Dendrobaena*) *kempi* Stephenson 1922, Rec. Indian Mus., Calcutta, vol. 24, p. 441. (Type locality, Kufri, Simla Hill states. Types, two, presumably in the Indian Museum.)

Allolobophora (*Dendrobaena*) *kempi*, Stephenson, 1923, Oligochaeta, *in* Fauna of British India, Ceylon and Burma, London, p. 502.

Octolasium cyaneum, Cernosvitov, 1937, Rec. Indian Mus., Calcutta, vol. 39, p. 111. (Murree, Punjab.)

Dendrobaena kempi, Gates, 1939, Vest. Cesk. Spol. Nauk, Praze, 1938-1939, p. 151. (Ootacamund, Nilgiri Hills, South India, at elevations of 6700-8000 feet.)

Octolasium cyaneum, Gates, 1951, Proc. Nat. Acad. Sci. India, B, vol. 21, p. 19. (Simla.)

Stephenson's species was distinguished from other Indian lumbricids, except *mariensis*, by presence of hearts in xii. The Ootacamund specimens also appeared to have an extra pair. Junctions with the ventral blood vessel, which lateral hearts must have, were not found in specimens secured at Simla not far from the type locality of *kempi*. However, the supposed hearts are only dorsally directed continuations of the extra-oesophageal trunks. These continuations, unfortunately, do look very much like hearts in a dissection from the dorsal side. There remain then no taxonomically important differences from *cyaneum*.

Reproduction probably is not biparental as no sperm have been found in the spermathecae (nor any spermatophores externally) of any of the specimens that have been available from various parts of the world. Uniparental reproduction, whether sexual or asexual, presumably would predispose to successful colonization after introduction.

The species would appear to have been much more common at Ootacamund than elsewhere in India or indeed at any of the localities from which the writer has collected it.

OCTOLASIUM LACTEUM (Orley, 1881)

Eophila himalayana Cernosvitov 1937, Rec. Indian Mus., Calcutta, vol. 39, p. 109. (Type locality, Simla. Types, two, presumably in the Indian Museum.)

Cernosvitov's species is known only from his description. Several days' search at the type locality in 1944 by a good collector yielded a number of specimens of *lacteum* as well as representatives of two other peregrine forms that were previously unknown in India.

Absence of seminal vesicles in segments ix and x is the only character available to distinguish *himalayana* from *lacteum*. Undoubtedly the quadrivesiculate condition was the reason, and indeed the only one, for referring types of *himalayana* to the genus *Eophila*. Unfortunately the condition of the material submitted to Cernosvitov for study was poor, as the writer saw before it was mailed. Most of the specimens were more or less softened or brittle and alcohol-browned. In macerated individuals the smaller vesicles of the ix-x, especially when vestigial, may be indistinguishable from adjacent tissues. In brittle material the vesicles are apt to be broken off during dissection so as to leave no macroscopically recognizable traces of their former presence.

Reproduction in *lacteum* probably is not biparental (though copulating couples have been seen, Gates, 1953), spermatophores never having been found externally nor sperm seen in the spermathecae of any of the specimens that have been available from various parts of the world. Some strains probably are male sterile but in others maturation of sperm appears to be so sparse as to warrant anticipation of parthenogenesis. With reproduction now asexual, seminal vesicles no longer are necessary and can be eliminated without harmful results to the individual or the strain. Seminal vesicles of ix-x have been quite small to vestigial in some strains recently examined and apparently have been lacking in others. The pair in ix alone or that in x alone has been quite small, vestigial, or unrecognized in other strains. Occasionally even the vesicles of xi have been vestigial when those of ix or ix and x were better developed. As these reductions or eliminations take place within the limits of what must otherwise be considered a species, there is now no good reason for recognition of *himalayana*.

Indian localities at which *lacteum* has been found are Darjiling, Mussoorie, Simla (all Himalayan), Murree subdivision (Punjab). All are well within the temperate zone.

DISCUSSION

Fourteen lumbricid species, if the unallotted residue of the *caliginosa* complex is counted as one, are now known to be present in the Indian subcontinent. All of them obviously are exotic there. No evidence is available to indicate any endemicity in adjacent regions of Baluchistan, Afghanistan and Tibet, below the Hindu Kush and Karakorum ranges. Lumbricids never were found in northern Burma and no endemics were discovered by Chen (1933, 1946) in the Yangtze Valley and the interior province of Szechuan in China. There is now no reason to anticipate lumbricid endemicity south of the Tian Shan and Altai mountains, Mongolia and Manchuria. Korea and Japan appear to have one or more native forms but none is known from Manchuria.

Twelve of the Indian lumbricids are present in the British Isles where no members of the family now seem to be endemic.

Twelve are widely distributed in North America. Many of them are present in South America, Africa, Australia, New Zealand as well as in various oceanic islands. One species, *Bimastos parvus*, usually is assumed to have had an American origin. The others certainly are all from Europe, from whence the worms were ferried to other continents and to the oceanic islands. The only way earthworms are known to be transported for such distances is in ballast or in earth with those plants that are cultivated by man. Transportation of the plants is unquestionable. The data now available (in MS) show that even a handful of the fertile, unsterilized earth surrounding the plant roots is liable to have contained cocoons or small juveniles and that larger samples often must have contained one or more adults. From the earliest transoceanic centers of successful colonization the exotic worms may have been transported by flood waters as well as by anglers, and, certainly, were distributed, on a geometrically increasing scale, by florists and horticulturalists as well as by innumerable householders. The alien species accordingly are properly called peregrine, the original meaning of which is foreign or imported.

In India, lumbricids are common in the Punjab and in the Northwestern Frontier Province. In the Himalayas, lumbricids never have been reported from Sikkim, Bhutan and Assam where there are no summer resorts, nor from Nepal where until very recently Europeans were excluded. Only in the region around Darjiling and in the sector west of Nepal are these worms known to be present. In the regions around the hill stations of both sectors lumbricids not only are common but also, in some part of the year at least, dominant. In the Gangetic Valley, which is well within the temperate zone, lumbricids are rare. Only 44 individuals, all of one species (*B. parvus*), were included among the 30,000 earthworms identified during the course of a four-year survey of the fauna of the Allahabad sector. No lumbricids were present among some 15,000 thousand earthworms collected in a Jubbulpore sector of the Deccan below Allahabad. Farther down the peninsula lumbricids have not been found until well into the far south and then at elevations of 5000-8000 feet but only in and around summer resorts.

Exotic plants are grown in pots as well as in the ground at all Indian, Burmese and Malayan localities where lumbricids are present. These plants were taken to the hills since 1800, as summer resorts were developed by Europeans, but could have been introduced into many lowland areas of southeast Asia during the previous three centuries. Much earlier than 1500, during the period between Alexander's invasion and the downfall of the Graeco-Bactrian kingdoms, some cultivated plants may have been taken from Europe to the Punjab and Kashmir.

The exotic plants with which European earthworms were taken to the hill resorts of southeast Asia are common in the western portion of the Gangetic plains, in the Jubbulpore region of the Deccan as well as in Ceylon where there are no lumbricids. The same plants also have been taken many times from the hills to the lowlands, probably most frequently to larger municipalities quickly reached from hill resorts, e.g., from Darjiling to Calcutta. Absence of all lumbricids in most of such plant transportations and presence of only *B. parvus* in the remainder is improbable. Deliberate mass introductions of lumbricids to certain sections of India and the Malay Peninsula in the last twenty years have been no more successful.

Failure of the very lumbricids that have successfully colonized in the Americas, Africa, Australia and New Zealand to establish themselves in so many parts of southeast Asia to which they were introduced does not now appear to be attributable to the rigor of any competition provided by native species. An American glossoscolecid earthworm, *Pontoscolex corethrurus* (Müller, 1856), possibly introduced more recently and much less frequently, is widely domiciled throughout southeast Asia as well as Malaysia and in some localities appears to have become the dominant species. An exotic ocnerodrilid and a peregrine megascolecid, as well as a south Indian species of *Lampito*, now are common throughout the Gangetic Valley. A score or more of other exotic earthworms are established in Ceylon.

Moreover, the very numerous unsuccessful introductions that there must have been do not now seem to be attributable, as a rule, to absence of appropriate habitats. Most of the peregrine lumbricids seem to be tolerant of considerable variation in pH, moisture content and basic chemical constitution of the soil as well as in the amount of digestible organic matter. Nor has the reversal of seasons that exists below the equator prevented acquisition of domicile.

A first approximation to an explanation of the unsuccessful introductions probably could have been given long ago if distributional data had been particularized instead of being camouflaged by geographical generalizations and erroneous adjectives such as cosmopolitan. The Lumbricidae, prior to human intervention in the situation, were confined to the temperate zone of the Northern Hemisphere and, possibly, to some adjacent Arctic portions of Eurasia. Transported to every part of the world where Europeans have lived, lumbricids have acquired permanent domicile in the temperate zones and the tropics but in the latter only on the highlands. The elevations at which worms were collected usually are not stated in the literature but the tropical sites appear to be above the 5000 foot level. An inherent inability to survive in the less rigorous and more equable climate of the tropical lowlands seems to have been demonstrated.

All lumbricids are able to withstand the rigors of a temperate zone winter. Forms such as *D. octaedra, L. rubellus* and *A. chlorotica* (Savigny, 1826), that now live respectively in Nova Zemlya, northern Siberia and Greenland, must be able to withstand freezing temperatures (and being frozen?) for long periods. *D. octaedra* also has been able to colonize around Mexico City and Bogotá (Colombia) as well as on the Palni Hills of south India. The other two species appear to be somewhat less adaptable as they are not known to be present anywhere in the tropics though more liable to transportation. *A. trapezoides* appears to be even less adaptable as it is certainly known only from areas with a climate more like that of the Mediterranean lands from which it presumably was taken. The ''endemic'' lumbricids occasionally must have been transported but without being able to take advantage of the opportunities for extending their range. Furthermore, the distributional records published in the last fifty years seem to hint that even in their own areas the natives are being replaced by peregrine forms that may have been introduced there too by man. Accordingly, the family, as a whole, seems now to be definitely limited in ability to ''advance,'' by climatic factors (presumably thermal), and seems to lack the youthful characteristics implied by such words as ''powerful'' or ''conquering.'' Even in the area that the lumbricids have ''conquered'' without human assistance, dominion is shared with two other families, the Hormogastridae and Criodrilidae.

Characteristics of youthful vigor and great evolutionary adaptability, it now appears, were too hastily imputed to the Lumbricidae as a whole because of the distributions of less than a score of peregrine forms. Reproduction in some of these forms is parthenogenetic which has been thought to predispose to successful colonization. Peregrine forms with obligatory biparental reproduction, however, are much more common in considerable areas of North America. More important then than parthenogenesis now seems to be an ability to tolerate human interference in the earthworm environment. Those species, the haemerophiles, which are able to endure the disturbances of the soil involved in agricultural and horticultural practices are predisposed, as it were, to transoceanic and subsequent intraregional carriage as well as to survival in new areas that are also cultivated or otherwise influenced by man. One of the peregrine species, *Eisenia foetida,* has been thought to be haemerobiontic, i.e., dependent on culture, though that characterization, at least in the vicinity of Darjiling, seems exaggerated. Even *D. octaedra,* sometimes said to be haemerophobic, certainly lives so close to sites of human activity as to be frequently transported.

Introduction of lumbricids, according to Stephenson (1930, p. 905), "frequently causes the disappearance of the endemic earthworm fauna." The evidence usually cited for that conclusion is absence of native species in and around municipal areas of Chile and Australia that were investigated by Michaelsen during the present century. Whether endemics previously had been common at those sites is of course unknown, and the earthworm habitats therein had been long subject to modification by man. Such little information as is now available hints that indigenes are haemerophobic. Culture, then, could have left areas formerly inhabited by earthworms open to rapid colonization by any of the preadapted species. These, of course, were most likely to be from Europe, as were the settlers.

As the supposed competitive virility of the Lumbricidae also seems to be evidenced by little more than the predisposition of a few species to colonization in vacant but climatically restricted areas, there remains no reason for believing the family to be the "youngest" of the earthworms. Although India and China now must be excluded from the lumbricid domain, there still seems to be little reason to question a former range from the Mississippi

River in North America across Europe and through Siberia to Japan. Most of the earthworm families of Michaelsen's last classification (1928), such as Sparganophilidae, Criodrilidae, Hormogastridae, Syngenodrilidae, Eudrilidae, Moniligastridae, are much more restricted geographically. If area is an indicator of family age (and there is at present little else from which to judge), the Lumbricidae are much older than has been thought, possibly as ancient as any of the four remaining families in Michaelsen's system.

Prior to the Pleistocene ice ages there may well have been, in the vast area between the Mississippi and Japan, many more lumbricid species than are extant. Advance of ice sheets resulted in disappearance of earthworms from Greenland, Iceland, Canada, the northeastern part of the United States, northern Europe and perhaps also the British Isles. In North America a few species of two lumbricid genera survived but to this day they are largely confined to infrequently investigated habitats in the Appalachians. In Europe, the endemics, with a few exceptions that need further consideration, also have not advanced into the glaciated area. In that region the common species are those which seem most likely to have been living, during the glacial periods, just south of the ice cap. How closely they were able to follow the northward retreating ice remains to be learned. As none is known to be haemerophobic and many are haemerophilic the influence of man on their distribution in northern Europe must be determined first. That influence, hitherto underestimated for much of the world, enabled peregrine lumbricids, mainly from northern Europe, to acquire domicile throughout most of the settled regions of non-tropical North America in less than 500 years.

SUMMARY

Soil around roots of plants has carried lumbricids to every part of the world where Europeans have lived. A high degree of tolerance for human disturbance of their habitats predisposes a score of species to transoceanic as well as subsequent intraregional carriage and also colonization in vacant habitats where haemerophobic endemics have been eliminated by agriculture.

Acquisition of domicile in the tropics only at elevations above 5000 feet by otherwise successful colonizers shows an inherent inability to adjust to the milder and more equable climate of the lowlands. The size of the lumbricid domain, though India and China are excluded, indicates that the family is old. The Lumbricidae are conservative except as parthenogenesis permits more rapid accumulation of mutations.

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B R E V I O R A

Museum of Comparative Zoology

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A NEW GENUS OF ERETHIZONTID RODENTS FROM THE COLHUEHUAPIAN OF PATAGONIA

BY BRYAN PATTERSON

Completion of a monograph of the Deseadan rodents by Professor Albert E. Wood and myself, which includes incidental discussion of Colhuehuapian rodents, necessitates publication of this note. A full account of the new form will be given in a revision of the Colhuehuapian mammals now in preparation.

Material of this rodent is contained in the collections of the Museo Argentino de Ciencias Naturales (MACN), the Museo Municipal de Mar del Plata, the Muséum Nationale d'Histoire Naturelle, The American Museum of Natural History and the Chicago Natural History Museum. For the privilege of examination and description, I am obliged to the authorities of these institutions, and in particular to Dr. J.-P. Lehman who was so kind as to forward specimens from Paris to Cambridge. For the opportunity of working in Buenos Aires and in Paris my thanks are due, respectively, to the John Simon Guggenheim Memorial Foundation and to the Carnegie Corporation.

Seven species of erethizontids have been described from the Colhuehuapian: *Eosteiromys homogenidens* Ameghino, *Steiromys pseudonectus* Bordas, *Steiromys segregatus* Ameghino, *Parasteiromys uniformis* Ameghino, *Steiromys axiculus* Ameghino, *Steiromys tabulatus* Ameghino and *Steiromys nectus* Ameghino. The first three of these seem to be synonymous. *Eosteiromys* is a valid genus with a non-molariform $\mathrm{P}^{\underline{4}}$, distinct postorbital processes, and nasals very strongly convex both anteroposteriorly and transversely. "*Parasteiromys*" *uniformis*, as Wood and I point out, appears to be referable to *Steiromys*, and is the only representative of this genus in the fauna. The last three species are indistinguishable, and *S. tabulatus* and *S. nectus* are hereby placed in the synonymy of *S. axiculus*. This species, which is clearly not referable to *Steiromys*, is the type of the new genus.

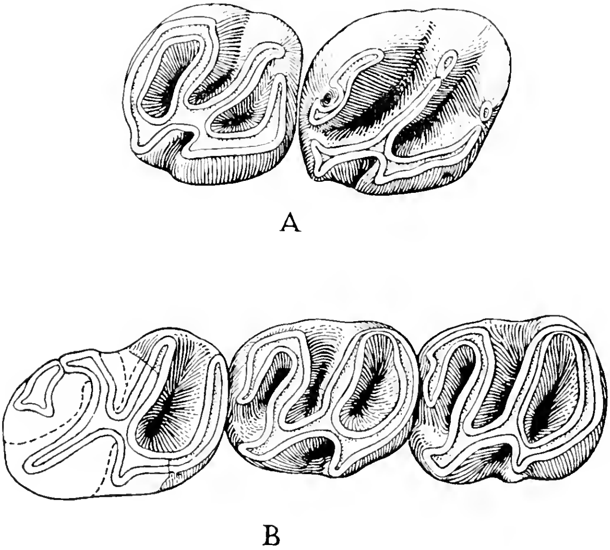

Figure 1. *Hypsosteiromys axiculus* Ameghino. *A*, $\mathrm{RP}^{\underline{4}}$ — $\mathrm{M}^{\underline{1}}$; *B*, $\mathrm{LP}_{\overline{4}}$ — $\mathrm{M}_{\overline{2}}$. X4.

HYPSOSTEIROMYS[1] gen. nov.

Type species:—*Steiromys axiculus* Ameghino 1902.

Distribution:—Colhuehuapian, Patagonia.

Diagnosis:—Cheek teeth with higher, more compressed lophs and lophids and deeper fossettes and fossettids than in other forms; $\mathrm{P}^{\underline{4}}$ not molariform, lacking metaloph; neoloph absent on $\mathrm{M}^{\underline{1-2}}$, present on $\mathrm{M}^{\underline{3}}$, rudimentary on $\mathrm{P}^{\underline{4}}$; lophs and lophids showing marked tendency to irregular, very shallow notching;

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[1] υΨι, on high, plus *Steiromys*, in allusion to the relative height of the molar crowns compared to those of other erethizontids.

lower I small, short, extending posteriorly to end of $M_{\overline{3}}$; conspicuous depression in maxillary anterior to tooth row and medial to root of zygomia.

HYPSOSTEIROMYS AXICULUS Ameghino

Steiromys axiculus Ameghino 1902, p. 109.
Steiromys nectus Ameghino 1902, p. 109.
Steiromys tabulatus Ameghino 1902, pp. 109-110.
Stichomys regius? Bordas (non Ameghino) 1939, p. 428 fig. 9.

Type:—MACN no. A 52-171, fragment of right ramus with root of I, $M_{\overline{1-3}}$ ($M_{\overline{3}}$ not fully erupted).

Type of S. nectus:—MACN no. A 52-177, fragment of right ramus with root of I, $dm_{\overline{4}}$, $M_{\overline{1-2}}$ ($M_{\overline{2}}$ not fully erupted).

Lectotype of S. tabulatus:—MACN no. A 52-172, fragment of left ramus with $P_{\overline{4}}$ — $M_{\overline{3}}$, crushed alveolus of I. Two other syntypes, an upper and a lower incisor from different individuals (MACN no. A 52-180), are of very dubious reference.

Horizons and localities:—All specimens but one are from the Colhué-Huapí formation in the Barranca south of Lake Colhué-Huapí, Province of Chubut; the exception (Bordas 1939, MACN no. 11247) is from the Trelew formation in the South Barranca of the Chubut Valley at Gaiman, Province of Chubut.

Diagnosis:—As for the genus.

I append measurements of Ameghino's types, and drawings by Mrs. Dorothy Marsh of two specimens in the Muséum Nationale d'Histoire Naturelle collection. Measurements in millimeters.

	$I_{\overline{1}}$		$dm_{\overline{4}}$		$P_{\overline{4}}$		$M_{\overline{1}}$		$M_{\overline{2}}$		$M_{\overline{3}}$	
	ap.	tr.	ap.	tr.	ap.	tr.	ap.	tr.	ap.	tr.	ap.	tr.
MACN no. A 52-171	—	3.0±					5.6	4.4	5.7	4.8		
MACN A 52-177	—	2.4	7.3	3.5			5.0	4.3				
MACN A 52-172					7.1	5.2	5.3	4.9	5.2	5.2	5.7	4.6

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B R E V I O R A

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A NEW BARYLAMBDID PANTODONT FROM THE LATE PALEOCENE

By Bryan Patterson and Elwyn L. Simons

A quarry discovered during the field season of 1939 by a Chicago Natural History Museum party working in the late Paleocene beds of western Colorado yielded numerous disarticulated remains of a large barylambdid pantodont. It was at once evident, following preparation, that this animal was distinct generically from the large *Barylambda faberi*, and certainly distinct specifically from the smaller *Haplolambda quinni* (Patterson, 1939), both from the same horizon. The nature of the type and only specimen of *H. quinni* (the anterior half of a skeleton, much of it pieced together and restored from weathered-out fragments) left some doubt as to the degree of relationship between this form and the new one, and description of the latter was accordingly postponed. During recent years much pantodont material has been obtained from the Paleocene of the Polecat Bench formation of Wyoming by Princeton University parties under Professor Glenn L. Jepsen, supported by the William Berryman Scott Research Fund. This has now been prepared and is under study by Simons. Comparison of the Chicago and Princeton collections shows that *Haplolambda* and the new form are represented in both and that they are beyond doubt generically distinct. A specimen from Colorado in the Carnegie Museum also proves referable to the new form.

Edinger (1950, 1956) has published some notes on the frontal sinus and endocranial cast of Colorado specimens of the new form under the name of *Haplolambda?* sp.

We wish to express our sincere thanks to Professor Jepsen and to Dr. J. LeRoy Kay for the opportunity of studying specimens in the collections under their respective charges.

PANTODONTA
BARYLAMBDIDAE

LEPTOLAMBDA[1] gen. nov.

Type species. L. schmidti sp. nov.

Distribution. Late Paleocene, Tiffanian stage; Silver Coulee beds, Polecat Bench formation, Park and Bighorn counties, Wyoming; Plateau Valley beds, DeBeque formation, Mesa County, Colorado.

Diagnosis. $I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{3}{3}$, no diastemata. Incisors above small, with lateral crest on each side; lower incisors larger than upper with lateral crests more prominent, forming a spatulate tooth comparatively longer anteroposteriorly and shorter transversely than in *Barylambda*. Canines smaller than in *Barylambda*, in supposed females incisiform. Premolars of typical barylambdid pattern; P^1_1 one rooted; $P^{\underline{1}}$ usually broader transversely than in *Barylambda*. Talonid bases of $P_{\overline{2\text{-}3}}$ comparatively larger than in *Barylambda* or *Haplolambda*, with serial homologue of crista obliqua directed anteriorly, not running obliquely anterointernally to long axis of tooth as in *Barylambda*. Upper molars differing from those of *Haplolambda* and resembling those of *Barylambda* in $M^{\underline{2}}$ larger than $M^{\underline{1}}$; distinguished

Figure 1. *Leptolambda schmidti* gen. et sp. nov. Upper dentition of right side, PU No. 14996 (unshaded teeth from PU No. 14680). x 1½.

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[1] From the Greek *leptos*, thin, slender; with reference to the less robust postcranial skeleton and more slender construction of the long bones than in *Barylambda*, plus *-lambda*, referring to the *lambda*-shaped molar crests, and to agree with related genera.

from *Barylambda* by presence of heavier cingula on $M^{\underline{1-2}}$, absence of backward rotation of protocones of $M^{\underline{1-3}}$. Metacone of $M^{\underline{3}}$ less reduced than in *Haplolambda*. Skull with wider, longer frontal area than in *Barylambda* and *Haplolambda;* head as a whole smaller in proportion to body size than in other barylambdids. Cervical centra and neural arches very short, weak; thoracic and lumbar vertebral centra comparatively long. Postcervical vertebrae with lower neural spines than in *Barylambda* and *Haplolambda*. Caudals without (or at most with small, anterior) haemapophyses; caudal centra longer in proportion to width and height than in *Barylambda*. Scapula not as broad anteroposteriorly, particularly in postscapular portion, as in *Barylambda*, broader than in *Haplolambda;* spine proportionately narrower than in *Barylambda*, lacking tuberosity. Clavicle more slender than in *Barylambda*. Bones of forelimb shorter relative to hind than in *Barylambda;* deltopectoral crest of humerus not as flat, less projecting medially; shaft of ulna less broad from front to back, strongly retroflexed, olecranon relatively longer than in *Barylambda* and *Haplolambda*. Metacarpal I and trapezium not fused as in *Haplolambda*. Metacarpal V much shorter than in *Barylambda*, relatively shorter than in *Haplolambda*, with large lateral expansion in proximal half. Proximal and mesial phalanges differing from *Barylambda* in much greater compression (or foreshortening) along axis of digit. Bones of hind limb less robust than in *Barylambda;* femur with more slender, less flattened shaft, third trochanter nearly vestigial; tibia with more slender shaft, no pronounced cnemial crest, distal extremity proportionately less broad; proximal articulation for fibula less projecting laterally; tuber calcis of calcaneum very much shorter.

LEPTOLAMBDA SCHMIDTI[2] sp. nov.

Figs. 1-3

Type. CNHM[3] No. P26075, incomplete skull, mandibles, numerous vertebrae and ribs, incomplete scapula and pelvis, various leg and foot bones.

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[2] Named for Dr. Robert G. Schmidt, who, with Dr. James H. Quinn, discovered the quarry from which nearly all the Plateau Valley material of this species was obtained.

[3] Abbreviations are as follows: CNHM, Chicago Natural History Museum; CM, Carnegie Museum; PU, Princeton University.

Hypodigm. Type and CNHM Nos. P26076-7, incomplete skull, various vertebrae and ribs, incomplete scapula, various leg and foot bones; P15558, P15571, incomplete dentitions; CM No. 11353, facial region of skull with dentition; PU Nos. 14680, 14879, and 14996, partial skeletons; PU Nos. 14681, 14990, 14992, mandibles.

Horizon. DeBeque formation, Plateau Valley local fauna, Mesa Co., Colorado; lower levels of the Silver Coulee beds, Polecat Bench formation, Park and Bighorn counties, Wyoming.

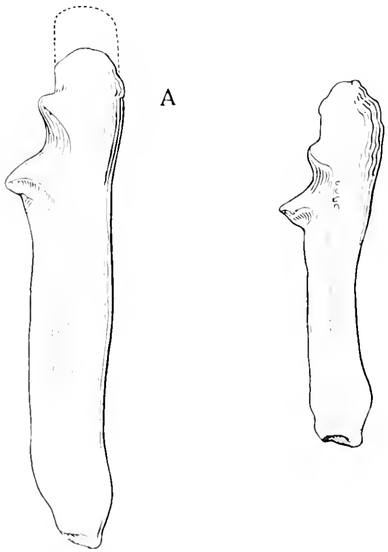

Figure 2. *A*, ulna of *Barylambda faberi* Patterson, CNHM No. P26110, and *B*, ulna of *Leptolambda schmidti* gen. et sp. nov., PU No. 14879. x $^{1}/_{3}$.

Localities. CNHM Nos. P26075-7 from one quarry approximately four miles SSE. of DeBeque, Mesa Co., Colorado (due to complete lack of association in this quarry there is uncertainty as to the precise allocation of the individual bones to these numbers); CM No. 11353, 2 to 3 miles west of DeBeque, Mesa Co., Colorado; PU Nos. 14680 and 14681 from the south side of Polecat Bench, Park Co., Wyoming; PU Nos. 14879, 14990, 14992, and 14996 from separate localities along a NE-SW line between the towns of Lovell and Greybull in T 54 and 55 N, R 95 and 96 W, Bighorn County, Wyoming.

Diagnosis. As for the genus; size approximately as in *Barylambda faberi* or somewhat smaller, but proportions clearly very different. Specimens from Colorado and from Wyoming fall

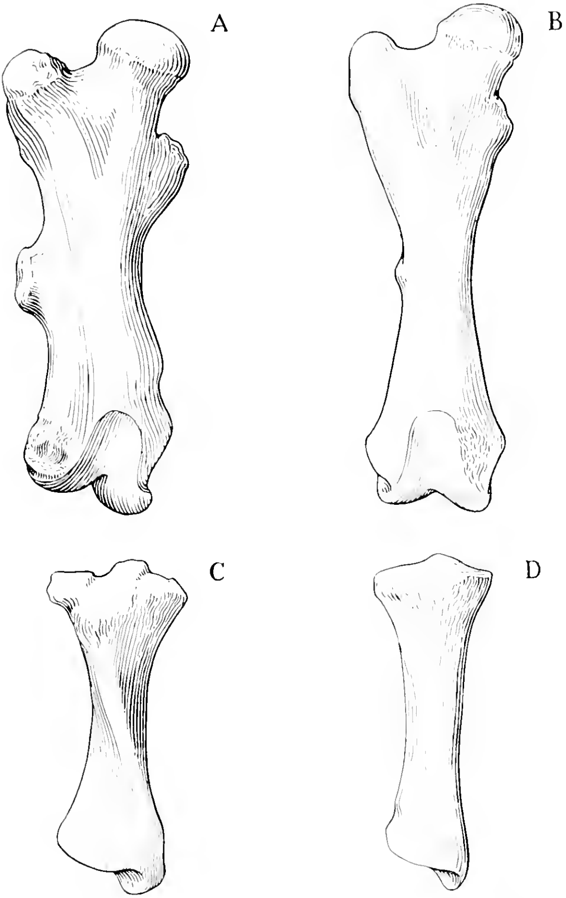

Figure 3. Femora and tibiae of *A*, *C*, *Barylambda faberi* Patterson, CNHM No. P14944, and *B*, *D*, of *Leptolambda schmidti* gen. et sp. nov., CNHM Nos. P26075, type and P26077. x $^{1}/_{8}$.

into two rather sharply defined size groups, one 20-30 per cent smaller than the other. The distinction is most apparent in the region of the canine, within the dentition, and in the postcranial skeleton. Differences of approximately this order of magnitude also occur in *Barylambda faberi*. We interpret them as indicating a sexual difference in size.

TABLE 1

MEASUREMENTS OF THE DENTITION, IN MILLIMETERS

		CNHM P26075	CM 11353[4]	PU 14680	PU 14879	PU 14996
I^1	ap		6.0			
	tr		5.2			
I^2	ap			7.7		
	tr			6.3		
I^3	ap		8.8	9.1		
	tr		9.0	6.8		
C	ap	14.5	13.4	10.9		
	tr	15.0	13.5	8.8		
P^1	ap		15.0	14.6	13.8	
	tr		14.0	8.4	8.0	
P^2	ap	18.0	16.0			18.2
	tr	25.0	26.0			25.5
P^3	ap	20.5	17.0		17.0	17.8
	tr	27.2	29.5		25.0	27.0
P^4	ap		18.0			
	tr		32.0			
M^1	ap		26.0	23.0		24.5
	tr		36.0	31.5		31.6
M^2	ap	26.0	27.0	23.5	22.8	25.3
	tr	36.0	39.0	32.5	34.1	35.3
M^3	ap	21.0	21.0	17.4	18.1	19.8
	tr	34.5		30.0	31.2	33.4

		CNHM P26075	PU 14680	PU 14681	PU 14990
I^1	ap		8.0	8.8	8.0
	tr		6.0	6.2	6.2
I^2	ap		10.0	11.0	10.5
	tr		6.2	6.8	7.0
I^3	ap		11.5	12.7	10.5
	tr		7.0	7.7	7.0
C	ap		12.8	15.7	12.3
	tr		8.8	11.4	7.2
P^1	ap		13.5		16.0
	tr		8.6		8.6
P^2	ap		20.5	21.5	19.0
	tr		12.3	15.7	12.6
P^3	ap	22.5	20.5	20.5	19.0
	tr	18.0	16.0	18.3	15.0
P^4	ap	22.0	21.0	21.6	20.2
	tr	20.5	18.0	19.5	17.0
M_1	ap	25.0	22.5	23.2	21.8
	tr trig	19.5	17.0	18.0	18.2
	tr tal	19.5	17.8	18.3	16.0
M_2	ap	26.7	23.0	24.5	23.3
	tr trig	21.0	17.0	18.2	17.2
	tr tal	17.0	17.0	18.3	15.4
M_3	ap	31.5	26.0	30.4	29.0
	tr trig	19.0	16.3	18.2	17.5
	tr tal	13.5	13.4	14.4	12.5

[4] The anteroposterior diameters of the upper cheek teeth of this specimen appear to have been somewhat reduced by wear.

Remarks. The Carnegie Museum specimen furnishes an interesting footnote to the history of Paleocene exploration. The Plateau Valley fauna did not come to scientific attention until the early 1930's, following Edwin B. Faber's discovery of the type and other specimens of *Barylambda faberi.* CM No. 11353, however, was collected by Earl Douglass about 1909, was tentatively identified as *Pantolambda?* sp., and the horizon recognized as Paleocene. Having made and correctly interpreted this remarkable find, Douglass went on to the discovery of the great Jensen dinosaur quarry, exploitation of which so fully occupied the rest of his working life that he was never able to follow up the lead provided by this first identified Paleocene mammal from western Colorado. As an additional item of interest, his specimen provides our only adequate knowledge of the facial region of *Leptolambda schmidti*, a part otherwise represented only by isolated maxillaries in the Chicago Natural History Museum material and by a much crushed skull in the Princeton collections.

The field evidence in Colorado suggests that *Leptolambda schmidti* differed from other Plateau Valley pantodonts as regards habitat. The previously known forms were all found in mud- or siltstones, whereas every specimen identifiable as *L. schmidti* was collected from the fillings of stream channels. The quarry that yielded the great bulk of the material was in such a situation, the disarticulated bones occurring at the junction of a channel fill with the underlying mudstone but clearly deposited in the channel. *Leptolambda* presumably inhabited higher ground marginal to the basin in which DeBeque sedimentation was going on, with fragments and occasionally whole or partial carcasses being carried down into the area of deposition. The specimens of *Leptolambda* collected in the Bighorn Basin of Wyoming neither confirm nor deny this conjecture. At least three specimens, PU Nos. 14680, 14681, and 14879 were collected from mudstones, whereas PU Nos. 14990, 14992, and 14996 were recovered from sandstones. Nevertheless, the possibility that *Barylambda* and *Leptolambda* were adapted to rather different environments is suggested, in Wyoming, by the fact that the former genus has not been recovered from the Bighorn Basin, although *Leptolambda* is comparatively common there for a pantodont, being represented by more than twenty-five separate finds. Since these two genera occur at the same stratigraphic levels in Colorado it is clear they were co-existent in time and therefore the absence of *Barylambda* in the Polecat Bench formation suggests that the environmental conditions under which it flourished did not exist in the region of the Bighorn Basin during the deposition of the Silver Coulee beds.

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AFFINITIES OF THE PATAGONIAN FOSSIL MAMMAL NECROLESTES

By BRYAN PATTERSON

Since its description by Ameghino in 1891, the curious little fossorial *Necrolestes* from the Santa Cruz beds has never rested securely in the system. Ameghino himself always regarded it as an insectivore allied to the African chrysochlorids. Scott (1905), in his description of excellent material collected by the Princeton Patagonian Expeditions, compared it with *Chrysochloris* and *Notoryctes* and concluded that it was an insectivore related to the African form: "What does seem probable is that *Necrolestes* is an offshoot from some early member of the family which was at the same time the ancestor of *Chrysochloris*." Gregory (1910, p. 259) and Schlosser and Woodward in various editions of Zittel accepted *Necrolestes* as an insectivore, but others have queried or denied such a relationship. Leche pointed out that *Necrolestes* resembled *Notoryctes* about as much as it did *Chrysochloris*, that as a marsupial it would raise fewer zoogeographical difficulties than as an insectivore, and that its affinities were far from decided: ". . . die Beziehungen des Necrolestes zu den lebenden Säugern durch das bisher dargelegten material keineswegs als festgestellt betrachtet werden können" (1907, p. 143). Abel (*in* Weber 1928, pp. 128-129), while discussing the genus under the Insectivora, expressed similar reservations. In current reference works, *Necrolestes* has been questionably included either among the marsupials (Romer 1945, p. 611) or among the insectivores (Simpson 1945, p. 53). Saban (1954, p. 422) has made the passing suggestion that it may be a palaeanodont edentate. One author who came out unequivocally for marsupial affinities was Winge (1941, pp. 79-80, 217-218), who regarded the incisor formula, reported by Scott to be $\frac{4}{4}$, as proof of such relationship. He believed *Necrolestes* to be a didelphoid derivative, classifying it in a separate division, Necrolestini, of his family Cladosictididae (=Borhyaenidae).

No first hand account of this little creature has appeared since Scott's study. His work was perforce done without benefit of the binocular microscope, and his conclusions as to affinities suffered from the fact that he evidently compared *Necrolestes* only with the equally highly specialized *Notoryctes* and the chrysochlorids, not at all with more generalized insectivores and marsupials. It had always seemed to me that a form represented by such excellent material — with most of the skeleton preserved in one or another of the Princeton specimens it is actually among the better known fossil mammals — should reveal enough in the way of structure to permit at least its infraclass affinities to be firmly established. Recent examination and further preparation of the Princeton material has shown this to be indeed the case. *Necrolestes* is beyond any doubt a marsupial and, as regards its position within the order, Winge's suggestion of a remote relationship with the borhyaenids is perhaps as reasonable a one as can now be offered. Scott's account is in general very good indeed. The brief description that follows is supplementary to his and corrects it in a few points.

I wish to express my sincere thanks to Professor Glenn L. Jepsen and to Dr. Donald F. Baird, who very kindly took the photographs from which the drawings prepared by Mrs. Dorothy Marsh were made.

MARSUPIALIA
BORHYAENOIDEA
NECROLESTIDAE

Necrolestes patagonensis Ameghino

Knowledge of the species, the only one of the family thus far discovered, rests essentially on three specimens in the Princeton collections:

15065. Skull, crushed dorsoventrally and lacking parts of occiput and basicranium, mandible (now missing), various vertebrae and ribs, proximal end of humerus. Ten miles South of Coy Inlet, Santa Cruz; collected by O. A. Peterson.

15384. Occiput and part of basicranium, mandible, some isolated upper teeth, numerous vertebrae from all parts of the column, pelvis, humerus, radius, ulna and various bones of the fore foot. Five miles South of Coy Inlet, Santa Cruz; collected by O. A. Peterson.

15699. Skull, incomplete posteriorly, mandible, right humerus, radius and ulna, left radius, incomplete ulna, femur, tibia, fibula, calcaneum, astragalus, cuboid. Killik Aike, Santa Cruz; collected by J. B. Hatcher.

DENTITION

Dental formula. It can be definitely stated that this is $\mathrm{I}\frac{5}{4}$, $\mathrm{C}\frac{1}{1}$, postcanines $\frac{6}{6}$ (probably $\mathrm{P}\frac{2}{2}$, $\mathrm{M}\frac{4}{4}$). Recognition of the correct number of upper incisors at this late date, more than half a century after the full account of the material, comes as somewhat of a surprise. The evidence is unmistakable, however (Fig. 1 A, B). In 15699, $\mathrm{I}\frac{1-4}{}$ are preserved on the left side and the alveoli of these four teeth, together with $\mathrm{I}\frac{5}{}$, on the right. No. 15065 retains right and left $\mathrm{I}\frac{1}{}$, right $\mathrm{I}\frac{5}{}$ and the alveoli of all other members of the series. Curiously enough, van Iterson, the artist who drew Scott's figures, indicated the correct number (Scott 1905, pl. 64, figs. 1, 2a). For 15699 he showed five incisors in right side view, reversing $\mathrm{I}\frac{1-4}{}$ from the left side, and for 15065 the right and left $\mathrm{I}\frac{1}{}$, right $\mathrm{I}\frac{5}{}$ and the alveoli of right $\mathrm{I}\frac{2-4}{}$ (the alveoli of left $\mathrm{I}\frac{2-5}{}$ were at that time concealed by matrix). The figure of 15065 has right $\mathrm{I}\frac{5}{}$ erroneously labeled as $\mathrm{I}\frac{4}{}$. Determination of the postcanine formula is uncertain. Believing that he was dealing with an insectivore, Scott gave it as $\mathrm{P}\frac{3}{3}$, $\mathrm{M}\frac{3}{3}$. Since we have a marsupial on our hands, either this formula could be correct, with $\mathrm{M}\frac{4}{4}$ missing, or the first premolar could be the missing tooth, which would give $\mathrm{P}\frac{2}{2}$, $\mathrm{M}\frac{4}{4}$. The latter possibility seems to me the more likely of the two. The last four cheek teeth above and below are uniform in structure, which suggests, although of course does not prove, that all are molars, while the second pair of teeth, especially the lower, although largely molariform, do show some resemblances to the anterior pair.

Upper teeth. The first four incisors are of similar structure, with the crowns rectangular, compressed anteroposteriorly, the labial face slightly convex in the dorsoventral diameter and bearing a faint median groove. $I^{\underline{2}}$ is the largest, $I^{\underline{1}}$ slightly smaller and $I^{\underline{3\text{-}4}}$ of equal size and slightly smaller than $I^{\underline{1}}$. $I^{\underline{5}}$ is the smallest of the series. It is a bluntly pointed tooth, worn obliquely on the posterior face by the anterior surface of the lower canine.

Relative to the sizes of the other teeth, the single-rooted, trihedral canines, both upper and lower, are enormous. The upper is somewhat variable, that of 15699 being stouter, more triangular and with a larger anterior face than that of 15065.

The first upper cheek tooth, $P^{\underline{2}}$ as here interpreted, is double-rooted, implanted obliquely, and consists of a high, conical paracone, an anterior basal cusp and a shearing edge running from the apex of the paracone to the large but non-cuspidate metastylar area. The remaining teeth of the postcanine series are unilaterally hypsodont, curving outward toward their bases and tapering to small, bluntly pointed single roots (Fig. 1C). The enamel extends nearly to the end of the root of the lingual surface and for only a short distance up the crown on the labial. $M^{\underline{1\text{-}3}}$ are essentially narrow isosceles triangles as regards crown contour; $P_{\overline{3}}$ has a convex anterior and $M^{\underline{4}}$ a convex posterior border. $M^{\underline{1\text{-}2}}$ are subequal, $M^{\underline{3}}$ is slightly smaller and $M^{\underline{4}}$ reduced in size. The internal cusps are presumably paracones, being in line with the paracone of $P^{\underline{2}}$, and the greater part of the crowns is formed by the stylar area. There is no vestige of a protocone. These teeth are thus descriptively zalambdodont, but no structural details are apparent in the worn material available.

Lower teeth. The incisors resemble those of the upper series and are not, as Scott stated, laterally compressed. $I_{\overline{1}}$ is much larger than the others, which are subequal. The canine is narrower and less trihedral than the upper, with a smaller anterior face.

$P_{\overline{2}}$ is double-rooted, elongate anteroposteriorly and bears three cusps, a high, acute protoconid and smaller, subequal anterior and posterior basal cusps. The molars are alike in structure and are mirror images of the uppers, with no traces of talonids. The second postcanine, $P_{\overline{3}}$ as I believe, differs from them in being less narrowly triangular and in the possession of a vestigial anterior basal cusp serially homologous with that occurring on $P_{\overline{2}}$. The less worn of the lower molars available have heart-shaped crown contours caused by a shallow, ephemeral indentation between the bases of the paraconids and metaconids. No doubt $P_{\overline{3}}$-$M_{\overline{4}}$ are mirror images of the corresponding upper teeth as regards unilateral hypsodonty, enamel distribution and root structure but no loose examples are available. Wear on all molars is limited to the crowns, where the abrasion surfaces are nearly plane. It is quite evident that in active occlusion the trigonids of the lowers worked across the trigons of the uppers.

SKULL

As is the case in other small fossorial forms, no suture is apparent in any specimen of *Necrolestes.* The chief peculiarity of the skull is of course the extraordinary upturned snout, which extends well above and in front of the incisors (Fig. 1 A, B). Scott was in some doubt as to whether this feature might not have been exaggerated by distortion in 15699, particularly as there is little trace of it in 15065. It appears to be natural, however. No. 15699 has undergone slight lateral compression, in the course of which the maxillaries and premaxillaries have been broken away from and slightly pinched in relative to the nasals, but this does not appear to have affected the dorsal profile of the facial region. No. 15065 has been badly crushed dorsoventrally in this region and the upturned portion has been weathered off. The anterior narial openings (Fig. 1 A, B) extend forward to the tips of the nasals and do not end short of them, as Scott's figure shows them as doing. The median spine described by Scott as extending upward and forward from the mid-point of the premaxillaries evidently continued to the tips of the nasals as an ossification in the septum. It is partly broken away but remnants of it are still present. Between $I^{\underline{3}}$ and the canines, the premaxillaries are very deeply excavated for the reception of the lower canines, perhaps the most extreme development of this character to be seen in the Marsupialia.

The upwardly arching zygomatic arch is well developed for so small an animal (Winge described it as slender, but this was in comparison with the arch of the borhyaenids) and quite similar to that of small didelphids such as *Marmosa.* Extension of the jugal to the glenoid articulation is a marsupial character. Despite the obliteration of the sutures, there can be little doubt that the jugal of *Necrolestes* was so constructed. A prominent preglenoid process is present. The glenoid surface extends forward to this buttress and is in consequence deeply concave anteroposteriorly. Precisely similar conditions exist in other marsupials, in which the buttress is formed by the jugal. A post-

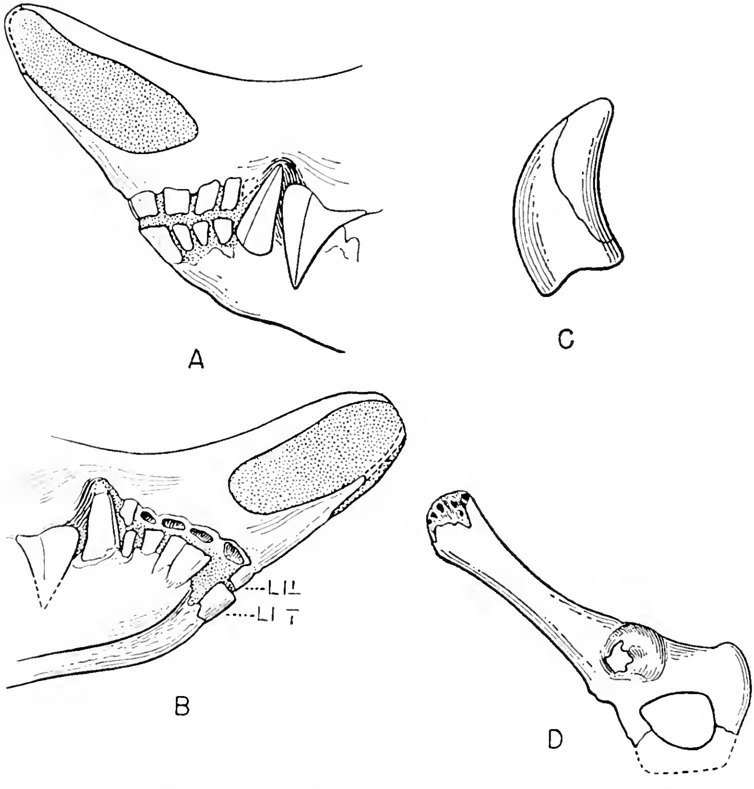

Fig. 1. *Necrolestes patagonensis* Ameghino. *A, B,* right and left sides of snout region of skull, X3 approx. (*LI,* left incisor); *C,* left M^2, anterior view, X6; *D,* left innominate bone, lateral view, X2 approx.

glenoid process is lacking. The extent of the lachrymal cannot, of course, be seen. The lachrymal foramen, however, is so very similar to that of various didelphids as regards both position and size (far more so than to that of the chrysochlorids, with which Scott compared it) as to suggest that the bone itself was likewise comparable. Within the orbito-temporal region, the optic foramen appears to be confluent with the sphenorbital fissure.

The long, slitlike incisive foramina are very didelphid-like, while the complete absence of palatal vacuities is a point of resemblance to the borhyaenids. The posterior border of the palate is moderately thickened and the posterior nares are divided by a median bony septum. For a marsupial this is very unusual; it may be an adaptation for providing an increased rigidity that would be useful to an animal using its upturned snout as an earth mover.

Specimens 15065 and 15384 reveal a good deal of the structure of the basicranium and auditory region, much of which had hitherto been concealed by matrix. The basicranium is very short. The greater part of the right side of the basisphenoid is preserved in 15065 and this portion is perforated, at the level of the glenoid cavity, by a large foramen, which appears to be the carotid. The bone is almost flat and there is no indication of a tympanic wing. The basioccipital, of which only a small part is preserved in 15384, was clearly short and wide. As noted by Scott, the condyles are relatively very large and wide; as in *Marmosa* there is a conspicuous median notch between them that opens forward from the foramen magnum. The latter opening is large and faces posteriorly. There is no paroccipital process, the "broad and distinct" process so identified by Scott being the mastoid. That part of the alisphenoid external to the foramen ovale, of which the lateral rim is preserved, is present in 15065; it shows no trace of any development of an alisphenoid bulla. It is perforated by a small foramen, presumably vascular, situated midway between the foramen ovale and the glenoid cavity. The periotic is short and robust, with a well rounded promontorium, which I take to have been the basis for Scott's incorrect statement that the "tympanic bulla" was "ossified and moderately inflated." Anteriorly, the bone terminates bluntly and, posteriorly, there is no trace of a tympanic wing.

The fossa subarcuata is very large, and the anterior vertical semicircular canal is free from surrounding bone. The mastoid process appears to be large.

Immediately posterior to the glenoid cavity is a more or less triangular pocket, whose medial border is formed by the petrous portion of the periotic, the lateral by the squamosal and mastoid, which descend below the level of the glenoid and are concave on their medial surfaces, while the squamosal appears to be the main contributor to the roof, with the other elements participating to a lesser extent. A low transverse ridge crosses the roof of this pocket, partially dividing it into a large anterior portion, which is open below, and a smaller posterior portion, which is floored by the mastoid process. The fenestra ovalis and the apertura tympanici canalis facialis open into the pocket and the groove for the facial nerve is plainly visible in the lateral side of the periotic. This pocket, then, is the tympanic cavity, and the tympanic itself, of which no part remains, obviously provided a partial floor to the ventrally open anterior portion. There is no emargination of the squamosal marking the passage of the auditory meatus, which must have passed laterally below and behind the glenoid cavity. Within the pocket, in 15065, there is a minute foramen immediately behind the glenoid and a larger one just posterior to it. These I take to be the postzygomatic and postglenoid foramina. The tympanohyal, descending from the crista facialis, is fused with a small medial projection from the mastoid process in 15065 but stands free in 15384. The ''foramen'' stylomastoideum primitivum is entirely open, merely the termination of the facial groove, as in various didelphids. Posterior to the tympanohyal is the opening of a short tubular recess, covered laterally by the mastoid and exoccipital, that runs back to the condyle. An almost identical recess occurs in small didelphids, e.g. *Marmosa*, and presumably houses M. stapedius. Of the preserved foramina not heretofore mentioned, the lacerum posterius is large and the condylar, due to the shortness of the basicranium, is very close to it. The latter, so far as I can detect, is single. There appears to be no subsquamosal foramen.

The posterior portion of the mandible is greatly reduced and the angle consequently very small. Notwithstanding, this process bears an internal ledge and this is inflected and concave dorsally.

The fossorial specialization has resulted in a highly modified skeleton that shows numerous resemblances to other, similarly adapted forms, as Scott pointed out. Making due allowance for this, there is nothing that argues against a didelphoid ancestry for the Necrolestidae. The lack of an anticlinal vertebra, a point emphasized by Scott as a resemblance to the chrysochlorids is also true for the thoracic series of some of the smaller didelphids, and in these the neural spines of the lumbars do not incline forward to any appreciable extent. There is clear evidence of a well-developed tail, in agreement with didelphids and borhyaenids.

The proportions of the pelvis closely resemble those of the smaller didelphids and, as Scott pointed out, there was surely a well-developed pubic symphysis. The ilium is more rodlike than in the Didelphidae, a difference possibly related to the fossorial adaptation of *Necrolestes.* In very close agreement with didelphids, there is a conspicuous pectineal prominence that stands well out from the anterior margin of the pubis. The relatively large epipubis of the smaller opossums extends up nearly to the pectineal prominence, and I suspect that the same was true of *Necrolestes.* On the right side of 15384 there is a small fragment of bone attached to this area of the pelvis by matrix, and it is just conceivable that this could be a remnant of the epipubis itself.

DISCUSSION

Winge was correct in his opinion that *Necrolestes* was a marsupial. The incisor formula is diagnostic for a large segment of this order. There is nothing of a conflicting nature in the structure of the skull or postcranial skeleton; on the contrary numerous features described above point so strongly in the same direction that there is no further need to elaborate on the ordinal position of the genus. Saban was quite right in seeking to exclude the Necrolestidae from the Insectivora, and his tentative suggestion of palaeanodont affinities was a reasonable one, given the information in Scott's account. The new facts do not support it, however. The Palaeanodonta resemble the Xenarthra in the possession of an ossified bulla composed of ecto- and entotympanic elements (Patterson and Segall, MS.) which *Necrolestes* does not have; the dentition and the pelvis are quite different, and so on. There is, of course, a general resemblance between *Epoicotherium* and *Necrolestes* but, like the resemblance between the latter and the chrysochlorids, this is due to convergence.[1]

There remains for discussion the problem of where, within the Marsupialia, *Necrolestes* should be placed. The isolated position of the genus — its lack of any ancestors combined with its great specialization — prevents any satisfactory conclusion, although some approximation is possible. The facts of zoogeography would seem to limit the field to the known South American groups. One of these, the Caenolestoidea, may at once be excluded from consideration. No known caenolestoid approaches *Necrolestes* in any significant way; the dentitions of the earliest forms are specialized in completely different directions. The remaining two groups, the Didelphoidea and the Borhyaenoidea, on the contrary, do show resemblances of a basic sort to the Necrolestidae. Some of these have been mentioned in the description. As regards the dentition, the incisors of didelphids — and presumably of the earliest borhyaenids — could readily have given rise to those of *Necrolestes;* the canines are large in the two, and the lower is received into a socket in the upper jaw; the zalambdodont molar type of the necrolestids could readily have evolved from tribosphenic molars of the sort that were no doubt present in the early members of both groups. The skull and postcranial skeleton of *Necrolestes* reveal, beneath the façade of fossorial specialization, unmistakable borhyaenid and didelphid resemblances.

If, as seems virtually assured, the ancestry of the Necrolestidae is to be sought near the base of the didelphoid-borhyaenoid complex, then the question arises as to whether it is nearer to one or to the other of these superfamilies, or is equally distinct from both. *Necrolestes* is one of the most specialized of American marsupials, specialized in a manner totally unlike anything seen in the Didelphoidea or in the Borhyaenoidea. To seize upon this as an excuse for erecting a superfamily for the reception of one

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[1] Since this was written, McDowell (Bull. Amer. Mus. Nat. Hist., **115**, 173-4, 1958) has asserted that *Necrolestes* is a member of the suborder Xenarthra. In addition to the characters of the auditory region just cited that oppose reference to the suborder Palaeanodonta, the presence of rooted, enamel-covered teeth and the absence of the diagnostic xenarthran vertebral and pelvic structures prevent acceptance of this opinion.

genus whose phylogeny is totally unknown, would be the height of irresponsibility, however. Furthermore, there are one or two characters that hint at a more acceptable possibility. As will be evident from the descriptive notes, there are more resemblances to the didelphids than to the borhyaenids in the anatomy of *Necrolestes.* This is not surprising: the didelphids include the least specialized of marsupials and no doubt retain a good deal of the ancestral structure relatively unmodified. The adequately known borhyaenids are relatively much more specialized and would therefore be less likely to display basic resemblances to *Necrolestes.* However, in such characters as the absence of palatal fenestrae and the lack of an alisphenoid bulla, *Necrolestes* is closer to all or some of the borhyaenids, which conceivably may indicate that the family arose from the borhyaenoid stock shortly after its divergence from the didelphoid. Such evidence, of course, is of the slenderest yet I nevertheless clutch at these straws and, in accord with Winge, very tentatively place the Necrolestidae in the Borhyaenoidea.[2] As a marsupial, *Necrolestes* adds one more example to the long series of convergences and parallelisms for which the extinct South American mammalian fauna is justly famous: one of convergence toward another order (Insectivora, Chrysochloridae), one of parallelism within the order (*Notoryctes*).

With the removal of *Necrolestes* from the Insectivora, an order of mammals — one widespread elsewhere at an early date — has definitely been eliminated from the early Tertiary South American scene. As I have briefly stated (1957, p. 57), it is becoming evident that the earliest South American mammalian fauna must have been an unbalanced one, of the sort encountered on islands. If, as has usually been supposed in recent years, the Americas were united by land in the late Cretaceous and early Paleocene it is very difficult to understand the absence from the southern continent of any traces of multituberculates, insectivores, taeniodonts, creodonts, fissipeds and pantodonts, to name only the groups that are known, or may with confidence be inferred, to

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[2] I prefer Simpson's classification of the marsupials into six groups (1945) to those classifications that unite Didelphidae, Borhyaenidae and Dasyuridae into one. Admittedly, these families are closer to each other morphologically than any one of them is to other marsupial groups, but keeping them separate (or at least keeping the Australian and South American groups separate) accords better with the zoogeographical data, which, when adequately understood, have an importance for mammalian taxonomy and phylogeny that can hardly be overestimated.

have been in existence in the north during all or part of this time.[3] That none of these would have made its way over a land connection had such then been in existence is improbable in the extreme. It appears to me much more likely that no such connection existed. Projecting backward in time from the known early Tertiary mammalian faunas of South America, it is possible to visualize the relatively few major groups represented as having evolved from a small number of successful colonizations by ancestors that survived the hazards of overseas transportation from North America by natural rafts. A minimum of three such colonizations would have sufficed, but a more plausible total would be four, perhaps even more. I am in full agreement with Darlington (1957, p. 364) on this point.

One successful landfall by a breeding pair or by a gravid female could have started the marsupial radiation, and another the edentate. The various ungulate groups might conceivably have resulted from a single colonization, but at least two seems more probable. From small, generalized condylarths could have evolved the litopterns, astrapotheres, xenungulates and pyrotheres. The notoungulates, by far the largest and most varied group of South American hoofed mammals, were, I suspect, the descendants of ancestors that were already members of this order by the time they made their landfall; they may have arrived earlier than the condylarths. The really extraordinary abundance and diversity of notoungulates, especially notable by contrast with the other ungulate orders, would be at least partially explicable under this view. It is implied, of course, that the Notoungulata were of northern origin and that the known Holarctic forms — *Palaeostylops* of the late Paleocene of Mongolia and *Arctostylops* of the early Eocene of North America — were lingering survivors in that region. It is possible to think of these northern forms as immigrants from the south, but I am encouraged to doubt this by the structure of their teeth, which seems to me sufficiently different in detail from anything known among South American notoungulates as to indicate some inde-

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[3] Primates had almost surely come into existence by the early Paleocene. They make their first appearance in South America in the Colhuehuapian, which suggests that they may not have reached the continent until after the Mustersan, perhaps at about the same time as the rodents. With a group so rare in the fossil record there is always a large element of doubt as to the reality of absence, and I therefore omit them from the list, which is quite imposing enough without them.

pendent evolution.

From the haphazard, unbalanced beginning thus visualized, the South American mammalian fauna in time achieved balance of a sort peculiarly its own. The early immigrants had by chance drifted to an area whose size, physical diversity and multitude of available niches provided the space essential for such a development.

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. September 19, 1958 Number 95

A NEW BOLIVIAN LAND SNAIL OF THE GENUS DRYMAEUS

By Juan Jose Parodiz

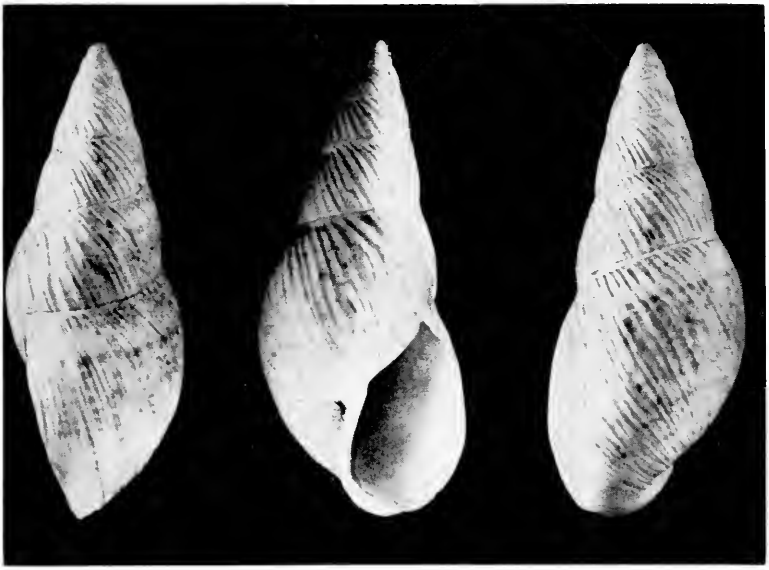
Acting Curator of Invertebrates, Carnegie Museum
Pittsburgh, Pa.

Drymaeus pereirai sp. nov.

Description. Shell subconical, elongated. Whorls, seven, increasing gradually, the last being approximately ⅔ of the total length with its major diameter scarcely larger than one half of the same length. Suture white, marginated below and somewhat shouldered above, a character which is more evident at the base of the third post-embryonic whorl. Surface sulcate with very fine and irregular axial riblets, more distinct on the middle portion of the shell. The interspaces between these riblets are variable in width and there are 3, 2 or occasionally only 1 riblet per mm., with some microscopical spiral lirations, more noticeable on the zone of the last whorl opposite the aperture. The riblets start on the suture, forming a very distinct marginated area. Color (in the holotype) white, with traces of brown bands broken into points and divided by three white zones. This spotted coloration is limited to the intercostal spaces and is not present on the high part of the riblets which remains white, giving a diffused silky aspect. Aperture oval, with rounded base, shiny white, enameled inside and somewhat iridescent; the superior part of the columellar lip a very pale pink; peristome thin and not reflexed. The protoconch has the same pale pink-lilac shade of the peristome.

Measurements in mm.:

	Shell			*Aperture*		*Last Whorl*
	Length	Width		Length	Width	Length
Holotype	30	12.5	10.5	13.5	7.5	19.5
Paratype		10	9	12	6.5	16.5



Drymaeus pereirai, sp. nov. M.C.Z. no. 168843, El Carmen, Prov. Chiquitos, Depto. Santa Cruz, República de Bolivia. Hno. F. S. Pereira and Carl Gans, collectors. (Holotype X 2½.)

Locality. Estación El Carmen (between Palmito and Santa Ana) on the railroad Corumbá-Santa Cruz, Prov. Chiquitos, Depto. Santa Cruz in the oriental plains of southeastern Bolivia. Holotype No. 168843 in Museum of Comparative Zoology and paratype in Carnegie Museum Accs. 16,073. Collectors: Hno. F. S. Pereira and Carl Gans, 1953.

The paratype (which has the early whorls decollated) is evidently a younger specimen as shown not only by its smaller dimensions but by some traces of carination in the last whorl, and fresher colors. The very pale spotted coloration in the paratype deserves an explanation, since it is very possible that other specimens with intermediate patterns will be found. The three brownish bands are more distinct, with the dividing white zones also very conspicuous; the medium, broader band shows darker or clearer triangular areas; the umbilical zone is completely white; the lower spiral white zone continues into the aperture and the upper one, on the suture; the dark bands are visible inside the aperture; as in the paratype, the oblique axial riblets remain white.

The marginated suture, the irregular axial-oblique riblets, and the very pale pink-lilac tint on the columellar lip, are the more important features of this new species. Two other species of *Drymaeus* are known which have a roughened surface of pseudoriblets: *D. sulcosus* (Pfeiffer) from Mexico, which is a larger and stronger species with a thick and reflexed peristome, and some young specimens of the Central American *D. jonasi* (Pfeiffer) — such as those figured by Pilsbry in 1899 (Manual of Conchology, (2) 13, p. 54, pl. 10, fig. 64) — which is different in many other characters such as the angulate base of aperture and its broader shape.

The region where this new species has been found should have an extensive exploration from the malacological point of view. We know better a number of characteristic species from the western side of Santa Cruz, on the subandean zone and oriental cordillera of Bolivia, as well as many others along the Paraguay River, from Corumbá to the south. The locality El Carmen is in an intermediate region, more than 200 miles wide, between the Llanos of Izozo and the Paraguay River, being a northern extension of the Boreal Chaco.

The species is named for Hno. F. S. Pereira who obtained the specimens while collecting with Dr. Carl Gans along the zone Corumbá-Santa Cruz in 1953. I wish to express my appreciation to Dr. J. Bequaert and Dr. W. J. Clench of the Museum of Comparative Zoology, for giving me the opportunity to report upon this new species.

B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. September 19, 1958 Number 96

A NEW DICHOBUNID ARTIODACTYL FROM THE UINTA EOCENE[1]

By C. Lewis Gazin
Smithsonian Institution

INTRODUCTION

Recently, Mr. Bryan Patterson turned over to me for study a lower jaw belonging to an *Antiacodon*-like dichobunid from the Uinta upper Eocene. The specimen was discovered by him among some materials secured by the Museum of Comparative Zoology in an exchange with the Cleveland Museum of Natural History. The label accompanying the specimen reveals that the jaw was collected by Mr. D. C. Roberts near the entrance to Myton Pocket, a well-known collecting locality for upper Eocene mammals in the Uinta Basin of northeastern Utah.

The specimen is particularly significant in showing that the *Antiacodon* line did not become extinct in Bridger middle Eocene time but survived at least until the Uinta C horizon of the upper Eocene. The form represented, while clearly related to *Antiacodon,* shows certain distinctive modifications rather beyond the limits that may be ascribed to that genus. Moreover, the extended range in time of this line, together with the very distinctive and divergent characteristics brought to light (separating it from the better-known Homacodontinae), weakens my earlier objection (1952, p. 24) to applying separate subfamily recognition to the antiacodonts. The name Antiacodontinae might well designate this phyletic sequence.

The first antiacodont to be placed on record was the Bridger form, described by Cope (1872, p. 2) in his first "Palaeontological

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

Bulletin" as "*Lophiotherium*" *pygmaeum*. The same form was described scarcely a month later by Marsh (1872, p. 210) as *Antiacodon venustus*. Cope early recognized Marsh's genus but later felt that it was not sufficiently well characterized and in 1875 (p. 256) proposed the name *Sarcolemur* for the species he had named *Antiacodon furcatus*. These I have shown (1955, p. 23) are synonymous, so that the genotypic Bridger species is *Antiacodon pygmaeus*. The first recognizable illustration of the lower jaw of *Antiacodon* (as *Sarcolemur*) was furnished by Osborn (1902) but, following Cope, he regarded it as a primate. Matthew in 1909 was evidently the first to realize that *Antiacodon* was an artiodactyl, although earlier in the same year, while including "*Sarcolemur*" in the Artiodactyla, he believed *Antiacodon* to be a leptictid. Evidently the earliest form showing a relationship to the antiacodonts is the Wasatchian genus *Hexacodus* (Gazin, 1952, p. 73), a form that might be regarded as an antiacodont, but that also includes within its range of characteristics certain indications of an ancestry for *Microsus*, a typical homacodont.

DICHOBUNIDAE Gill
ANTIACODONTINAE, new subfamily

AUXONTODON[2], new genus

Type. Auxontodon pattersoni, new species.

Generic characters. Small incisor-like canine. Much enlarged and probably caniniform P_1. Second to fourth premolars anteroposteriorly elongate. Marked diastema between P_1 and P_2. Little or no diastema between P_2 and P_3. Cheek teeth resembling those of *Antiacodon*. Inferior margin of lower jaw strongly convex in anteroposterior profile.

Comparison. The three lower incisors of *Auxontodon,* as indicated by the root portions, were small, about equal and decidedly procumbent. The root of the lower canine, which is also procumbent and closely parallel to those of the incisors, is only slightly larger. The root of P_1, on the other hand, is much larger

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[2] From Greek, *Auxontos,* increasing: and *odon,* tooth; in allusion to the increased size of the first lower premolar.

than that of the canine and appears to be more accurate, so that while the root appears to extend well back in the jaw, the crown may have been more nearly erect. There is a marked diastema between the alveolus for P_1 and those for P_2, and evidently only a very slight diastema separating P_2 from P_3. The diastema between P_2 and P_3 in *Antiacodon* is variable and evidently somewhat greater than in *Auxontodon*. In A.M.N.H. No. 12697 it is about 2.5 mm. whereas in U.S.N.M. No. 18000 it is 3.9 mm.

P_2 is not preserved in the *Auxontodon* specimen, but P_3 is seen to be an elongate tooth with a distinctly high primary cusp or protoconid and a very well-defined metaconid almost posterior to it. There would appear to be no talonid on P_3 but there is a low, distinct paraconid. P_4 has a more distinctly developed talonid with a conspicuous entoconid, better developed and more widely spaced from the crest extending down the posterior slope of the protoconid than in *Antiacodon*. The metaconid is prominent as in *Antiacodon* but the anterior extremity of this tooth, though damaged, seems more forward-protruding than in the earlier genus. M_1 shows a characteristic antiacodont form with a high paraconid and with the crista obliqua extending to the apex of the more worn metaconid. The hypoconulid is posterior to the crest between the hypoconid and entoconid, but appears less conical than in *Antiacodon* — more as a prominent upward arching of the posterior cingulum.

The jaw of *Auxontodon* shows a decidedly convex lower margin, viewed from the side. It is more nearly straight in *Antiacodon*. A mental foramen of moderate size is noted beneath the posterior root of P_3. It is in this position or slightly more forward in *Antiacodon*. However, in *Auxontodon* there is a larger foramen below a point just posterior to the alveolus for the P_1, opening lateral to the root and extending backward parallel to it. In A.M.N.H. No. 12697 of *Antiacodon pygmaeus* the larger and more anterior mental foramen is just anterior to the posterior root of P_2.

Discussion. Perhaps the most significant feature observed in *Auxontodon* is the much-enlarged root of P_1. In homacodonts in general, although details in this respect are not known in all genera, there is no marked tendency toward differentiation of a strongly caniniform tooth. Nevertheless, it was noted that in such more advanced homacodonts as *Mytonomeryx* and *Pentacemylus* the root portion of P_1 is distinctly larger than that of the canine. Moreover, it is more robust than in either of the roots for P_2. However, in these genera the crown of P_1 is premolar-like and forms with the incisors, canine and following premolars a nearly gradational series in size. In the more-selenodont Eocene artiodactyls, such as the agriochoerids, leptotragulids and hypertragulids, P_1 early becomes caniniform.

In none of the known material of *Antiacodon pygmaeus* is the anterior portion of the lower jaw sufficiently preserved to indicate with any certainty the extent to which P_1 was developed. In A.M.N.H. No. 12697 of this species the jaw is preserved to about 1.7 mm. in advance of the roots for P_2 but this portion of the lower jaw is relatively slender and there is no evidence of a root for P_1 extending back in the jaw. Nevertheless, *Antiacodon* and *Auxontodon* show a rather strong tendency toward selenodonty and it is not surprising to find this line within the Dichobunidae showing tendencies paralleling the more highly selenodont families.

AUXONTODON PATTERSONI[3], new species

Figure 1a

Type. Left ramus of mandible with P_3-M_1 and part of M_3, M.C.Z. No. 9316.

Horizon and locality. Uinta C, near entrance to Myton Pocket, about 7 miles east of Myton, Duchesne County, Utah.

Specific characters. Size of lower jaw much larger than in *Antiacodon pygmaeus*. Other characteristics of the species have not been distinguished from those cited for the genus.

Discussion. The lower jaw, M.C.Z. No. 9316, is the only specimen known of *Auxontodon pattersoni.* Evidently this species was a very rare element of the fauna, as represented in the Uinta Basin, particularly considering the extensive collecting that has been carried on in the Uinta area and the relative abundance of artiodactyls encountered, both bunodont and selenodont.

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[3] Named for Mr. Bryan Patterson, who first recognized the true relationships of *Auxontodon.*

Measurements in millimeters of lower jaw and dentition in type specimen of *Auxontodon pattersoni*, M.C.Z. No. 9316

Depth of lower jaw at diastema between P_1 and P_2	8.0
Depth of lower jaw beneath M_2, lingually	12.1
Length of cheek tooth series from anterior margin of alveolus for P_1 to posterior margin of M_3	46.5
Length of diastema between P_1 and P_2	5.0[a]
Length of cheek tooth series from anterior margin of first alveolus of P_2 to posterior margin of M_3	37.2
Length of lower molar series, M_1-M_3, inclusive	19.2
P_1, anteroposterior diameter of root portion at alveolus	4.0[a]
P_1, transverse diameter of root portion at alveolus	2.5
P_3, length: greatest width	6.3[a]:3.0
P_4, length: greatest width	6.8[a]:3.6
M_1, length: greatest width	6.1:4.4

[a] Approximate

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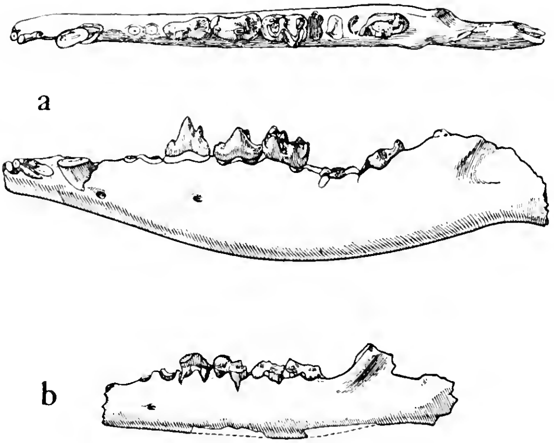

Figure 1. (a) *Auxontodon pattersoni*, new genus and species, occlusal and lateral view of left ramus of mandible, M.C.Z. No. 9316, with (b) lateral view of left ramus of mandible of *Antiacodon pygmaeus*, U.S.N.M. No. 18000. All natural size. Drawing prepared by Lawrence B. Isham.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. OCTOBER 27, 1958 NUMBER 97

FUSION OF CERVICAL VERTEBRAE IN THE ERETHIZONTIDAE AND DINOMYIDAE

BY CLAYTON E. RAY

Comparative postcranial osteology has been a curiously neglected source of evidence in the study of relationships among caviomorph and hystricomorph rodents though Landry, 1957, pp. 5-30, has made some use of postcranial osteology on the subordinal level. It seems useful, therefore, to call attention to a peculiarity observed in the cervical vertebrae of the living erethizontine (Fig. 1) and dinomyid (Fig. 2) caviomorphs. The second (axis) and third cervicals are firmly fused together in *Erethizon*, *Coendou*, *Echinoprocta* (the postcranial skeleton of *Chaetomys* is apparently unknown), and *Dinomys*. This condition was noted by Giebel (1877, p. 273) for *Coendou* (=*Cercolabes*) only and has apparently not been recorded in the literature since, having been overlooked, for example, by Scott (1905, p. 422) in contrasting the skeletons of *Sciamys* and *Erethizon*, by Anthony (1926, pp. 124, 126) in his detailed comparison of the skeletons of *Elasmodontomys*, *Erethizon*, and *Dinomys*, and by Swena and Ashley in their recent (1956, pp. 8-10) osteology of *Erethizon*. The first four cervicals are missing from the type (in part) skeleton of *Dinomys* figured by Peters (1873, Pl. 3, fig. 4). Landry (1957, p. 46) and Fields (1957, pp. 337, 341. 384) have mentioned but not described the tendency toward fusion of cervical vertebrae in *Dinomys* and in *Olenopsis*.[1]

Cervical vertebrae of the following caviomorph and hystricomorph genera have been available for examination or are ade-

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[1] Patterson (personal communication) questions Fields' (1957, p. 323) assignment of his Colombian material to the genus *Olenopsis*. Thus, even though the animal described is a dinomyid, it is not necessarily true that *Olenopsis* is a dinomyid.

quately described in the literature: *Acanthion, Thecurus, Hystrix, Atherurus, Trichys, Erethizon, Coendou, Echinoprocta, Eocardia* (Scott, 1905, p. 465), *Schistomys* (Scott, 1905, p. 482), *Cavia, Kerodon, Galea, Prodolichotis* (Fields, 1957, p. 373), *Dolichotis, Hydrochoerus, Dinomys, "Olenopsis"* (the material from the La Venta of Colombia, not the Santa Cruz of Patagonia). *Elasmodontomys, Amblyrhiza, Cuniculus, Dasyprocta, Myoprocta, Perimys* (Scott, 1905, p. 437), *Lagostomus, Lagidium, Chinchilla, Neoreomys* (Scott, 1905, p. 395), *Capromys, Geocapromys, Plagiodontia, Myocastor, Sciamys* (Scott, 1905, p. 422), *Ctenomys, Abrocoma, Isolobodon, Proëchimys, Hoplomys, Isothrix, Echimys, Dactylomys, Thryonomys,* and *Bathyergus.* Included in this list is at least one representative from every family of caviomorph and hystricomorph rodents (as given by Wood, 1955) excepting the Petromuridae. It is not likely that the condition of the cervicals in this monotypic African family would alter the general picture in any way. In none of the genera listed, save the three erethizontids and *Dinomys*, was cervical fusion noted.

ERETHIZONTINAE

The fusion in *Erethizon* is typical of the Erethizontinae and will serve as the basis for description. Some two dozen individuals were examined. The neural spine of the third cervical is here relatively higher than in mammals generally and is enveloped on either side by the broad lateral lamellae of the neural spine of the axis. The two neural spines become more broadly fused to one another with increasing age (though in part distinguishable in all specimens seen). In immature individuals the lateral lamellae of the axis are closely applied to the neural spine of the third cervical but are not fused to it, and in one individual (MCZ[2] 811) diverge posterodorsally to form a bifid process. The area of most profound fusion is between the postzygapophyses of the axis and the prezygapophyses of the third cervical, the trace of the articular surface becoming obliterated with age. Although the centra become tightly fused, particularly near the ventral midline, their

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[2] Throughout the discussion MCZ refers to Museum of Comparative Zoology, AMNH to American Museum of Natural History, CNHM to Chicago Natural History Museum, and UCMP to University of California Museum of Paleontology.

union is in part discernible in all individuals. The pleurapophyses of the axis approach those of the third cervical quite closely, but attain contact in only one individual (MCZ 819), in which the distal extremity of the right pleurapophysis (only) of the axis touches and is narrowly fused to the dorsolateral surface of the corresponding pleurapophysis of the third cervical. In none of the specimens examined was there any suggestion of fusion between the third and fourth cervicals.

DINOMYIDAE

Dinomys is represented by two subadult skeletons[3] (CNHM 66891 and 57186), by a young adult skeleton (CNHM 69593), and by an adult skeleton in part pathological (AMNH 70354). The nature of the fusion between the axis and third cervical is very similar to that in the Erethizontinae. Already in the immature individuals the neural spines are closely appressed and largely fused, whereas the mutual zygapophyseal articulations are completely and indistinguishably fused. As in some individuals of *Erethizon*, the lateral lamellae of the axial neural spine in all four specimens of *Dinomys* diverge posterodorsally to form a bifid process. These lamellae are broadly separated in CNHM 69593, and the intervening space is occupied by the neural spine of cervical three and by a connecting network of cancellous bone. In CNHM 57186 (Fig. 2A) and in AMNH 70354 a slit-like foramen situated on either side just medial to the zygapophyses passes into the neural canal between the neural arches of the axis and third cervical. This foramen may be interpreted as the vestige (preserved here for the passage of nerves and blood vessels) of the open space normally present between the neural arches of successive vertebrae. It is not present in CNHM 66891, and is but inconsistently and weakly developed in the erethizontids examined. There is on the articular facet of each postzygapophysis in CNHM 69593 a small foramen with a well-defined channel extending from it to the posterior (right) and postero-

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[3] Not adults as stated by Fields (1957, p. 320), but subadults judging from the slight wear undergone by $P\frac{4}{4}$, the open basisphenoid-basioccipital sutures, and the open epiphyses throughout the skeleton. The young adult is characterized by $P\frac{4}{4}$ in full use, closed basisphenoid-basioccipital suture, open vertebral epiphyses, and tight but discernible limb epiphyses.

medial (left) edge of the facet. I suspect that this foramen is homologous to the one discussed above, and that the functionally single postzygapophysis is in fact compounded from a posterolateral contribution from the axial postzygapophysis and an anteromedial contribution from the third cervical postzygapophysis. This suspicion is reinforced by the presence of complementary subdivisions in the prezygapophysis of cervical four (particularly the left), by the enveloping of the third cervical by the axis to a greater extent than in any other specimen of *Dinomys*, by the juxtaposition of the supposed axial postzygapophyses and the lamellae of the axial neural arch, and by the complete absence of the line of fusion as seen in lateral view in the other *Dinomys* specimens examined (Fig. 2A). Although the vertebral epiphyses (and second intercentrum at the base of the odontoid process) remain open throughout the column in the subadult and young adult specimens, the epiphyses between axis and third cervical are fused together (Fig. 2B). As in the erethizontines the pleurapophyses on either side approach closely but do not touch except in the youngest individual (CNHM 66891) in which the distal extremity of the left axial pleurapophysis is fused narrowly to the dorsal surface of the pleurapophysis of the third cervical. The pleurapophyses of the axis in CNHM 69593 are peculiarly developed into broad lamellae which extend posterodorsally lateral to the prezygapophyses of cervical four. Neither in the two subadult individuals nor in the young adult are cervicals three and four fused to one another. However, in the older of the two subadults (CNHM 57186) and in the young adult (CNHM 69593), roughened areas are present immediately anterior to the postzygapophyses of cervical three, posterior to the prezygapophyses of cervical four, and in the area of contact between the neural spines, suggesting the possibility of fusion at these points, with increased age. The contact surface between centra three and four in CNHM 69593 is not at all planar but curves anteriorly at both dorsolateral corners. Clearly very little movement could have occurred between cervicals three and four in this individual. AMNH 70354 presents a special problem owing to its pathological nature and to the lack of a series of normal adult skeletons from which to determine the average condition. Here the centra of cervicals two through seven are fused as are the neural spines and zygapophyses of cervicals two through five. The fusion of the centra between cervicals five and six and between six and seven is effected by gross ventral exostoses. Otherwise cervicals five through seven are independent of one another just as they are in the three younger individuals at hand and in the subadult figured by Peters (1873, Pl. 3, fig. 4), all of which strongly suggests that these vertebrae are not ordinarily fused in *Dinomys*. The fusion of centra two through five may be enhanced by lesser exostoses. All post-atlantal cervicals are more or less marked by the rugose, spongy, asymmetrical growth indicative of pathology, as are many of the other vertebrae (notably the posterior thoracic and anterior lumbar). However, the exostoses are not so pronounced as to definitely indicate that cervicals four and five are here abnormally included in the fused series. That cervical five was not fused to cervical four in the type skeleton is clearly shown by the accidental loss of the fourth and the preservation of the fifth (Peters, 1873, p. 231). On the basis of the condition in the subadult and young adult animals (and its analogy to the erethizontines) and the pathology of AMNH 70354, it seems reasonable to conclude tentatively that only cervicals two and three are normally fused in *Dinomys*, and that cervical four may be added in older animals. The final solution awaits more specimens.

Thus *Dinomys* and the erethizontines are very similar in the fusion of cervical vertebrae, with the reservation that fusion seems to be more variable in nature and extent in *Dinomys* than in the erethizontines (judging from the considerable diversity observed among only four individuals of *Dinomys*). Certain differences may be noted in the morphology of the vertebrae in the two groups. The anterior articular facets of the axis in erethizontines are entirely convex and situated on low pedestals serving to separate them from the peglike odontoid process, whereas in *Dinomys* the facets are concave in frontal section in such a way that they form a curved surface continuous medially with the bluntly conical odontoid process (cf. Figs. 1B, 2B). In the erethizontines the centra of cervicals two and three are relatively deep dorsoventrally, with a prominent anteroposterior mid-ventral ridge (especially in *Erethizon* and *Coendou*); in *Dinomys*, relatively shallow dorsoventrally with a flattened venter. In

Erethizon the articular facets of the postzygapophyses of cervical three are situated relatively high on the neural arch, are about equally laterally and ventrally directed, planar, and somewhat isolated from the body of the neural arch; in *Dinomys* the articular facets are relatively low, dominantly ventrally directed, concave in transverse section, and an integral part of the neural arch (cf. Figs. 1C, 2C).

Of extinct erethizontids and dinomyids only the dinomyid from the La Venta Miocene of Colombia, described by Fields (1957, p. 323, et sqq.) under the name *Olenopsis* (=*Drytomomys*) *aequatorialis* (Anthony) 1922, includes cervical vertebrae. The specimens preserved are both articulated series of subadult vertebrae, the one set (UCMP 39969) including a fragment of the left postzygapophysis of the axis and cervical three through thoracic one, all perfectly preserved excepting the distal extremities of pleurapophyses; the other set (UCMP 41636) including most of the neural arch and spine of the axis, complete (excepting pleurapophyses) cervicals three, four, and five, and fragmentary cervicals six and seven lacking portions of the neural arches. I am very sorry to be unable to agree with Fields' characterization (1957, p. 337) of the cervical vertebrae as "showing tendency toward fusion of anterior part of series, as in *Dinomys*." I can discover no certain evidence for fusion between any of the vertebrae preserved. The prezygapophyses and anterior end of the centrum of cervical three in UCMP 39969 bear well-preserved, smooth articular facets as in normal diarthroses. The fragment of the left postzygapophysis of the axis adhering to the third cervical appears to be merely cemented by matrix as are the articulations in all cases. The anterior articular facet of cervical three is exposed and smooth also in UCMP 41636. The neural arch of the axis in this specimen is slightly skewed upon that of cervical three in a clockwise direction as viewed from above with the result that the two vertebrae are not perfectly articulated but are separated by a thin layer of cementing matrix. The two neural spines are nowhere in contact, that of cervical three being quite low as in the succeeding cervicals and unlike the tall spine of the third cervical in *Dinomys*. That the absence of fusion in the fossils is not due merely to immaturity is shown by the youngest specimen of *Dinomys* (CNHM 66891) the dentition of which is comparable in stage of wear to that of the dentigerous elements associated with each of the fossils (Fields, 1957, Figs. 15, 16A, 16B). The possibility remains that fusion could have occurred later in the ontogeny of the extinct form, but even granting this possibility the tendency could have been by no means as strong as in *Dinomys*.

TAXONOMIC DISCUSSION

Evidence from myology (Parsons, 1894, pp. 295-296; Wood and White, 1950, p. 592), external characteristics (Pocock, 1922, p. 422), parasitology (Vanzolini and Guimarães, 1955, p. 43), dentition (Wood, 1950, p. 95), serology (Moody and Doniger, 1956, p. 54), and paleontology and paleogeography (Wood, 1955, p. 180) has clearly indicated that erethizontids and hystricids show no particular resemblances to one another beyond the possession of quills,[4] structures shared also with hedgehogs, echidnas, and some tenrecs as well as with other rodents. This distinctness of New and Old World porcupines was recognized by some workers many years ago (e.g. Tullberg, 1899, p. 108), but only recently has the opinion been expressed that erethizontids are isolated from other caviomorphs. Simpson (1945, p. 94) followed by Wood (1955, p. 182) has accorded superfamilial rank to the New World porcupines, whereas Moody and Doniger (1956, p. 53) have asked, "Should the erethizontids be accorded their own suborder?" In support of this suggested isolation are the findings that *Erethizon* is serologically as distinct from *Cavia* and *Dasyprocta* as from *Hystrix* (Moody and Doniger, 1956, p. 52), that erethizontid Mallophaga fall into one isolated group and those of other caviomorphs into another (Vanzolini and Guimarães, 1955, pp. 30, 31), and that "Deseadan caviomorphs are all very closely related, except for the erethizontids, which were already distinct" (Wood, 1955, p. 182). It should be

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[4] In point of fact, the quills are structurally rather dissimilar in the two groups. For example, the distal portion of the quill in all three genera of Erethizontinae is furnished with a covering of imbricate, proximally directed barbs (described and illustrated for *Erethizon* by Loweg, 1900, p. 853, Pl. 28, fig. 6 and by Shadle and Po-Chedley, 1949, p. 173, fig. 1), whereas I am able to find such barbs in none of the five genera of Hystricidae (Loweg, 1900, p. 853 notes their absence in *Hystrix cristata* and none are described by Lochte, 1957 in his detailed study of the quills in *Hystrix hirsutirostris*).

pointed out that the serological, parasitological, and (Deseadan) paleontological information is unknown for dinomyids, which therefore cannot on these grounds be summarily lumped with "other caviomorphs" as opposed to erethizontids. Aside from the similarity in cervical fusion demonstrated here, Pocock (1926, p. 228) has noted a "tolerably close resemblance" between the feet of *Dinomys* and of *Erethizon* and *Coendou*, and Fields (1957, p. 348) has pointed out the similarity of the auditory ossicles in *Erethizon*, *Dinomys*, and *Olenopsis aequatorialis*. Attractive as this evidence is, it furnishes an inadequate basis for asserting any special relationship between erethizontids and dinomyids. Indeed contrary evidence from dentition and cranial osteology seems at present to be more compelling. In this connection the relationship between the axis and third cervical in *Chaetomys* and in the Deseadan erethizontids will, when known, be of great interest in helping to determine, respectively, the affinities of *Chaetomys*, and the antiquity of fusion in the erethizontids. If fusion had already taken place in the Deseadan (Oligocene) erethizontids then it might reasonably be concluded that the fusion in dinomyids is independent since it apparently had not occurred by late Miocene time. Furthermore, one would expect fusion to occur in *Chaetomys* if it is truly an erethizontid.[5]

In conclusion, present evidence indicates that the constant and exclusive fusion of cervical vertebrae two and three, together with the morphological features described above, furnishes a valid taxonomic character for the living Erethizontinae. Appraisal of the possible broader value of the character awaits evidence from *Chaetomys*, normal adult *Dinomys*, and fossil erethizontids (and additional fossil dinomyids).

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[5] A cautionary, if confusing, example is provided by the Pedetidae, in which cervical fusion may prove to be irregularly distributed. Hatt (1932, pp. 640, 715) found cervicals two and three to be fused in *Pedetes surdaster* but not in *P. cafer* (as Hatt was well aware, this character should be checked on more specimens than were available to him). In early Miocene time fusion had not taken place in *Megapedetes* (MacInnes, 1957, p. 13) but may well have taken place in the more specialized *Parapedetes*. Stromer (1926, pp. 130, 131) does not mention fusion in his description of the cervical vertebrae of *Parapedetes*, but the specimen was embedded in matrix and the character could easily have been overlooked. It goes almost without saying that the pedetids are so remote from caviomorphs and the fusion of their cervical vertebrae is a response to such different selective pressures that this common character is of no taxonomic significance whatever.

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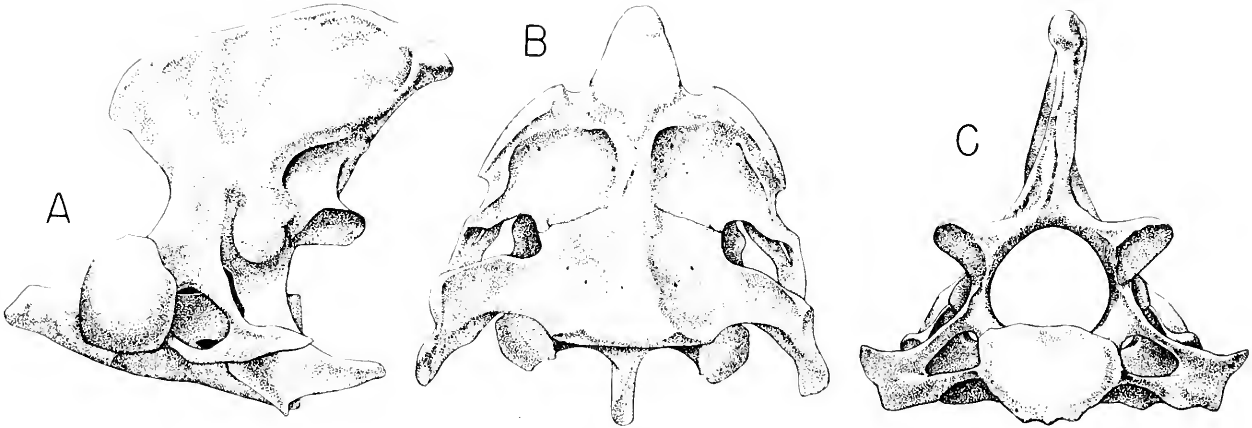

FIGURE. 1. (A) Lateral, (B) ventral, and (C) posterior views of the fused axis and third cervical vertebra of *Erethizon dorsatum*, MCZ 819. Approximately x2.

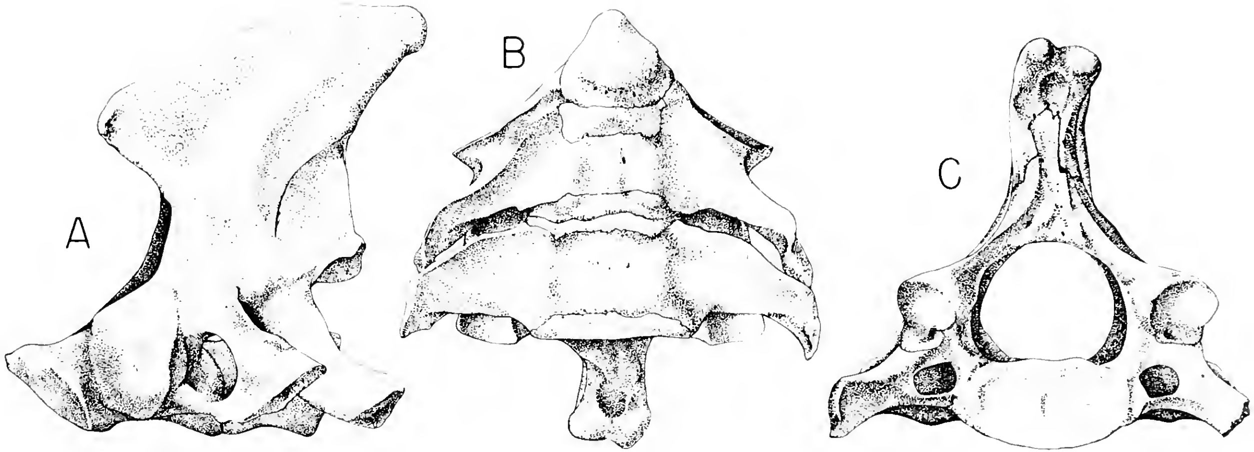

FIGURE 2. (A) Lateral, (B) ventral, and (C) posterior views of the fused axis and third cervical vertebra of *Dinomys branickii*, CNHM 57186. Approximately x2.

B R E V I O R A

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TWO NEW SPECIES OF BATHYLAGUS FROM THE WESTERN NORTH ATLANTIC WITH NOTES ON OTHER SPECIES

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While reviewing the Atlantic bathylagids for the forthcoming volume of "Fishes of the Western North Atlantic," two apparently unnamed species were encountered and are herein described as new. In addition, notes on several related bathylagids are presented.

Bathylagus compsus, sp. nov.

Figure 1

Bathylagus glacialis Beebe (*non* Regan), 1933, p. 114.

Holotype. U.S. National Museum 171755, 44.4 mm. in standard length; collected by Richard H. Backus on board the "Blue Dolphin," haul RHB 457, July 17-18, 1953, Isaacs-Kidd midwater trawl. Trawl down at 2255 hours, up at 0210 hours. Depth 69.5 m. Locality, within a circle 12 miles in diameter with the center at 39° 45′ N., 71° 08′ W. *Paratype:* USNM 171754 (1), 38 mm. in standard length; data as for the holotype.

Diagnosis. A *Bathylagus* with an extensive gill opening, reaching almost halfway up the side of the body; an anal fin base longer than the length of the caudal peduncle; and dark pigment present on the margins of the scale pockets.

Counts and measurements. Measurements given as per cent of standard length, holotype first, followed by the paratype in parenthesis. Dorsal 11 (10), anal 19 (20), pectoral 9 (9), ventral 9 (10), branchiostegals 2 (—) ; preanal 75.9 (76.8), preventral 52.5 (52.1), predorsal 47.3 (50.0), prepectoral 27.0 (—), head length 25.0 (26.3), snout 5.6 (5.3), eye 10.0 (9.2), greatest body depth 16.9 (15.3), least depth of caudal peduncle 6.3 (6.6), dorsal fin base 8.8 (6.8), anal fin base 16.9 (15.0), interorbital 9.0 (—).

Description. A graceful, elongate fish with the greatest depth a short distance behind the head. The dorsal profile of the head descends from the nape to the interorbital in almost a straight line. It curves downward near the anterior edge of the orbit and descends to a point above the nares where another inflection occurs causing the profile to drop more steeply to the upper lip. The dorsal rim of the orbit does not enter the dorsal profile in the larger specimen but does in the smaller. The ventral profile of the head rises more gently than the dorsal profile descends. The interorbital area is broadly concave between the supraorbital canals. The maxillary extends back to a vertical from a point slightly in front of the anterior edge of the orbit. Minute papillae are present on the ventral margins of the maxillary and premaxillary. The jaws are rounded and subequal.

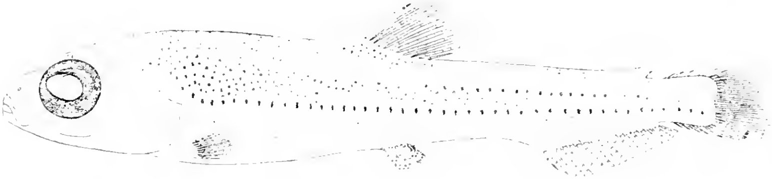

Figure 1. USNM 171755. Holotype of *Bathylagus compsus.*

The eyes are directed laterally and lack adipose eyelids. A crescent of white tissue is present over the iris of the posterior half of the eye.

The height of the gill opening is slightly less than half the greatest height of the body and extends beyond the dorsal edge of the pectoral fin base by a distance equal to two and one-half times the length of the pectoral fin base. In his description of post-larvae of this species, Beebe (1933, p. 119) stated "gill openings characteristically small"; however, he gave no quantitative data, nor did he discuss this character in larger specimens.

The pectoral fin inserts a short distance behind the head on the ventrolateral contours of the body. The dorsal fin originates close to the midpoint of the body and has its base raised above the body. The ventral fins insert on the ventral surface of the body under the posterior part of the dorsal fin base. The anal fin base is set off from the body and is longer than the dorsal fin base and longer than the length of the caudal peduncle. The adipose fin is placed over the posterior end of the anal fin base. The fins are all broken off short.

The pigmentation of specimens in alcohol is striking and serves as an important diagnostic character, at least in adolescent specimens. The ground color is a light yellow-brown. The muzzle, the opercular apparatus and a ring around the orbit are dark brown. The opercle is overlaid with an iridescent sheen and is probably silvery in life. The iris is iridescent gun-metal blue and may also be silvery in life. The dark lining of the peritoneal cavity shows through the body wall and outlines the body cavity. A single row of large, dark chromatophores runs the entire length of the body slightly below the lateral line. A second and less distinct line parallels the first line a short distance above the lateral line. The right side of the paratype shows a striking resemblance to Beebe's (1933, p. 118) figure of an adolescent specimen. The left side of the paratype and both sides of the holotype vary in that the anterior portion of the upper line is lost in a scattering of smaller, lighter chromatophores. The venter is lightly peppered with small, dark chromatophores which are more densely distributed on the dorsum. Brown pigment cells are also present on the dorsal surface of the head behind and before the interorbital area and on the cheeks. The caudal, dorsal and adipose fins have scattered brown chromatophores, while the anal, ventral and pectoral fins are immaculate or bear only a very few pigment cells. In both specimens the posterior half of the body has the ragged remnants of scale pockets colored by large, dark chromatophores (not shown in Fig. 1).

Relationships. Bathylagus compsus appears most closely related to *B. nigrigenys* and *B. longirostris*, the only other known species of *Bathylagus* with extensive gill openings and elongate anal fin bases. The types of *B. compsus* differ from specimens of *B. nigrigenys* of comparable size in having more anal rays, 19 to 20 in *compsus*, 13 to 17 in *nigrigenys;* a shorter preventral distance, 52.1 to 52.5 in *compsus*, 56.7 to 61.4 in *nigrigenys;* in having a less deep body, 15.3 to 16.9 in *compsus*, 18.9 to 22.6 in *nigrigenys*. In addition, adolescent *nigrigenys* apparently lack the striking pigment pattern found in *compsus*. Other less trenchant differences are also present.

I have examined neither adolescent specimens of *B. longirostris* nor adult specimens of *B. compsus* and so hesitate to compare proportional measurements; however, *B. longirostris* differs markedly from *compsus* in its complete lack of pigment on the scale pockets.

Discussion. In his studies on Bermuda *Bathylagus*, Beebe (1933) identified one of the forms upon which he reported as *Bathylagus glacialis* Regan, a species originally described from the Antarctic. More recent studies by Norman (1937) and Cohen (MS.) strongly suggest that *B. glacialis* Regan is a synonym of *B. antarcticus*. I have examined a series of *B. antarcticus* from southern waters, and I find they differ from Beebe's descriptions of his Bermuda material. Unfortunately, I have not been able to obtain Bermuda specimens for direct comparison; however, the two specimens at hand differ so markedly from *B. antarcticus* (which is probably restricted to far southern seas) and agree so well with Beebe's description that I feel no qualms at referring Beebe's *glacialis* to *Bathylagus compsus*.

Beebe (1933) also presented an osteological study of this species, and there seem to be a number of discrepancies between his findings and those of Chapman (1943), who presented an osteological study of *Bathylagus pacificus*. The differences appear so marked that they could be used to separate genera or even higher taxa. I was fortunate in having at my disposal the identical cleared and stained specimens upon which Beebe based his descriptions (Stanford University 45302, from Bermuda) and I was able to note several points which require comment. These are briefly noted since they are of some importance in the classification of the bathylagids. 1. The frontals: Beebe states that the frontals are fused and he also figures them as such. I find that the frontals are not fused but instead are slightly separated in the midline. The underlying cartilage has taken up some of the stain and the edges of the bone are difficult to see unless they are gently lifted. 2. The sphenotic: The bone which Beebe labels the pterotic in his dorsal view of the skull (Fig. 38) is actually the sphenotic and is so labeled in the lateral view (Fig. 36). 3. Supramaxillary: Beebe shows supramaxillaries in Figure 36, although he does not mention them in the text. I find no supramaxillaries, but instead a more heavily stained ridge which may have been mistaken for a joint. 4. Branchiostegals: Although he shows two branchiostegals in all of his figures and I find two branchiostegals in his specimen, Beebe gives three or four branchiostegals as a generic character. I know of no species of recent *Bathylagus* with other than two branchiostegal rays. Hubbs (1919) notes a single branchiostegal ray in *Bathylagus pacificus;* however, I have found two in this species. Chapman (1943) also reports two.

With regard to general shape and placement of bones, I find *Bathylagus compsus* in good agreement with Chapman's account of *B. pacificus*. Since Beebe did not dissect his specimen, his account of the deeper bones of the skull is necessarily sketchy.

The name *compsus* is from the Greek *kompsos*, elegant or pretty, and refers to the general appearance of this attractive species.

BATHYLAGUS GREYAE, sp. nov.

Figure 2

Holotype. Chicago Natural History Museum 49730, 71 mm. in standard length; collected by the "Caryn," haul 38, August 6, 1948, 35 foot otter trawl. Trawl in at 2245 hours, out at 0200 hours. Depth of haul 500-550 m., 1500 m. wire out, bottom depth 2000 to 2560 m. Locality, Bermuda, 32° 13.5′ N., 64° 32.5′ W.

Paratype. Stanford University 50974 (1), 35.5 mm. in standard length, collected by the Bermuda Oceanographic Expeditions of the New York Zoological Society, 1929-1930, net 35, April 24, 1929. Net down at 9:54 A.M., duration of haul 3 hours, 36 minutes. Depth of haul 1646 m. to surface. Locality, Bermuda, an 8 mile circle with its center at 32° 12′ N., 64° 36′ W.

Diagnosis. A *Bathylagus* with an extensive gill opening, reaching more than halfway up the side of the body; an anal fin base equal to or shorter in length than the length of the caudal peduncle; and dark pigment present on the margins of the scale pockets.

Counts and Measurements. Measurements given as per cent of standard length, holotype first, followed by the paratype in parenthesis. Dorsal 11 (13), Anal 13 (13), pectoral 12 (13), ventral 10 (11), branchiostegals 2 (—), gill rakers on lower arm of first arch in holotype 16, preanal 81.0 (79.1), preventral 58.4 (61.1), predorsal 48.2 (50.7), prepectoral 28.9 (32.7), head length 25.3 (29.6), snout 5.9 (7.0), eye 9.4 (see description for comments on eye of paratype), greatest body depth 13.4 (16.9), least depth of caudal peduncle 8.4 (8.4), dorsal fin base 12.0 (11.8), anal fin base 9.7 (9.9), lateral line scales probably between 45 and 50 on both specimens.

Description. An elongate and much laterally compressed fish with the greatest depth behind the head, tapering very little to the caudal peduncle. The dorsal profile of the head slopes gently downward in almost a straight line from a point behind the eye to a point near the nostrils, from whence it descends more steeply. The dorsal rim of the orbit projects into the dorsal profile of the head. The interorbital area between the supraorbital canals is broadly rounded. A well developed pineal apparatus is present and is visible through a clear window in the deeper pigmentation of the braincase. A broad ring of dense pigment about the window gives the appearance of an iris. The posterior edge of the maxillary does not reach a vertical from the anterior edge of the orbit. Minute papillae are present on the epidermal covering of the maxillary, premaxillary and dentary. The jaws are rounded and equal.

Figure 2. CNHM 49730. Holotype of *Bathylagus greyae* (this figure is a reconstruction of the somewhat distorted holotype and should not be used for measurements). Lower figure is of the opercle of *Bathylagus ochotensis*.

The mouth of the holotype is damaged, making it difficult to discern any details of dentition; however, the single row of upper teeth are conical and apparently restricted to the head of the vomer. The compressed dentary teeth are smaller than the vomerine teeth with the exception of a pair of small, spike-like teeth which project at the symphysis of the dentaries.

The eyes are directed laterally and lack adipose eyelids. A crescent of white material is present over portions of the iris. The left eye of the paratype presents certain peculiarities. It has a horizontal diameter of 3.5 mm. compared to 4.2 mm. for the right eye. In addition, the left eye has two small lenses visible through the pupil.

The height of the gill opening is more than half the greatest height of the body and extends beyond the dorsal edge of the pectoral fin base by a distance equal to about two and one-half times the length of the pectoral fin base in the holotype and about one and one-half times in the paratype.

The pectoral fin inserts a short distance behind the head on the ventro-lateral contours of the body. The dorsal fin originates close to the mid-point of the body. Both the dorsal and anal fin bases are set off from the body. The dorsal fin base is slightly longer than the anal fin base. The anal fin base is equal in length to the length of the caudal peduncle. The ventral fins insert on the ventral surface of the body under the posterior part of the dorsal fin base. The dorsal adipose fin is placed over the center of the anal fin base. A weak ventral adipose fin is present directly anterior to the vent of the paratype.

The ventral half of the holotype has a light, straw-colored ground color. The dorsal half of the fish is brown, while the opercle and the snout are dusky. Small, dark-brown chromatophores are scattered at random over the sides of the fish on a field of still smaller, more densely distributed, light-brown chromatophores. The sides of the head and all of the fins are lightly peppered with dark-brown pigment cells. Dark pigment is also thickly distributed on the margins of the scale pockets. Some of the scale pockets bear remnants of a purplish, translucent material which is common to a number of *Bathylagus* species. The paratype has faded badly, and little in the way of pigmentation remains.

Relationships. *B. greyae* is closest to *Bathylagus ochotensis* (which has *B. nakazawai* as a synonym, Cohen, MS.). It differs in having a greater preanal distance, 81.0 in the type of *greyae*, 73.7 and 77.6 in two specimens of *ochotensis* of comparable size; in having a longer preventral distance, 58.4 to 61.1 in *greyae*, 51.3 to 57.1 in 17 specimens of *ochotensis;* in having the anal fin base slightly shorter than the dorsal fin base, while in *ochotensis* the anal fin base is longer than the dorsal fin base. In addition, the postero-ventral margin of the opercle is smooth in *greyae*, while in *ochotensis* it is drawn out into five, finger-like projections (Fig. 2).

This species is named for Mrs. Marion Grey of the Chicago Natural History Museum in recognition of her contributions to the study of deep-sea fishes.

BATHYLAGUS LONGIROSTRIS Maul

Until the present time this species has been known only from the type, apparently taken at Madeira. I have examined a single specimen from the Gulf of Mexico, south of Pensacola, Florida, collected by the U.S. Fish and Wildlife Service vessel "Oregon" and deposited in the Chicago Natural History Museum. In addition, two specimens collected in the Central Pacific (30° 16.5′ N., 179° 54′ E. and 29° 54′ N., 168° 32′ W.) by the Pacific Oceanic Fishery Investigations (POFI) are apparently referable to *B. longirostris.* Descriptions of the above specimens will be included in a projected revision of the Bathylagidae.

BATHYLAGUS BERICOIDES (Borodin)

This species has been previously recorded three times, each from the Western North Atlantic. I have examined an unrecorded specimen from Bermuda (SU 42715) and a specimen from "Oregon" st. 1028 (Chicago Natural History Museum). The latter was provisionally identified as *Bathylagus microcephalus* by Springer and Bullis (1956). *B. bericoides* is also present in POFI collections from the central Pacific (39° 31′ N., 178° 54′ W.; 39° 08′ N., 164° 51′ W., and 42° 16′ N., 179° 52′ W.). These specimens will be treated at greater length in the future.

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BREVIORA

Museum of Comparative Zoology

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A NEW SUBSPECIES OF *CHAMAELEO JACKSONI* BOULENGER AND A KEY TO THE SPECIES OF THREE-HORNED CHAMAELEONS

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A small collection of reptiles collected on Mt. Meru, Tanganyika Territory, in August 1956, by Lt. Col. J. Minnery was sent to the Museum of Comparative Zoology by Mr. C. J. P. Ionides. It included three male chamaeleons that Mr. Loveridge believed to represent a new form but did not describe since he desired to confirm the characters on a large series. Fourteen additional specimens were obtained through Mr. Ionides in 1957 and seven in 1958 after Mr. Loveridge had retired as Curator of Herpetology. Five of these last have been sent to the British Museum (Natural History). These twenty-four specimens, together with an additional one already in the collection of the Museum of Comparative Zoology, form the basis on which the following form is described. (The name has been suggested by Mr. Loveridge.)

CHAMAELEO JACKSONI MERUMONTANA subsp. nov.

Type. A male, Museum of Comparative Zoology No. 56152 (collector's No. 7651), apparently adult, collected at Laikinoi, near Arusha, Mt. Meru, Arusha District, Northern Province, Tanganyika Territory, at 7500 ft. alt., August 1957 by Lt. Col. J. Minnery.

Paratypes. Twenty-four. MCZ 44327, male, Mt. Meru, east at 9000 ft. alt., 1938, Cooper collector; MCZ 54790-92, males, same locality as type, August 1956, Lt. Col. J. Minnery collector; MCZ 56153-59, males and 56151, 56160-64 females, same data as type;

MCZ 56989 male and 56990 female, same locality as type, January 1958, Lt. Col. J. Minnery, collector; BM (5 specimens), same locality as type, January 1958, Lt. Col. J. Minnery, collector.

Diagnosis. A chamaeleon with three annulated horns in the male, closest to *Chamaeleo jacksoni* Boulenger, but differing from it in smaller size, in having the occipital and postorbital areas covered with smooth or weakly convex scales (rather than strongly convex scales) and in having fewer and larger scales between the preocular horns.

Description. Three annulated horns, one rostral and two preocular in position and subequal in length. (In males only, females with only a rostral horn, proportionately shorter and with two sharp horn scales instead of the preocular horns.) Preocular horns arising from the anterior end of the raised supraorbital ridges and separated by a mosaic of enlarged flattened scales, a few of them with antero-posteriorly oriented ridges. (This ridging is more marked in some of the paratypes than in the type.) The minimum number of scales counted between the preocular horns (males) or horn scales (females), 7 in the type, 6 or 7 in the paratypes (see table below).

The supraorbital ridges continued posteriorly as low ridges to the posterior border of the head, separating the posterior dorsal and lateral head scales into postorbital and occipital areas. These areas are covered with enlarged scales, some of which are flat and others weakly convex. (The number of completely flat scales in these regions varies in the paratypes but never are there many strongly convex scales present.)

A moderately low curved profile to the casque; a parietal crest present, two or three scales high, forked anteriorly to form low ridges that extend antero-laterally toward the supraocular ridges, but do not meet them. These branches of the parietal crest separate the large flat occipital scales from an area of small strongly convex scales that are distinct from both the occipital scales and the interorbital scales anterior and lateral to them.

No occipital lobes; a very low ridge marking the posterior border of the casque and separating the head scales from the smaller nape scales.

Small, soft, triangular tubercles on the upper portion of the eyelid.

A median dorsal crest of enlarged scales extending from the shoulder region nearly to the base of the tail, these trianguloid scales largest and most pointed anteriorly, becoming smaller and more rounded posteriorly, separated by one to four scales. In some cases the small scale immediately in front of the large one is distinctly larger than the others but it never approaches the largest in size or shape. No crest on the tail.

The scales on the rest of the dorsal and lateral surfaces markedly heterogeneous in size on both body and tail, with an irregular arrangement of large flat scales among small granular ones and intermediates in size and convexity. The dorsal surfaces of the limbs similarly scaled but with large plates predominating, particularly on the forelegs.

The ventral surface covered by uniform granules with some very tiny ones between them, except for the sides of the throat where there are elongate patches of the very small granules. No gular or ventral crest evident.

Color (in alcohol) : The horns, the interorbital and snout scales, the supraorbital ridges, and the anterior enlarged dorsal crest scales light brown. The rest of the animal blue, lighter dorsally and on the head, limbs, and tail and darker on the lips, sides of throat and sides and venter of the body. (All the male paratypes show this distribution of light yellow brown but vary in the intensity of blue on the rest of the body. The females are blue with the rostral horn dark brownish.)

Measurements: See Tables 2 and 3.

Discussion. The Mt. Meru specimens described above are most similar to *Chamaeleo jacksoni* Boulenger which was described from Nairobi. However, they differ in a number of respects. The comparison below is based on eighteen adult specimens of the typical race from various localities in Kenya Colony.

The most striking difference is the small size of the Mt. Meru series. The largest male measures 91 mm. in snout-vent length, the largest female 86 mm. In the Kenya series of eighteen, eleven measure 97 mm. or over, snout-vent length. The largest male is 167 mm., the largest female 140 mm.

In *merumontana* the occipital and postorbital scales are flat or a few of them weakly convex, giving a smooth appearance to the occipital and postorbital areas. In the Kenya specimens many of these scales are strongly convex giving a bumpy appearance to these areas.

In the Mt. Meru series, the scales between the preocular horns (interorbital scales) are larger and fewer in number than in the Kenya specimens. The table below shows the specimens arranged according to the *least* number of scales counted between the horns.

TABLE 1

SCALES BETWEEN PREOCULAR HORNS OR HORN SCALES

Numbers of scales		6	7	8	9	10	11	12
Number of specimens with each scale count	Mt. Meru	8	17	0	0	0	0	0
	Kenya	0	1	3	8	5	0	1

In the Mt. Meru series the large flat interorbital scales (some of them sometimes having a median keel) differ sharply from the more posterior small strongly convex scales between them and the branches of the parietal crest. In the Kenya specimens the interorbital scales do not differ markedly from the scales behind them.

In the Kenya specimens the dorsal crest is formed by groups of two scales, the first of which is smaller than the second, but both are larger than the scales between groups, and both are pointed — at least in part. The enlargement of the anterior scale is much less evident in some of the smaller specimens. In the Mt. Meru specimens the anterior scale in each group is relatively smaller. It is usually but little larger than the surrounding scales, so that the crest seems to be composed of single, isolated, enlarged scales.

The ridges on the head of the Kenya form are more distinct than those of the Mt. Meru series. This is particularly true of the ridge along the posterior border of the casque and the anterior branches of the parietal crest. The more marked parietal crest gives a noticeably higher profile to the casques of the large males from Kenya.

The body scales of all of the specimens are markedly heterogeneous. The two forms differ only in that the large scales tend to be flatter in the Mt. Meru specimens than in the Kenya specimens.

In seven of the eight Mt. Meru females the rostral horn is well developed, although shorter than that of a male of equivalent size. The eighth female has a very small rostral horn, and none has preocular horns. In the six large Kenya females, one has both rostral and preocular horns developed. In the other five the preocular horns are 2 mm. or less. Three of these have a rostral horn and two have only a sharp rostral scale.

Loveridge, 1957, gives the range of *Chamaeleo jacksoni* as "Highlands of Kenya Colony and Tanganyika Territory." Apparently his inclusion of Tanganyika was based on the MCZ specimen No. 44327 from Mt. Meru, listed here as a paratype of *C. j. merumontana*. No other specimens or records of *C. jacksoni* from Tanganyika have been located. Therefore, the range of *C. j. jacksoni* can be restricted to the highlands of Kenya Colony, and that of *C. j. merumontana* can be given as Mt. Meru, between 7500 and 9000 ft. alt.

Of the type and those paratypes collected by Lt. Col. J. Minnery, C. J. P. Ionides writes: "They are found on bushes and in low small trees. Laikinoi is a farm on the very edge of the rain forest." (Letter dated 5 December 1957.)

Three-horned chamaeleons. In the course of describing this form, specimens of the five other species of three-horned chamaeleons were examined. A few notes and a key for the identification of these species are included below.

The six species characterized by the possession of three annulated horns in the male do not seem particularly closely related. The other morphological characters that they have in common are negative rather than positive: lack of spurs in either sex; lack of axillary pockets.

Among them, *C. jacksoni* seems closest to *C. johnstoni* Boulenger, again primarily on negative characters: absence of occipital lobes, absence of a gular crest, absence of a dorsal fin, but also in the possession of heterogeneous body scales.

C. werneri Tornier and *C. fulleborni* Tornier seem quite closely related to each other, though not to either *C. jacksoni* or *C.*

johnstoni. The only other close relationship involving these species seems to be between *C. johnstoni* and *C. ituriensis* Schmidt, the latter a hornless chamaeleon of the eastern Belgian Congo forest.

C. oweni Gray is widespread throughout the lowland rain forest in West Africa extending into eastern Belgian Congo. All the others are mountain forest forms in East Africa: *C. fulleborni* from the Ngosi Volcano, Poroto Mountains, Ukonde, Tanganyika Territory; *C. werneri* from the Uluguru and Uzungwe Mountains, Tanganyika Territory; *C. johnstoni* from the virgin forest of Uganda, Belgian Ruanda-Urundi and the adjacent Belgian Congo; *C. deremensis* Matschie from the Usambara and Uluguru Mountains, Tanganyika Territory; *C. jacksoni* from the highlands of Kenya Colony and Mt. Meru, Tanganyika Territory.

It is noteworthy that except in the Uluguru Mountains no two species of three-horned chamaeleons are known to occur together. This is evidence supporting the suggestion that the three horns serve these chamaeleons as a means of species recognition. The case of the two species occurring together on the Uluguru Mountains supports rather than contradicts this view. These two chamaeleons are very different in appearance. *C. deremensis* is large, laterally compressed and with a high dorsal fin; *C. werneri* is smaller and stocky with no dorsal fin. Even with the presence of three horns in both there could be little opportunity for confusion. In eastern Belgian Congo where a close relative of the three-horned *C. johnstoni, C. ituriensis,* occurs with the three-horned *C. oweni,* both species are similar in size and proportions, but *C. ituriensis* is hornless.

Key to the three-horned chamaeleons

1.	High sail like dorsal fin	*C. deremensis*
	No high sail like dorsal fin	2.
2.	Body scales equal in size or nearly so	*C. oweni*
	Body scales differing markedly in size	3.
3.	Well developed occipital lobes	4.
	No occipital lobes	5.
4.	Occipital lobes continuous across back of casque as a flap	*C. werneri*
	Occipital lobes separated by a gap in the middorsal region	*C. fulleborni*

5. Dorsal crest of much enlarged scales in groups of one or two . . . . 6.
No dorsal crest of much enlarged scales . . . . 7.
6. Occipital and postorbital scales strongly convex, scales between preocular horns smaller and more numerous (7-12), size larger . . . . *C. j. jacksoni*
Occipital and postorbital scales flatter, scales between preocular horns larger and fewer (6-7), size smaller *C. j. merumontana*
7. *Dorsal profile of body smooth or undulating . . . *C. j. johnstoni*
Dorsal profile of body crenulated . . . . *C. j. crenulata*

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* *C. johnstoni crenulata* not seen, this section of the key taken from Laurent, 1951.

Table 2

MEASUREMENTS OF MT. MERU SPECIMENS

Museum Number	Sex	Snout-vent Length	Rostral horn Length	Preocular horn length	Head length (snout to end of casque)	Scales between preocular horns
MCZ 44327	male	68	13	11	22	7
54790	"	88	19	18	28	6
54791	"	76	16	14	24	7
54792	"	60	7	6	19	7
*56152	"	91	19	18	29	7
56153	"	73	18	18	24	6
56154	"	78	15	13	26	6
56155	"	75	16	15	25	7
56156	"	73	17	16	24	7
56157	"	90	20	16	29	7
56158	"	71	11	10	24	6
56159	"	64	10	8	20	7
56989	"	86	23	22	26	6
BM ——	"	78	17	15	26	7
——	"	82	16	15	24	7
——	"	57	9	7	19	7
——	"	79	14	13	25	7
56151	female	74	7	—	23	7
56160	"	77	7	—	23	6
56161	"	80	8	—	22	6
56162	"	81	8	—	25	7
56163	"	74	8	—	23	7
56164	"	86	6	—	26	7
56990	"	78	8	—	24	6
BM ——	"	79	2	—	24	7

* Type of *C. j. merumontana*

TABLE 3

MEASUREMENTS OF KENYA SPECIMENS

MCZ Number	Sex	Snout-vent length	Rostral horn length	Preocular horn length	Head length (snout to end of casque)	Scales between preocular horns
Embu District						
7842	male	110	15	15	35	9
7842	female	140	—	—	41	12
Meru						
11467	male	167	35	33	52	9
29454	‘‘	118	22	22	41	10
Lukenya						
34995	female	99	7	—	31	10
34996	male	111	16	16	36	9
Parklands, Nairobi						
18365	male	98	15	13	30	9
18366	female	123	13	6	37	9
18367	‘‘	97	5	2	29	8
31365	‘‘	103	3	2	32	9
31366	‘‘	105	—	—	31	8

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BREVIORA

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ON THE PINEAL ORGAN OF THE TUNA, THYNNUS THYNNUS L.

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A conspicuous pineal spot has been found in many scombrid fishes, e.g. *Thynnus*, *Germo*, *Parathynnus* and *Neothynnus* and the related genera *Auxis*, *Katsuwonus*, *Euthynnus* and *Sarda*. Underlying the pineal spot a fontanelle or "pineal window" (Rivas, 1952) is present in the last four mentioned genera and also in *Scomber* and *Scomberomorus*. Rivas investigated the pineal apparatus of the tuna, *Thynnus thynnus* L. and claimed a photoreceptory role of the pineal area, but he "failed to reveal the presence of a pineal organ, which is apparently absent or greatly reduced" (Rivas, 1952, p. 174). My researches show, however, that a pineal organ is present in the tuna.

A supply of the bluefin tuna, *Thynnus thynnus* L. was obtained from an expedition on board M/S "Delaware," belonging to U.S. Fish and Wildlife Service. Five fishes were dissected, and the pineal organ of each was sectioned and stained, using Bodian's protargol method (Romeis, 1948, p. 421) to determine the presence of nerve elements, and Heidenhain's azan stain (Romeis, 1948, p. 344) for the general histology. The sections were cut at 8 microns, using paraffin technique.

Dissections of the Bouin-preserved material of the tuna revealed, as had previously been pointed out by Kishinuya (1923), Gregory (1933), Godsil and Byera (1944), and Rivas (1952), the presence of a fontanelle, underlying a conspicuous white pineal spot 15 x 30 mm. in size, in a specimen weighing 350 lbs. (Fig. 2). The spot is situated slightly caudally from an assumed line connecting the centers of the eyes. The dermal layer over the pineal fontanelle was found to be translucent, transmitting about 20 per cent of the light, measured with a photometer.

The fontanelle in the frontal bone, below the dermal layer (Fig. 3), was filled with a jelly-like translucent substance, and measured slightly less than the overlying white pineal spot, about 10 x 30 mm. in the specimen mentioned above.

About 5 mm. below the edge of the frontal bone, the jelly-like material passed into a more cartilaginous type of tissue. A tubular excavation around the pineal organ was formed below the pineal fontanelle, leading down to the brain at an angle of 60 or 70 degrees (Fig. 1). The excavation had a diameter of 10 mm. The end-vesicle of the pineal organ was situated immediately below a dome-shaped cartilage (Figs. 1, 4). The vesicle was approximately 10 mm. in diameter and connected to the diencephalon by a stalk. Ventrally the stalk had a white cord which distally seemed divided into two branches; in the specimen photographed the stalk was 30-35 mm. in length (Fig. 1).

The histological examination of the end-vesicle showed a structure similar to that of most other teleost fishes. The lumen, however, was larger and the walls were thinner, consisting of only one or two layers of cells (Figs. 4, 5). Because the pineal cells were secretory and had cytoplasmic processes extending into the lumen of the vesicle, the cells of the end-vesicle and the stalk (Figs. 4, 5) were similar to the primary sensory cells in teleosts described by N. Holmgren (1920) and Friedrich-Freksa (1932). There were also present supporting cells ("Stützzellen" Friedrich-Freksa, 1932) which had more hyperchromatic nuclei and more indistinct cytoplasm than the sensory cells.

A cross-section of the pineal stalk revealed, especially in the distal part, folded walls. Connective tissue, stained blue with Heidenhain's stain, formed a thin layer inside and outside the wall of the stalk. Silver impregnation did not give any evidence of axons either in the pineal vesicle or in the stalk. A tractus pinealis is present, at least in the proximal portion of the pineal stalk, in many teleost fishes. Apparently the tuna is one of the exceptions.

The pineal structures in the tuna were found to be very vascular, especially below the end-vesicle of the pineal organ (Fig. 4) and in its walls. There, many small blood vessels filled with blood corpuscles were found.

Rivas (1952) suggested positive phototropism in tunas using the experiments of Hsiao (1952) to support his idea. The latter found that both the Pacific yellowfin tuna (*Neothynnus macropterus*) and the Pacific little tunny (*Euthynnus yaito*) showed phototaxis. In these experiments the pineal area was considered to be partly responsible for phototaxis. Breder and Rasquin (1947, 1950) also have shown a correlation in certain teleost fishes between the degree to which the pineal area is exposed to light and the amount of positive phototaxis. Grunewald-Lowenstein (1956) demonstrated in the teleost *Astyanax* that prolonged exposure to light or darkness had an effect on the glycogen content of the pineal. Rasquin (1958) reported that the pineal secretion in teleosts was affected by light; this has also been found to occur in higher animals (Quay, 1956). While there is evidence that light in some way stimulates the pineal's secretory activity, it is also known that the diencephalon in some fishes is light sensitive (Scharrer, 1928; Young, 1935). This had already been indicated by von Frisch (1911) who demonstrated some continuing sensitivity to light by the teleost *Phoxinus* after extirpation of the pineal. Since von Frisch gives us reason to believe that the lining of the ventricle of the diencephalon has light-sensitive cells, and the work of Scharrer and Young corroborate this, the whole pineal area must be included in any discussion on the location of the light-sensitive apparatus. While the histological examination of the tuna's pineal organ showed thin walls which could possibly transmit light, the interior cells did not show any pronounced secretory activity. Therefore, taking into consideration the preceding evidence presented in this paper, one can conclude that while there are morphological indications of the possible light sensitivity of the pineal area in the tuna, there is not yet enough physiological evidence to make a firm commitment as to the possible ecological or hormonal control by this area.

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Fig. 1. Dissected specimen showing the end-vesicle of the pineal organ and the pineal stalk, ending in the diencephalon. This picture also shows the tubelike excavation extending from the upper edges of the frontal bone to the brain. Photo 3.5 x.

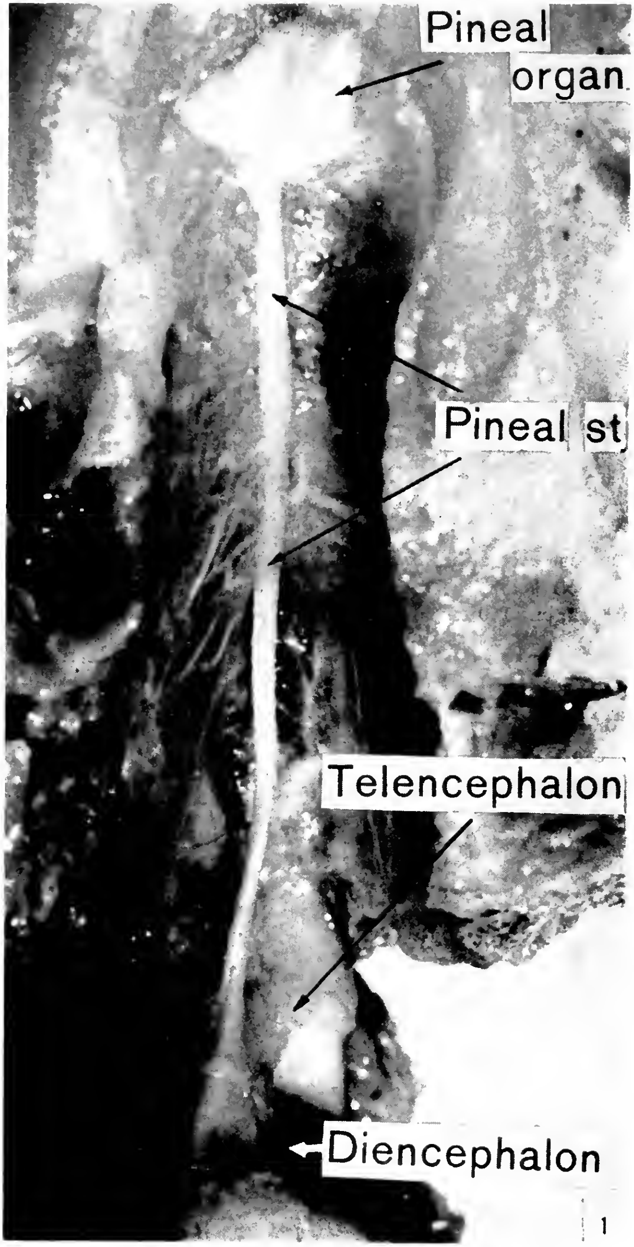
Pineal organ
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Fig. 2. The pineal spot of *Thynnus thynnus*. Specimen of 350 lbs. Natural size.

Fig. 3. The pineal fontanelle in the frontal bone. A jelly-like material is present in the fontanelle.

Fig. 4. Part of the pineal organ situated below the cartilaginous tissue mentioned above. Note the conspicuous lumen of the organ and the presence of blood vessels below the end-vesicle. Fixation Bouin's solution. Heidenhain's azan stain. 150 x.

Fig. 5. Section of the wall of the end-vesicle. Cytoplasmic processes are extending into the lumen of the pineal organ (arrow). Fixation Bouin's solution. Heidenhain's azan stain. 1200 x.

Fig. 6. Cross-section through the distal part of the pineal stalk, showing its folded walls. Fixation Bouin's solution, Heidenhain's azan stain. 300 x.


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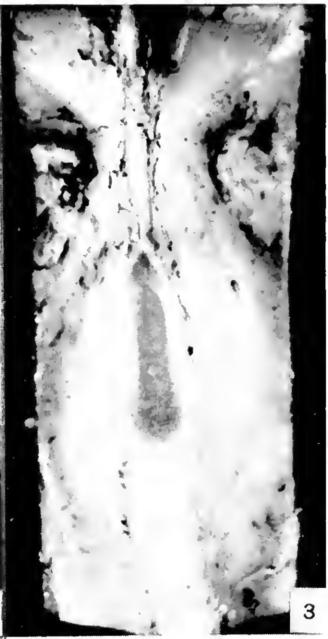
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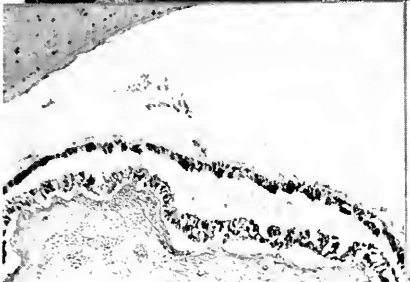
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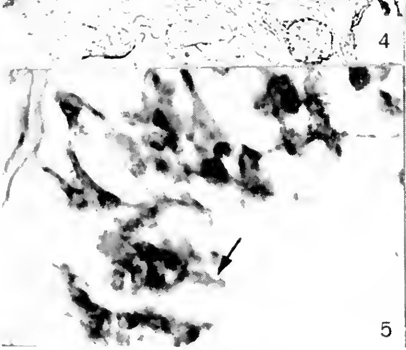
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Museum of Comparative Zoology

Cambridge, Mass. March 2, 1959 Number 101

CERVICAL RIBS IN TURTLES

By Ernest E. Williams

The existence of cervical ribs in Recent turtles is frequently denied. In fact, however, cervical ribs in turtles have been discovered and rediscovered several times over. They are rudimentary in all post-Triassic forms and the nature of these highly peculiar rudiments is evident only in embryos or young specimens. The only description with any pretensions to fullness is that of C. K. Hoffman (1879, repeated in Bronn's Thierreich 1890). There is brief mention of their occurrence in embryos by Ruckes (1929), Naef (1929) and Emelianov (1937). None of these previous observations has been sufficiently detailed to make the nature and relationships of the rib elements quite clear, and, except for rather crude and incomplete sketches in Hoffman, no figures have been given.

I have myself seen cervical ribs and rib rudiments in both adults and embryos (Emydinae) or in adults only (Testudininae, Chelydridae, Dermochelyidae, Chelyidae and Pelomedusidae). Embryos of *Emys orbicularis* given me by Dr. B. W. Kunkel and of *Pseudemys* sp., loaned me by Dr. H. Ruckes, and of *Chrysemys marginata* and *Chelydra serpentina* in the Minot Collection, Harvard University, have provided me with the opportunity to study the embryonic condition and developmental history of the cervical rib rudiments, while I have been able to examine adult conditions from specimens in the osteological collections of the Museum of Comparative Zoology (MCZ), the American Museum of Natural History (AMNH), the United States National Museum (USNM), the British Museum (Natural History) (BM), the Institut des Sciences Naturelles in Brussels, the Senckenberg Museum in Frankfort, the Zoologische Staatssammlung in Munich and the Laboratoire d'Anatomie Comparée of the Museum National d'Histoire Naturelle de Paris (LAC).

In the course of the present study a wide variety of conditions has been observed, including (in adults) considerable intraspecific variation. In many instances the ribs are fragmented or broken into little ossicles, which have been many times reported but rarely correctly interpreted. In yet other instances

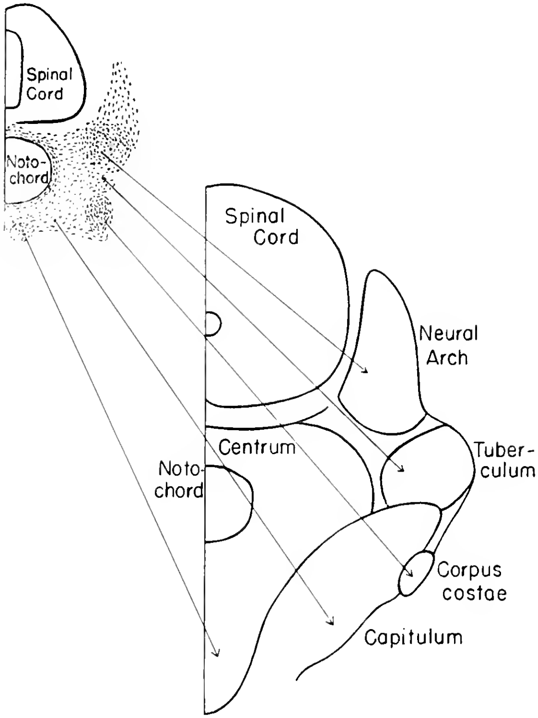

Fig. 1. Diagram to show the rib region in prechondral and cartilage stages of the cervical vertebrae of *Emys orbicularis*.

the ribs are still more rudimentary, represented in the adults only by cryptic fused elements. It would, in fact, be very difficult to understand the ribs of Recent adult forms if it were not for the evidence of embryos, and (as we shall see) of the Triassic fossils.

The embryonic cervical ribs of emydine turtles are *two-headed* with a dorsal tubercular attachment at the region of the neurocentral suture and a ventral attachment to the anterior intercentral ossicle, when that is present, or to the anterior centrum when the intercentrum is absent. These ribs may first be distinguished in precartilage stages (Fig. 1). They are then not very different from the precartilage cervical ribs of other reptiles.

With the onset of chondrification, however, these ribs undergo a partial degeneration. The dorsalmost portion chondrifies at its place of attachment to the neurocentral suture, but no joint forms here, and the separateness of the element is indicated at most by a suture line in cartilage (a line of small densely-packed, poorly-differentiated cartilage cells like those which constitute the cartilage neurocentral suture).

From the dorsal rib rudiment at the neurocentral suture a band of prechondral (later ligamentous) tissue extends ventroanteriorly toward the anterior intervertebral region. In this band there is embedded at the middle of its length a separate small cartilage nodule. The prechondral or ligamentous band then continues forward to attach anteriorly to a separate anteroventral nodule alongside a median intercentrum or to this element fused onto the intercentrum as a lateral parapophysial projection.

In the Emydinae, therefore, the bicipital rib of the membranous stage has fragmented into three distinct chondral elements. The morphological interpretation of these elements will be discussed a little later; for the present it will be well to have neutral terms for them, avoiding questions of homology. I suggest, therefore, calling the dorsalmost element the alpha rib element, the middle one the beta, and the ventralmost the gamma element.

I have seen this fragmented condition of the cartilage ribs in both *Emys* and *Pseudemys* embryos. I have not had the material to follow these structures into ossification stages, but the same elements are readily recognized in adult *Emys* and *Pseudemys* and in other Recent emydines.

In all living cryptodires the alpha element of the embryonic ribs is apparently represented by the low indistinct transverse processes found anteriorly at the junction of neural arch and centrum on each cervical. C. K. Hoffman (1890) has reported that this element ossifies separately in tortoises but remains cartilaginous in other forms. The second statement appears to be erroneous (except for *Dermochelys*); the first I cannot confirm from personal observation, but the statement has been repeated (whether copied or verified) by J. S. Thomson (1932).

I have three times observed separate ossification and hypertrophy of this element, in all cases as individual variations and always on the eighth vertebra — once asymmetrically (on the left side only) in a specimen of *Pseudemys scripta elegans* (Lafayette College), once symmetrically in *Gopherus berlandieri* (A.M.N.H. 91916), and once symmetrically in *Pyxis arachnoides* (L.A.C. 1885-34) (Fig. 2). Siebenrock (1906) has reported the same condition in the last form. These conspicuous abnormal examples apart, the alpha element appears in all Recent adult types to be a cryptic fused element.

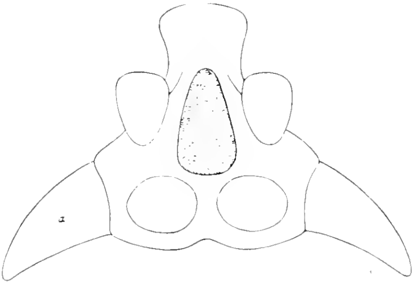

Fig. 2. *Pyxis arachnoides*. Anterior view of abnormal 8th vertebra. Symmetrical hypertrophied alpha elements.

The ventral rib elements, when present, are less frequently cryptic, but extreme intraspecific variability makes their description somewhat difficult.

In emydines, the gamma element may be present on all the cervicals, usually fused with the intercentra on the anterior vertebrae, free on the middle vertebrae, and fused again but with the anterior end of the centrum on the last cervical. I have seen free gamma ossicles in: *Batagur baska*, *Kachuga tectum*, *Orlitia borneensis*, *Malaclemys terrapin*, *Pseudemys scripta*, *Pseudemys floridana*, *Pseudemys rubriventris*, *Pseudemys terrapen*, *Chrysemys picta*, *Graptemys geographica*, *Graptemys oculifera*, *Clemmys insculpta*, *Clemmys muhlenbergi*, *Clemmys guttata*, *Clemmys leprosa*, *Clemmys marmorata*, *Emys orbicularis*, *Emydoidea blandingi*, *Deirochelys reticularia*, *Terrapene carolina*, *Geoemyda trijuga*, *Geoemyda punctularia*, *Cuora amboinensis* and *Cyclemys dentata*. When it is considered that these are small elements which, if free, are readily lost by the usual methods of skeletal preparation, it becomes very probable that gamma ossicles are typically present in the Emydinae. Indeed, in one instance they are probably invariably present: the antero-ventrolateral processes lying alongside the hypapophysis of the eighth centrum in emydines are apparently fused gamma ossicles. Similar fusion of gamma ossicles occurs rather frequently at the anterior end of the seventh centrum.

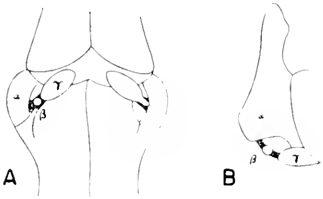

Fig. 3. *Terrapene carolina*. A. Ventral view of joint between 5th and 6th cervical centra showing separate beta and gamma rib elements. B. Anterior view of 6th vertebra in the same specimen. Compare Fig. 5.

The beta element, on the other hand, is unknown in adults except on the middle cervicals of a few individuals of certain emydine species. Here again, however, the probability of loss of these very small and loosely-attached elements must be taken into account as a possible explanation of the apparent rarity of these elements in adults.

An instance in which both ventral rib elements are well developed is seen in Figure 3A. The joint between centra 5 and 6 of a specimen of *Terrapene carolina* from my own collection is shown in ventral view. The gamma elements are relatively large flattened ossicles attached to the ventral side of the centrum (centrum 5) just below the paired, convex, posterior central articular surfaces. These ossicles extend posteriorly and somewhat laterally to lie partly underneath the anterolateral diminutive transverse processes (alpha rib elements) of the posterior vertebra (vertebra 6). Gamma and alpha rib elements are connected on each side by ligaments in which are embedded small rounded ossicles which are evidently the persisting beta elements. Figure 3B shows the same elements in anterolateral view. (Compare Fig. 4.) The only element of the morphological chain which we saw in the embryo that is missing in this case is the median intercentrum; this is consistently absent on the posterior cervicals of turtles.

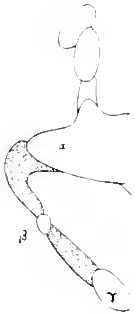

Fig. 4. *Pseudemys* sp. embryo. Section through right side of a middle cervical vertebra in early cartilage stages showing all three rib elements. Compare Fig. 3B.

Museum specimens in which I have seen comparable conditions (i.e. both beta and gamma ossicles present) are: *Clemmys muhlenbergi* U.S.N.M. 29228, *Clemmys insculpta* U.S.N.M. 63089 and *Chrysemys picta* U.S.N.M. 29233, as well as *Emys orbicularis* B.M. 1920-1-20-2248 and other specimens of this species at the British Museum. I should emphasize that these specimens are not the only ones by any means in which I have observed beta and gamma ossicles together; these are only certain readily accessible specimens upon which my observations may be confirmed. Museum specimens are not likely to have preserved these elements; careful preparation of specimens is required to reveal them.

As mentioned above, on anterior cervicals the gamma ossicles may be fused with the true median intercentra (or with the anterior of the two centra between which they lie), but occasional specimens show them separate from and lying alongside the intercentra, presenting in such cases the appearance of tripartite intercentra. I have seen this condition in *Chrysemys picta* U.S.N.M. 29233, *Pseudemys floridana* U.S.N.M. 60492, and *Orlitia borneensis* U.S.N.M. 37788 — in the first case only at the odontoid-second centrum articulation, in the two latter also at the joint between centra 2 and 3. I have seen such apparent triple intercentra also in *Chelydra serpentina* (a specimen at Lafayette College, A.M.N.H. 28942, and specimens 18308 and 18361 in the Natural History Museum of the University of Kansas).

Siebenrock (1907) mentions gamma ossicles in *Platysternon megacephalum*, regarding them, however, as rudimentary ventral arches. He says: "Rudimentäre unteren Bogen, Hypapophysen, kommen so wie bei *Macroclemmys* Gray and bei vielen Emydidae am ersten bis fünften Halswirbel vor; sie fehlen dagegen bei *Chelydra* Schw., wie ich mich an drei darauf untersuchten Skeletten überzeugen konnte."

As Siebenrock states, gamma ossicles appear to be usually absent in *Chelydra* except at the odontoid-second centrum articulation, but one specimen of this genus at the Senckenberg Museum has gamma ossicles on centra 3 to 5, as does another specimen in the Staatssammlung at Munich. I have not myself seen any gamma ossicles in *Macroclemys*, though Siebenrock mentions them above, nor in *Staurotypus* or in *Kinosternon*. Beta ossicles have not been seen in any of the Chelydridae *sensu lato*.

I have seen neither of the ventral rib ossicles in *Dermatemys*, and I have seen gamma ossicles only rarely in the Testudininae (e.g. at the odontoid-second centrum joint in *Gopherus berlandieri* A.M.N.H. 91916), but Siebenrock (1906) records a series of gamma ossicles in *Acinixys planicauda*, and Thomson (1932) reports them on the fourth, fifth and sixth vertebrae of *Testudo ibera* and *T. graeca*.

In the Cheloniidae and Dermochelyidae one ventral rib element is usually present on most or all the cervicals. It is cartilaginous in *Dermochelys* (e.g. U.S.N.M. 29492, see also the figure in Völker 1913), bony in *Caretta caretta* (e.g. U.S.N.M. 29372) (Fig. 5) and *Eretmochelys imbricata* (e.g. U.S.N.M. 59866). A special condition is seen in *Chelonia mydas* (A.M.N.H. 46837) (Fig. 6A) in which on vertebra 7 the rib rudiment is seen to be fused to the right anterior side of the vertebra in such a way as to enclose a small "vertebrarterial" canal. The "vertebrarterial" canal is incomplete laterally on the left side of the same vertebra. In another specimen of the same species (A.M.N.H. 5912) (Fig. 6B) the "vertebrarterial" canal is completed laterally by cartilage on both sides of the seventh vertebra.

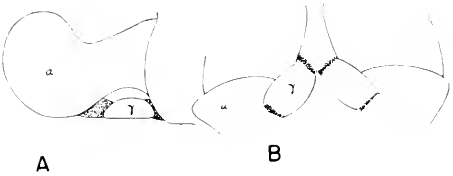

Fig. 5. *Caretta caretta*. A. Anterior view of 6th vertebra. B. Ventral view of joint between 6th and 7th centra in the same specimen.

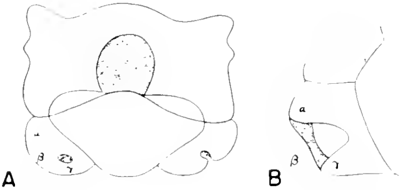

Fig. 6. *Chelonia mydas*. A. Anterior view of 7th cervical vertebra. B. Anterior view of right side of the 7th vertebra of another specimen.

I have seen ossified gamma ossicles also in the Eocene sea turtle *Eosphargis gigas* in the magnificently preserved specimen in the Brussels Museum.

Beta ossicles are unknown in the Cheloniidae, and they may in fact be merged with the rather larger apparent equivalents of the gamma ossicles of emydines.

I have seen no trace of rib rudiments except the transverse processes in adult trionychids or in *Carettochelys*, but gamma ossicle equivalents exist in at least *Chelus* and *Erymnochelys* of the Pleurodira.

These peculiar conditions of the rib elements in modern turtles are fortunately traceable to a more primitive condition in Triassic turtles. Jaekel (1916) has described and figured the situation in *Triassochelys dux* (=*Proganochelys quenstedti*), and I can confirm his description in all essentials, having examined the magnificent skeletons of *Proganochelys* in the possession of the Stuttgart Museum, which are to be described by Dr. K. Staesche.

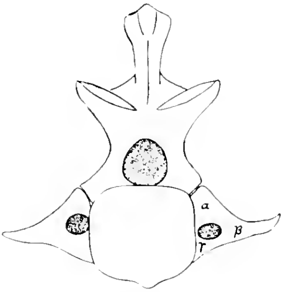

Fig. 7. *Proganochelys quenstedti* (=*Triassochelys dux*). Anterior view of 7th cervical vertebra showing bicipital rib. (After Jaekel.)

Figure 7 presents an anterior view of the seventh cervical vertebra in *Proganochelys* (after Jaekel). It will be seen that these are ribs of a normal bicipital type, the tuberculum lying across the neurocentral suture, the capitulum articulating more ventrally with the side of the centrum. Ribs of this type were present on cervicals 2 to 7. The eighth rib much resembled the abnormal vertebrae of *Pseudemys*, *Pyxis*, etc. described above. It is single-headed rather than bicipital, elongate rather than short. It curves downward distally to a degree appropriate to its length. Its single head lies across the neurocentral suture in the position of the tuberculum. Probably the eighth and the ribs behind it retain only the tuberculum of the two original rib heads.

The congruence of the bicipital ribs in *Proganochelys* with the ribs that would be expected if the embryonic rib elements of Recent turtles were fully developed is very complete. With this evidence before us, the interpretation of the otherwise very singular, even anomalous rudimental rib ossicles of Recent turtles can hardly be questioned.

I have seen similar small ossicles that are apparently rib rudiments in large lizards, e.g. *Iguana iguana* A.M.N.H. 1269 (Comparative Anatomy collection). The phenomenon of rib fragmentation is thus not confined to the neck of turtles. Indeed, there is a considerable literature on anomalous rib conditions in Amniota (Baur 1886, Howes and Swinnerton 1901 — *Sphenodon;* Noble 1921 — *Sphaerodactylus;* Schinz and Zangerl 1937b — *Gallus;* Virchow 1929 — *Ornithorhyncus:* Albrecht 1882, Hayek 1928, de Burlet 1917, Federow 1910, Abel 1909 — various mammals.)

These special conditions have, I feel, implications of greater morphological moment than appears on the surface. They may require a careful re-examination of the origin and morphology of ribs throughout the Amniota.

Rib fragmentation in tetrapods occurs typically in regions of the column in which special movements are taking place (neck of turtles, lizards, etc., tail of amniotes generally), and in which, therefore, the thoracic rib pattern is not useful, or in aquatic forms in which the thoracic pattern itself may prove unstable. It is a phenomenon, therefore, of degeneration — of breakdown of the two-headed ribs primitively present in tetrapods, presumably throughout the column. However, it is precisely the origin and evolution of the two-headed ribs of tetrapods that is still a puzzle — a puzzle to which, I believe, these special conditions along with the ontogeny of less modified ribs have something to contribute. Specifically, the question of the possible origin of two-headed tetrapod ribs from a *union* of the dorsal and ventral ribs of fishes still needs a definitive yes or no answer.

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PLATE

Emys orbicularis embryo. A section through the anterior end of the 2nd cervical vertebra in an advanced cartilage stage. Compare Fig. 1.

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. April 9, 1959 Number 102

A NEW JAMAICAN GALLIWASP (SAURIA, ANGUIDAE)

By Garth Underwood
Department of Zoology, University College of the West Indies, Jamaica

The anguid lizards whose Jamaican vernacular name, "galliwasp," has gained some currency, are generally distributed in Central America and the Greater Antilles. Five distinct species are already known from Jamaica (Grant 1940, Cousens 1956). In this paper I describe the sixth Jamaican species. As a resident in this island I regret that I am obliged to describe this species on the basis of a single specimen; however, after several years no further material has been secured. As the species is not merely very distinct but also represents a species group new to Jamaica I delay its description no longer as it widens the scope of known galliwasp radiation as well as reminding us of the gaps which remain in our knowledge.

In May 1952 Mr. R. P. Bengry and Mr. G. R. Proctor, 3rd. of the Institute of Jamaica, were engaged in general collecting, zoological and botanical, on the north coast of Jamaica in the parish of St. Mary. In turning over a pile of coconut trash at Boscobel they captured a number of specimens of the common galliwasp of the lowlands, *Diploglossus crusculus;* with these galliwasps was the specimen here described. A number of attempts to find further specimens in the same area have failed; I can only suppose that this individual had wandered from its customary habitat, which remains unknown. The coast here backs onto limestone hills which are covered by dry scrub forest.

A description based upon a single specimen unavoidably contains tedious detail. By making comparisons with its nearest relatives I have endeavoured to recognise features significant in defining the species. With more material it will probably be possible to simplify and improve the description.

I do not follow Burt and Burt (1931) and Taylor (1956) in maintaining a distinction between the genera *Diploglossus* and *Celestus*. After examining material of 22 different species I cannot see good grounds for supposing that there are two stocks of galliwasps which merit generic rank, and I therefore use the older name *Diploglossus*.

As the generic name is compounded from Greek roots, I form the specific name likewise. To draw attention to what I believe to be its most striking single feature I call it:

DIPLOGLOSSUS MICROBLEPHARIS sp. nov.

Type and only known specimen. M.C.Z. 55764; collected by R. P. Bengry and G. R. Proctor, 3rd. May 1952, Boscobel, St. Mary, Jamaica, West Indies, 18°24′N, 76°58′W.

Diagnosis. A plump, short-limbed galliwasp with small palpebral aperture, nasal shield excluded from rostral, frontal broader than long, very pronounced median keels on proximal caudal scales, few scale-organs on dorsal scales (less than one per scale).

Description. I believe this form to be most closely related to *D. delasagra* of Cuba and *D. pleeii* of Puerto Rico; the description has been prepared with specimens of these species before me. A number of the features of the head squamation appear to be related to the reduction of the size of the palpebral aperture; these are marked with an asterisk; in some cases modification of the squamation is asymmetrical. To make the description easier to follow I have italicised those characters in respect of which the new species differs from *both* of the related species. Where a count can be made on two sides I have separated the left hand count from the right hand count by a comma. Head broad; width: length = 0.79:1. Rostral twice as broad as high, in contact with supranasals and 1st labial. Three supranasals (asymmetrical), right meets frontonasal, 1st loreal, nasal, rostral and in midline left supranasal (also in *pleeii*); the two left supranasals together apparently represent a divided scale similar to the right supranasal; together the two scales make the same contacts as the right supranasal. Nasal meets 1st and 2nd labials, 1st loreal and supranasal. Prefrontal about as long as frontonasals, contact with 2nd loreal and 1st supraorbital, *short contact with 3rd loreal*. Very broad frontal, *width greater than length*, broad contact between frontal and parietals (also in *pleeii*). *Four supraorbitals*, 1st much the largest. Third loreal meets 1st supraorbital, not separated by intercalary scale**. Preocular meets 1st supraciliary, 1st supraorbital, 3rd loreal, 5th supralabial *and subocular**. Subocular meets 5th and 6th labials (also in *pleeii*). Three supraciliaries. *Postorbitals 3,2**. Postocular appears as last member of partly concealed row below supraciliaries. Three temporals between fronto-parietal and labials: upper temporal separated from parietal; lower temporal meets labials 6 and 7 and nearly enters margin of orbit between subocular and lower postorbital*. Single nasal between supranasal, loreal 1 and labials 1 and 2. Three loreals: 1st low, elongated, between supranasal, nasal, labials 2 and 3 and loreal 2 (also in *pleeii*); 2nd loreal squarish, between frontonasal, prefrontal,

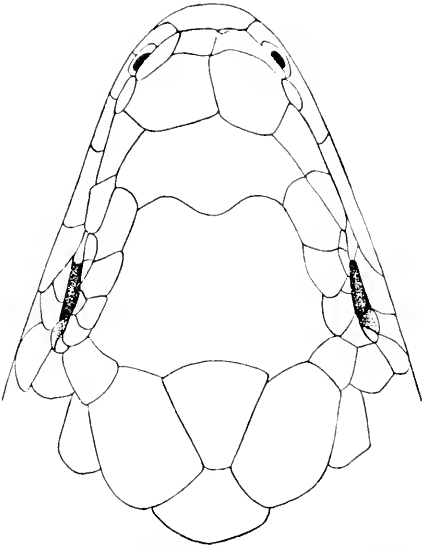

Fig. 1. Dorsal view, head of *Diploglossus microblepharis* type.

loreals 1 and 3 and labials 3 and 4; 3rd loreal squarish, between 2nd loreal, *prefrontal*, supraorbital 1*, preocular and labials 4 and 5. No scale between 3rd loreal and prefrontal*. Eight supralabials (also in *pleeii*). Small mental, half width of rostral; 7 infralabials, prominent postmental in contact with labials 1 and 2, followed by 4 pairs of chinshields (also in *pleeii*). 1st pair meeting in midline.

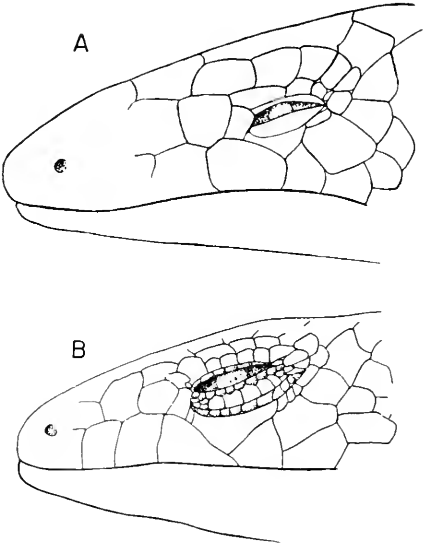

Fig. 2. A. Scales around left eye of *Diploglossus microblepharis* type. B. Scales around right eye of *Diploglossus pleeii*.

Head length (snout to posterior margin of earhole) 14 mm., width 11 mm. Palpebral aperture about 1 mm. long, ear-opening about $\frac{1}{2}$ mm. in diameter. Palpebral marginal scales reduced, lower palpebral scales very thin. Pupil circular.

Middorsal scales with 16-20 parallel striae and a pronounced central keel, caudal end of most striae broken. Accentuation of central keel fades out and interruption of striae increases on lateral dorsal scales; striae fade out altogether on flanks, the ventral scales being smooth and flat. Towards shoulders central keels fade, and on neck striae fade out; towards rump central keels become very pronounced, and keels become so pronounced on proximal half of tail as to give it, dorsally, the appearance of a polygonal prism. Towards tip of tail keels fade out. Ventral caudal scales smooth and flat.

Scale organs on head extend back dorsally about as far as occipital scale, ventrally about as far as 15th postmental scale; scale organs very few on back (less than 1 per scale), absent on flank save before groin, absent on belly; a few scale-organs on outer face of thigh; scale-organs present on back and sides of proximal tapering portion of tail, aggregated on the mesial (dorsal) side of the central keel of each scale. Fourteen scales from a middorsal row gave the following scale-organ counts: 0 1 1 0 1 0 0 1 0 3 1 1 0 0 (mean 0.64); 4 groin scales gave the counts: 2 3 1 1. Scale-rows at midbody 43, mental to vent 109 scales, occipital to point above vent 105, from anal to chest (on line joining axillae) 72, some union of dorsal scale-rows over rump, at level of ankles 20 scale-rows round tail.

Third digit of forelimb slightly longer than 4th; lamellae, 3rd digit 7, 8, 4th digit 7, 7. Scales on outer face of upper arm with faint striae (no central keels), scales of forearm quite smooth, scales of inner face of forelimb with striae. Hindlimb: length of 4th toe to length of 3rd toe as 1.4 to 1; 4th toe lamellae 11, 12; scales of outer face of thigh with striae; scales of shank also with central keels; scales of inner face of hindlimb with faint striae but no keels.

General colouration medium brown. Top of head uniform brown; upper labials white with brown spots, lower labials with a few spots only; throat white; neck and back speckled with brown, speckles on back loosely arranged in about 20 backwardly pointing chevrons; speckling fades out fairly abruptly on sides, above ear-hole, on flanks and above groin; speckling less regular on tail; upper side of forelimb and outer face of forearm and hand closely speckled; upper side of hindlimb and outer face of shank and foot speckled, inner face of thigh darker brown, some brown onto sole of foot.

Dimensions. Snout-vent 87 mm., tail (tip regenerated) 83 mm., forelimb 13 mm., hindlimb 18 mm., axilla-groin 58 mm.

Discussion. Burt and Burt (1931) make an explicit distinction between *Diploglossus* and *Celestus*. Their discussion begs the question as to whether or not there are two natural groups which might properly be regarded as genera; they seek only a formal basis for their discrimination. They overlook the fact that two West Indian species of "*Celestus*" have claw sheaths and therefore belong to *Diploglossus* as they define it. This mistake appears to be due to the fact that Boulenger (1885) did not have material of *delasagra* or *plecii*. He implied that they do not have sheathed claws by placing them with the other island forms in section II of his key: "No large ungual sheath; frontal anteriorly in contact with a single shield." I am very doubtful of the statement by Burt and Burt that the claws of the forms with a sheath are "semi-retractile to retractile"; I see no indication of mobility. I checked a series of species in respect of: claw sheaths, number of prefrontal shields, nasal-rostral contact and scale-

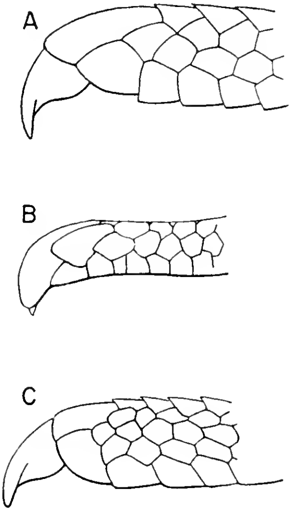

Fig. 3. A. Lateral view of 4th toe of *Diploglossus microblepharis* type. B. Lateral view of 4th toe of *Diploglossus plecii*. (Claw is concealed by sheath.) C. Lateral view of 4th toe of *Diploglossus hewardii*.

organs on the dorsal scales. The results are summarised in the accompanying table; I have included the Hispaniolan endemic genera *Sauresia* and *Wetmorena*.

We see that there are four Antillean forms which have sheathed claws and conversely two mainland forms with naked claws. As is recognised by Burt and Burt and by Taylor the number of prefrontals is not correlated with the claw-sheath condition. The character of three prefrontals is however confined to the mainland (and Malpelo) species, with the interesting exception of *darlingtoni* from the mountains of Hispaniola. Of the three M.C.Z. specimens, one, the type, has 3 prefrontals, the other two have only one (Cochran, 1941, states that the type has only one). Contact between nasal and rostral scales is shown by all the mainland forms but also by two Antillean forms (*delasagra* and *pleeii*).

The scale-organs of the trunk call for more detailed comment. These organs do not appear to have been noticed in the Anguidae; McDowell and Bogert (1954) state that they are not present; Scortecci (1940) did not find them. I have, however, found them, at least on the head, on every anguid examined. They were checked by prying off the horny scales with a needle and mounting in polyvinyl alcohol. The preparations are in the Museum of Comparative Zoology. I am not yet in a position to offer a critical appraisal of this character. A cursory comparison of the scale organs on various parts of the body of several species indicated some striking differences in respect of their occurrence on the dorsal scales; representatives of the available species were therefore checked for this character. The scale-organs are visible as thin refracting spots in the horny scales. On the trunk and tail scales they are localised in two areas on either side of the midline and nearer to the posterior margin. Commonly there are scale-organs on both sides of the midline of a scale. Counting the scale-organs separately for each side of a longitudinal row there is sometimes a significant asymmetry; the higher number of scale-organs is in such cases found on the side nearer to the mid-dorsal line, i.e. the mesial side. The scales of the flanks and the sides of the tail usually have all the scale-organs on their dorsal sides, i.e. the sides nearer the dorsal midline. I have not found scale-organs on belly scales nor on ventral tail scales.

Most of the dorsal scale-organ counts were made on a row of about ten dorsal scales taken from near the dorsal midline. To form an idea of the reliability of such counts I mounted pieces of dorsal slough from two Jamaican *D. crusculus*. Each lateral dorsal scale-row is clearly indicated in this species by a break in the colour pattern. Including the lateral dorsal rows one slough had a complete block of 196 scales (14 rows of 14) and the other of 403 scales (13 rows of 31). Counts of scale-organs were

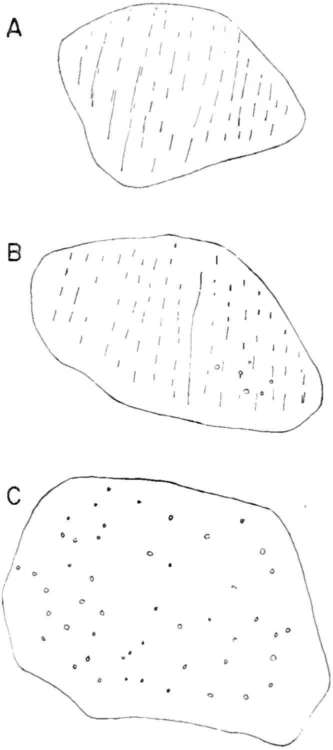

Fig. 4. Scales and scale-organs in *Diploglossus microblepharis*. A. Mid-dorsal scale to show interrupted striae. B. Scale from right side of tail near base to show size and position of scale-organs (reversed under microscope). C. Right fronto-nasal to show distribution of scale-organs.

made on all of these. On the outer three rows of scales 97.8 per cent of the scale-organs lay on the inner side. The scale-organs were less asymmetrically distributed on the inner rows of scales; there were however more on the inner side of each scale-row than on the outer side. The reversal of the asymmetry did not take place about the midline, however, but between the 2nd and 3rd rows to the left of the midline. The lateral dorsal scale-rows had rather high scale-organ counts; the other rows differed from one another in apparently random fashion, but a difference between two rows would be maintained throughout their lengths (not scale by scale but for groups of scales large enough to smooth out random variations). One specimen had the highest count (3.0 organs per scale) for the 5th row, right of centre, and the lowest counts (2.2 organs/scale) for the 2nd, 3rd and 4th rows, right of centre. The other specimen had the highest count (5.6 organs/scale) for the centre row and the lowest (4.2 organs/scale) for the 3rd row, right of centre. Discounting the lateral dorsal scale-rows it was possible to make a count of 10 consecutive scales in 60 different ways for one specimen; the lowest total was 20, the highest 33, mean 26.25, standard variation 11.0 per cent of mean. There were some irregularities in the squamation of the other specimen; avoiding these, 222 such counts were possible; the lowest total was 31, the highest 67, the mean 51.49, standard variation 15.7 per cent of mean. I tried some counts of 10 scales in a transverse row and 10 scales diagonally but the results did not suggest that these would be more reliable. I have not eliminated the possibility that the counts may be correlated with size or with sex.

All of the mainland species lacked dorsal scale-organs save *monotropis* (23 scales from two specimens of the latter averaged 4.1 organs/scale). A group of Antillean species (*delasagra*, *plecii* and *darlingtoni*) likewise lacks dorsal scale-organs; *microblepharis* is intermediate in that many scales are without organs. It is noteworthy that *Sauresia* and *Wetmorena* both are in agreement with the majority of insular forms in the possession of dorsal scale-organs.

Preliminary examination of a number of forms suggests that these scale-organs may have value as a systematic character at the species level. There may be differences in the number of organs per dorsal scale; when the organs are absent from the back they may or may not also be absent from the flanks. The number of organs on the scales of the groin may also be useful. For example, the type of *Panolopus costatus* Cope has a dorsal average of 2.2 organs/scale (10 scales), the type of *Diploglossus stenurus* Cope (listed as a synonym of *costatus* by Cochran) has a dorsal average of 5.0 organs/scale (16 scales); to this is added a mean of 7.4 organs/groin scale for *costatus* (5 scales) and 17.4 organs/groin scale for *stenurus* (5 scales). When it is noted also that the adpressed limbs of *costatus* fail to meet by about 15 scales whereas those of *stenurus* overlap by about 5 scales, there seems to be little question that *stenurus* is a distinct form. *D. enneagrammus* is noteworthy for the fact that each groin scale bears a single very large organ. Differences were also noted in the distribution of the scale-organs on the occipital scale. For example, the Jamaican *D. hewardi* has scale-organs scattered around the posterior margin of the occipital whereas *D. crusculus* and *D. barbouri* have the scale-organs generally scattered over the occipital.

Surveying the distribution of variant characters amongst the different forms, I cannot arrive at any firm ideas concerning the species groups. However, to provide a basis for discussion I put forward a scheme which accords reasonably well with the evidence. I propose to regard *monotropis* as primitive in respect of: the presence of dorsal scale-organs; the presence of sheathed claws; the contact between nasal and rostral scales; the presence of 3 prefrontal scales and the stoutness of the limbs. The general occurrence of scale-organs on the trunk of lizards of various families suggests that this is a primitive condition. As with the teeth, however, we cannot assume that the only changes in phylogeny have been reductions in number, so we must be prepared to allow re-extension of scale-organs onto the back if other evidence requires it. Conditions in lizards generally suggest that many small scales are more primitive than few large scales; on these grounds I suppose three prefrontals to be more primitive than one. In the case of claw-sheaths we have either to suppose that they have arisen within the genus several times or that they have been lost several times; as a working hypothesis I prefer the second proposition. As regards the proposition that the nasal-rostral contact is primitive, I can only argue that this hypothesis appears to fit the other assumptions better. That stout limbs are more primitive than weak limbs is not likely to be questioned. In South America *fasciatus* and *resplendens* resemble *monotropis* but lack the dorsal scale-organs; *Ophiodes* may be derived from this branch. On Malpelo, *millepunctatus* likewise resembles *monotropis* but has the claw-sheath reduced as well as lacking dorsal scale-organs. In northern Central America *enneagrammus* and *cyanochloris* superficially resemble such Antillean forms as *crusculus* and *costatus;* however they retain a nasal-rostral contact and lack dorsal scale-organs. The three species *delasagra, pleeii* and *microblepharis* do appear to represent a natural group; even here we have some complexity since *microblepharis,* presumably primitive in retaining a few dorsal scale-organs, has lost the nasal-rostral contact and partly lost the claw-sheath retained by the other two species. It seems clear therefore that *microblepharis* cannot be derived from *delasagra* or *pleeii,* nor can the converse view be entertained. The *delasagra-pleeii* and *microblepharis* stocks may be separately derived from a Central American ancestral stock. On the evidence of the distribution of mammals, Darlington (1957, p. 510) suggests that Cuba and Jamaica represent two ports of entry for Central American stocks in the Antilles. This group must be surely represented by an undiscovered form in Hispaniola. The remaining Antillean species perhaps form a natural group: *darlingtoni* is the most isolated form. On the grounds that they retain claw-sheaths I suppose *Sauresia* and *Wetmorena* to be early offshoots of the Antillean stock. I cannot see good grounds for recognising the genus *Sauresia* as distinct from *Diploglossus.* The disappearance of one digit, small in a number of other forms, is a trivial feature which cannot be of much adaptive significance; the species is not set off in other respects. *Wetmorena,* on the other hand, is clearly set apart by the loss of the ear-opening, a feature of manifest adaptive significance in a burrowing animal.

The forms so far discussed all belong to McDowell and Bogert's subfamily Diploglossinae. All of them have numerous scale-organs on the head although they may be reduced on the trunk. A few representatives of their subfamily Gerrhonotinae were cursorily examined. No scale-organs at all were found on the trunk and only a few on the anterior part of head. A loreal and 3rd supralabial scale were examined of one specimen each of: *Gerrhonotus liocephalus*, *Barissia imbricata*, *Elgaria multicarinata*, *Abronia deppii* and *Ophisaurus apus*. *Elgaria* most closely approached the Diploglossinae in the partially sheathed claws, short nasal-rostral contact and the possession of more loreal scale-organs than the others. The three prefrontals of *Abronia* resemble those of *Diploglossus*. The loreal and labial of *Gerrhonotus* had only one scale-organ each. The *Barissia* had none on the loreal and four on the labial. *Ophisaurus* resembled the others in the absence of scale-organs from the trunk and posterior part of head and in the small number on the anterior part of head. *Anguis fragilis* is similar to *Ophisaurus* in the possession of a few scale-organs on the anterior head only.

I am indebted to Mr. C. Bernard Lewis, Director of the Institute of Jamaica, who generously turned this specimen over to me for study. I am grateful to Dr. E. E. Williams for access to the collection of the Museum of Comparative Zoology and for the benefit of discussion. Dr. R. Zweifel kindly allowed me to study some additional specimens in the American Museum of Natural History.

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Table

	Claw-sheath	Prefrontal	Nasal-rostral contact	Scale-organs on back
Diploglossus				
fasciatus	+	3	+	—
resplendens	+	3	+	—
monotropis	+	3	+	+
millepunctatus	½	3	+	—
cyanochloris	—	1	+	—
enneagrammus	—	1	+	—
microblepharis	½	1	—	few
delasagra	+	1	+	—
pleeii	+	1	+	—
darlingtoni	—	1 or 3	—	—
hewardi	—	1	—	+
occiduus	—	1	—	many
duquesnayi	—	1	—	+
crusculus	—	1	—	+
barbouri	—	1	—	+
badius	—	1	—	+
costatus	—	1	—	+
rugosus	—	1	—	+
curtissi	—	1	—	+
stenurus	—	1	—	+
Sauresia				
sepsoides	+	1	—	+
Wetmorena				
haetiana	+	1	—	+

B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. April 10, 1959 Number 103

TWO NEW SPECIES OF *ELEUTHERODACTYLUS* FROM PUERTO RICO

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Some years ago Dr. J. A. Ramos of the Biology Department of the University of Puerto Rico collected, at the Cambalache Forests, a small frog that differed strikingly from the *Eleutherodactylus cramptoni* collected at the same locality and date, by the very short length of the fingers and relatively short, thick hind limbs. The specimen was said to have been collected in bromeliads but no voice record was taken, so that the description of the apparently new species was postponed until more paratypes could be obtained and the voice recorded. So far, four more trips have been made to the same locality, at night and during the daytime, but all of them have been unsuccessful, although a strange voice that could have been of frog or insect was heard on several occasions. The Cambalache Forests are of the semiarid, deciduous type, and spiny trees and bushes are common, so that catching a calling frog at night is not an easy matter.

More recently, another apparently new frog was collected at Doña Juana Forests and, although this first collection consisted of 40 individuals, the animal was not heard to produce any voice in spite of the fact that all the specimens were caught at night and enough time was given each one to call. The description of this form was likewise postponed and, in the month following the first collection, 16 other individuals of the same species were collected at El Yunque, on the other end of the island. No voice was heard to come from any of these animals, so that it was tentatively concluded that the species is mute. Since well developed gonads are found in both sexes, the lack of voice cannot be attributed to immaturity, especially if it is considered that frogs of the genus *Eleutherodactylus* seem to call throughout the year in Puerto Rico.

Descriptions of both species have been prepared in the belief that they should be recorded and that their publication may be of help in determining distribution and habits.

The author wishes to express his appreciation to Mr. Jorge Rivera Lopez, to Dr. Ruth Turner, and to his wife, Mrs. Eneida B. Rivero, who helped him collect in the field.

ELEUTHERODACTYLUS RAMOSI sp. n.

Type. Museum of Comparative Zoology No. 30428, a ♀ from Cambalache Forests, n. Puerto Rico, Coll. J. A. Ramos, Aug. 1952.

Diagnosis. A small *Eleutherodactylus* with uniform coloration, very short fingers and short limbs, the heel and elbow of which do not meet when adpressed along the side of the body.

Description. Head broader than long; snout subovoid; tongue large, ⅔ free and nicked behind; vomerine odontoids in two strong oblique series behind and between the choanae; eyes of moderate size, their diameter equal to distance between eye and nostril; interorbital space broader than an upper eyelid; canthus rounded; loreal little inclined, not concave; tympanum moderately distinct, covered above by a supratympanic fold, ½ the eye diameter; fingers strikingly short, the longest not longer than the orbital diameter; no definite palmar tubercles; larger disks smaller than the tympanum; no apparent metatarsal tubercles; toes free, the first well separated from the others; disks of toes smaller than those of fingers; heel of the adpressed hind limb extends to the posterior margin of the tympanum; heels overlap when legs are placed at right angles to the body; heel and elbow do not meet when adpressed along the flank.

Skin above, smooth. Ventral surfaces smooth except on the posterior part of the belly, where slight rugosities or granulations can be seen under a lens; posteroventral aspect of thighs, granular.

Color. Above, uniform brown, with minute dots (melanophores) under a lens; no apparent canthal or supratympanic streaks. Below, infuscated white, the melanophores being scattered and sparser than on the upper surfaces.

Measurements. (mm.) ♀ snout-vent 22; head length 7.3; head breadth 8.3; femur 8.2; tibia 9.6.

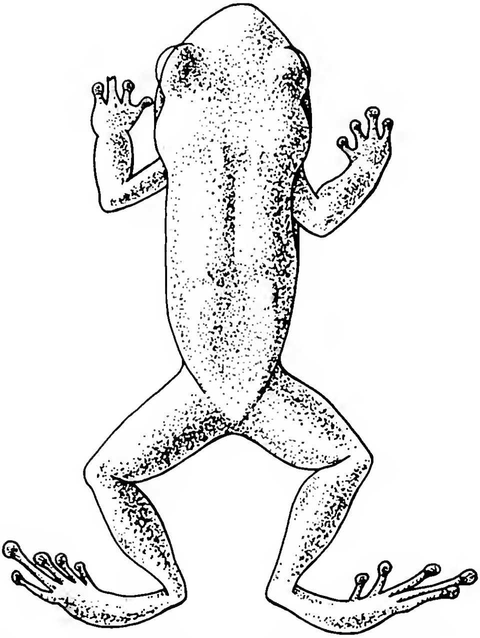

Fig. 1. *Eleutherodactylus ramosi* Type, MCZ 30428 (M. Estey del).

Remarks. *E. ramosi* is most closely related to *E. cramptoni* with which it occurs at the Cambalache Forests. It differs from that species in its very short fingers, smaller disks, broader head and shorter and thicker hind limbs, the heel of which does not even approximate the elbow when both anterior and posterior limbs are adpressed alongside the flank. It was the very short fingers and thick hind limbs that made the author describe this species on the basis of only one specimen.

Eleutherodactylus eneidae sp. n.

Type. Museum of Comparative Zoology No. 30429, a ♀ from Doña Juana Forests, Villalba, Puerto Rico. Coll. J. A. and E. B. Rivero, August 1956.

Diagnosis. A medium sized *Eleutherodactylus* with rounded canthus rostralis, interorbital space as broad as an upper eyelid, tubercular dorsum, barely overlapping heels, mottled and variegated dorsal coloration and immaculate ventral surfaces.

Description. Head slightly broader than long; snout short subovoid; tongue oval, ½ free and nicked behind; vomerine odontoids in two oblique series behind the small, oval choanae, their external extremities commencing at level with the vertical of the center of the latter; canthus rounded; loreal sloping; interorbital space as broad as an upper eyelid; eye diameter greater than distance between eye and nostril, almost as long as the snout; tympanum small, not too distinct, ⅓ the eye diameter; first finger shorter than second, which is longer than last; three metacarpal tubercles and two smaller ones in line behind the wrist, just in back of the central metacarpal tubercle; disks fan shaped, broader than the tympanum; two small metatarsal tubercles; subarticular tubercles distinct; toes free, their disks slightly smaller than those of the fingers; heel of the adpressed hind limb extends to the posterior corner of the eye; heels barely overlap when tibiae are placed at right angles to the body.

Skin above, studded with small, evenly distributed tubercles; eyelids tubercular; a small tubercle at the heel. Below, granular on the belly and thighs, very slightly granular on the throat; a ventral discoidal fold. Male with a slight fold on each side of the throat.

Color. Above, light gray with blotches and mottles of darker gray or brownish gray; eyelids darker than the body color; loreal area whitish gray, with small darker spots along the upper lip; limbs light gray, with brownish gray striations and mottling; loins with a golden brown stain; posterior aspect of the thighs with a diffuse, irregularly margined brownish marking on the distal end. Ventral surfaces immaculate, powdered with brown, except for a thin gray rim along the lower margin of the lip.

Measurements. (mm.) ♀ snout-vent 26.2; head length 10.5; head breadth 10.5; femur 11.9; tibia 12.6.

Remarks. Paratypes include 39 specimens from Doña Juana cloud forests, with the same data as the type (U.P.R. 611-12, 614-51) and 16 from El Yunque (U.P.R. 595-610, El Yunque, sixth rain shelter to Pinnacles, 1 Sept. 1956). All were collected at night on the floor or on the leaves or trunks of bushes, palms or tree ferns at not more than 5 or 6 feet from the ground.

The largest of the 54 paratypes is only 2 mm. larger than the average sized type, an indication of a very uniform size for fully grown individuals. This is contrary to the situation existing in *Eleutherodactylus portoricensis* where considerable variability is found in any collection.

The following variations are found among the paratypes of *Eleutherodactylus eneidae*:

1. In poorly preserved specimens, a slight canthus may be apparent, but ordinarily the snout is rounded in cross-section and there is no angle at the canthal margin. This character easily differentiates this species from *E. portoricensis*, its closest Puerto Rican ally.
2. The heel of the adpressed hind limb may extend to any point on the eye (posterior corner, middle or anterior corner).
3. The golden brown stain of the loins is present in most but not all individuals.
4. A small, black spot or short streak is generally found above the tympanum.
5. The dorsum is always mottled and variegated but the ground color may be lighter or darker than in the type.

Eleutherodactylus eneidae is most similar to *E. portoricensis* from which it can be distinguished by its more uniform, adult size, rounded canthus not bordered by a white line (as in most *E. portoricensis*), absence in most specimens of a well defined interorbital bar; smaller tympanum; dark eyelids; narrower interorbital space (much broader than the upper eyelids in *E. portoricensis*), more tubercular dorsum, different coloration and probable absence of voice.

Some examples of *E. portoricensis* are also mottled above, but the mottling is usually brown, and the well defined canthus, broader interorbital space and persistent interorbital bar make the species easily distinguishable. It can also be said that if a specimen is more than 30 mm. snout-vent length, it is not *E. eneidae*.

Eleutherodactylus eneidae is quite common in the cloud forests of Doña Juana and El Yunque and it is very strange that the species had not been named before. It appears possible, however, that collections of *E. portoricensis* may include this species. This may be the case, for example, with Schmidt's (1928:46) Figure 11c, but this figure may just as well represent a color phase of *E. portoricensis*.

E. eneidae is somewhat similar in coloration to *E. flavescens* from the Dominican Republic, but it differs from that species in many important details. It also looks somewhat like Schmidt's (*op. cit.*:53) figure of *E. locustus* but Dr. R. G. Zweifel of the American Museum compared it with the type of that species and found that three specimens of *E. eneidae* "are very different in size and general appearance from *locustus*." Furthermore, Zweifel found very little difference between *cramptoni* and *locustus*, and suggested that they might be synonyms. Males of *E. cramptoni* have vocal sacs (described as absent by Schmidt) and the proportion of tibia and femur (heels cross in *locustus*, meet in *cramptoni*), mentioned as a difference between the two species, does not, according to Zweifel, seem to exist. On the other hand, Schmidt described the voice of *E. locustus* as the "most distinctive of any noted in Puerto Rico," so that it is perhaps better to keep the two forms separate until more field studies can be made.

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Eleutherodactylus eneidae. Type, MCZ 30429 (J. A. Rivero phot.).

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. April 13, 1959 Number 104

STUDIES ON FISHES OF THE FAMILY OPHIDIIDAE. III. A NEW SPECIES OF *LEPOPHIDIUM* FROM BARBADOS[1]

By C. Richard Robins

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Among the collections of The Museum of Comparative Zoology, Harvard University, are two cusk eels collected off Barbados, British West Indies, during the operations of the Steamer "Blake." They represent a new species of *Lepophidium* which is described below.

Lepophidium kallion, sp. nov.

(Figure 1)

Holotype. Museum of Comparative Zoology 28057A, a female, 117 mm. in standard length; collected in 200 fathoms "off Barbados," "Blake" station 291, presumably in February or March, 1879 (see Pierce and Patterson, 1879:15).

Paratype. MCZ 28057B (1), a male, 162 mm. in standard length; data as for holotype.

Diagnosis. Dorsal rays 133, anal rays 108; pectoral rays 23 or 24, gill rakers 10, vertebrae 74 (15 precaudal and 59 caudal vertebrae), pyloric caeca 6 (1 dorsally, 5 ventrally). Upper sides with dark brown markings in two series, the upper forming a longitudinal stripe on either side of the dorsal-fin base. Snout tip fringed with numerous fleshy projections.

Description. A healed injury at the caudal end of the paratype has resulted in the loss of about eight caudal vertebrae including the hypural plate. Counts of vertebrae and of rays in the vertical fins, listed in the diagnosis, are therefore based

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[1] Contribution No. 221 from The Marine Laboratory, University of Miami.

solely on the holotype. Pectoral rays number 23-23 (holotype) or 23-24 (paratype), the caudal rays 9. Three rudimentary gill rakers are on the upper arm of the first arch of both specimens and 6 or 7 developed rakers are on the lower arm. The holotype has an additional rudimentary raker on the lower arm: both specimens have a total of 10 gill rakers on the first arch. Branchiostegal rays number 7. The pyloric caeca are blunt, and number 6 (1 dorsally and 5 ventrally).

L. kallion possesses the general characteristics of *Lepophidium* (see Robins, 1959:361).

Morphometric data follow (in each instance the figure in parenthesis refers to the paratype): standard length, mm., 117 (162-damaged); head length 23.0(34.6); tip of snout to origin of dorsal fin, 27.8 (39.3); tip of snout to origin of anal fin, 42.8 (67.2); tip of snout to occiput, 15.5(22.5); tip of snout to posterior end of maxillary, 11.1 (15.8); depth of body, at occiput, 13.7 (23.2); at origin of dorsal fin, 13.0 (24.6), at origin of anal fin, 13.1 (20.7); length of pectoral fin, 11.4 (14.5); length of pelvic rays, 8.6 and 6.4 (12.4, 9.5); length of caudal fin, 7.1 (damaged); tip of snout to posterior end of lateral line, 112 (150); horizontal diameter of bony orbit, 3.5 (5.1); post-orbital length of head, 12.7 (19.5); snout length (to margin of orbit), 4.2 (6.5); bony interorbital, 3.5 (5.1).

Despite their age the distinctive color pattern is readily seen on the type specimens. The dorsal, caudal and anal fins are pale with scattered melanophores and with a well defined dark margin. The pectoral fin is clear with some melanophores on its basal third.

The body is almost straw-colored in preservative although the scattered melanophores lend a dusky appearance to the belly. Two series of dark brown markings on the upper sides dominate the body coloration. The uppermost series starts as a collar just behind the occiput, runs laterally to a point above the opercle and then extends as a dark stripe, just above the lateral line, most of the distance to the caudal-fin base (Fig. 1). It is broken posteriorly into a series of dashes. In the holotype the stripe is less continuous than in the paratype. The lower series of dark brown markings extends posteriorly from the shoulder as a series of elongate blotches, just below the lateral line. Caudally, the lower series crosses the lateral line and merges with the dorsal series. Two dark spots occur on the nape between the dorsal-fin origin and the occipital collar. The head is generally dusky. A short dark bar extends from the upper end of the gill slit, rearward along the dorsal margin of the operculum. The snout is not spotted but a few dark spots may have been present on top of the head, behind the interorbital region. As seen from above, the dark margin of the dorsal fin appears to be a mid-dorsal stripe.

The floor of the mouth and the gill bars are pale and the gill chamber silvery with numerous melanophores. The roof of the mouth especially toward the pharynx is dusky but not black. The gastrointestinal tract is sooty black except for the stomach.

Figure 1. Lateral view of the paratype of *Lepophidium kallion*, MCZ 28057B, 162 mm. in standard length, collected off Barbados, "Blake" station 291.

As in other species of *Lepophidium*, the swimbladder is similar in both sexes, a rather thin-walled sac, with no posterior opening or tube. It occupies the dorsal portion of the body cavity.

Numerous short, pointed, non-depressible teeth are present on the premaxillary, dentary, vomer, palatines, and pharyngobranchials. Those on the outer row of the premaxillary and dentary are best developed. The dentigerous areas are papillose, especially the lips. A prominent spine is easily detected under the skin on the snout and on the upper posterior margin of the opercle.

Scalation is typical of the genus. The scales are cycloid, imbricate and in regular rows on the body. The postorbital portion of the head is also scaled. In *L. kallion* the scales are imbedded and the skin must be scraped away to determine the number of scale rows. About 8 and 25 rows are present between the lateral line and the dorsal- and anal-fin origins, respectively. Some 165-170 rows cross the lateral line between the posterior edge of the hypural plate and the point of opercular attachment. So many other characters are available to the systematist that the labor involved in approximate enumeration of scale rows in ophidiids seems unjustified.

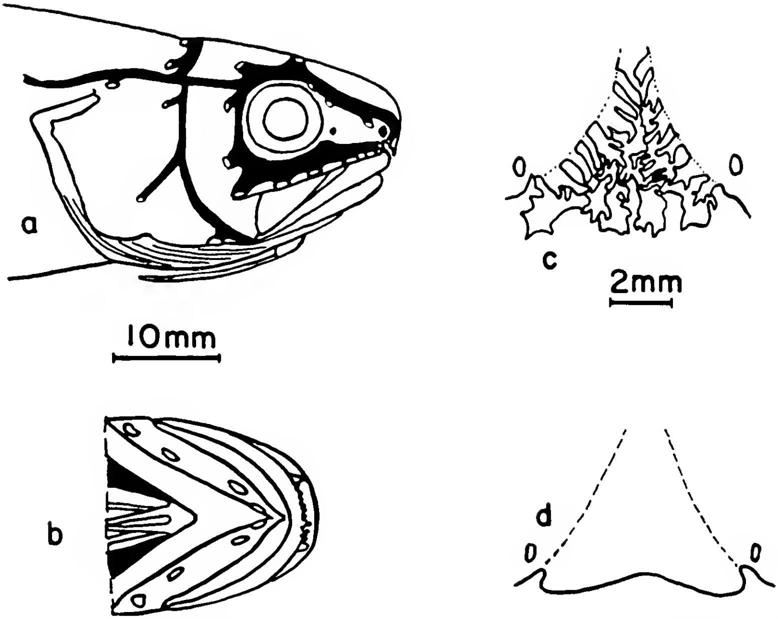

Figure 2. (a, b). Diagram of lateralis system on head of *Lepophidium kallion* (see text for explanation). (c). Development of fleshy tabs on tip of snout of *L. kallion*. (d). Tip of snout of *L. marmoratum* (Goode and Bean).

The lower rim of the snout is incised anterior to the nostrils. Four fleshy tabs project from this margin (Fig. 2 c). The actual shape of these tabs apparently varies, for the paratype is less decorated than the holotype. Two rows of fleshy tabs run dorsally from in front of the anterior nostril and join just anterior to the rostral spine (Fig. 2 e).

Böhlke and Robins (in press) have demonstrated specific differences in the lateralis system on the head. In *L. kallion* this system may be divided into the lateral, supratemporal, supraorbital, infraorbital and preoperculomandibular canals. Hubbs and Cannon (1935, pl. 2) provided illustrations of these canals in several darters and Robins and Miller (1957:216-217) similarly treated *Cottus.*

A schematic presentation of the lateralis system of *L. kallion* is given in Figure 2 (a, b). In the lateral view the canals are shown in black. A single pore occurs on the lateral canal just anterior to the attachment of the gill membrane. Three pores (one median) are on short caudally-projecting side canals extending from the supratemporal canal. Each supraorbital canal consists of six pores (one above and slightly behind the eye, one median coronal pore, two over the anterodorsal margin of the eye, one behind and above the anterior nostril and one opening caudally into the subnasal depression. Each infraorbital canal consists of eight pores (one behind the eye, one behind and below the eye, one at the posterior end of the suborbital rim, four on the suborbital rim above the jaw, and one opening anteriorly into the subnasal depression. The preoperculomandibular canal is more difficult to trace on the type material of *L. kallion*, especially on the sides of the head. Apparently it opens through 6 pores. The four pores along the ramus of the lower jaw are large and easily seen (Fig. 2 b). One tiny pore opens off a side canal just below the junction of the preoperculomandibular canal with the lateral canal. Another pore opens off a long side canal on the lower third of the operculum. In at least one other species of *Lepophidium* a second pore occurs below this one but it could not be found in *L. kallion.*

The posterior nostril is nearly on the anterior rim of the orbit and is small and circular. The larger anterior nostril opens through a short tube, above the subnasal depression, near the anterior end of the snout.

The name is from the Greek *kallion*, meaning more beautiful, and refers to the distinctive pattern of this species in contrast to the more drab species of *Lepophidium*.

Relationships. Serious consideration need be accorded only *L. marmoratum* (Goode and Bean). Other Atlantic species were briefly mentioned by Robins (1959:366-367). *L. marmoratum* differs from *L. kallion* in many features. 1) The upper sides are spotted instead of striped. 2) The upper half of the head and the snout are spotted. 3) It possesses more gill rakers, usually 11, occasionally 12 or 13. 4) The longer division of the pelvic ray is considerably longer than the pectoral fin. 5) Probably, there are fewer dorsal rays (121-129) and, 6) fewer pyloric caeca (3-5). 7) The snout is smooth, its lower rim entire (Fig. 2 d) without any of the numerous fleshy tabs of *kallion*. 8) A subnasal pore is present on the infraorbital canal just below the posterior nostril.

L. kallion and *L. marmoratum* are intimate species within the framework of the genus. The color patterns of the two although quite different are of a similar nature, quite unlike that of *L. staurophor* Robins, *L. jeannae* Fowler or *L. cervinum* (Goode and Bean). The pigmentation of the gut, peritoneum, and oral and branchial chambers are the same, a distinctive combination. The gill rakers are similar, those on the lower arm diminishing gradually in size instead of shifting from equally developed rakers to rudiments.

More detailed consideration of *marmoratum* is beyond the scope of this paper.

ACKNOWLEDGMENTS

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BREVIORA

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BUFO GUNDLACHI, A NEW SPECIES OF CUBAN TOAD

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INTRODUCTION

The discovery of a new species of Cuban *Bufo* is surprising considering the amount of herpetological collecting that has previously been done in Cuba, the apparent abundance and widespread distribution of the new species, and the fact that Cuba already possesses three species of *Bufo*. *Bufo peltacephalus* Tschudi, *B. empusus* Cope and *B. longinasus* Stejneger have long been known from the island, the last species having been described in 1905. In contrast, the other Greater Antillean islands, Hispaniola and Puerto Rico, possess but a single species each of *Bufo*: *B. lemur* in Puerto Rico and *B. guntheri* on Hispaniola.

The new species is named in honor of Juan Gundlach, the 19th century Cuban naturalist and collector. Gundlach in his "Contribucion a la erpetologia cubana," published in 1880, actually recognized the existence of the species here described as new. He mentions collecting a small species of toad 33 millimeters in length, near Habana. The toads had a distinctive call and some were in amplexus. Gundlach sent some specimens of this toad to Wilhelm Peters at the Berlin Museum who declined to recognize the specimens as a new species because he thought that they might represent juveniles of *Bufo peltacephalus*. Gundlach justly chided Peters for failing to realize that a juvenile would not be calling, in amplexus and laying eggs. It has taken nearly 80 years to prove Gundlach correct.

Bufo gundlachi, sp. nov.

Type. M.C.Z. 30551, male, collected about 14 kilometers N.E. of the city of Camaguey, Provincia de Camaguey, Cuba, by Ramon Molina and Rodolfo Ruibal on August 22, 1957.

Paratypes. M.C.Z. 30552-81, all with the same data as the type.

Diagnosis. A small toad differing from *Bufo longinasus*, the only other known small toad of Cuba, by the following characters: shorter hind limbs (see Table 1); high supraorbital and supratympanic crests that are lacking in *B. longinasus;* the skin of the males more spinous than in *B. longinasus* males; and in having the parotid gland small and lateral rather than large and dorsolateral as in *B. longinasus* (see Figures 1-4 for comparisons). Readily distinguished from juvenile specimens of *B. peltacephalus* by the structure of the supraorbital and supratympanic crests as well as by the presence of a thin white mid-dorsal stripe in *B. gundlachi*, absent in juvenile *B. peltacephalus.* Readily separable from adult *B. peltacephalus* by size (see Table 2). Separable from *B. empusus* by the fact the

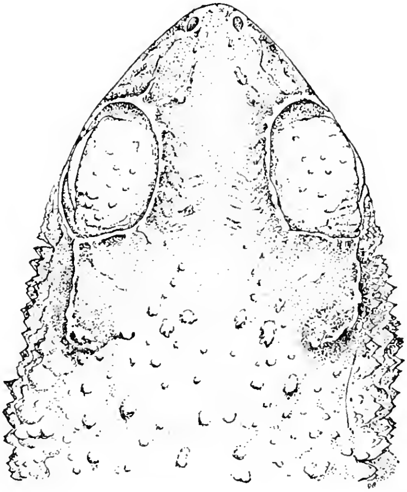

Figure 1. Dorsal view of the head of *B. gundlachi*, MCZ 30552. The pigment patterns have been excluded from the drawing.

tubercles on the dorsum of *B. empusus* are not spinous, as they are in *B. gundlachi*, that in *B. empusus* the tympanum is proportionately much smaller than in *B. gundlachi*, and that the metatarsal tubercle of *B. empusus* is large and keratinized while that of *B. gundlachi* is smaller and not keratinized.

Description of type and paratypes. A small, short-legged toad (see Table 1 and Table 2). Head with high supraorbital crests that are continuous with the supratympanic crests (see Figure 1). The posterior end of the supratympanic crest is usually thicker than the crest proper. The area between the two supratympanic crests is marked by a number of well-developed protuberances or bosses. A low canthal crest is often present. The rest of the head surface may show smaller isolated rugosities and ridges (see Figures 1 and 3). There is considerable variation in the size and extent of the rugosities in the various specimens.

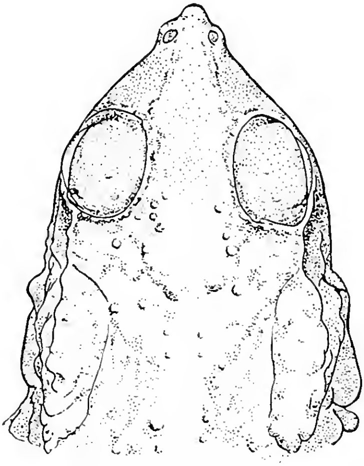

Figure 2. Dorsal view of the head of *B. longinasus dunni*, AMNH 60802. The pigment patterns have been excluded from the drawing.

Eye with a horizontal elliptical pupil. Tympanum small and not sharply demarcated. Parotid gland spinous, lateral in position, irregular in outline, and not clearly demarcated in many specimens. Skin of the dorsum, tubercular, with some of the tubercles bearing a spinous termination. Ventral skin rough and granular.

Manus with large tarsal tubercle and inner toe of males with a darkly pigmented patch on median surface. Third finger the longest, then fourth, second, and first (in that order). A large flat metacarpal tubercle. Pes with a pair of metatarsal tubercles and a tarsal tubercle. Toes partially webbed.

Color. The new species is very variable in general pattern as well as color. In life (type and paratypes) the dorsal area varied in color from brown to dark green. A distinct, thin, white middorsal line was evident in all specimens. The most common pattern was one of a dark green or brown dorsal area containing some darker blotches and having a reddish brown band bordering it on each side. In turn this reddish brown band was bordered ventrally by a darker brown band. The dorsal anterior surface of the head was usually lighter in color than the dorsal body area (see Figure 5). The males differ from the females in having a darkly pigmented throat.

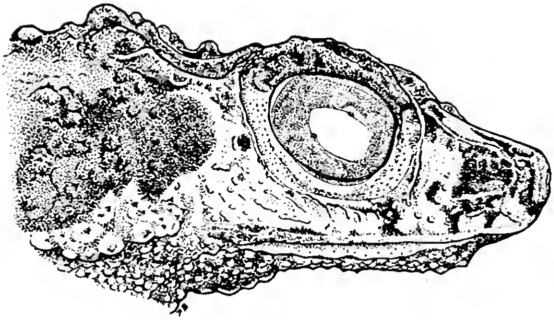

Figure 3. Lateral view of the head of *B. gundlachi*, MCZ 30552.

After preservation in alcohol or formalin the same general color and pattern is visible except that no green is evident and the general pattern is often obscured and darkened. The dorsal area may be dark and patternless or show three pairs of dark blotches, one pair above the level of the forelimbs, another pair at the middle of the body, and the third pair at the posterior tip of the urostyle. This dorsal area is in many specimens bordered by a lighter band (the reddish brown band of the living animal).

The darker band that borders this band ventrally originates on the tympanum (see Figure 3), covers most of the parotid gland (except for the ventral edge of the gland which is white), and extends along the ventrolateral margin of the body. Usually there is evident a darker stripe anterior to the insertion of the forelimb and in some cases a short thin dark stripe is present on the midline of the chest. Otherwise (with the exception of the dark throat of males) most specimens have a spotless ventral surface, though a few specimens show various degrees of dark mottling on the throat, chest and/or belly.

Other specimens. Specimens of the new species have also been collected in Pinar del Rio, Habana, Isla de Pinos, Las Villas, and at other localities in Camaguey. Most of these specimens were collected by Dr. Albert Schwartz of Albright College, who very generously made his material and notes available to me. Morphologically, all of the populations are similar. The only specimens that may be sufficiently distinct from the types to represent a different subspecies are from Isla de Pinos. These specimens appear to be small, immature individuals; however, they differ from other specimens in being much less rugose and spinous and in having a more sharply contrasting color pattern. Since only two specimens are available from Isla de Pinos it would appear best to reserve any subspecific designation of the forms until more specimens are available.

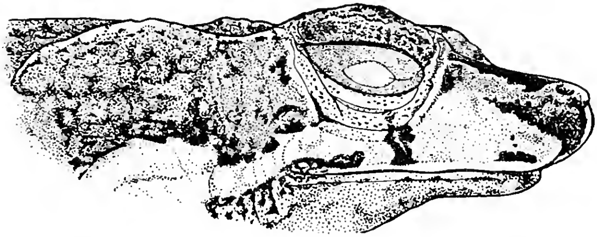

Figure 4. Lateral view of the head of *B. longinasus dunni*, AMNH 60802.

The only other noticeable differences observed were that the Contramaestre, Camaguey, specimens had swollen and enlarged parotids as compared to other populations. Also the specimens from near Herradura, Pinar del Rio, were characterized by the fact that males were more spinous than the females.

List of other specimens examined. Pinar del Rio: 2.3-2.8 mi. E. of La Mulata, AMNH 60821-28; 2.9 mi. E. of Isabel Rubio (formerly Mendoza), AMNH 60829: 2 mi. S.E. of Herradura, AMNH 60830-56; near Herradura, MCZ 2833 (3 spec.); 5.5 mi. E. of Candelaria, AMNH 60890-918. Habana: Prov. of Habana, MCZ 19394; Isla de Pinos, AMNH 61222-23. Las Villas: 28 km. E. of Trinidad, AMNH 60884-89. Camaguey: Embarcadero de Moron, AMNH 60857; 9.4 mi. S. of Contramaestre, AMNH 60858-83.

Ecological data. The type and paratypes were collected at two sites in the open serpentine savanna between Camaguey and the Sierra de Cubitas. The toads were found in medium size choruses in the afternoon after a heavy and intense rainstorm. All the low, poorly-drained areas of the savanna were flooded and the congregations of toads were in these shallow, grass-covered temporary pools. The toads were in the water when calling and were wary, submerging at the approach of the collectors. The call was loud for such a small animal and might be reproduced as CREE-CREE-CREE. Also calling at this time was a small species of *Eleutherodactylus*. A single specimen of *B. empusus* was found near the pools. No egg-laying had yet occurred when the specimens were collected.

The many specimens collected by Albert Schwartz were collected in similar shallow ponds in open fields. In this respect the new species differs from *B. longinasus*, which so far has always been collected along streams in wooded areas (Stejneger, 1905; Barbour, 1914 and 1926).

B. gundlachi has been collected from the provinces of Pinar del Rio, Habana, Las Villas, and Camaguey, and from Isla de Pinos. It is, therefore, a widespread form in Cuba and will probably be found to inhabit also Matanzas and the lowland areas of Oriente. All of the other species of Cuban toads are characterized by a similar islandwide distribution: *B. empusus* and *B. peltacephalus* have been collected in all the provinces and on Isla de Pinos, while *B. longinasus* has been found in what appear to be isolated populations in Pinar del Rio, Las Villas and Oriente.

Since it seemed unlikely that the American museums had missed collecting *B. gundlachi* until 1957, a search was made of the collections of *B. empusus* in the Museum of Comparative Zoology and in the American Museum of Natural History with the idea that specimens of the new species had been collected but had mistakenly been identified as juvenile *B. empusus* (the juveniles of *B. empusus* are rare in collections and thus are poorly known, while the young of *B. peltacephalus* are relatively common and known). This proved to be the case and a number of specimens of the new species were uncovered in this fashion. The relative scarcity of the new species from collections and the fact that all of the specimens collected by Albert Schwartz and myself were from choruses would indicate that *B. gundlachi* is a subterranean species and thus difficult to locate outside of the breeding season.

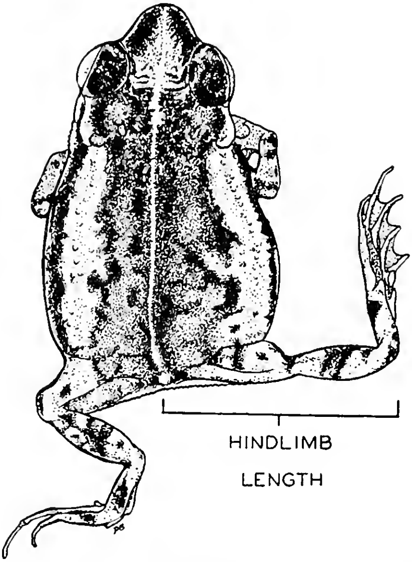

Figure 5. Dorsal view of *B. gundlachi*, MCZ 30552. Measurement of the hind limb length is indicated.

DISCUSSION

In Table 1, a summary of the quantitative data expressing the difference in the length of the hind limb of *B. gundlachi* as compared to the other species of West Indian toads is provided. In the case of *B. empusus* and *B. peltacephalus* it was felt to be more meaningful to measure only juvenile specimens since only the small specimens of these two species could be confused with *B. gundlachi.* The measurement of the body length was done with Vernier calipers and actually is the measurement from the tip of the snout to the posterior tip of the urostyle. When measuring the specimen, it was held so as to flatten the body. The length of the hind limb is considered to be the distance from the vent to the tarso-metatarsal joint measured with a ruler (see Figure 5). The data on Table 1 do not demonstrate any apparent difference between the various populations of *B. gundlachi* in regard to hind limb length. The data do demonstrate a significant difference between *B. gundlachi* and *B. longinasus dunni* (and probably the other subspecies of *B. longinasus* as well) in this regard. The data for the juvenile specimens of *B. peltacephalus* overlap the lower range of *B. gundlachi* while the juvenile specimens of *B. empusus* overlap the upper range of the new species.

Figure 6. Lateral view of the head of *B. empusus*, MCZ 3733.

A comparison of the external characters of the new species with those of the other species of Cuban toads indicates that *B. gundlachi* resembles *B. empusus* and *B. peltacephalus* more than it does *B. longinasus*.

B. empusus, *B. peltacephalus* and *B. gundlachi*	*B. longinasus*
1. Parotid gland short and lateral in position.	1. Parotid gland elongate and expanded dorsally.
2. Various degrees of supratympanic and supraorbital cranial crests.	2. Absence of well developed cranial crests.

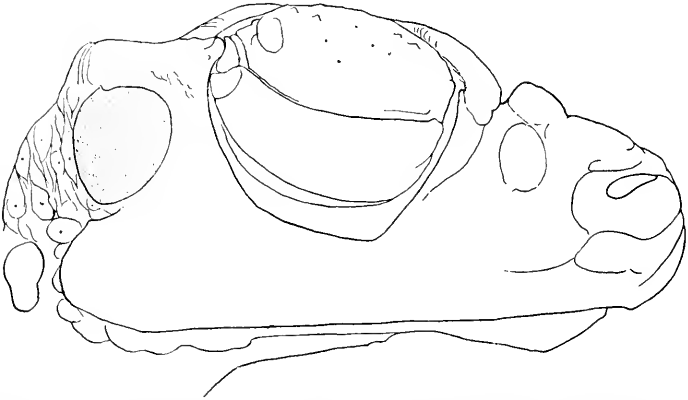

Figure 7. Lateral view of the head of *B. peltacephalus*, MCZ 29287.

As a consequence of the peculiarly ossified tympanic region, *B. empusus* would appear morphologically to stand out from *B. gundlachi* and *B. peltacephalus*. However, all three species appear to be more closely related to the other West Indian species, *B. lemur* and *B. guntheri*, than to the Cuban *B. longinasus*. In addition to the characters listed above, *B. longinasus* is distinctive in the pointed snout of adult specimens, a feature which is, however, less obvious in the young. Schmidt (1928) rightly pointed out that the Puerto Rican and Hispaniolan species are more similar to each other than to the Cuban species. Nevertheless, *B. lemur* and *B. guntheri* are characterized by short lateral parotids and well-developed cranial crests and are thus similar to the *peltacephalus-empusus-gundlachi* group. *B. longinasus*, as Barbour (1914) observed, stands out as a unique West Indian species unrelated to any of the other known forms.

A word is in order here concerning *Bufo turpis* Barbour from Virgin Gorda near Puerto Rico. I have compared the type (MCZ 4099) of this species with a number of specimens of *B. lemur* from Puerto Rico (MCZ 30614-5 and AMNH 10148 to 10151) and can find no valid reason for considering *B. turpis* a distinct species. The differences in the shape of the dorsal crests cited by Barbour (1917) are insignificant and clearly within the expected range of variation of a species. Nor does the single specimen of *B. turpis* give any evidence of being subspecifically distinct. Consequently *B. turpis* should be placed in the synonymy of *B. lemur*.

Figure 8. Dorsal view of the head of *B. guntheri*, MCZ 3104.

The key to the West Indian species of *Bufo* here presented does not include the subspecies of *B. longinasus*. *B. longinasus ramsdeni* described by Barbour in 1914 is known only from the two not too well preserved original specimens from Oriente, and *B. longinasus* is only known from Stejneger's original type from Pinar del Rio. *B. longinasus dunni* described by Barbour in 1926 is the only form of which series of specimens are available. Until further specimens of *B. l. longinasus* and *B. l. ramsdeni* are available it will be impossible to critically determine the validity of the three named forms. Also not included in the key is the introduced *B. marinus*. This form has been successfully introduced into the Lesser Antilles and Puerto Rico, Hispaniola, and Jamaica. It has been introduced into Cuba at least once (Scaramozza, 1947) but interestingly enough there is no evidence that it has established itself on Cuba. It is an attractive hypothesis to attribute the failure of *B. marinus* in Cuba to the existence of *B. peltacephalus*. This native species is almost as large as *B. marinus* and successfully inhabits the cultivated areas of Cuba and thus represents a form that has adapted itself to a situation in which much of the original habitat has been destroyed.

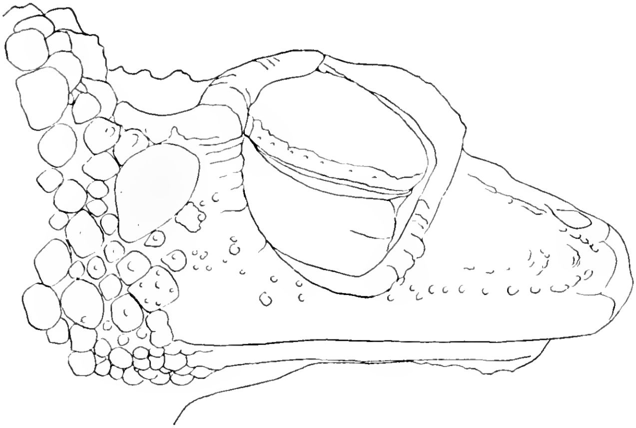

Figure 9. Lateral view of the head of *B. guntheri*, MCZ 3104.

Key to the native West Indian species of Bufo

1. Tympanum not evident, covered by pustulous skin (Figure 4); parotid elongate, the length greater than the width (Figure 2) . . . . *B. longinasus*
   Tympanum not covered by pustulous skin; parotid not elongate 2
2. Tympanum small, completely encircled by bone (Figure 6); sharply inclined profile to snout (Figure 6) . *B. empusus*
   Tympanum not encircled by bone; profile not sharply inclined 3
3. Hind limbs short, the body length/hind limb ratio ranging from 1.57 to 1.93; adult size small (maximum body length, 36 mm.); a thin median dorsal white line (Figure 5) . *B. gundlachi*
   Hind limbs longer, the body length/hind limb ratio ranging from 1.27 to 1.65; adult size larger (body length as great as 170 mm.); no median dorsal white stripe 4

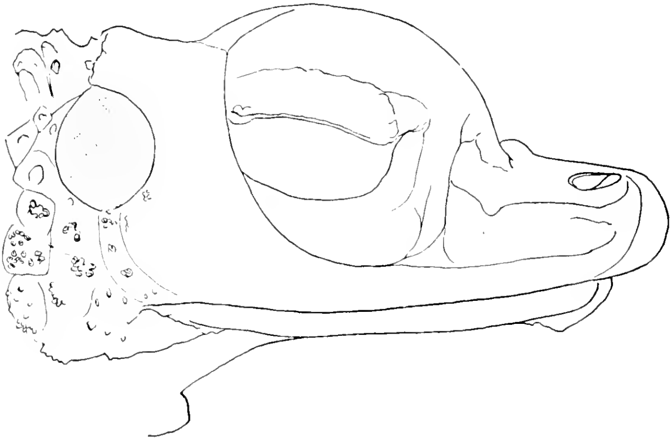

Figure 10. Lateral view of the head of *B. lemur*, MCZ 30615.

4. A canthal knob (Figure 7); orbital crests indistinct *B. peltacephalus*
   No canthal knob; well developed supraorbital and supratympanic crests 5
5. Median supraorbital crest and posterior supraorbital crest forming a right angle (Figure 8); preorbital crest equal to supraorbital crest in thickness . . *B. guntheri*
   Supraorbital crests confluent and forming an arc; preorbital crest thinner and less pronounced than supraorbital crest (Figure 10) *B. lemur*

TABLE 1

Values of the ratio $\frac{\text{Body length}}{\text{Hind limb length}}$

Species	*Locality*	*Number of Specimens*	*Mean Value of Ratio*	*Range*
Bufo gundlachi	Pinar del Rio Province	48	1.75	1.59-1.93
	Habana Province	1	1.60	1.60
	Isla de Pinos	2	1.73	1.60-1.86
	Las Villas Province	5	1.71	1.68-1.75
	Camaguey Province	48	1.73	1.57-1.93
Bufo longinasus dunni	Las Villas Province	27	1.36	1.27-1.54
Bufo longinasus ramsdeni	Oriente Province	2	1.49	1.46-1.53
Bufo longinasus longinasus	Pinar del Rio Province	1	1.50	1.50
Bufo empusus (juveniles)	Camaguey Province	10	1.92	1.76-2.10
Bufo peltacephalus (juveniles)	Cuba	9	1.53	1.46-1.65
Bufo guntheri	Hispaniola	11	1.49	1.32-1.59
Bufo lemur	Puerto Rico	6	1.52	1.45-1.59

TABLE 2
Maximum body length of native West Indian species of *Bufo*

Species	*Sex*	*Maximum Body Length (in mm.)*
gundlachi	♀	36
longinasus	♀	34
empusus	♀	74
peltacephalus	♀	170
guntheri	♀	80
lemur	♀	105

ACKNOWLEDGMENTS

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BREVIORA

Museum of Comparative Zoology

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THE OCCIPITO-VERTEBRAL JOINT IN THE BURROWING SNAKES OF THE FAMILY UROPELTIDAE

By Ernest E. Williams

In 1939, R. Hoffstetter described an amazing condition of the head joint in the peculiar burrowing snakes of South India and Ceylon — the Uropeltidae. Quite in contrast with the condition found in all other amniotes, the first vertebral centrum was said to be fused with the occipital condyle, while the second vertebral centrum was unmodified and procoelous like those behind it. According to Hoffstetter, also, the atlas neural arches, united ventrally by a ligament, embraced the neck of the occipital condyle. The species he personally examined was *Rhinophis blythii.*

The head joint of *Rhinophis planiceps* (= *R. philippinus*), as Hoffstetter was well aware, had previously been described by Baumeister (1908, pp. 499-502, fig. 22). He, like Hoffstetter, had found the first vertebral centrum (= odontoid process) to be absent as a distinct structure. His account differed, however, from that given more than thirty years later by Hoffstetter in one very important detail. He did not find the atlas embracing the neck of the occipital condyle; instead it was in its normal place posterior to and articulating with the head of the condyle. Baumeister also interpreted the situation very differently, believing the first vertebral centrum to have been reduced and for the most part fused with and forming the major element in the anterior articular surface of the second vertebral centrum.

Whether as described by Hoffstetter or by Baumeister, it is sufficiently evident that the head joint in the uropeltids examined by them is profoundly different from the head joint in any other amniotes. In the course, therefore, of a general study of the head joint in reptiles I have found it necessary to give special attention to this feature in this family and in related groups. The simple anatomy of the articulation needed to be carefully restudied, its taxonomic incidence established, and its morphological interpretation reassessed.

Since a detailed discussion of these points would be a lengthy digression in any more general paper, I publish this account separately.

Skeletons of the following members of the family Uropeltidae have been specifically prepared for this study. In each case the head joint was examined at the moment of separation of head and vertebral column and before further preparation.

Melanophidium wyandense
Platyplectrurus madurensis
Plectrurus perroteti
Pseudotyphlops philippinus
Rhinophis blythii
  philippinus
  sanguineus
Teretrurus rhodogaster
Uropeltis ceylanicus
  ocellatus
  pulneyensis
  rubrolineatus

This list includes at least one member of every genus currently recognized in the family and several species of two of these genera, including both the species for which the head joint has previously been described.

In this suite of specimens differences of a specific or generic character are indeed observable, but they involve only minor details. The general pattern is remarkably uniform.

In every case the second vertebra articulates directly and by a simple concavity with the ball-like convexity of the occipital condyle. *There is no intervening odontoid process.* The condylar articular surface is never notched dorsally or indented medially.

An atlas neural arch is always present. It is never placed over the neck of the condyle, as reported by Hoffstetter (Fig. 1B), but instead is, as Baumeister stated, always in articulation posteriorly with the neural arch of the second vertebra, and ventroanteriorly with the ball-like convexity of the occipital condyle. In its articulation with the occipital condyle it furnishes a dorsolateral supplementary rim to the cup-like anterior concavity of the centrum of the second vertebra.

An atlas ventral arch may or may not be present. It is present as a distinct element only in *Uropeltis pulneyensis* (Figs. 3A and B). In some of the forms examined it may have been fused into the ventral margin of the anterior concavity of the second centrum. The presence of a slight anteroventral projection — absent in *U. pulneyensis* — is suggestive of this (Figs. 2B and D: Fig. 3D).

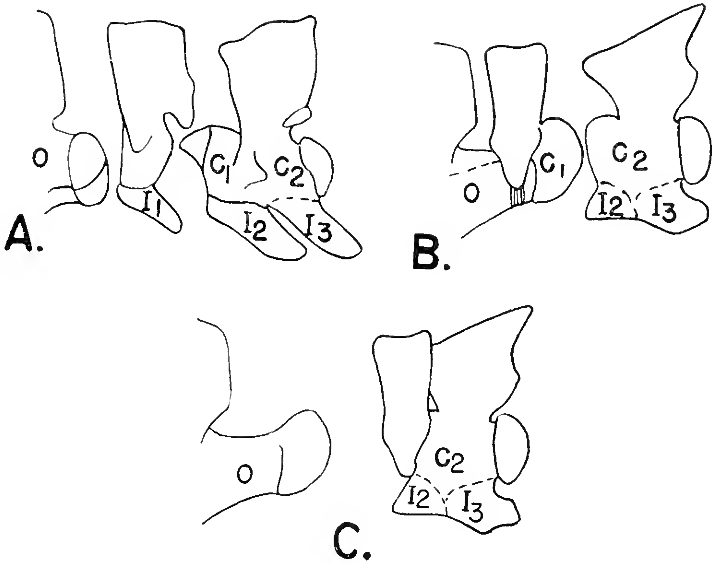

Fig. 1 A. Head joint of *Typhlops steinhausi* (after Hoffstetter). B. Head joint of *Rhinophis blythii* (after Hoffstetter). C. Real condition of the head joint of *Rhinophis blythii*. *Abbreviations:* C_1 = centrum 1, the odontoid; C_2 = centrum 2, the axis centrum. I_2 = second intercentrum; I_3 = third intercentrum. O = occiput.

The contribution of the pedicels of the atlas neural arch-halves or of the ventral arch (when present) to the concavity which receives the occipital condyle, is in all cases minor. The major articular surface is always provided by the second centrum.

The uropeltid head joint may be usefully contrasted with that of a more primitive snake, *Cylindrophis rufus*, which is quite typical of the more usual squamate condition.

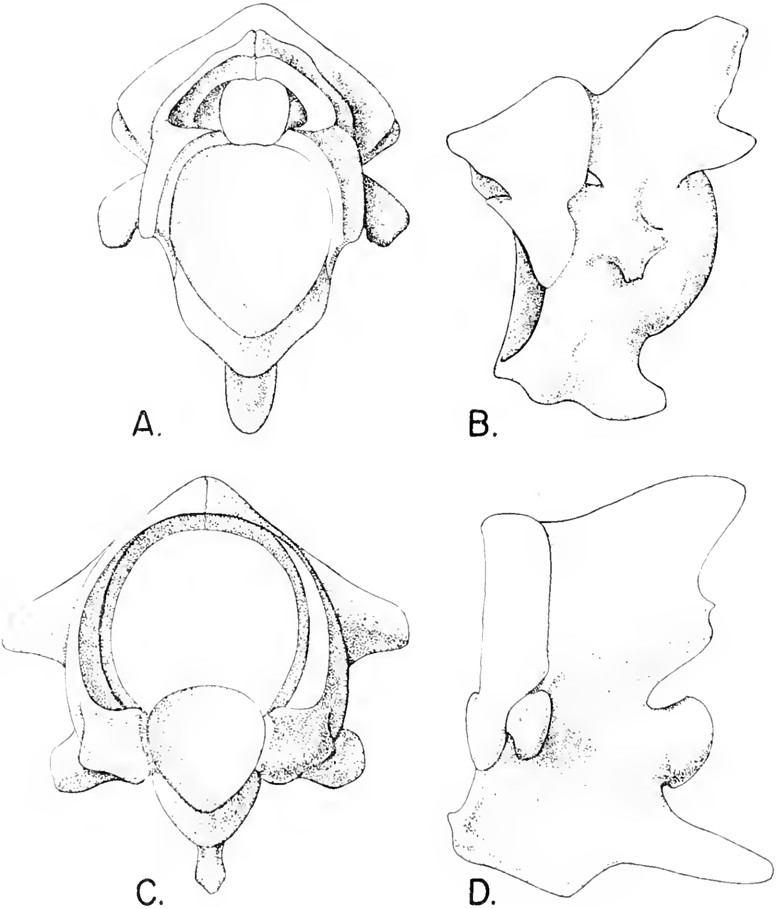

Fig. 2 A. Anterior view, atlas and axis of *Rhinophis sanguineus*. B. Side view, atlas and axis of *Rhinophis sanguineus*. C. Anterior view, atlas and axis of *Platyplectrurus madurensis*. D. Side view, atlas and axis of *Platyplectrurus madurensis*.

In *Cylindrophis rufus* the occipital condyle bears definite traces, in well-marked grooves, of its origin by the union of three bones and is not hemispherical but distinctly indented on its dorsal surface. This indentation is the *fovea dentis* (Gaupp, 1908, p. 518), and is the place of attachment of the *ligamentum apicis dentis*. In many forms this ligament chondrifies or ossifies in whole or in part as a small conical projection from the odontoid process which it is then convenient to call an *apex dentis* (new term). In *C. rufus* the apex dentis is a small cartilage cone.

The occipital condyle is received into a concavity formed by the ventral portions of the atlas ring, the lateral margins of which are formed by large articular surfaces on the pedicels of the atlas neural arch-halves and the articular surface of the ventral arch.

The dorsal margin of the concavity is furnished by the *ligamentum transversum atlantis*, while the outer portion of the bottom of the cup is the *septum interarticulare* (Gaupp, 1908, p. 528). Beneath the ligamentum transversum atlantis and perforating the *septum interarticulare* by means of the *foramen septi* the apex dentis projects forward into the *fovea dentis* of the condyle.

The contact of the occipital condyle in *C. rufus* is thus primarily with the atlas ring and its associated ligaments, only to a minor degree with the odontoid process, mostly by its apex dentis, and not at all with the centrum of the second vertebra.

The atlas ring in *C. rufus*, as in other typical squamates, forms posteriorly a cup for the reception of the odontoid process, entirely similar to that described for the occipital condyle. The same parts participate in a substantially similar way.

The odontoid process in *C. rufus* projects forward from the second vertebra. It is not a conical, distinctly tooth-shaped process, as in most mammals. In *C. rufus* it is an essentially wedge-shaped element, flat dorsally, posteriorly with a flat surface that is suturally united with the true centrum of the second vertebra. Its anterior surface slopes sharply backward. Medially, just below the point of juncture of anterior and dorsal surfaces the small cartilaginous cone that is the apex dentis arises so abruptly as to seem a separate element; it has frequently, though probably incorrectly, been regarded as representing the vestigial centrum of a proatlantic vertebra.

Ventral and somewhat posterior to the odontoid process is the second or axis intercentrum, an element much larger than the odontoid process; it is suturally united to the ventroanterior surface of the true centrum of the second vertebra and projects

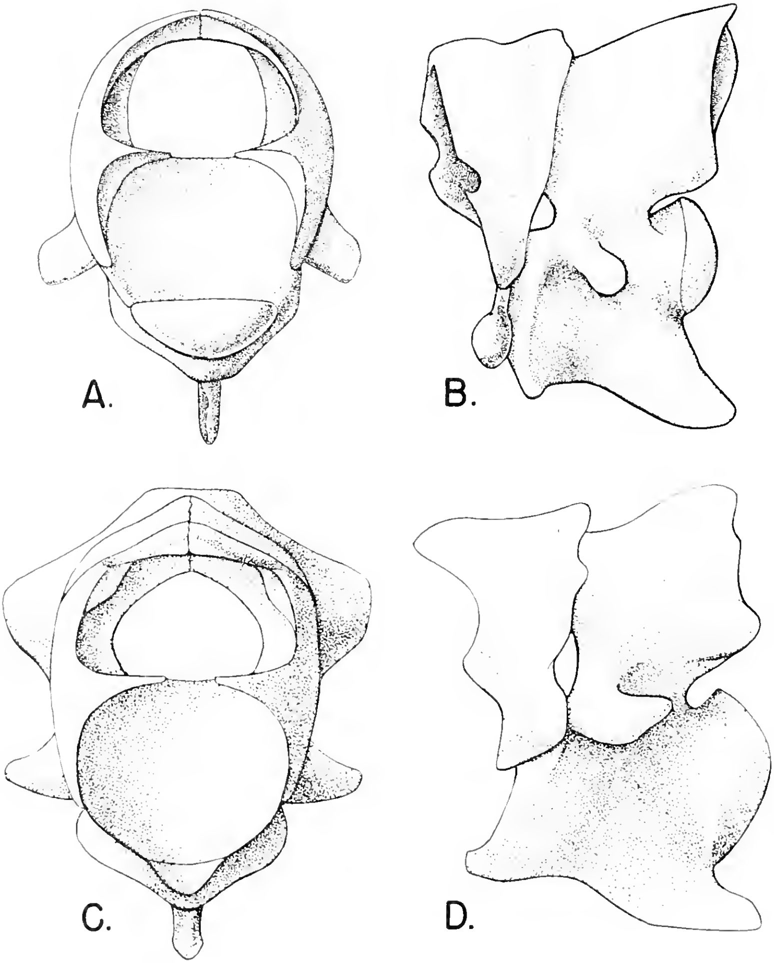

Fig. 3 A. Anterior view, atlas and axis of *Uropeltis pulneyensis*. B. Side view, atlas and axis of *U. pulneyensis*. C. Anterior view, atlas and axis of *Uropeltis ocellatus*. D. Side view, atlas and axis of *U. ocellatus*.

obliquely backward as the first of two ventral spines on the axis vertebra. Anteriorly this element articulates with the ventral arch of the atlas.

With minor differences in details of shape and size this description would serve for the head joint of any typical squamate or of *Sphenodon* (cf. *Typhlops,* Fig. 1A), and with no serious modifications except in regard to relative size of the odontoid process and second intercentrum, it will serve for any crocodile or most turtles.

The essential differences between the uropeltid head joint and that typified by *Cylindrophis rufus* are:

1. The condyle of the uropeltids lacks a fovea dentis.
2. There is neither a ligamentum apicis dentis nor an apex dentis.
3. The articular surfaces on the atlas neural arch pedicels are reduced.
4. The atlas ventral arch is reduced as a whole or more frequently has disappeared altogether as a distinct element.
5. There is no odontoid process.

Somewhat aberrant among squamates is the head joint of *Cylindrophis maculatus* of Ceylon (Fig. 4). The occipital condyle is not notched dorsally, nor indented medially. The grooves indicating the place of union of the three participating bones, are, however, present. There was apparently no ligamentum apicis dentis or apex dentis. The basal portions of the atlas ring — including the neural arch pedicels, but especially the ventral arch — are highly developed. The two neural arch pedicels almost meet mid-dorsally, reducing the ligamentum transversum atlantis to an extremely short connection between the two. The area which could have been filled by a septum interarticulare is very small; perhaps there was none. The odontoid process itself seems somewhat reduced and truncate in front.

In certain ways in which uropeltids differ from typical squamates, *C. maculatus* appears to be modified in a direction opposite to that seen in the uropeltids. The basal parts of the atlas are enlarged in *C. maculatus,* reduced in uropeltids.

In certain other ways *C. maculatus* approaches the uropeltids: in the absence of the fovea dentis and of the correlated ligamentum apicis dentis or apex dentis.

Even the enlargement of the atlas basal elements can, however, be interpreted as tending in the direction of the uropeltids. The typical squamate and other reptilian condition is complex, essentially two joints, one within the other. On the outside there is a major condylar convexity fitting into an atlantal cup; inside this is a joint oriented in the opposite direction — a convexity arising from the odontoid (atlas centrum), fitting into a small concavity within the condyle. See diagram Figure 5A.

The uropeltids and *C. maculatus* have simplified this arrangement by abolishing the internal odontoid joint and perfecting a ball and socket joint entirely comparable to the joints between vertebrae, posteriorly. (Fig. 5B.)

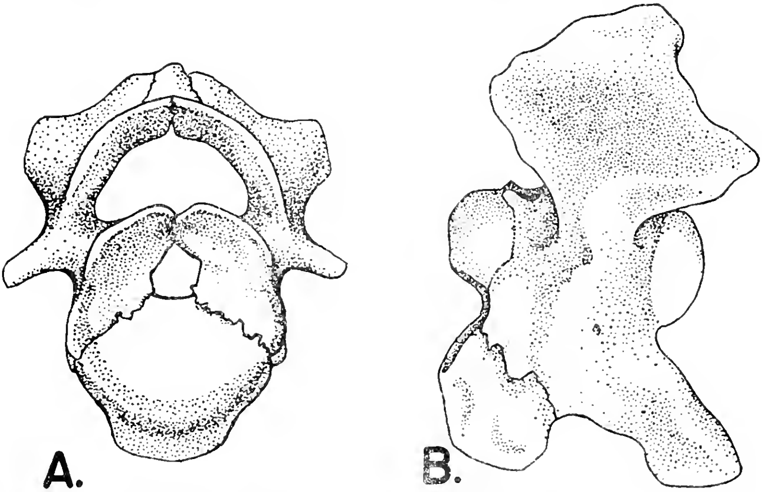

Fig. 4. *Cylindrophis maculatus.* A. Anterior view of atlas. B. Side view of axis.

If this be the correct interpretation of the results achieved by the uropeltid – *C. maculatus* modification, it may reasonably be wondered why the extreme uropeltid condition was found adaptively necessary. *C. maculatus* has achieved a reasonably good ball and socket joint without losing the odontoid process entirely. A hypothesis may be offered here, for future mechanical and functional analysis to test. The axis of *C. maculatus* even with some reduction of the odontoid is much longer than the vertebrae behind it. The uropeltid axis on the contrary is *as short or shorter than* the vertebrae behind it. We may assume that in the still unanalyzed functioning of the uropeltid head joint this shortening of the axis[1] has been mechanically and thus selectively valuable. That this shortening has been accomplished by reduction of the odontoid to essential nullity we may believe to have been an accident of evolution in this specialized group — or we may see in it the culmination of a trend begun in an ancestral form which must have been similar to *C. maculatus*.

It must be explained that although *C. maculatus* occurs in the same area as the uropeltids, shows in several respects special morphological resemblances to them, and may well have had a long history independent of other members of the group, part of the resemblances between *maculatus* and the uropeltids may well be parallelism. At least, as Bellairs and Underwood (1951, p. 231) have indicated, the presence of two ventral transverse scale rows to each body segment in uropeltids rather than one as in *Cylindrophis* is possibly primitive and prompts the inference that the uropeltids have not been directly derived from *Cylindrophis* or its immediate relatives.

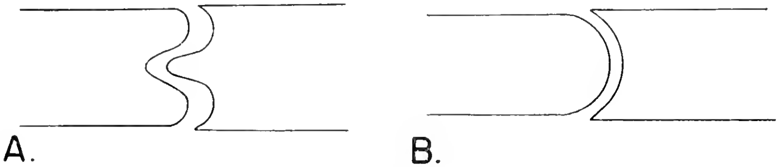

Fig. 5. Diagrammatic horizontal section of the head joint region. A. in most reptiles. B. in uropeltids.

Thus, while it is interesting to suggest that the uropeltid head joint may in the course of its evolution have gone through a stage directly comparable to that in *C. maculatus* — a stage in which the basal parts of the atlas were enlarged rather than reduced — there is no compelling reason derived from any demonstrated direct phyletic relation of *C. maculatus* to the uropeltids to accept such a stage as a necessary intermediate. It would appear

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[1] Most uropeltids have also elongated the pedicel of the occipital condyle, but this is not true in *Melanophidium* which seems in skull and scutellation the most primitive member of the family.

simpler to suppose that in the uropeltids the modification of the head joint was accomplished from the first by strong reduction of the ventral parts of the atlantal ring and of the odontoid simultaneously. The question is one, however, on which critical evidence is unavailable.

If the course of evolution of the uropeltid head joint is likely to remain for some time unknown, more hope may be offered that its ontogeny can be examined. The uropeltids are ovoviviparous; it will therefore be worthwhile to examine the collections already in existence for pregnant females. Though this would be unlikely to provide a stage by stage view of the ontogeny of the head joint region, in the present state of our knowledge *any* glimpse of the development (as of the function or the evolution) of this region in uropeltids would put us substantially farther ahead.

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BREVIORA

Museum of Comparative Zoology

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A REVISION OF THE DACETINE ANT GENUS *NEOSTRUMA*

By William L. Brown, Jr.
Museum of Comparative Zoology, Harvard University

INTRODUCTION

The genus *Neostruma* Brown includes six known neotropical species forming a compact and distinctive group in subtribe Strumigeniti of tribe Dacetini. This genus evidently was derived within the New World tropics from the *gundlachi* group (''subgenus *Pyramica*'') of the large tropicopolitan genus *Strumigenys* Fr. Smith.

The *S. gundlachi* group is also neotropical in distribution. It contains a graded series of species, linked to the more ''typical'' *Strumigenys* through the *S. connectens* group (Kempf, 1958, Rev. Brasil. Ent., 8:59-68), that foreshadow *Neostruma* in head shape, development of serial denticulation of the mandibles, lengthening of labral lobes, reduction of pilosity and spongiform appendages, and other characters.

Neostruma is set off from these by its very long labral lobes with their short trigger hairs, and by the distinctive form and armament of the mandibles, featuring very short apical fork teeth and a series of denticles on each side of a submedian (preapical) tooth (Fig. 5). With the exception of *N. myllorhapha* new species (Fig. 4), a ''countercurrent'' specialist with secondarily elongate mandibles, the *Neostruma* species show a coadaptive complex of characters converging toward those of *Smithistruma* Brown, but not reaching the same degree of completeness (see Brown and Wilson, in press). Among the characters involved in this complex are the following:

1. Shortening of mandibles.
2. Reduction of apical fork.

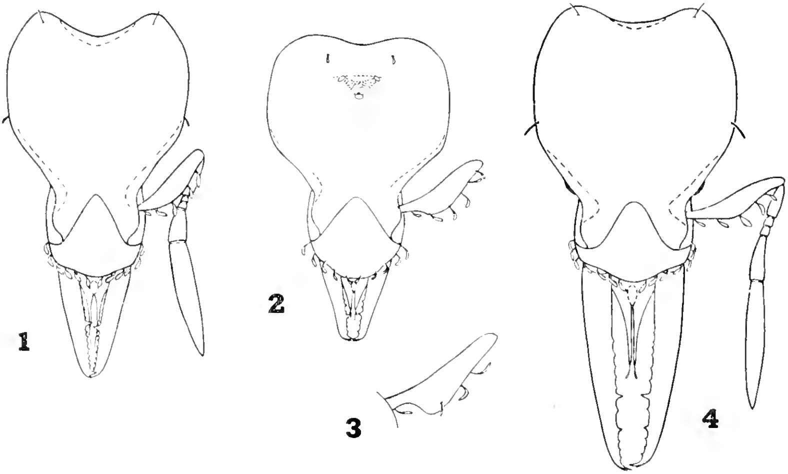
3. Development of serial mandibular denticulation.

4. Transformation of basal tooth into a perpendicular "basal lamella."

5. Slight lengthening, depression and narrowing of head, with some lessening in prominence of occipital lobes and occipital excision.

6. Shortening and incrassation of antennal scapes.

7. Elongation of labral lobes.



Figs. 1-4. *Neostruma* spp., dorsal views of heads, mandibles and antennae. Fig. 1. *N. zeteki* n. sp., paratype worker. Fig. 2. *N. metopia* n. sp., holotype female, funiculus omitted. Fig 3. *N. crassicornis* (Mayr), left antennal scape of worker. Fig. 4. *N. myllorhapha* n. sp., holotype worker. All figures drawn to same scale.

8. Reduction in length of labral trigger hairs.

9. Inability to open mandibles widely (limit is much less than 180°).

10. Hunting behavior is of "strike-hold-sting" type (as based on observation of *N. mustelina;* see below).

11. Foraging less active and less frequent (*N. mustelina*) than in several *Strumigenys* species studied, but much as in *Smithistruma* spp.

The species form small colonies, chiefly in the leaf litter of rain forest or tropical evergreen forest, and nests occupy cavities in rotting twigs, pieces of bark or similar forest-floor vegetable debris so far as we know. Four of the species (*brevicornis, myllorhapha, metopia, zeteki*) occur in Central America, one (*mustelina*) is widespread in tropical Mexico, and one (*crassicornis*) is known only from southeastern Brazil. It seems strange that no records of the genus are available for northern or Amazonian South America, but then collecting in these regions has scarcely begun so far as the Dacetini are concerned. All of the records we now have are from mainland localities; the genus apparently is absent from the West Indies. In the areas where it occurs, the genus is usually not scarce, but exists in fair numbers along with species of *Strumigenys*, particularly of the *gundlachi* group, and many other cryptobiotically foraging ants. The food, judging from what we know of *Neostruma mustelina*, consists primarily of small entomobryomorph Collembola and possibly some other minute terrestrial arthropods as well. Hunting behavior is like that of *Smithistruma* rather than like the *Strumigenys* so far studied.

The material used in this study has come from various sources (see Acknowledgements at end of paper), but the principal places of deposition are the United States National Museum, Washington (USNM), and the Museum of Comparative Zoology at Harvard College, Cambridge, Massachusetts (MCZ).

The measurements and proportions used, and their abbreviations, are as in my other papers on dacetine ants; see especially Brown, 1953, Amer. Midl. Nat., 50: 7-15, or Brown, 1953, Jour. New York Ent. Soc., 61: 53, 101.

NEOSTRUMA BROWN

= *Neostruma* Brown, 1948, Trans. Amer. Ent. Soc., 74:111. Type species: *Strumigenys crassicornis* Mayr, 1887, by original designation (+ 3 spp.).

< *Strumigenys*, auct. (+ 3 spp.).

Worker. Small to minute, resembling members of the *Strumigenys gundlachi* group (from which *Neostruma* appears to have been derived; see Brown and Wilson, in press). Mandibles inserted rather far apart, linear, tapering to an apical fork of two very short teeth separated by 2-4 minute intercalary denticles. Basal lamella present, separated from basal condyle by a deep notch, perpendicular to shaft, broad and flat, subtruncate or rounded at apex, normally hidden beneath clypeus when mandible is closed. Inner borders of mandibles armed with a row of small teeth or denticles on the apical half or two-thirds, arranged as follows: a *preapical* series of 3-8 denticles, immediately proximad of apical fork; a single larger submedian tooth; proximad of this, a short *medial* series of indistinct denticles, beyond which the shaft is unarmed to the basal lamella (Fig. 5). Labrum with a broad basal part and greatly elongate, parallel tapered lobes, extending half or more the exposed length of the closed mandibles. At their apices, the labral lobes each bear 2-3 short trigger hairs; one or two additional pairs of fine hairs on their upper surfaces before the tips. When the mandibles are closed, the labrum is tilted ventrad, but when they are open, it is raised to point straight forward between them. Apparently the same "springtrap" arrangement holds in this genus as in *Strumigenys*. Palpi segmented 1, 1, as in *Strumigenys*.

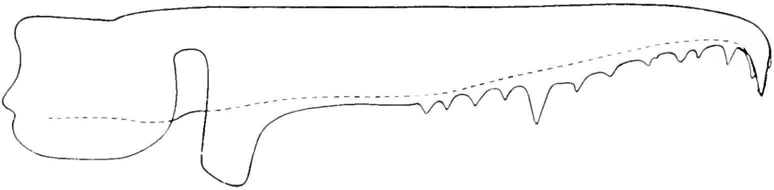


Fig. 5. *Neostruma zeteki* n. sp., greatly magnified dorsal view of left mandible as dissected out of the head.

Head rather elongate, depressed, with moderately expanded occipital lobes, narrowed anterior portion, and moderately well-developed elliptical compound eyes set well forward of midlength, but only partly or not at all visible from above. There is a tendency, best seen in *brevicornis*, *zeteki* and especially *metopia*, for the head to be impressed or concave in front of the vertex. Antennae 6-segmented, as in *Strumigenys*, but scape shortened and incrassate, with curved (and sometimes lobulate) anterior margin.

Alitrunk compact; pronotum depressed and nearly plane above, bounded by a distinct anterior and less distinct lateral margins, meeting at blunt humeral angles. In profile, the dorsal outline is convex from pronotum to propodeum, with a depression (or flat area) in the region of the mesonotum. Promesonotal suture obsolete; metanotal groove weak to absent. Propodeal teeth laterally compressed, acute, their apices directed slightly dorsad, their infradental lamellae narrow and concave. Petiole pedunculate, its rounded node with a feebly developed posterodorsal collar of spongiform lamella; no ventral appendages. Postpetiole subreniform, much broader than petiole, with weak lateral and ventral spongiform appendages. Gaster with a narrow basal spongiform margin and a band of short basal costulae; rest of surface smooth and shining.

Head, alitrunk, legs, and both nodes finely and evenly reticulate-punctulate and opaque, except for a smooth, shining patch on the mesokatepisternum.

Mandibles with oblique pointed and linear-spatulate hairs directed mesad from dorsal surfaces, especially near insertions. Clypeal and anterior scape margins each with a series of bordering spatulate hairs; one erect truncate, clavate or remiform erect hair on the posterior edge of each occipital lobe, one on each lateral occipital border (Figs. 1 and 4), one on each humerus, and one on each side of the mesonotum (these hairs are often small and fragile, and are often missing in part); two on the petiolar node, four on the postpetiole, and 16-20 on the gastric dorsum. Ground pilosity moderately developed to obsolescent except in *N. crassicornis*, consisting of sparse, fine, reclinate or subreclinate hairs on the head, legs and antennae, often invisible on head, shorter on clypeus.

Color varying from ferruginous yellow to dark brown. The gaster is often darker than the rest of the body.

Female like worker, but with larger eyes and fully developed flight apparatus, and otherwise differing from the workers as *Strumigenys* workers differ from their females. Forewing as in Wheeler's figure 11D in his book, "Ants," p. 25, except that in *Neostruma* the apical section of R (labeled "*f*" by Wheeler) is lacking.

Males known only for *N. mustelina;* these are basically like males of the smaller species of *Strumigenys*.

SPECIES EVOLUTION AND RELATIONSHIPS

The six species recognized here represent six morphologically distinguishable samples; of these, *crassicornis* is distinct in a number of good characters from the other five samples, and there is every reason to maintain it as a good species. Its range in southern Brazil and northern Argentina, so far as the present incomplete collections show, is separated by the bulk of the South American continent, or over 3,000 miles, from the nearest known locality of any of the other species. In Panama, we find two sympatric species, *zeteki* and *metopia*, which are very different from one another (Figs. 1 and 2). In *zeteki*, the head is long and exceedingly flattened, and the mandibles are fairly long, with many denticles, while *metopia* has a deep, short, broad head and very short mandibles. So far, our knowledge of the distribution of both of these species is limited to knowing that they both have been taken on Barro Colorado Island in the Canal Zone.

Two of the remaining three species (*brevicornis* and *mustelina*) are very similar to one another and to *zeteki*, and *mustelina* also approaches *metopia*. In fact, these four species can be arranged as the morphocline *zeteki* → *brevicornis* → *mustelina* → *metopia*. In their distribution, however, *zeteki* and *metopia* occur together in Panama, *brevicornis* is in Costa Rica and Honduras (and presumably also in between, in Nicaragua), and *mustelina* is widespread in tropical Mexico. Thus we see that the morphocline is partly also a geographical cline running from Panama to Mexico: *zeteki* → *brevicornis* → *mustelina*. This situation suggests that *zeteki*, *brevicornis* and *mustelina* could amount to one clinally varying species occupying much of Central America and tropical Mexico, and that the *zeteki* population may represent extreme character displacement in the presence of *metopia*, which is itself displaced toward the other extreme. An alternative possibility should not yet be excluded: *metopia* could belong with *brevicornis* and *mustelina*, and could represent a reversal of cline where *zeteki* is present and displaces it. Despite the interest of this possible character displacement situation (see Brown and Wilson, 1956, Syst. Zool., 5: 49-64), we unfortunately lack the material needed to confirm it at the present time. We have no samples from Guatemala (between the ranges of *mustelina* and *brevicornis*) or from western Panama (between *brevicornis* and *zeteki* with *metopia*). A second difficulty is that the available material of *brevicornis*, and especially of *mustelina*, each representing a wide and varied range in Central America and Mexico respectively, shows no obvious infraspecific clinal trends corresponding to that seen *among* the several species. Instead, allowing for individual or local nest-series variation in size, color and other minor characters, the constancy of the "diagnostic" characters holds very well, allowing a complete separation of four morphological species. In view of all of the facts outlined, and the various interpretations possible, I am treating *mustelina, brevicornis, zeteki* and *metopia* provisionally as separate species without strong prejudice as to their eventual status.

The last species to be discussed is the remarkable *N. myllorhapha*, known only from the single type worker from Costa Rica. As Figure 4 shows, this species is quite distinct from all its congeners. It represents an apparent reversal of the trend in *Neostruma* toward shortening of the mandibles. That this is a true reversal is attested by the great elongation of the labral lobes. The *Neostruma* ancester of *N. myllorhapha* obviously had the shortened mandibles, reduced trigger hairs, and elongate labral lobes characteristic of all the existing species of the genus. When the mandibles started to elongate in the line leading to *myllorhapha*, the trigger hairs did not elongate again, but instead the labral lobes bearing them were drawn out to an extreme length, in this way compensating for the unrecovered loss of length of the hairs needed to activate the snap-closure of such long mandibles.

NEOSTRUMA MUSTELINA (Weber)

Strumigenys mustelina Weber, 1934, Revista de Ent., 4:34, fig. 11, female. Type locality: Jicoltepec, Veracruz. Syntypes in MCZ.

Worker (8 specimens measured from 3 nest series). TL 1.6-1.8, HL 0.41-0.46, ML 0.15-0.16, WL 0.43-0.46 mm.; CI 79-81, MI 35-39, ICD 48-52. Habitus intermediate between Figure 1 and Figure 2. The dimensions and proportions overlap those of *N. brevicornis*, but the tendency in *N. mustelina* to smaller size, relatively broader and deeper head, shorter mandibles, and deeper promesonotum is evident on comparison of series. The space between the apical fork and the submedian tooth is shorter than in *brevicornis,* and bears only 4 preapical denticles, a number quite constant in 55 worker and female specimens examined, representing 13 separate nests. These preapical denticulae are longer and more acute than is usual in *brevicornis,* and the third one (counting from the apex toward the submedian tooth) is a little larger than its fellows. It is the constancy of the preapical denticular number in Mexican series which, above all other considerations, leads me to recognize *mustelina* as a species distinct from *brevicornis.* (Before the recent acquisition of several good Mexican series, I had considered *N. mustelina* to be synonymous with *N. brevicornis,* and had sent out specimens labeled accordingly. All such material labeled as "*N. brevicornis*" from Mexican localities should now be considered as belonging to *N. mustelina.*)

The color varies from light yellowish-ferruginous to dark brown. Other characters as in *brevicornis.*

Female (3 specimens measured from 3 different localities): TL 1.9-2.3, HL 0.48-0.52, ML 0.18-0.20, WL 0.51-0.55, forewing L 1.6-1.8 mm.; CI 83-84, MI 36-38, ICD 49-51.

Male (1 specimen reared from nest taken at Las Hamacas, Veracruz): TL 1.7, HL 0.38, HW across eyes 0.38, WL 0.52 mm.

Habitus much like that of other small strumigenite males; head rather large compared to rest of body. Mandibles simple, acute, too small to be opposable. Labrum broad, divided, not elongate. Strong longitudinal frontal groove in front of median ocellus. Antennae not clavate. Notauli present, moderately distinct. Angle of propodeum obtusely rounded; teeth reduced to low carinae, rounded above. Petiole low, node rounded; both petiolar and postpetiolar nodes smooth and shining, like entire gaster and lower posterior sides of alitrunk. Rest of body reticulate-punctulate, appendages finely punctulate, opaque. Erect hairs few and fine, positioned more or less like the clavate hairs of the female. Sparse fine reclinate ground hairs on both surfaces of head and on appendages. Color brown, head blackish, appendages tan.

Material examined. 13 nest series, half of them extensive, all from Mexico: TAMAULIPAS: Aldama (F. Bonet leg.). VERACRUZ:

Jicoltepec, syntypes of *mustelina*, collector unknown. Pueblo Nuevo, near Tetzonapa, and Las Hamacas, about 17 km. north of Santiago Tuxtla (E. O. Wilson leg.; see notes below). Volcan San Martin, dark brown series, ca. 1100 m., forest debris (C. J. Goodnight leg.). GUERRERO: Oaxtepec (F. Bonet leg.). CHIAPAS: Ocosingo and Finca El Real, Ocosingo Valley, leaf mold in hillside (C. and M. Goodnight and L. J. Stannard leg.).

Several colonies of this ant were taken by Wilson during August, 1953, at Pueblo Nuevo and Las Hamacas, Veracruz, in tropical evergreen forest. The ants were found foraging in the leaf litter and nesting in small rotting bits of wood in the litter. One nest (No. 235) contained 24 workers, 1 queen, 4 worker pupae and 5 larvae. Another (No. 237) held 26 workers, 1 queen, 18 worker pupae, 13 larvae of various sizes, and a number of eggs. In one natural nest, an entomobryid was found with larvae feeding on it. Nests in captivity readily captured entomobryid Collembola, including one *Orchesella*-like species. The ants are sluggish hunters, and often show immobile "ambush" behavior, with mandibles held open at about 30°-40° (as in *Strumigenys gundlachi*). When the ant strikes a springtail, the springtail almost always jumps, often several times in rapid succession. The ant hangs on, bulldog-fashion, and immediately curls in a rapid attempt to sting. On one occasion, the collembolan prey jumped and left behind a leg in the jaws of the ant, which bore it back to the nest. Small symphylans, millipedes, campodeids, a mosquito, mites and other arthropods offered to the *Neostruma* were ignored or avoided. One small symphylan was caught, but later rejected. One nest was maintained in the laboratory for two years, during which time it produced two separate sets of males and winged females (sexes in about equal numbers). From this nest, placed under a bell jar in the sunlight, the males and winged females flew out, but remained inactive for days on the ceiling and upper walls of the jar, apparently without mating. They appeared to try to move toward the light. During the two years we kept this colony in a small plaster nest, it was given nothing to eat but entomobryid and isotomid collembolans, a diet which allowed it to maintain itself in a flourishing condition.

One Las Hamacas colony produced an anomalous individual, probably a gynandromorph, in which the right half of the head and both mandibles are worker, while the left half of the head is fully male.

NEOSTRUMA BREVICORNIS (Mann)

Strumigenys brevicornis Mann, 1922, Proc. U. S. Nat. Mus. 61(13):38, worker, female. Type locality: La Ceiba, Honduras. Syntypes in USNM, MCZ.

Worker (10 specimens measured from 4 nest series). TL 1.8-2.2, HL 0.45-0.53, ML 0.17-0.22, WL 0.44-0.53 mm.; CI 75-80, MI 37-42, ICD 46-50. Habitus intermediate between Figure 1 and Figure 2. Although its dimensions and proportions overlap those of *N. mustelina*, *N. brevicornis* is generally larger and has a slightly narrower head and longer mandibles, and the head and promesonotum are usually a little more strongly depressed. The space between the apical fork and submedian tooth is relatively a little longer and usually bears 5 minute, subequal preapical denticulae, these appearing smaller than the preapical denticulae of *N. mustelina*. Very rarely, 6 denticulae are present, and one specimen was seen with 5 on one side and 4 on the other.

Medial denticulae 3-5 in number, small and irregular.

Color varying widely from yellowish-ferruginous to dark brown. The dark brown specimens (Tablazo) apparently come from a highland area in Costa Rica that has produced melanic variants of many wide-ranging dacetine species.

Female (2 specimens from 2 nests): TL 2.1-2.3, HL 0.48-0.52, ML 0.19-0.20, WL 0.58 mm.; CI 77-81, MI 38-40, ICD 50.

Color as in corresponding workers or a little darker.

Material studied: HONDURAS: La Ceiba (W. M. Mann leg.; syntypes). COSTA RICA: Bataan, Abaca Plantation, "in rhizome" (C. H. Batchelder leg.). "Costa Rica," without further locality, 2 separate series (F. Nevermann leg.). Turrucares (A. Bierig leg.) Tablazo, dark brown series (A. Bierig leg.). Peralta Sta. (P. P. Calvert).

NEOSTRUMA ZETEKI new species
(Figs. 1 and 5)

Holotype worker. TL 2.0, HL 0.53, ML 0.20, WL 0.52 mm., CI 68, MI 38, ICD 38. Paratypes: TL 1.8-2.1, HL 0.50-0.56, ML 0.19-0.22, WL 0.47-0.53 mm., CI 67-70, MI 37-40, ICD 37-39.

This species is distinguished from *brevicornis* by its relatively narrow head and by the very strong depression of the head and alitrunk. The mandibles show 6 to 8 subapical denticles and a quite distinctly enlarged submedian tooth. The medial denticular series varies from 4-7 units. The coloration is light to medium ferruginous, gaster darker brown. The average size is also larger than that of *brevicornis*, but these two species are very similar in all other respects.

Dealate female. TL 2.5, HL 0.58, ML 0.22, WL 0.63, CI 71, MI 38, ICD 41. Male unknown.

Holotype (USNM): Barro Colorado Island, Panama Canal Zone (James Zetek). Paratypes (USNM, MCZ, etc.) Several small series, received mixed with other dacetine and basicerotine species, mainly collected by Mr. Zetek on Barro Colorado during 1941-1943. Known only from the type locality.

Several colonies are represented in the type material, and judging from these the species seems very constant and distinctive.

NEOSTRUMA METOPIA new species
(Fig. 2)

Holotype female, dealate. TL 2.2, HL 0.50, WL 0.56, CI 78, MI 32, ICD ca. 50.

Very close to *brevicornis*, and similar to the female of that species except in the much shorter mandibles and the form of the vertico-occipital region of the head. In *metopia*, the ocellar triangle is raised on a blunt ridge or prominence, the latter almost rectangular in lateral view. The ocelli are much closer together than in *brevicornis;* the distance between the anterior and each posterior ocellus being 2-2½ ocellar diameters, while in *brevicornis*, this same distance equals 4-4½ ocellar diameters. The vertex in front of the raised ocellar area falls away rather sharply and is here decidedly concave. In full face view the prominence appears as a curved, blunt and poorly defined transverse ridge centering at the ocellar triangle. The small space between the posterior ocelli is shining and partly smooth, and much of the region inside the triangle is blackened. A single small, suberect, spatulate occipital hair rises posterior to, and to each side of the ocellar triangle, but there are no other specialized erect or suberect hairs on the verticocciput. The *brevi-*

cornis female usually has an additional pair of hairs placed even with or a bit anterior to the ocelli. This character is, however, subject to damage, and should not be trusted on the basis of one specimen.

The preapical denticles are 3 in number on both mandibles. Medial denticles 3-4, uneven. Submedian tooth slightly but distinctly larger than the largest of the denticles.

Color medium-light ferruginous. Color sculpture and other characters as in *brevicornis.*

Holotype (Weber Coll.). Barro Colorado Island, Panama Canal Zone (N. A. Weber leg., 1938, no. 871).

NEOSTRUMA CRASSICORNIS (Mayr)
(Fig. 3)

Strumigenys crassicornis Mayr, 1887, Verh. zool.-bot. Ges. Wien, 37:577, worker. Type locality: "St. Catharina." Types in Naturhistorisches Museum, Vienna.

Worker. TL 2.0-2.3, HL 0.52-0.57, ML 0.18-0.20, WL 0.47-0.53 mm., CI 70-75, MI 34-37, ICD 48-50. This species, which ranges in the Parana Basin and eastward, is distinguished from the four Central American species by its slightly larger size, by the peculiar, sublobately incrassate antennal scapes, by its more swollen, reniform postpetiole, by the extreme reduction of its spongiform appendages, and by the more broadly spatulate ground pilosity of the head.

The preapical mandibular series of denticles varies in number of units from 3-7, and the submedian tooth is relatively large and distinct (contrary to Emery's figure, otherwise a fairly good representation). Color light to medium ferruginous.

Female (one specimen measured). TL 2.7, HL 0.58, ML 0.22, WL 0.62 mm., CI 78, MI 38, ICD ca. 50.

Material examined. Southeastern BRAZIL: Parecy Novo, 2 series (Hansen leg., Rambo leg.). Nova Teutonia, S. Catarina (F. Plaumann leg.). ARGENTINA: Posadas, Misiones (F. Silvestri leg.).

NEOSTRUMA MYLLORHAPHA sp. nov.
(Fig. 4)

Holotype worker. TL 2.4, HL 0.58, ML 0.37, WL 0.62, scape L 0.23, funiculus L 0.52 mm.; CI 74, MI 64, ICD 45.

Like *brevicornis,* but differing in the strikingly elongate, coarsely denticulate mandibles and the correspondingly long labral lobes and antennal funiculi. Head gently and evenly convex above, without a distinct impressed area in the center. Alitrunk rather evenly convex in lateral-view profile, mesonotal area slightly flattened, but not impressed. Sculpture and erect hairs as in *brevicornis,* the hairs rather fine, truncate.

Color light ferruginous, mandibles and appendages more yellowish, gaster brown.

Holotype and sole known specimen labeled simply, "Costa Rica" (F. Nevermann leg.), from the collection of Father Thomas Borgmeier of Jacarepaguá, Brazil.

ACKNOWLEDGEMENTS

Thanks are due to Father Thomas Borgmeier, Dr. M. R. Smith and Dr. Neal A. Weber for the opportunity to study material under their care. Dr. E. O. Wilson furnished valuable notes on the behavior and ecology of *N. mustelina* in its natural habitat, and furnished captive live nests of this species for laboratory study; he also criticized the manuscript before publication. The figures were mostly drawn by Mrs. Nancy Buffler.

B R E V I O R A

Museum of Comparative Zoology

CAMBRIDGE, MASS. MAY 7, 1959 NUMBER 108

SOME NEW SPECIES OF DACETINE ANTS

By WILLIAM L. BROWN, JR.
Museum of Comparative Zoology, Harvard University

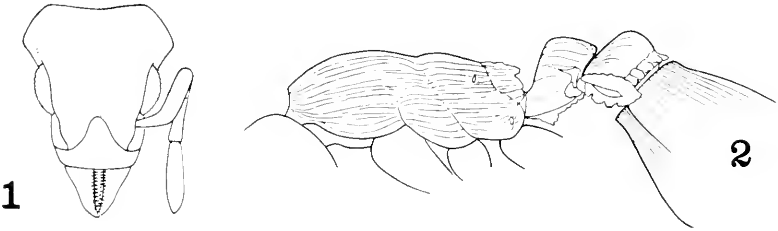
The five species of ants described here include two in *Colobostruma* Wheeler (which genus I currently consider to include *Alistruma* Brown and *Clarkistruma* Brown), one in the *gundlachi* group of *Strumigenys* Fr. Smith, one in *Smithistruma* Brown, and one in *Codiomyrmex* Wheeler. These descriptions are offered in order to validate names used in a general paper on dacetine evolution by E. O. Wilson and myself, which we hope to publish shortly. The paratype variation and other data pertaining to the two *Colobostruma* and the *S. gundlachi* group species are to be discussed in revisions of these groups now in preparation. Abbreviations for measurements and proportions used are given in Brown, 1953, Amer. Midl. Nat., 50: 7-15; and Brown, 1953, Jour. New York Ent. Soc., 61: 53 and 101. The initials [MCZ] refer to deposition of types in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

COLOBOSTRUMA CERORNATA new species
(Figs. 1, 2)

Holotype worker. TL 2.5, HL 0.59, HW 0.52 (CI 88), ML 0.17 (MI 29), WL 0.71, scape L 0.31, greatest diameter of eye 0.17 mm.

Shape of head as in Figure 1 (drawn from a paratype); seen in side view, deep, convex above, with occiput rounded. Mandibles with a stout apical tooth and lesser preapical tooth; inner margins straight, edentate (though appearing falsely denticulate due to integumental microstructure); beneath the border, however, are fine, sharp teeth arranged serially, visible only from below or when mandibles are open (Fig. 1).

Eyes very large, with 80-85 coarse facets, set in shallow depressions or scrobes below cariniform dorsolateral margins of head. Antennae with curved scapes to fit around eyes when retracted; funiculus with 3 segments, the second of these long, representing the fused segments II, III, and IV of the related 6-segmented species. Labrum large, covering under-mouthparts when retracted, bipartite, the two rounded lobes separated by a shallow notch.



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Figs. 1 and 2. *Colobostruma cerornata* new species, worker paratype.

Fig. 1. Head; full-face (dorsal) view, right antenna and pilosity omitted.
Fig. 2. Alitrunk, nodes and base of gaster, side view, pilosity omitted.

Alitrunk as in Figure 2 (drawn from a paratype). Promesonotum gently convex, weakly submarginate along dorsolateral borders; humeral angles prominent, subacute, margined with white waxlike material, also edging the anterior pronotal border except in the middle. No promesonotal suture; alitrunk constricted at distinct metanotal groove. Propodeal lamellae (no teeth distinguishable) waxlike, white, thick, soft and irregular, readily bent or distorted (as seen in paratypes). Petiole and postpetiole with waxlike borders, simulating modest spongiform appendages (as in *Strumigenys*). Gaster both above and below with coarse longitudinal costulae, waxlike at base, the dorsal costulae extending more than 1/3 the length of the basal segment. Gaster otherwise loosely shagreened, weakly shining, as is also the posterior portion of the postpetiolar disc.

Head dorsally covered with shallow indistinct foveolae, mostly contiguous; the boundaries between these form fine longitudinal rugules or costules. This coarser (but not conspicuous) sculpture is overlain by dense, opaque punctulation which also extends to the rest of the head; gula also with loose longitudinal costulation. Alitrunk, petiolar node, and anterior part of postpetiolar disc distinctly longitudinally costulate, the costulae often whitish and waxlike in appearance, especially on sides of alitrunk and extending onto propodeal lamellae. Intercostular spaces, antennae, legs and mandibles chiefly very finely and shallowly, but densely, punctulate-granulose, opaque.

Head and scapes covered evenly above by numerous whitish, suborbicular, subappressed squamose hairs of nearly equal size throughout. Hairs on alitrunk dorsum narrower, more cochlear and more erect, less abundant, not conspicuous. Numerous short, spatulate erect hairs on both nodes and both gastric surfaces, curved caudad. Mandibles and legs with short, sparse appressed hairs.

Color dull yellow; legs, mandibles and antennae light yellow.

Holotype [MCZ] a worker taken foraging on Dempster Head (also called Telegraph Hill), at Esperance, Western Australia, February 4-6, 1955 (E. O. Wilson leg., journal no. 428). Dempster Head is a large, rounded gneissic-outcrop hill with low heath-like shrubs and some dwarf wattles and mallee. Paratypes were taken at the type locality and on the sandplain about 8 km. northeast of the old (abandoned) Thomas River Station, about 65 miles (airline) east of Esperance, near the end of January, 1955, by E. O. Wilson and C. P. Haskins. All specimens were taken at night by sweeping the low heath-like vegetation. Variation is mostly in size, and this is not particularly marked.

This species is very distinct from all other *Colobostruma* in its very large eyes, small size, and particularly in its peculiar pilosity (recalling that of certain *Strumigenys* species), and its waxlike costulation and pedicellar appendages. The 3-segmented funiculi are also found in two or three other *Colobostruma* species. This is one of a peculiar large-eyed, depigmented fauna of ants, including three species of *Colobostruma*, found foraging at night on low heath-like vegetation of the coastal plain of this isolated part of Western Australia.

COLOBOSTRUMA AUSTRALIS new species
(Fig. 3)

Holotype worker. TL 3.2, HL 0.73, HW 0.66 (CI 90), ML 0.19 (MI 27), WL 0.85, scape L 0.37, greatest diameter of compound eye 0.17 mm.

Head like that of *C. alinodis* (Forel), but shorter: evenly convex above; lateral lobes behind eyes evenly rounded. Clypeus broadly triangular, flat, rounded behind, with slightly convex anterior (free) margin mesad. Mandibles triangular, flattened above, with slightly down-curved apices; masticatory margins very finely denticulate (as seen when mandibles are fully closed), but ventral to this margin is a row of fine, acute, oblique teeth, visible from above only on opened mandible. Apex of mandible with one stout tooth and one smaller (preapical) triangular tooth. Antennae with sigmoidally-curved, incrassate (but not lobed) scapes; funiculus with 5 distinctly separated segments. Labrum large, tongue-like, with rounded, entire margin.

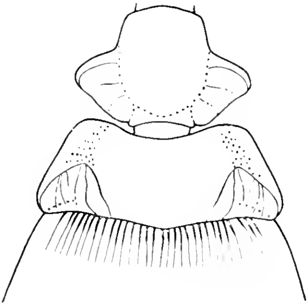

Fig. 3. *Colobostruma australis* new species, worker paratype (Kallista), petiole, postpetiole and gastric base as seen from above.

Alitrunk with a depressed, nearly flat pronotum having blunt, almost rounded humeral angles, not marginate. Mesonotum distinct, convex, rising above pronotum and propodeum. Promesonotal suture and metanotal grooves marked by shallow sulci. Propodeum downsloping caudad, convex between large, broad lamellae, each forming a large acute tooth above, concave below, with a ventral projection.

Petiolar node subcuboidal as seen from side and above, with short, downsloping peduncle, lateral alae, and a short, oblique anteroventral spine trailing a narrow, areolate keel. Postpetiole shorter and lower in side view, but broader in dorsal view (Fig. 3). Basal costulae extending about 1/8 the length of the basal segment. Gaster otherwise smooth and shining. Head, alitrunk and both nodes coarsely but shallowly foveolate, the foveolae centrally punctate, most distinct and mostly contiguous on head, becoming smaller, less distinct and sparser caudad and on clypeus.

Interfoveolar spaces vary from nearly smooth, shining (on occiput) to finely shagreened and opaque (nodes, clypeus). Mandibles, antennae, legs, petiolar peduncle finally punctulate-granulose, opaque. Lower pleura indefinitely rugulose, opaque.

Pilosity confined to four stiff truncate and a few smaller flexuous hairs at the gastric apex. Legs, mandibles, and antennae with very fine, short, sparse reclinate pubescence. Color ferruginous yellow, with dark brown markings, one on vertex, one on center of clypeus, extending to frontal triangle, a large diamond-shaped spot in the center of the first gastric tergum, flanked on each side by a similar spot. This "three diamond" pattern occurs also in some other species of the genus.

Holotype worker [MCZ] one of a nest series taken in a large red-rotten log in wet *Eucalyptus regnans*-tree fern forest at Kallista, in the Dandenong Range, Victoria, Australia (J. Clark and W. L. Brown leg., September, 1950). Several paratype series, including males and females, were examined from Kallista (J. Clark leg.), Narbethong (J. J. McAreavey leg.), and Ferntree Gully (J. Clark leg., Brown leg.) in Victoria, and from Moss Vale (T. Greaves leg.) and Dorrigo (W. Heron leg.) in New South Wales. This species is obviously widespread in moist forests in southeastern Australia. Its nests are normally in rotting wood. It is distinguished from the other *Colobostruma* species, described and undescribed, by means of its 6-segmented antennae with non-lobate scape, its "normal" head, with rounded lobes in back of the eyes, its partly shining sculpture and its predominantly yellow color.

STRUMIGENYS JAMAICENSIS new species

Holotype worker. TL 2.6, HL 0.54, HW 0.44 (CI 81), ML 0.41 (MI 76), WL 0.60, scape L 0.37 mm. (SI 84). Resembles *S. gundlachi,* but larger in size and with relatively much longer mandibles and antennae. Mandibles with gently convex outer borders and straight inner (masticatory) borders, the latter bearing 8 denticles on the left and 7 on the right; denticles strong and acute, occupying about the apical 2/3 of the free inner border, roughly decreasing in size from apex toward base of mandible.

Alitrunk relatively longer than in *gundlachi,* forming two separate convexities divided by the rather deeply impressed metanotal groove. Petiole, postpetiole and gaster also a little longer and more slender than in *gundlachi.* Sculpture and pilosity much as in *gundlachi,* although the ground hairs tend to be less conspicuous in the new species, and the erect hairs larger; *gundlachi* has more but shorter erect hairs on the gastric dorsum. Color blackish-brown; mandibles and legs medium brown. The color is considerably darker than is usual for *gundlachi,* but samples of *gundlachi* from Jamaica are also rather dark — nearly as dark as *jamaicensis.*

Holotype (Collection of the Illinois Natural History Survey, Urbana, Illinois) a worker from a series taken at Corn Puss Gap (about 2000 feet), St. Thomas Parish, eastern Jamaica (H. B. Mills leg.), INHS accession no. 49627, Mills no. J-18. Paratypes from the type collection and in two series from Hardwar Gap (about 4000 feet), Portland Parish, Jamaica (Mills leg.), INHS accession nos. 49613 and 49616, Mills nos. J-4 and J-7, deposited in INHS, MCZ and elsewhere. Paratypes are similar to holotype; principal variation is in mandibular teeth, varying from 6-8 in number.

The large size, long mandibles, long scapes and slender alitrunk will distinguish this species at once from the other two members of the *S. gundlachi* group on Jamaica, *S. gundlachi* Roger and *S. eggersi* Emery. The long scapes and blackish color, among other characters, distinguish *S. jamaicensis* from the Cuban and mainland species of the group.

SMITHISTRUMA WEBERI new species
(Fig. 4)

Holotype worker. TL 2.3, HL (omitting cervical flange) 0.61, HW 0.39 (CI 64), ML (estimated from open mandibles) 0.08, WL 0.58, scape L 0.27 mm.

Head and mandibles as shown in Figure 4; dorsum of head gently convex behind in both directions, in side view its dorsal outline nearly straight from vertex to clypeus, central or "frontal" part of head gently convex from side to side. Clypeus with a broad and very shallow transverse impression near midlength; tumulus of clypeus broad, indicated by dashed lines in Figure 4. Eyes fairly large and convex. Mandibles small, with basal lamella like that of *S. truncatidens* Brown, but more slender and with broader apical expansion; diastema distinct; first tooth of principal series very small, second tooth largest; all teeth acute. Scapes incrassate, broadest near the middle, only slightly bent near their bases.

Pronotum depressed, broad, gently convex and forming a single profile convexity with mesonotum; promesonotal suture present but inconspicuous. Seen from above, promesonotum broadly oval, separated in center front by a short transverse margin from the cervix, but not marginate on sides; no humeral angles. Metanotal groove distinct but shallow; propodeal dorsum slightly convex (straight in profile), terminating in a pair of very small triangular teeth subtended by narrow, nearly straight infradental lamellae. Petiole with a peduncle about as long as its node; node high, rounded, with a flat, smooth, steep anterior face defined by weak carinae on both sides and above. Free portion of nodal summit seen from above trapezoidal, a little broader than long. Postpetiolar node with a convex, smooth and shining disc about twice as wide as the petiolar node. Both nodes, as well as the anterodorsal gastric margin (but not the anteroventral face of the gaster), provided with unusually voluminous spongiform appendages in all the usual positions. Base of first gastric segment with coarse costulae extending about 1/3 the free length of the segment. Gaster otherwise smooth and shining.

Head, alitrunk and petiolar node generally punctate-rugulose, this sculpture much coarser and more irregular than in other

Smithistruma species. Pronotal rugules more longitudinal. The mesepisterna and propodeal dorsum are densely punctulate, and the metapleura, propodeal declivity, anterior face of petiolar node and tumulus of clypeus are mostly smooth and shining. Antennae, scrobes, exposed parts of mandibles and legs finely punctulate-granulose.

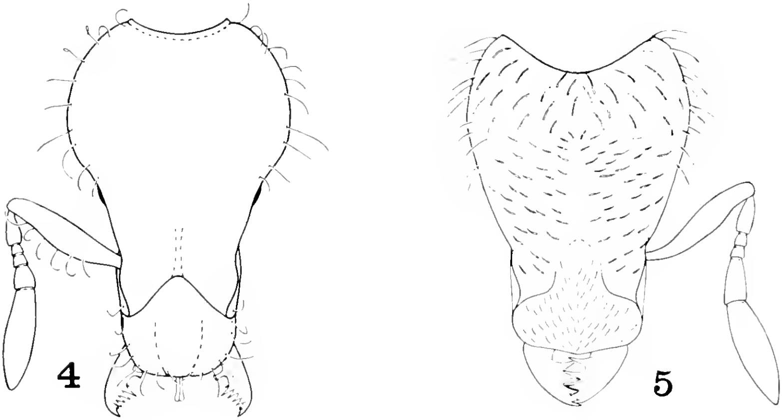

Fig. 4. *Smithistruma weberi* new species, holotype worker, full-face view of head, showing principal fringing pilosity only. Fig. 5. *Codiomyrmex semicomptus* new species, paratype worker with rather narrow head, full-face view of head.

The dorsal surfaces of head, thorax proper, both nodes and both upper and lower sides of gaster, and also the anterior border of clypeus and scapes, with long, fine curved hairs. On the dorsal surface of the head proper, the 50-60 hairs are erect, mesally curved, and have narrowly flattened-clavate apices. On the clypeus, there are an additional 30 or more hairs of various lengths, predominantly directed anterolaterad, but with their apices mostly recurved dorsad and more or less posteromesad. The central clypeal hairs have slightly enlarged apices. Hairs, more peripherally situated on cranium, scapes and clypeus, are finer and tend to have apices merely truncate, rather than enlarged (Fig. 4). The long hairs on the rest of the body become progressively finer caudad, and many of them show "furled coachwhip" looping, or else arch back to the surface. Arched and looped hairs are abundant on the gastric dorsum. Appendages clothed with fine arched-reclinate hairs.

Color light reddish-ferruginous, extremities more yellowish.

Holotype a unique worker from Ango, Belgian Congo, 1948 (N. A. Weber leg., no. 2170), in the Weber Collection. Several years ago I saw another worker of this species from northern Angola (Machado leg.) in Dr. F. Bernard's collection; because at that time I thought he might eventually describe this species, I did not record the details.

CODIOMYRMEX SEMICOMPTUS new species
(Fig. 5)

Holotype worker. TL 2.1, HL 0.56, HW 0.42 (CI 75), ML 0.10 (MI 18), WL 0.52, scape L 0.25 mm. Shape of head and mandibles as in Figure 5, drawn from a paratype, but slightly wider across occiput. Dorsal surface of cranium strongly convex in the center, sloping toward occiput and anteriad (toward clypeus), so that the occipital lobes are narrowly rounded apically as seen from side. Mandibles strongly convex, rising above the anterior clypeal border (as is usual in *Codiomyrmex*); with five strong, acute conical teeth, the first (nearest base) and fourth a little smaller than the second and third, the apical (fifth) tooth smallest. The basal lamella is normally hidden beneath the clypeus at full closure; it is set at a lower level than the principal teeth and oblique to them, and is separated from them by a brief diastema; in shape and size it resembles the lamella of *Smithistruma weberi* (Fig. 4), but is sharply truncate without being broadened at the apex. Clypeus almost perfectly plane.

Alitrunk narrow, only slightly more than half as wide as the head, its dorsum almost flat from side to side and defined by lateral margins, but forming one gentle convexity from pronotum to propodeal teeth, with only a slight dip at the posterior mesonotum. Seen from above, the pronotum is evenly rounded and marginate, without humeral angles and only slightly wider than the propodeum; promesonotum with a faint median longitudinal carinula. Propodeum curving evenly down into the concave declivity between the dorsolateral margins and the propodeal teeth; teeth with horizontal dorsal borders, completely involved in the broad infradental lamellae, which are briefly concave below the short acute dorsal tips, then below this broadly convex.

Petiole large, its peduncle rapidly enlarging caudad, but distinctly differentiated from the large node. Node high in front, with a strong, bluntly raised anterodorsal margin and steep bicarinate anterior face, the dorsal surface then strongly convex and sloping caudad; node distinctly longer than high, and, seen from above, longer than broad, with rounded sides and truncate anteriorly. Postpetiolar disc broadly subelliptical, broader than long and about 1 1/3 times as broad as petiolar node. A full complement of voluminous, areolate spongiform appendages present in all the usual positions on both nodes and at the base of the gaster. Gaster depressed, much broader than deep. Basigastric costulae distinct, crowded, effaced mesally, extending about 1/5 the length of the first segment.

Gaster otherwise, both nodes, entire alitrunk, most of legs, anterior frontal area of head, and clypeus smooth and shining except for scattered piligerous punctures. Scrobes, upper sides of hind coxae and petiolar peduncle densely reticulate-punctate. Mandibles, antennae and small parts of legs finely punctulate-granulose, subopaque to opaque. Cranium, both dorsal and ventral surfaces, loosely and rather coarsely rugose or costulate, the rugae running more or less longitudinally. Between the rugae are various coarse and fine punctures, rendering the surface here opaque (more shining near the midline).

Occiput and rest of dorsal surfaces of body, including the entire legs, with numerous long (mostly 0.07-0.10 mm.) fine hairs with tapered or truncate tips, becoming more spatulate on center of head, and on anterior half of head proper represented by shorter, appressed linear-spatulate hairs directed mesad, this appressed pilosity repeated in miniature on clypeus. Scapes each with a row of short remiform hairs, inclined apicad. Mandibles, antennae, gula, and tarsi with fine reclinate hairs.

Color deep reddish-brown, head and gaster darkest; clypeus, mandibles, antennae and legs yellowish-ferruginous.

Holotype [MCZ] a worker, chosen from a series of 18 workers taken together in heavy, dense eucalypt forest adjoining rain forest at Shipton's Flat, about 20-25 miles south of Cooktown, Queensland, Australia (P. F. Darlington leg.). The 17 paratypes are very similar to the holotype, and vary hardly at all in measurements; several are subteneral; these will be placed in the MCZ and with other ant collections.

This species greatly resembles the larger Sumatran ant *Weberistruma jacobsoni* (Menozzi) in shape of head and thorax proper, as well as in sculpture and pilosity, but many details are different, including the diagnostic shape of the petiole (clavate, with only feebly differentiated node in all *Weberistruma*). From the two other known *Codiomyrmex* species, *C. thaxteri* Wheeler (Trinidad) and *C. loveridgei* Brown (Nyasaland), the new species is distinct in many characters, but it fits this genus in formal diagnostic characters and is obviously similar in overall habitus. It is becoming clearer with each new find that the genera *Codiomyrmex*, *Weberistruma*, *Glamyromyrmex* and their relatives are interrelated. Although each species in this relict group is very distinct, the generic limits are at present not very satisfactory.

This capture is a remarkable one, regardless of eventual generic placement, because it represents the first short-mandibulate species of subtribe Strumigeniti found on the Australian continent.

BREVIORA

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ON THE PINEAL AREA AND ADJACENT STRUCTURES OF THE BRAIN OF THE DIPNOAN FISH, *PROTOPTERUS ANNECTENS* (OWEN)

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INTRODUCTION

The morphology of the pineal area of the dipnoan fish, *Protopterus annectens*, so far has not been described. In connection with an investigation of the central nervous system of *Protopterus annectens*, however, Burckhardt (1890, 1892) gave a brief description of the dorsal region of the brain, indicating the presence of a pineal organ and, interior to that organ, a conspicuous structure which he named coronarium. Because of the taxonomical position of *Protopterus*, and the considerable variation in the morphology of the pineal structures, especially among teleost fishes (Studnička 1905, Tilney and Warren 1919, Friedrich-Freska 1932, Rasquin 1958 and others), it seemed of interest to describe the dorsal differentiations of the brain of this dipnoan fish, with special reference to the pineal area, and to compare them with the corresponding structures of teleosts.

Material and methods. Four specimens of *Protopterus annectens* fixed in Bouin's solution, and one specimen in formol-alcohol, were investigated. Two heads were sectioned, one transversely and one sagittally, at 50 microns, using celloidin technique. In the others, the brain was dissected out and cut in paraffin at 7 microns. The celloidin sections were stained in Mallory's

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[1] Fellow of the Commonwealth Fund.

phosphotungstic acid haematoxylin (Romeis 1948, p. 163), and the paraffin sections were stained in Gomori's aldehyde fuchsin (Gabe 1953) and in Mallory's triple stain.

Terminology. Studnička (1905, p. 4) defined the pineal area as the dorsal parts of the diencephalon from the "commissura posterior to the paraphysis." This definition has been adopted in this study. Structures situated anterior of the velum transversum are generally called paraphysis. The latter belongs morphologically to the telencephalon (Kappers 1957, p. 52). In his description of the central nervous system of *Protopterus annectens*, Burckhardt (1892) called the conspicuous structure anterior of the velum transversum, the coronarium, probably because of its vascular pattern. However, this structure should be called paraphysis (Studnička 1905, p. 4). The present study has confirmed Studnička's opinion, for the structure satisfies all the criteria of a true paraphysis cerebri, mainly because of its position in front of the saccus dorsalis and the velum transversum but also because of its general structure. The terminology is in agreement with that discussed by Kappers (1956).

DESCRIPTION

No pineal spot is associated with the pineal area as found in certain teleosts, amphibians and lizards. The general morphology of the pineal brain area is shown in Figure 1. It includes a number of well-defined structures, namely: an organon subcommissuralis, underlying a conspicuous commissura posterior, a commissura habenulae, a pineal organ, and a saccus dorsalis.

The organon subcommissuralis (Fig. 5) consists of columnar, ciliated, secretory cells containing granular Gomori-positive material as in teleosts and other vertebrate classes (Wingstrand 1953). The pineal organ, arising from the commissura posterior area, consists distally of an end-vesicle which is attached to the brain by means of a proximally divided stalk. The pineal organ extends forward and overlies both the saccus dorsalis and the paraphysis and is situated close to the skull roof (Figs. 1, 2). The end-vesicle did not penetrate the skull in my material (cf. Wiedersheim 1893).

The histology of the vascularized pineal organ does not differ markedly from that found in teleost fishes, in which mainly two types of cells have been observed: the sensory cells and the supporting cells. The primary sensory cells (N. Holmgren 1918, 1920, Friedrich-Freksa 1932, Rasquin 1958, and others) in *Protopterus*, as in most teleosts, can be differentiated from the supporting cells ("Stützzellen," Friedrich-Freksa 1932) which show a strong affinity for the acid fuchsin of Mallory's stain especially the hyperchromatic nuclei of the cells. The cytoplasm of the supporting cells is reduced and the cell membranes seem almost to enclose nuclei. However, compared to teleost fishes, there are very few supporting cells present in the pineal organ of *Protopterus*. The primary sensory cell-type has a well defined nucleus with nucleoli, and the cytoplasm had a distal process similar to that of the amphibian sensory cell-type (N. Holmgren 1918, Bargmann 1943). The sensory cells in teleosts have been found to be secretory in nature (N. Holmgren, 1920). Since the pineal sensory cells resemble both those of the teleosts and the amphibians and there is a significant decrease in supporting

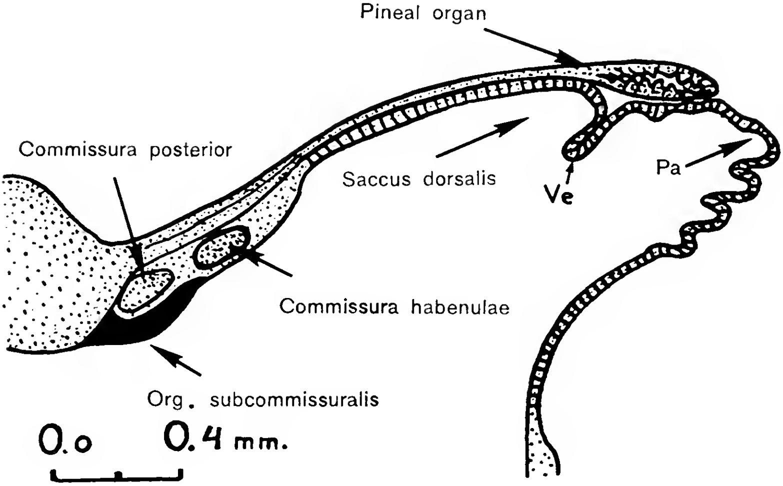

Fig. 1. Schematical picture of the pineal area and adjacent structures of the dipnoan fish, *Protopterus annectens*. The conspicuous paraphysis (*Pa*) is situated anterior to the velum transversum (*Ve*).

glial elements of the pineal organ, one is tempted to regard the pineal of *Protopterus* as a type intermediate between that of teleosts and amphibians.

No parapineal organ or rudiment of it could be found in any of the five specimens. A parapineal rudiment present in the adult has so far not been described in teleost fishes. A parapineal organ is, however, always present in the teleost embryo, but it degenerates in the adult.

Anterior to the pineal organ, the commissura habenulae is present in the dorsal roof of the diencephalon (Fig. 5), marking the limit between the parts of the diencephalon which posteriorly give origin to the pineal- and parapineal complex, and the parts which anteriorly form the saccus dorsalis and velum transversum.

In the commissura habenulae area, it is observed that the right nucleus habenulae is larger than the left one in two specimens, and of about the same size in one specimen. Similar variation has been observed in teleosts. Gierse (1904, p. 618) and Handrick (1901, p. 7) reported asymmetry between the habenular nuclei in certain deep sea teleosts. Such individual variation within one species was frequently found in a number of teleosts (N. Holmgren 1920); this fact already had been pointed out by Gierse (1904), who found that sometimes the nucleus habenulae dexter, sometimes the nucleus habenulae sinister was the larger. The significance of this asymmetry has been extensively discussed in the literature (Gaskell 1890, Friedrich-Freksa 1932, and others). The saccus dorsalis which surrounds the pineal stalk consists of neuroependym, which corresponds to the observations in teleosts (Studnička 1905, Friedrich-Freksa 1932). The anterior limit between the saccus dorsalis and the paraphysis is formed by a not very well defined velum transversum (Fig. 1), which indicates the anterior end of the pineal area.

The paraphysis, shown in Figures 3 and 6, is very much folded and vascularized. Vessels with blood corpuscles are observed between the folds (Fig. 6) of the paraphysis, where also aldehydefuchsin-positive material was observed (8).

Although the specificity of the aldehydefuchsin stain is not well established so far, it may be of interest to note that similar staining reactions were observed in the same slides in the subcommissural organ and also in the nucleus preopticus secretion of the hypothalamus.

The descriptions and comparisons presented in this paper have shown that there is no considerable difference between the pineal morphology of *Protopterus* and that of teleost fishes. The pineal organ of *Protopterus* resembles that of primitive teleosts, especially that of the Clupeidae and Salmonidae. The pineal region of *Protopterus* also resembles the pineal area of other dipnoans such as *Ceratodus* (Huxley 1876, Studnička 1905, and N. Holmgren and v. der Horst 1925). A well defined paraphysis cerebri has previously been observed in another dipnoan, *Ceratodus*, and in the chondrostean *Acipenser* (Studnička 1905). In selachians, on the other hand, the paraphysis, although present during the early ontogeny, is not found in the adult (Kappers 1957). In teleosts the conditions are essentially similar, although the paraphysis is present in a number of species (U. Holmgren 1959).

The resemblance in the histology of the pineal (as described above) between *Protopterus* and the amphibian is not surprising, considering the taxonomic position of the lungfish. The presence of aldehydefuchsin-positive material in the paraphysis has been dealt with by Scharrer (1951), who described the presence of such material in the paraphysis of certain snakes. This secretory material of the snake arose from the nucleus paraventricularis area of the diencephalon. The described aldehydefuchsin-positive granules in *Protopterus* were 2-3 times larger than red blood cells and appeared in close association with blood vessels. Their structure did not resemble that of blood elements. The origin and nature of the aldehydefuchsin-positive material could not be determined on the limited material at hand.

SUMMARY

The pineal area of *Protopterus annectens* was studied in five specimens. Its morphology resembles that of primitive teleost fishes. The histology of the pineal cells, on the other hand, is similar to that of amphibians.

ACKNOWLEDGEMENTS

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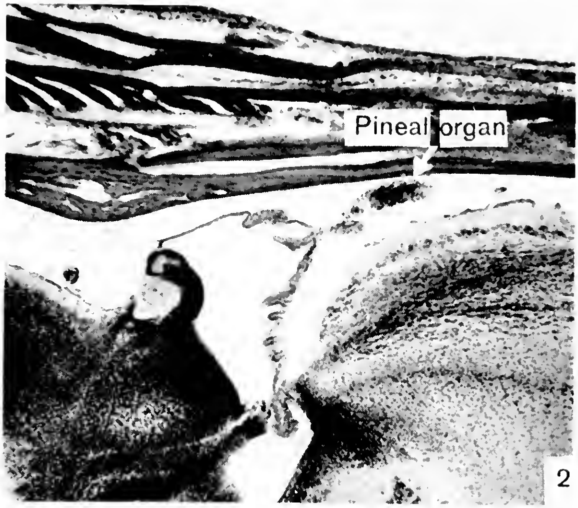
PLATE I

Fig. 2. Median section of the pineal area showing the pineal organ. The pineal stalk is surrounded on each side by the saccus dorsalis and the paraphysis. Fixation Bouin, Mallory's phosphotungstic acid stain, 50 microns. 25 x.

Fig. 3. Cross-section of the brain at the level of the paraphysis. Note that the paraphysis (*Pa*) forms an epiphysis-like structure. Fixation Bouin, Mallory's phosphotungstic acid, 50 microns. 30 x.



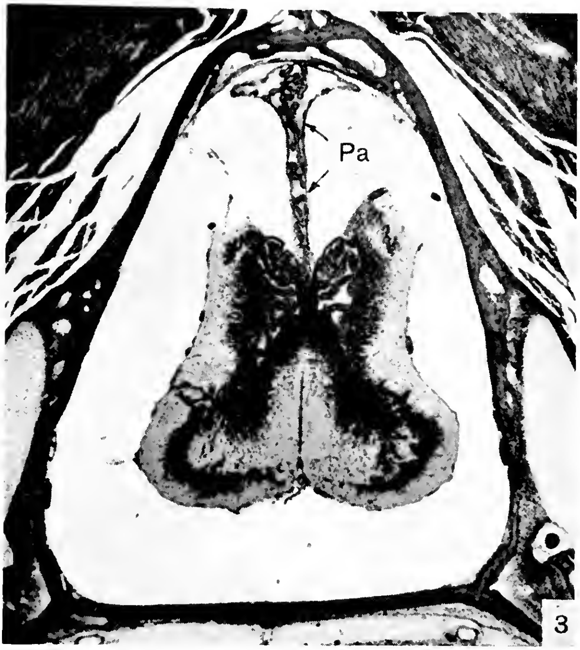


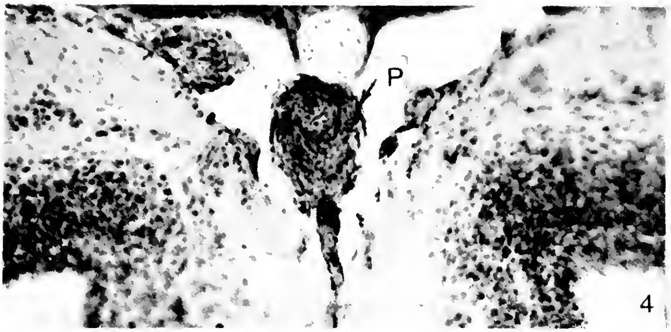
PLATE 1

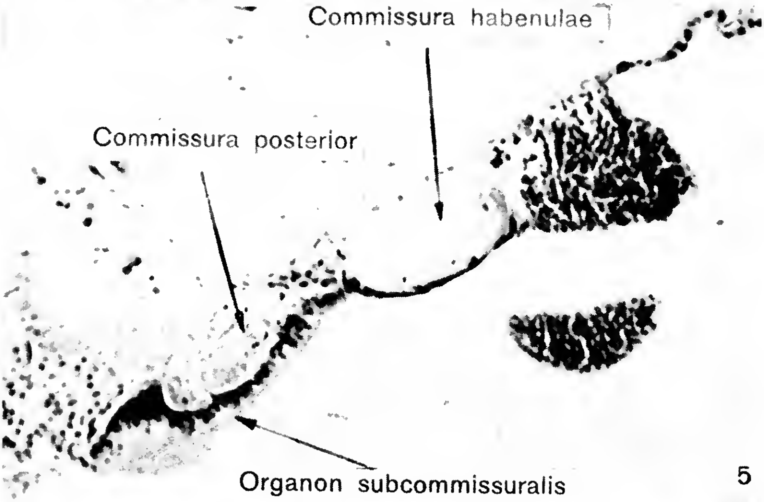
PLATE 2

Fig. 4. Cross-section of the diencephalon showing the pineal stalk (*P*). Fixation Bouin, Gomori's aldehyde fuchsin. 100 x.

Fig. 5. Sagittal section of the commissura posterior area. Note the large commissura habenulae compared to the commissura posterior. The pineal stalk has been removed. Fixation Bouin, Gomori's aldehyde fuchsin. 100 x.

Fig. 6. A part of the paraphysis showing aldehydefuchsin-positive material (*S*, arrows). Fixation Bouin Gomori's aldehyde fuchsin. 300 x.


P
4


Commissura habenulae
Commissura posterior
Organon subcommissuralis
5

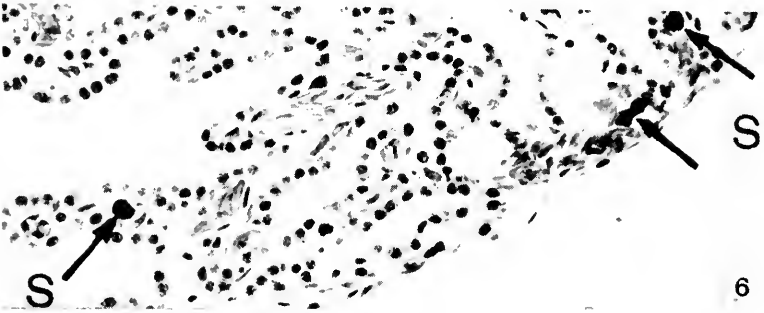

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PLATE 2

B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. June 16, 1959 Number 110

THE SPIDER GENUS *COLEOSOMA* (*ARANEAE*, THERIDIIDAE)

By Herbert W. Levi

This paper is one of a series describing American spiders of the family Theridiidae and redefining theridiid genera. The late Miss Elizabeth Bryant revised the genus *Coleosoma* (1944, Psyche, vol. 51, pp. 51-58), and my paper is intended to complement hers by re-illustrating the species and giving their distributions.

I should like to thank Dr. W. J. Gertsch of the American Museum of Natural History, Dr. R. V. Chamberlin, University of Utah, and Dr. A. M. Chickering, Albion College, for making collections available to me. The work was done with the help of a National Institutes of Health grant (E-1944). A National Science Foundation grant (G-4317) made possible the examination of types in European museums. I extend my thanks also to Prof. G. C. Varley for his hospitality at Oxford University, and to Prof. T. Jaczewski and A. Riedel of the Polish Academy of Sciences, Warsaw, for the loan of valuable specimens.

Coleosoma O. P. Cambridge

Coleosoma O. P. Cambridge, 1882, Proc. Zool. Soc. London, p. 426. Type species by monotypy: *Coleosoma blandum* O. P. Cambridge.

Small (less than 3 mm. total length) theridiid spiders. Eyes very small, eyes of posterior row one to two diameters apart. Clypeus projecting. Chelicerae without teeth on anterior margin or with one tooth. First leg longest; in females fourth leg next in length, in male second leg. Tarsal comb present but indistinct. Abdomen sometimes modified in female (Fig. 6), always modified in male. Colulus absent.

Epigynum very weakly sclerotized, openings indistinct, quite variable. Palpus with a functional median apopyhsis (M in Fig. 16); a sclerotized radix (R), a weakly sclerotized conductor (C) and a thread-shaped embolus (E).

The males of *Coleosoma* have a sclerotized ring around the anterior of the abdomen; the ring continues as a ventral shield and has a pair of lobes on the dorsum (Figs. 4, 9, 10, 15). In some species the abdomen may be constricted (Figs. 9, 10). These characters separate the males of *Coleosoma* from both *Chrysso* and *Theridion*. Unfortunately I know of no way to separate females from *Theridion*. *Coleosoma* is not close to *Lithyphantes* [=*Steatoda*] as Miss Bryant thought.

Simon incorrectly synonymized *Coleosoma* with *Theridion*, causing confusion. The catalogers, Petrunkevitch, Roewer, and Bonnet, have unfortunately followed Simon.

It is of interest that although the few species known to belong to *Coleosoma* are very closely related, and the males are difficult to separate, the species *C. floridanum* has the epigynum (Fig. 14) and internal genitalia (Fig. 13) entirely different from the other two. While *C. acutiventer* and *C. normale* have similar genitalia in the female as well as in the male, they differ greatly in the abdominal shape of the female. The abdominal shape is usually very conservative and often a good generic character in Theridiidae. This situation emphasizes the importance of having both males and females for correct generic placement, and of using more than one character for generic diagnosis.

Besides *C. blandum* of Ceylon, there are three additional species known, all occurring in America. One of these, *C. floridanum*, is cosmotropical and has been given numerous names.

As Miss Bryant (1944) made adequate descriptions of species, this has been omitted here.

Key to American Species of Coleosoma

Males

1a. Abdomen with a distinct median constriction (Figs. 9, 10). Palpal embolus of median length (Fig. 11) *acutiventer*
1b. Abdomen without median constriction (Figs. 4, 15) 2
2a. Palpus narrow, embolus short, radix projecting (Fig. 17) *floridanum*
2b. Palpus wide, embolus long, radix not projecting (Fig. 5) *normale*

Females

1a. Abdomen with an extension beyond the spinnerets, all dark gray or dorsum dark gray in color (Fig. 6) . *acutiventer*
1b. Abdomen shape not modified, usually light in color except for dorsal stripes 2
2a. Epigynum an indistinct white transverse depression divided into three portions (Fig. 14) . . . *floridanum*
2b. Epigynum with two indistinct longitudinal marks (Fig. 3) *normale*

COLEOSOMA BLANDUM O. P. Cambridge
Fig. 18

Coleosoma blandum O. P. Cambridge, 1882, Proc. Zool. Soc. London, p. 427, pl. 29, fig. 3. ♂ type from Ceylon, in the Hope Department of Entomology, Oxford University, examined.

Theridion vilnberabile Petrunkevitch, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 210. New name for *Coleosoma blandum* thought to be preoccupied by *Theridion blandum* Hentz.

This species is known only from the type specimen.

COLEOSOMA NORMALE Bryant
Figures 1-5; Map 1

Coleosoma normale Bryant, 1944, Psyche, vol. 51, p. 56, figs. 2, 5, 8, 10, ♀, ♂. ♂ type from Fort Myers, Florida, in the Museum of Comparative Zoology, examined.

The embolus of a male from Arizona is shorter than that from Florida specimens.

Habits. On shrubs; in dune grass (North Carolina).

Records. North Carolina. Carteret Co.: Bogue Bank (R. D. Barnes); Beaufort (R. D. Barnes); Carrot Isl. (R. D. Barnes). *Florida.* Alachua Co. (H. K. Wallace). Dade Co.: Kendall (A. M. Nadler). Highlands Co.: 3 mi. S. of Lk. Istokpoga (A. M. Nadler). Indian River Co.: Sebastian (G. Nelson). Pinellas Co.: Pass-a-Grille (A. M. Nadler). Sarasota Co.: Miakka Riv. State Pk. (W. J. Gertsch). *Arizona.* Virgin Narrows (W. Ivie). Yuma Co.: Mittry Lk. (V. Roth). *Mexico. Colima:* Cuyutlan (F. Bonet). *Nayarit:* San Blas (C. and M. Goodnight). *Puebla:* Tlacotepec (V. Roth, W. J. Gertsch). *Guerrero:* Acapulco (L. I. Davis). *British West Indies:* Great Bahama Isl., Pine Ridge (E. B. Hayden); South Bimini (A. M. Nadler). *Venezuela:* Rancho Grande (A. M. Nadler).

COLEOSOMA ACUTIVENTER (Keyserling)
Figures 6-11; Map 1

Achaea acutiventer Keyserling, 1884, Die Spinnen Amerikas, Theridiidae, pt. 1, p. 113, fig. 74, ♀. ♀ type from "Maragnioe," Peru, in the Polish Academy of Sciences, Warsaw, examined.

Coleosoma flavipes O. P. Cambridge, 1895, Biologia Centrali Americana, Araneidea, vol. 1, p. 154, pl. 19, fig. 12, ♂. ♂ syntypes from Teapa [Tabasco, Mexico], in the British Museum, Natural History. Bryant, 1944, Psyche, vol. 51, p. 52, figs. 1, 4, 7, 9, ♀, ♂. NEW SYNONYMY.

Argyrodes floridana Banks, 1900, Canadian Ent., vol. 32, p. 98. ♀ syntypes from Punta Gorda, Florida, in the Museum of Comparative Zoology, examined. NEW SYNONYMY. Not *Coleosoma floridana* Banks, 1900, described on same page.

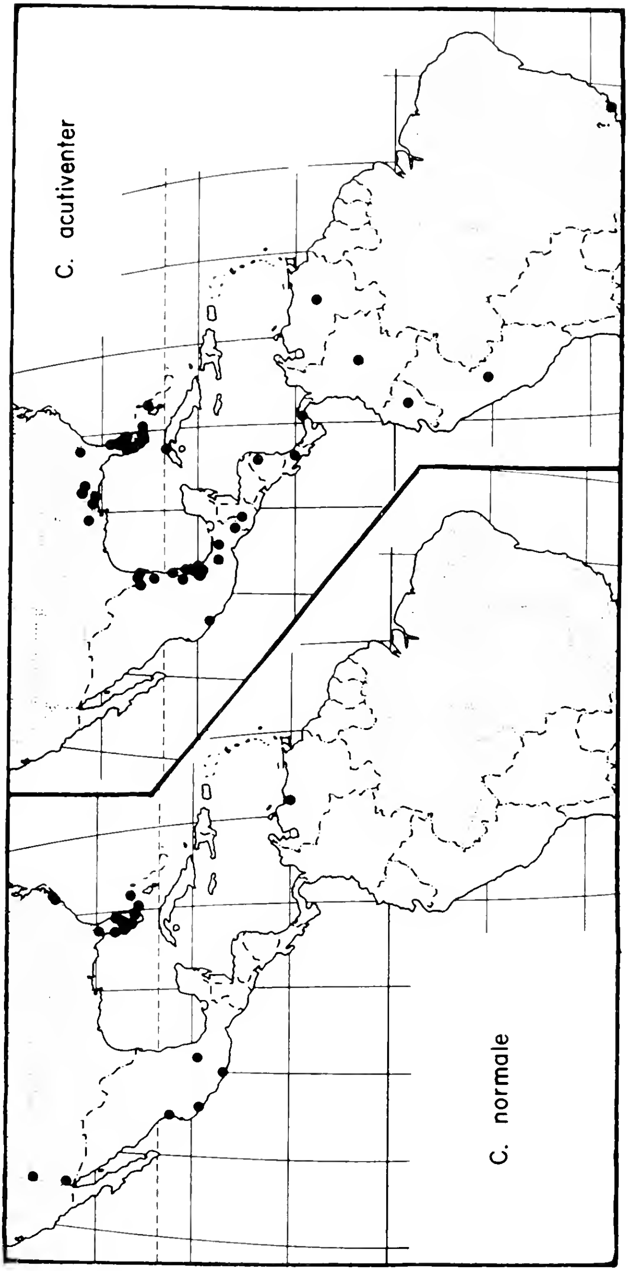
Chrysso nigripalpis Banks, 1929, Bull. Mus. Comp. Zool., vol. 69, p. 85, figs. 46, 72. ♀ syntypes from Barro Colorado Island, Panama Canal Zone, in the Museum of Comparative Zoology, examined. NEW SYNONYMY.

Achaea index Chamberlin and Ivie, 1944, Bull. Univ. Utah, biol. ser., vol. 8, no. 5, p. 36, figs. 87, 105. ♀ type from Brier Creek, 7 mi. north of Sylvania, Georgia, in the American Museum of Natural History.

Archer (1946, Pap. Alabama Mus. Nat. Hist., no. 22, p. 20) reports this species as having been collected from various habitats: sifting leaves from woods and on walls next to roofs in outhouses.

Distribution. Southeastern United States to South America.

Records. Florida: Collier Co.: Everglades (A. M. Nadler). Hardee Co.: Ona (W. J. Gertsch). Highlands Co.: nr. Sebring (W. J. Gertsch); Lake Placid (A. M. Nadler). Indian River Co.: Sebastian (G. Nelson). Lee Co.: Ft. Myers (W. B. Barrows). Orange Co.: Orlando (M. Nirenberg). Seminole Co.: Geneva (W. J. Gertsch). Volusia Co.: Deland (Lutz). *Alabama:* (Archer, 1946). Baldwin Co.: Silverhill (G. Nelson). *Mississippi:* Wilkinson Co.: Centreville (A. F. Archer). *Texas:* Cameron Co.: Big Tree Vine Assoc. (L. I. Davis); Harlingen (L. I. Davis); Edinburg (S. Mulaik); nr. Rio Hondo (L. I. Davis); Brownsville (S. Mulaik). *Mexico. Tamaulipas:* Tampico (L. I. Davis); nr. Nueva Morelos (A. M. Davis); Reynosa (S. Mulaik); San Fernando (L. I. Davis). *San Luis Potosí:* Tamazunchale (F. Bonet). *Colima:* Las Humedades, Armeria (F. Bonet). *Puebla:* Huauchinango (H. M. Wagner). *Veracruz:* Tecolutla



Map 1. Distribution of *Coleosoma normale* Bryant and *C. acutiventer* (Keyserling).

(H. M. Wagner); Jalapa (J. C. and D. L. Pallister); Orizaba (F. Bonet); Tuxpan (H. M. Wagner). *Oaxaca:* Playa Hati, Río Tonto (H. Wagner). *Chiapas:* Cacahuatán (C. and M. Goodnight). *Guatemala:* Moca (C. and P. Vaurie). *Nicaragua:* Musawas, Waspuc River (B. Malkin). *Costa Rica:* Turrialba (F. Schrader). *Panama:* Boquete (A. M. Chickering). *Canal Zone:* Barro Colorado Isl. (very common); Summit; Gatun; Experimental Gardens; Forest Reserve; Pedro Miguel (all A. M. Chickering). *Bahama Isl.:* North Bimini (A. M. Nadler); New Providence Isl. (E. B. Hayden). *Cuba:* nr. Havana. *Venezuela:* "in orchids from Venezuela" (G. Becker). *Colombia:* [no locality]. *Ecuador:* [no locality]. *Brazil:* Rio de Janeiro (H. Sick) determination doubtful — lacks posterior extension on abdomen.

COLEOSOMA FLORIDANUM Banks
Figures 12-17; Map 2

Coleosoma floridana Banks, 1900, Canadian Ent., vol. 32, p. 98. ♂ syntypes from Punta Gorda, Florida, in the Museum of Comparative Zoology, examined. Bryant, 1944, Psyche, vol. 51, p. 54, figs. 3, 6, ♀, ♂.

Theridion interruptum Banks, 1908, *ibid.*, vol. 40, p. 205, fig. 9. ♀ type from Miami, Florida, in the Museum of Comparative Zoology, examined.

Lithyphantes oophorus Petrunkevitch, 1930, Trans. Connecticut Acad. Sci., vol. 30, p. 170, figs. 8, 9. ♀ type from near Aguas Buenas, Puerto Rico, probably lost. NEW SYNONYMY.

Theridion delebile Petrunkevitch, 1930, *ibid.*, vol. 30, p. 206, figs. 53-56. ♀ type from near Rio Piedras, Puerto Rico, probably lost. NEW SYNONYMY.

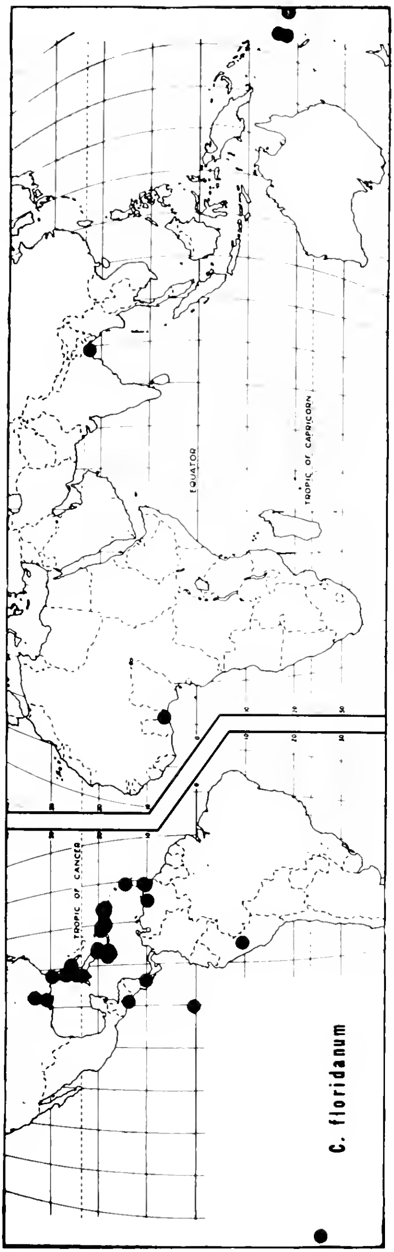
? *Theridion epiensis* Berland, 1938, Ann. Soc. Ent. France, vol. 107, p. 166, figs. 107-109, ♀. ♀ type from Epi, New Hebrides, in the Muséum Nationale d'Histoire Naturelle, Paris. NEW SYNONYMY.

Theridion rapanae Berland, 1942 Occas. Papers Bernice P. Bishop Mus., vol. 17, no. 1, p. 15, fig. 6, ♀, ♂. ♂ holotype from Rapa, Polynesia, probably in the Bernice P. Bishop Museum. NEW SYNONYMY.

Theridion albovittatum Caporiacco, 1955, Acta Biol. Venezuelica, vol. 1, p. 334, fig. 25. ♀ type from Barcelona, Anzoátegui, Venezuela, in the Caracas Museum, Venezuela, examined. NEW SYNONYMY.

Theridion aleipata Marples, 1955, Jour. Linn. Soc. London, vol. 42, p. 483, pl. 58, figs. 9, 13, 19, ♀, ♂. ♀ type from Aleipata, Samoa, probably in the Otago Museum, Dunedin. NEW SYNONYMY.

The type of *Theridion albovittatum* was examined; it is all shrivelled up and difficult to place. Caporiacco's drawings and



Map 2. Distribution of *Coleosoma floridanum* Banks.

proportions leave no doubt on the synonymy. The internal genitalia are typical.

There are probably numerous synonyms of this widespread common species in the literature; however the poor descriptions of many species of "*Theridion*" make it difficult to synonymize the names without examining the types.

Habits. This species has been found under stem of dead coconut leaf and under a rock (Petrunkevitch, 1930). Its habit of clinging to vegetation facilitates its world-wide distribution with cargo. Archer (1946, Pap. Alabama Mus. Nat. Hist., no. 22, p. 19) reports sifting it from leaf litter.

Distribution. Cosmotropical (Map 2), probably distributed by man. It may be native in America.

Records. Massachusetts: On bananas in Cambridge. *New Jersey:* Ramsey (W. J. Gertsch); probably an accidental introduction. *Florida:* Alachua Co.: Gainesville (W. J. Gertsch). Charlotte Co.: Punta Gorda (S. Rounds). Dade Co.: Kendall (A. M. Nadler); Perrine (A. M. Nadler). Monroe Co.: Key West (A. M. Nadler); Stock Isl. *El Salvador:* San Salvador (J. B. Boursot.) *Costa Rica:* [no locality]. *Panama Canal Zone:* La Boca; Pedro Miguel; Corozal (all A. M. Chickering). *Bahama Isl:* North Bimini (A. M. Nadler); South Bimini (C. and P. Vaurie). *Cuba:* Havana (Baker); Soledad (L. G. Worley); Ote. Chirivico (A. F. Archer). *Jamaica:* St. Ann's Bay; Kingston; Discovery Bay; Whitehouse; Holland Bay (all A. M. Nadler). *Haiti:* Trou Caiman (P. J. Darlington); Grand Rivière (W. M. Mann); Diquini (W. M. Mann); Ennery (P. J. Darlington). *Dominican Rep.:* San José de las Matas (P. J. Darlington); Puerto Plata (P. J. Darlington); nr. Ciudad Trujillo (A. M. Nadler); Boca Chica (A. M. Nadler). *Puerto Rico:* El Yunque; Mayaguez; Cidra, Treasure Isl.; Rio Piedras (all A. M. Nadler). *Martinique:* Fond la Haye (A. M. Nadler). *Trinidad:* Piarco (A. M. Nadler); Navy Base (R. Ingle). *Venezuela:* [no locality]. *Colombia:* [no locality]. *Peru:* Tingo Maria, 670 m (W. Weyrauch). *Galapagos Isl.:* Floreana. *Togo:* Ho, taken in Wisconsin in package of pressed plants (G. Naomasi). *India:* Taken in Honolulu, Hawaii in imported plants, "on cargo from Calcutta." (T. F. Chong). *New Hebrides:* [no locality] (J. S. Haeger, W. R. Enns).

Figs. 1-5. *Coleosoma normale* Bryant. 1. Female from side. 2. Female genitalia, dorsal view. 3. Epigynum. 4. Male abdomen from side. 5. Left palpus.

Figs. 6-11. *C. acutiventer* (Keyserling). 6. Female from side. 7. Female genitalia, dorsal view. 8. Epigynum. 9. Male abdomen from side. 10. Male, dorsal view. 11. Palpus.

Figs. 12-17. *C. floridanum* Banks. 12. Female abdomen, dorsal view. 13. Female genitalia, dorsal view. 14. Epigynum. 15. Male abdomen from side. 16. Palpus expanded (C, conductor; E, embolus; M, median apophysis; R, radix). 17. Palpus.

Fig. 18. *C. blandum* O. P. Cambridge, palpus.

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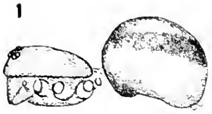

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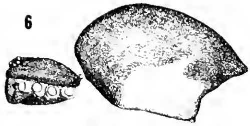

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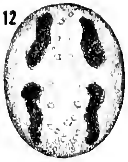

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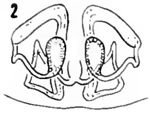

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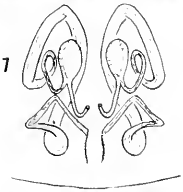

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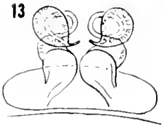

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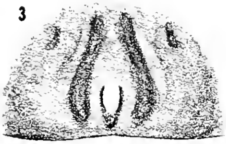

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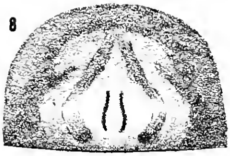

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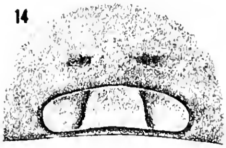

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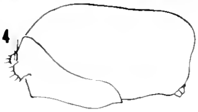

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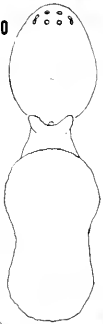

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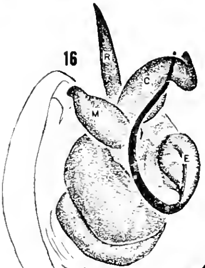

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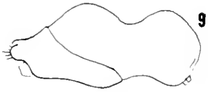

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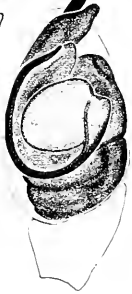

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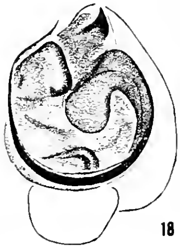

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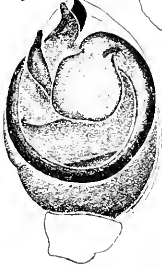

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BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. June 17, 1959 Number 111

ON THE CAUDAL NEUROSECRETORY SYSTEM OF THE TELEOST FISH, *FUNDULUS HETEROCLITUS* L.

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Zoological Institute, Uppsala, Sweden
Biological Laboratories, Harvard University

INTRODUCTION

It was early observed that a bulb-like structure was associated with the terminal portion of the spinal cord of certain fishes (Weber 1827, Rauber 1877, Arsaky 1813, Ziehen 1903, and Favaro 1925). This outgrowth of the spinal cord of different systematical groups of teleosts was described by Favaro (1925), who studied a large number of species. Because of the histological and morphological resemblance of this organ to the neurohypophysis, he named it "Ipofisi caudale."

Secretory cells in the terminal portion of the spinal cord were described first by Dahlgren (1914), and later by Speidel (1919, 1922). The latter also gave a histological description of some "irregular glandular cells," sometimes called "Dahlgren's cells," in the terminal portion of the spinal cord of certain elasmobranchs and teleosts. Recently Enami (1955 a) investigated the caudal portion of the spinal cord of the eel, *Anguilla japonica*, with respect to the secretory activity of "Dahlgren's cells" and found that neurosecretory cells were present in the terminal portion of the spinal cord. They extended caudally from the level of the last sixth or seventh vertebra. These neurosecretory cells, according to Enami, resembled the secretory cells of the hypothalamus, and had axons which served as neurosecre-

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[1] Fellow of the Commonwealth Fund.

tory pathways. The neurosecretory material was released at nerve endings, which terminate in a ventral outgrowth of the spinal cord. The outgrowth served as a storage depot for secretory material. This structure, which was named "Ipofisi caudale" by Favaro (1925), was called "Neurohypophysis spinalis" or "Urohypophysis" by Enami (1955 a).

These observations were extended by Enami and Imai (1955, 1956 a and b), with descriptions of the caudal neurosecretory system of a number of freshwater and marine teleosts. Recently Sano (1958 a and b) described the "Neurophysis" and the neurosecretory system of the spinal cord of *Tinca vulgaris* and a number of other teleosts. It has been suggested that the probable function of the caudal neurosecretory system would be osmoregulation (Enami, Miyashita and Imai 1956, and Holmgren 1958 b).

Terminology. Different names have been suggested for the above-mentioned outgrowth of the spinal cord, which serves as a storage organ for the neurosecretory material. Because the organ may be located either dorsal, ventral, or lateral to the spinal cord (Favaro 1925, Sano 1958 b), and since the term "neurohypophysis" has already been used for the "pars nervosa" of the pituitary gland, the name "neurohypophysis spinalis" is not adequate. In order to stress the fact that the organ is an outgrowth of the terminal portion of the spinal cord the name *urophysis spinalis*[1] has been adopted for this study. This name stresses the position of the organ relative to the body, regardless of its varying position in relation to the spinal cord.

Material and methods. Twenty specimens of the teleost fish, *Fundulus heteroclitus* L., standard length 4-6 cm., caught during different times of the year, were used for the anatomical description. Twelve embryos were also used in an attempt to determine the mode of development of the urophysis. For the anatomical and histological descriptions, the terminal portion of the spinal cord, including the adjoining vertebral column, was fixed in Bouin's solution to which 1 per cent of $CaCl_2$ had been added; Zenker's, Carnoy's and Orth's fixing fluids were also used. The tails were decalcified in 7 per cent HNO_3 and afterwards treated in 10 per cent Na_2SO_4, and the sections were cut at 4-8 microns, sagittally and transversely, using the usual paraffin technique.

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[1] Suggested by Dr. G. Fridberg, Zoological Institute, Stockholm.

The following staining techniques were used: Gomori's haematoxylin-phloxin method, Heidenhain's azan, Halmi's aldehyde fuchsin following performic acid oxidation (Holmgren 1958 a), Mallory's connective tissue stain, Bodian's protargol method, Masson's trichrome stain according to Gomori (1950), periodic acid-Schiff (PAS), and alcian blue.

DESCRIPTION

Location of the urophysis spinalis. The urophysis in *Fundulus* is observed as a round body, easily visible under the dissecting microscope. It lies at the end of the spinal cord, ventral to the terminal portion, above the articulation between the last vertebra and the hypural bone. This location of the urophysis (Figs. 1-4) is similar to that described for a great number of teleosts by Enami and Imai (1956 a and b), and Sano (1958 a and b). These authors also found that the urophysis is generally situated ventral to the spinal cord.

Morphology and histology. According to descriptions by Favaro (1925), the urophysis consists mainly of modified glial tissue. The blood vessels present in the organ enter from the connective tissue mantle which surrounds the spinal outgrowth. Rauber (1877), on the other hand, believed that the urophysis consisted mainly of connective tissue. Enami (1955 a) found both connective tissue and modified glial tissue in the organ, and stressed the similarity of the urophysis to the neurohypophysis of vertebrates and the sinus gland of Crustacea.

The urophysis spinalis of *Fundulus heteroclitus* is a very conspicuous structure measuring about 0.2 x 0.3 mm., which approximately corresponds to the size of the pituitary gland. It is covered by a heavily pigmented leptomeninx. The histological elements distinguished in the urophysis are mainly of three kinds. In the dorsal region, *nerve fibers* are found which emanate from the neurosecretory cells, situated in the terminal portion of the spinal cord (Fig. 1). Orange G positive Herring body-like secretory droplets are present at the end of these axons (Fig. 3). These 'secretory droplets' are probably dilated nerve endings. The colloidal masses within the dilated nerve endings stain red in Gomori's chrome haematoxylin-phloxin, thus showing affinity for the phloxin component. The staining reaction with azan is bluish-red. The nerve tracts are usually not distributed all over the organ as observed in some other species but merely confined to the dorsal region of the urophysis.

The urophysis is very vascular with blood vessels distributed throughout the organ (Figs. 4, 6). These vessels are of sinusoid type with thin walls, supported by argyrophilic connective tissue as shown with Bodian's protargol method. In the dorsal region of the urophysis the blood vessels frequently seem to surround intercellular spaces, which are most conspicuous in the area where the secretory tracts terminate. Besides the nerve endings, the urophysis consists of *argyrophilic connective tissue* and *neuroglia*. The glial cells contain very little cytoplasm, sometimes consisting only of small nuclei and surrounding membranes. The differentiation between the different types of tissue elements is especially well observed after using Heidenhain's stain. The distribution of the blood vessels indicates that the secretory material is taken up by the blood.

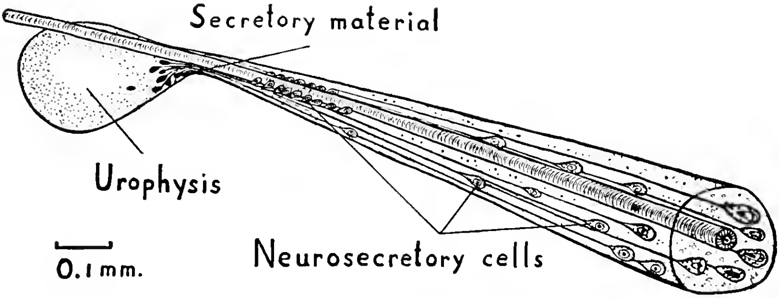

Fig. 1. Schematical picture of the caudal neurosecretory system of the teleost. *Fundulus heteroclitus* L.

Transverse sections show that the urophysis is surrounded by a sella turcica-like connective tissue capsule (Fig. 4). This extension of the leptomeninx is sometimes very heavily invested with melanophores. In other teleosts, the urophysis may be attached to the spinal cord by means of a stalk, which sometimes is very conspicuous (Enami and Imai 1956 a and b, Sano 1958 b).

The urophysis of *Fundulus heteroclitus* is very closely attached to the spinal cord by means of a stalk with a broad base. Most of the organ, however, is separated from the spinal cord. Cross-sections of the urophysis (Fig. 4) show a well defined space between the dorsal part of the organ and the ependymal parts of the spinal cord. Reissner's fiber is still present in this thin terminal portion of the spinal cord.

In the region where the spinal cord axons pass into the urophysis the secretory droplets are especially frequent (Fig. 3). The secretory material within the dilated nerve endings is here homogeneous and appears colloidal. The staining reaction also seems to have changed in a 'basophilic' direction (cf. below). Some of the secretory droplets were slightly aldehyde fuchsin-positive in the dorsal region of the urophysis, but the neurosecretory cells stained negatively.

The neurosecretory cells. The neurosecretory cells are present in the terminal portion of the spinal cord, appearing first at the level of the sixth vertebra from the caudal end and most concentrated above the third vertebra and caudally (Figs. 1, 5). The secretory cells, which contain Nissl substance, are obviously specialized nerve cells of multipolar, bipolar, and also unipolar type. The neurosecretory cells stain negatively with both Gomori's chrome haematoxylin and Halmi's aldehyde fuchsin. Instead, they take up the phloxin component of Gomori's stain and also show great affinity for the acid fuchsin of Mallory's stain, thus confirming the findings of Enami (1955 a).

The neurosecretory cells are also stained with the azocarmine of Heidenhain's stain thus showing a marked 'acidophilic' reaction which may be due to secretory material in the cytoplasm (cf. below). The spinal neurosecretory cells were observed to contain scattered small PAS-positive inclusions, but the secretory droplets within the urophysis stained negatively. A positive reaction would have denoted the presence in the secretion of considerable amounts of polysaccharides, mucopolysaccharides, glucoproteins or glycolipoids (Lillie 1954). The negative reaction to PAS agrees with the findings of Sano (1958b).

The neurosecretory cells have various sizes and shapes. Those which are situated closer to the urophysis, are generally smaller. The secretory cells are generally distributed all over the spinal cord which in the terminal portion does not show the usual separation into white and gray material. The secretory cells were found to contain a large nucleus with an irregular shape, as already indicated in the early descriptions by Speidel (1919, 1922). The size of the neurosecretory cells in *Fundulus*, however, was considerably less than the originally described spinal cells in skates and the eel (Speidel 1919, Enami 1955a). The secretory material usually contained very fine granules, and was generally distributed all through the cytoplasm but sometimes was merely confined to the periphery of the cells. The irregular nucleus contains one or more nucleoli and fine granular chromatin.

In the sections stained with Heidenhain's azan, it was easy to distinguish the neurosecretory cells, with their 'acidophilic' reaction, from the strongly 'basophilic' motor cells. Because of the irregular shape of the nuclei, sometimes two or several nuclear areas were visible when a cell was cut in a certain plane. In the cytoplasm of the secretory cells the 'acidophilic' material was observed in various amounts, indicating a cycle in the formation of the secretion. The 'acidophilic' reaction was interpreted as a measure of the secretory activity. Nerve cells in general and some neurosecretory ones from the hypothalamic system may show a 'basophilic' reaction (Scharrer and Scharrer 1954), perhaps due to a continuous synthesis of proteins, hormones and high amounts of ribonucleic acid. Observations on cells in different stages of secretion have indicated that the cell in the beginning of the secretory phase does not show a considerable 'acidophilic' reaction. As secretion begins the nuclei of the cells begin to enlarge and 'acidophilic' granulated material arises in the area around the nucleus. Later, the secretory material is often found in the periphery of the cells or distributed all through the cytoplasm. It has been suggested that the heavy 'acidophilic' reaction particularly in the periphery of the neurosecretory cells is due to accumulation in these areas of 'acidophilic' material and Nissl-substance (Sano 1958 b). The observations in this study support the suggestion by Sano (1958 b) that the nucleus takes an active part in the formation of the secretory material. No selective stain is so far known for the secretory material.

The secretory material of the nerve cells is transported in the axons which serve as neurosecretory pathways and is stored in dilated nerve endings and released in the dorsal region of the urophysis where the axons terminate. Observations were made on the staining reaction of the secretory droplets to acid alcian blue stain. The observed negative reaction would mean that the secretion does not contain disulfide groups. These observations agree with those by Sano (1958 b), who found that the secretion in the caudal neurosecretory system of *Tinca vulgaris* reacted negatively for the astra blue and alcian blue stains.

In the limited material examined (20 species), obtained during fall and winter, no pronounced seasonal differences were observed in secretory activity.

Development of the urophysis spinalis. The caudal neurosecretory cells and the urophysis spinalis were not developed in the stages immediately after hatching, length 15-20 mm. (Fig. 7). The hypothalamus-pituitary system was apparently actively secreting at this stage. These observations thus confirm the findings by Favaro (1925) and Sano (1958 b) that the urophysis spinalis and the caudal neurosecretory system develop late during the ontogeny. Sano (1958 b) noted that the urophysis spinalis was still not developed in *Salmo fario* at a size of 2.5-3 cm. In *Anguilla* of 6 cm. length, the caudal neurosecretory system had begun to function.

DISCUSSION

Many investigators have pointed out the similarity in structure between the posterior pituitary and the urophysis spinalis, and this analogy has also been stressed in the names suggested, e.g. "Ipofisi caudale" (Favaro 1925), "Neurohypophysis spinalis" (Enami 1956), and "Neurophysis spinalis caudalis" (Sano 1958 a, and Sano and Hartmann 1958). This similarity in structure and organization of the urophyseal system compared to the hypothalamic system was emphasized in this study by the fact that the secretory material in the urophysis was stored in dilated nerve endings.

As already mentioned above, there is no selective stain for the secretory material in the caudal neurosecretory system, although the dilated nerve endings show affinity for the orange G component of various stains. There is, however, reason to believe that the 'acidophilic' reaction of the cells is due to the presence of secretion. The terms 'acidophilic' and 'basophilic' as used in this study are relative, depending on fixation, staining and other treatment. The two terms have been used to indicate that the number of either acid carboxyl or basic amino groups of the protein molecule may be predominant (Romeis 1948). These terms may be useful in this case for descriptive purposes until a more selective stain for the caudal neurosecretory system has been developed.

There are reasons to believe that the neurosecretory cells in the teleost spinal cord, although they differ in size from the cells originally described by Dahlgren (1914) and Speidel (1919), are identical and homologous with those in the skates, in spite of the fact that Speidel (1922) did not find the corresponding cells in the spinal cord of *Fundulus*. The neurosecretory cells of *Fundulus* do not differ greatly from unmodified nerve cells, except for their staining reactions (cf. above). They are far less conspicuous and appear less "glandular" than the secretory cells of the skates and the eel and can therefore be readily overlooked.

Sano (1958 b) found that the neurosecretory material inside the axons could not be a pathological product of the cells or of the myelin sheath but must be considered as a true neurosecretion, as earlier indicated by Enami (1955 a, 1956). This study can further support these opinions by showing the conspicuous, Herring body-like, secretory droplets which are formed at the nerve endings in the dorsal region of the urophysis spinalis (Fig. 3). These secretory droplets are, according to this study, the dilated nerve endings, which serve to store the secretory material. The secretory material is thus generally not stored in the urophyseal tissues (cf. Enami 1955 a).

The origin of the secretory granules inside the neurosecretory cells has been extensively dealt with by Scharrer (1934), Palay (1943), Hild (1950), Scharrer and Scharrer (1954), Enami (1955 b), and others. According to these descriptions, the formation of the secretion is not fully understood. It has been observed that granules also are present in the nucleus of certain cells of the nucleus tuberalis lateralis of teleosts (Scharrer 1934, Stahl and Seite 1955, Enami 1955 b, Ortmann 1956, Stahl 1957).

According to Stahl and Seite (1955), the intranuclear granules probably cannot be connected with neurosecretion. Enami (1955 b), on the other hand, considered that the 'acidophilic' granules in the nucleus entered the cytoplasm through the nuclear membrane into the area around the nucleus or were emitted into neurites. The direct role of the nucleus in the secretory process has not yet been clearly demonstrated. As far as the caudal neurosecretory system is concerned, Sano (1958 b) believes that the nucleus very likely takes an important part in the formation of the secretion. The opinion of Scharrer and Scharrer (1954) and Enami (1955) that the secretory material may be formed out of the Nissl substance or at the expense of the latter, could not be confirmed in this study. As mentioned above, it was observed that the secretory material seemed to originate from the area around the nucleus, which was interpreted to mean that the nucleus plays an important role in the formation of the secretion.

It was previously noted that the secretion in the neurosecretory cells reacted negatively with Gomori's chrome haematoxylin and Halmi's aldehyde fuchsin. The secretory droplets (colloid masses) in the dorsal region of the urophysis (Fig. 3), on the other hand, showed some affinity for the aldehyde fuchsin. This difference in staining reaction with aldehyde fuchsin in the secretory cells as compared to the urophyseal colloid may indicate that physical or chemical changes have occurred in the secretory material in association with its storage in the nerve endings. A stronger reaction to Gomori's stain is also generally observed in the hypothalamus-pituitary system for the Herring bodies compared with the neurosecretory cells or the tracts. In the hypothalamus-pituitary system, the presence of a stainable carrier substance or prosthetic group, has been postulated (Schiebler 1951). If biochemical changes do occur at the release of the neurosecretory material at the nerve endings, it would affect the response to certain dyes.

The negative reaction of the caudal neurosecretory cells and the secretory material in the urophysis to the periodic-acid-Schiff stain is in contrast with the positive reaction in the hypothalamus-pituitary system. Schiebler (1951) found that the neurosecretory cells of the hypothalamus of the teleost *Esox* were strongly periodic-Schiff positive.

The studies by Enami (1955 a) and Sano (1958 a and b) have demonstrated the presence in fishes of a caudal neurosecretory system which morphologically is organized in much the same manner as the hypothalamus-pituitary system in vertebrates and the intercerebralis-corpus cardiacum system in insects, all showing characteristic synthesizing, transporting, and release-storage elements. Such a neurosecretory system is, according to this study, present and actively secreting in the teleost fish, *Fundulus heteroclitus* L.

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SUMMARY

An examination of the terminal portion of the spinal cord of the teleost *Fundulus heteroclitus* L. has confirmed the presence of a caudal neurosecretory system. The neurosecretory cells are distributed from and posterior to the sixth vertebra and are more concentrated above the third vertebra from the caudal end of the spine. Histologically, these neurosecretory cells are modified nerve cells of multi- bi-, and unipolar type. They show affinity to 'acidophilic' stains such as acid fuchsin, phloxin, and azocarmine. In contrast with the neurosecretory cells of the hypothalamus, these spinal cells are Gomori-negative and show no reaction for the alcian blue stain, the latter staining reaction indicating the absence in the secretion of sulfonate groups. The secretory material, which also shows negative periodic-acid-Schiff reaction, is transported from the neurosecretory cells in axons serving as secretory pathways, and the neurosecretion is stored in dilated nerve endings which terminate in a conspicuous organ, the *urophysis spinalis* (neurohypophysis spinalis caudalis, neurophysis, urohypophysis), which is a ventral outgrowth of the spinal cord. At the nerve endings, Herring body-like secretory droplets are formed. No seasonal changes in the secretory activity of the caudal neurosecretory system were observed. The urophysis shows histologically the same structure as the neurohypophysis

of the pituitary gland, containing nerve endings, modified glial tissue and blood vessels.

The urophysis and the caudal neurosecretory system must develop rather late during the ontogeny since it is not present in embryos immediately after hatching, at which time the hypothalamic-pituitary system is actively secreting.

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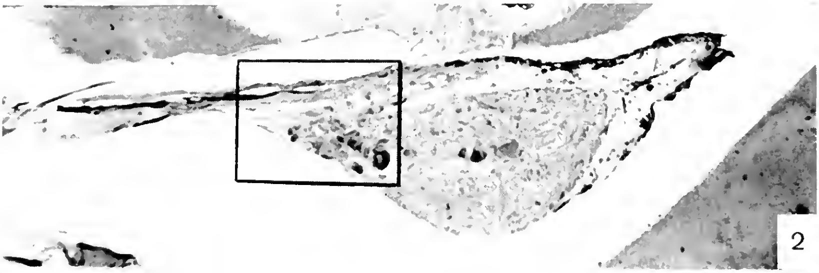
PLATE I

Fig. 2. Sagittal section of the terminal portion of the spinal cord, showing the urophysis spinalis, ventral to the spinal cord. The area inside the rectangle is shown in Figure 3. Fixation Bouin's solution. Halmi's aldehyde fuchsin stain. 8 microns, 100 x.

Fig. 3. The area, shown in the rectangle in Figure 2. The dilated nerve endings of the neurosecretory cells, terminating in the dorsal parts of the urophysis. These dilated nerve endings are similar to the Herring bodies of the neurohypophysis of the pituitary gland. Fixation Bouin's solution. Halmi's aldehyde fuchsin stain. 8 microns, 500 x.

Fig. 4. Transverse section of the urophysis spinalis and the ependymal terminal portion of the spinal cord. The leptomeninx covered with melanophores surround the organ. Note that the urophysis is heavily vascular. Fixation Bouin's solution. Mallory's triple stain. 8 microns, 500 x.

Fig. 5. 'Acidophilic' neurosecretory cells from the terminal portion of the spinal cord. Fixation Bouin's solution. Gomori's chrome haematoxylin-phloxin method. 8 microns, 1200 x.



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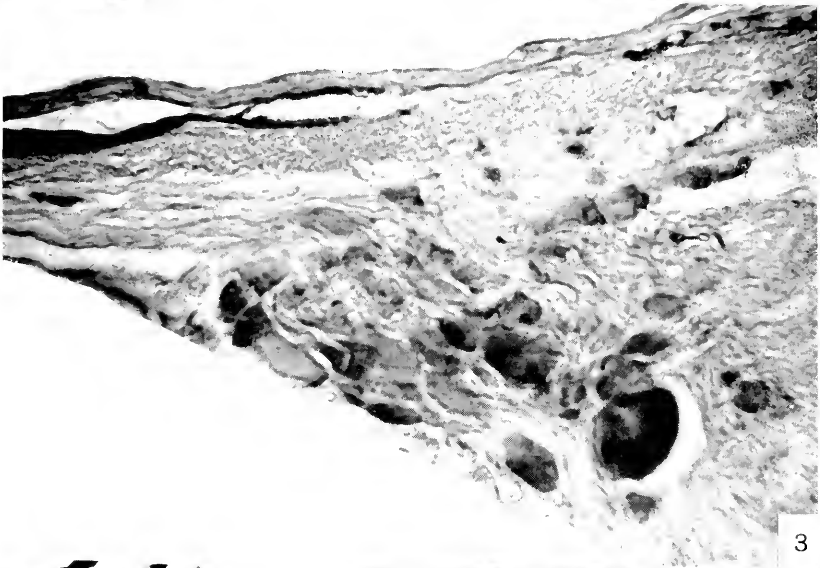

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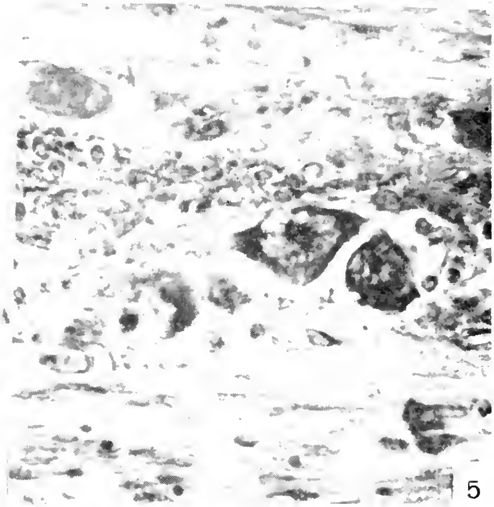

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PLATE I

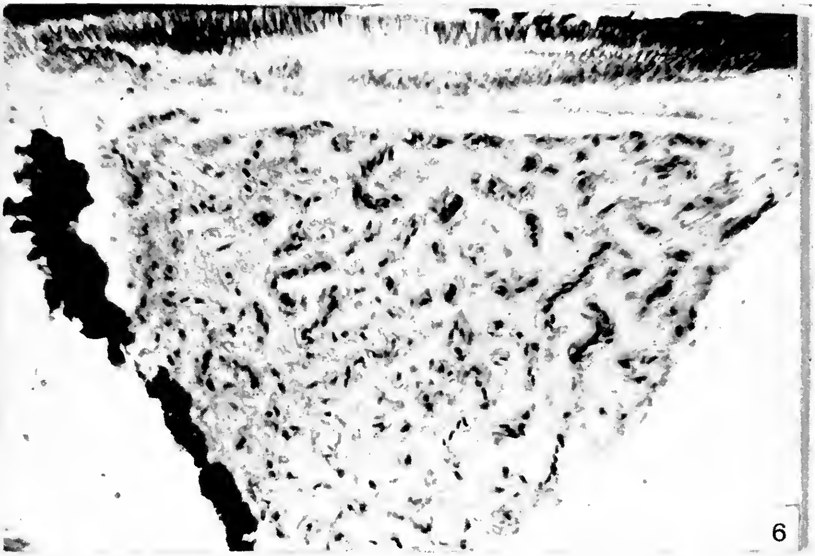

PLATE II

Fig. 6. Median section through the urophysis, showing the blood vessels. Fixation Bouin's solution. Bodian's protargol method. 8 microns, 500 x.

Fig. 7. Sagittal section of the terminal portion of the spinal cord in a newly hatched *Fundulus* embryo. Note that no urophysis nor any secretory cells are yet developed. Fixation Bouin's solution. Bodian's protargol method. 500 x.

BREVIORA

Museum of Comparative Zoology

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A MOUNTED SKELETON OF THE GIANT PLESIOSAUR *KRONOSAURUS*

By Alfred Sherwood Romer
and
Arnold D. Lewis

In 1924 Longman described a plesiosaur mandibular fragment of large size from the Lower Cretaceous of Queensland as the type of a new genus and species, *Kronosaurus queenslandicus*. Later (Longman 1932), some further fragmentary material, mainly the proximal ends of two limb bones, was obtained from the type locality near Hughenden, and a letter from Dr. Longman to Mr. W. E. Schevill in November 1932 mentions the discovery there of eight caudal vertebrae which appear not to have been described. The limb bone material, added to the evidence of the jaw fragment, indicated a plesiosaur of very large size. The remains suggested relationship to *Peloneustes*, and Longman (1932) published a hypothetical restoration of *Kronosaurus* based mainly on the work of Andrews (1913, fig. 26) on *Peloneustes philarchus*.

In 1931-32, Mr. William E. Schevill, a member of an expedition sent to Australia by this museum, explored the Queensland Lower Cretaceous deposits in the Richmond region, west of Hughenden. In Grampian Valley, 30 miles to the north of Richmond, he found a rostrum of a young individual of *Kronosaurus* (MCZ No. 1284). His attention was called, by a local resident, to the Army Downs region, five miles farther north. Here was found the skeleton (MCZ No. 1285) which is described below.

The specimen had been entombed, in an articulated state, dorsal surface up, in a limestone matrix. In recent times, however, the skeleton had been subject to erosion, so that it consisted essentially of a series of limestone nodules, freed from the underlying strata and nearly completely buried in the soil. Skull, neck, trunk and part of the tail were contained in a linear series of 15 nodules of varied size. Of these the first had been displaced and overturned; the others, however, appear to have undergone little or no displacement. Erosion had destroyed much of the outer parts of the nodules, so that, for example, most of the superficial bones of the skull had been destroyed, part or all of many of the neural spines had vanished, and the girdles, ribs and abdominal armor are incomplete. Erosion had, further, destroyed some of the contacts between successive blocks, but because of their seemingly undisturbed position, interpolation of materials once filling the gaps can be made with considerable confidence. No trace of the pectoral limbs was preserved. The pelvic limbs were present in normal articulation, extending out on either side from the large block containing the pelvic region, but even the femora were badly weathered and the more distal regions of the "flippers" were very poorly preserved.

The blocks, weighing in all nearly four tons, were excavated and shipped to Cambridge by Mr. Schevill. Two years later the skull was developed by Dr. T. E. White, and a description published by him (1935). Because of the very considerable outlay of time, energy — and money — necessary for the laborious task of preparation, the postcranial material lay untouched in storage for two decades. Three years ago, however, Mr. Godfrey Cabot, who is deeply interested in the subject of marine reptiles, furnished us with funds sufficient to pay the costs of preparing and mounting the skeleton. The work was directed by the junior author, with the assistance of Messrs. James A. Jensen and David Fuller.

As noted above, erosion had destroyed a fair fraction of this once complete and articulated skeleton, so that approximately a third of the specimen as exhibited is plaster restoration. There are, nevertheless, few points in which any great deviation from verity can have occurred in mounting the skeleton. As noted below, the exact number of cervical plus trunk vertebrae is uncertain, as is the length of the short tail. Trunk rib lengths are for the most part uncertain, but the curvature of the ribs as preserved furnished a rather safe guide to trunk proportions.

The front paddles are lacking, but can be restored with considerable confidence by comparison with preserved parts of the pelvic appendages. Upon completion of the mount, the only structural feature which we would wish to modify, given the opportunity, would be to move the pelvic girdle upward and backward by perhaps 20 cm.

Longman, we have noted, compared *Kronosaurus*, on the basis of the fragmentary remains available to him, to *Peloneustes* of the Oxford Clay. Our skeleton confirms his belief in the main. As will be seen from the description below, we are dealing with a pliosaur of somewhat similar nature, although of much larger size — our animal has about four times the linear dimensions of Andrews' restored skeleton with a total length, as restored, of 1280 cm. — about 42 feet. The head, however, is relatively larger in *Kronosaurus*, making up slightly over one-fourth of the total length, whereas in *Peloneustes* the skull is but one-fifth the length of the animal. Further, the trunk is relatively long in the Australian giant, and the neck extremely short; although the number of presacral vertebrae in *Kronosaurus* and *Peloneustes* is approximately the same, the beginning of the dorsal rib series and the position of the shoulder appears to have been about 10 vertebrae farther forward in our specimen. *Kronosaurus* thus appears to be the most stoutly built of plesiosaurs.

As a short-necked pliosaur, it is of course exceeded in length by some of the long-necked elasmosauroid types. In bulk, however, it seems certainly to be larger than any described plesiosaur, although Dr. L. B. Tarlo (*in litteris*) tells us that material of a Kimmeridge Clay pliosaur indicates an animal of comparable size.

As far as preserved, the *Kronosaurus* postcranial skeleton does not depart structurally in any marked manner from the general pliosaurid pattern, and hence need not be figured or described in detail. The notes given here can be followed by reference to the excellent descriptions and figures given by Andrews (1913) for Oxford Clay pliosaurs.

Vertebral column. The series of nodules containing the skeleton yielded part or all of 46 vertebrae between the atlas-axis and the proximal part of the tail. The sequence of the preserved vertebrae can be determined in every case from the sequence of the blocks containing them. But while various short series are in articulated position within a given block, and certain of the blocks were in contact, there are obvious gaps in the series, and we have restored 11 vertebrae in filling out the column to the proximal part of the tail. For the most part the number of missing vertebrae in these gaps can be determined with considerable confidence, through the relation of adjacent vertebrae to other structures, or the length of the eroded interval between blocks. It is possible that our restored vertebral count may vary by one or two segments from the true condition.

Anteriorly, vertebrae 1-5 were found in position behind the skull. Following a short gap, 4 further vertebrae were present in another block. The first of this succeeding series is nearly complete; the third has a complete rib (on the right side). From the evidence of rib lengths, position of rib facets, centrum dimensions, and the length of the gap between blocks, interpolation of 3 vertebrae between the first and second series appears reasonable, and we shall consider the second series to include vertebrae 9 to 12. An isolated neural spine and arch appears from its proportions and the nature of the rib facet to have occupied a short gap following vertebra 12. The next block contained vertebrae 14-16. It was necessary to break up, in the field, the large mass containing the pectoral girdle region. This caused two further gaps, the first of which can be accurately determined to involve one segment; the second, following a series of 5 vertebrae — presumably 18-22 — seems certainly to have been occupied by 3 vertebrae. There follows a series of 4 vertebrae, our numbers 26-29. Behind this is a block with 2 vertebrae separated by gaps both fore and aft. The first gap is of a length appropriate for 2 vertebrae; the second gap is short, but because of the imperfect nature of the vertebra behind it, it is uncertain whether a segment should be intercalated here, as we have done in the mount. Back of this point, an unbroken series of vertebrae, which we have restored as numbers 35-43, can be traced to a point close to the puboischiadic suture on the underlying pelvic girdle. Here 1 vertebra is definitely missing, followed by vertebrae 45-48, found above the ischium, and 49-50 close behind them. Three further adjacent blocks contain 4 vertebrae and parts of the centra of 3 others, bringing the total as restored to this point to 57 vertebrae.

From the rapid decrease in size seen within the post-pelvic series, it is obvious that the tail was short; we have restored it to give a total number of 79 vertebrae. As will be seen from the description of the rib attachments given below, there appear to be 12 true cervical vertebrae, 2 "pectorals," probably 30 dorsals, giving a total of approximately 44 presacrals, followed by 3 or 4 sacrals.

Centra. Measurements (in mm.) of some of the best preserved centra are as follows:

Centrum	*Length*	*Width*	*Height*
4	102	181	193
9	93	180	210
15	114	182	233
20	123	202	225
27	145	213	217
35	143	205	208
42	136	182	201
50	118	180	198
54	108	157	172

As can be seen, the length and width of the centra reach a maximum in the mid-dorsal region, with somewhat decreasing measurements toward the sacrum, and a sharp drop in size — particularly in length — in the proximal part of the tail. The height of the centrum is much more uniform, with a fairly marked increase along the neck to the anterior dorsals, and a very gradual reduction back of this point to the proximal caudals. In consequence of the differences in width-height relations, the proportions of the vertebrae, as seen in end view, differ considerably from one region of the column to another. Mid-dorsals and posterior dorsals are nearly circular in outline; anterior dorsals are considerably taller than broad, giving an oval contour, and both the cervicals and the posterior vertebrae, from the posterior dorsals back, are moderately taller than broad. The cervicals and anterior dorsals are about twice as high as long; however, the length of the centrum increases posteriorly along the dorsal series, while the height decreases, so that towards the sacral region the height is but half again the length; in the tail, with reduction taking place more rapidly in length than in height, there is some increase posteriorly in relative height.

Typical dorsal centra have the simple outlines of a short spool, with a smoothly curved lateral surface between raised anterior and posterior rims. Anteriorly and posteriorly, however, the presence of rib attachments modifies the lateral surfaces, as noted in more detail in the next section. In the cervicals the rib facets take the form of a circular "crater," with raised rims, occupying nearly the whole length of the lateral surface of the centrum. In the caudal region the low rib facet is of smaller dimensions. Above, it is joined by a vertical ridge, half way between anterior and posterior margins, which ran upward to the neuro-central suture. Below the rib facet, the preserved caudals, except the first two, are excavated laterally below a curved longitudinal ridge which is convex ventrally.

No chevrons were found with the few caudals present; however, presumed caudal 4 is bevelled ventrally on either side for chevron attachment.

Neural arches and spines. The axis neural spine is of large size. Many of the cervical spines behind this point are preserved. They are slender at the base, well tilted back and, in at least the posterior cervicals, broadened distally with a pronounced median groove, presumably for the attachment of ligaments. The anterior margin has a well-developed median keel for most of its height. Many of the dorsal spines are incomplete or absent; however, their general nature is apparent. They are broader at the base, and less inclined backward than the cervicals; the anterior keel is less pronounced and the distal grooving is absent. Three proximal caudals have partially preserved spines which slant strongly toward the rear. In the cervical region there are well developed zygapophyses. In the anterior part of the dorsal region zygapophyses are present, but reduced in size. Many of the neural arches of the more posterior vertebrae are imperfectly preserved or are absent, but it is significant that no trace of zygapophyses has been seen on any vertebra posterior to No. 27 (including several seemingly complete posterior dorsal and proximal caudal arches). Apparently connections between neural arches were made here, in piscine fashion, by ligaments alone.

Rib articulations. On the atlas-axis, a small conical tubercle is present, low down on either side at about the level of the suture between atlas intercentrum and centrum; presumably this represents a small fused rib. With the axis centrum there begins a series of cervical rib facets, oval in shape, with raised borders. No clear distinction could be seen between presumed dorsal and ventral areas of attachment. In the most anterior vertebrae the facets are situated low down on the centrum, with their lower rims about 2.5 cm. above the bottom margin of the centrum. The anterior ones are short ovals in outline, with the longer axis vertical, and measuring about 7 by 8 cm. Anteroposteriorly these facets cover most of the lateral surface of the centrum. On the 9th and 10th vertebrae the facets have moved upward to some extent, so that their lower margins are about 3.5 cm. above the level of the bottom of the centra. Here the surface is more markedly oval in shape, with diameters of about 5.5 and 10 cm. At vertebra 12, the upward tendency is more pronounced; the dorsal margin of the facet is at the line of suture between arch and centrum, and the surface measures 6 by 10.8 cm. As noted above, centrum 13 is missing. However, vertebra 14 is of the transitional type which has been termed "pectoral" (this vertebra appears to have lain above the scapula). The articular rib facet measures 5.5 by 11 cm.; its upper third lies definitely on the neural arch. Further, there is the beginning of a "transverse process"; the lower part of the articular area extends outward about 3 cm. beyond the level of the surface of the centrum, and the upper, neural arch portion is similarly produced.

Presumably the "pectoral" shift began with vertebra 13; by vertebra 15, there is a developed transverse process. This extends directly laterally to a distance of 19 cm.; the upper margin of the articular surface, which measures 6.5 by 13 cm., is at the level of the zygapophysial facets. The centrum forms a considerable part of the root of the process, but whether it reaches the facet surface is uncertain. On vertebra 16 the centrum enters broadly into the formation of the root of the transverse process, but fails to reach its distal end. On vertebra 18 the centrum buttresses a small area of the base of the process, with a ventral keel extending out from this area along the underside of the process. By vertebra 19 this keel has disappeared, the lower surface of the process is smoothly rounded, and the process springs from a point well above the arch pedicel. Here the dorsal surface of the process slants somewhat upward distally, extending out about 20.5 cm. from the midline. The processes in this region have become circular in section, measuring about 5 cm. in diameter at half-length, but somewhat expanded distally to an oval articular facet measuring about 7 by 11 cm. From this point back there is little change to be seen over much of the dorsal region in such processes as are well preserved. By vertebra 36, for example, the process, which here extends 19.5 cm. from the midline, has a diameter at midlength of about 6.5 cm., but expands distally to a nearly circular facet with a 7.5 cm. diameter. There is a slight posteroventral ridge development on the underside of the process, which is here directed somewhat posteriorly but does not rise appreciably toward its distal end. Similar processes are present to vertebra 43; but on this last vertebra the ventral ridge has increased in depth, so that the base of the process extends down to a point just above the suture between arch and centrum.

Vertebra 44 is missing. The following vertebra lacks the distal end of the process but its well preserved basal portion is narrow but tall, measuring 10.2 cm. in height, and although the line of suture is not clear, the lower two-fifths of the process definitely arises from the centrum. We are dealing with a sacral, and it is probable that vertebra 44 was a sacral as well. Vertebra 46 is also a sacral; the rib process is still deeper, measuring 11.8 cm. in height distally, and with a width not exceeding half the height. Approximately half the articular surface is furnished by the centrum. The process is much shorter than that of the dorsal vertebrae, extending only 13 cm. from the mid-line; further, its upper margin slants slightly downward and outward. The transverse process of 47 is smaller than that of 46, although similarly built, extending outward only 12 cm. and with a distal height of 8 cm. Possibly this was a further sacral. There is, however, no marked break between sacral and caudal elements.

Caudal rib facets can be followed for 7 vertebrae further. On vertebra 48 the lower margin of the base of the process has retreated upward a centimeter or more from the position found in 47; from this region backward, however, the ventral margin of the base moves ventrally so that by vertebra 55 it lies below the middle of the lateral surface of the centrum. Even more marked is a downward movement of the upper margin of the rib facet. Beyond vertebra 50 the neural arch takes no part in rib support, the depth of the transverse process diminishes, and from vertebra 53 back its attachment is an essentially circular facet centrally placed on the lateral surface of the centrum. There also takes place a gradual reduction in length of the transverse process, so that by vertebra 54 it is little more than a circular area projecting but slightly from the general contours of the centrum.

Ribs. On the first five vertebrae the ribs are fused to the centra and, except for the loss of most of rib 5 on the right side, were nearly completely preserved. The first rib, as noted, is represented by a short spine fused, without evidence of suture, to the vertebra; on ribs 2-5 the line of suture is evident, although rib and centra were coössified. These anterior cervical ribs are short and stout. They extend outward and somewhat backward, flattened dorsoventrally. The distal ends are somewhat expanded, the expansion being directed backwardly from the line of the shaft. Rib 9 on the right side is nearly complete, with an estimated total length of 140 mm. The head is large, measuring 99 by 55 mm., with the greater diameter vertical; the rib extends at first directly outward, but then turns sharply backward, with a twist such that the dorsal margin of the head turns to the back margin of the shaft. Distally, the rib thins to an oval, with diameters of 57 and 30 mm. at 13 cm. from the head, the major axis running from posterodorsal to anteroventral margins. Rib 11 is similarly built.

The more posterior cervical and "pectoral" ribs are poorly preserved. One distal rib segment which appears to have lain in the pectoral region shows a much flattened shape, 86 by 35 mm. in section, with a terminus which is little expanded. Presumably this rib bore part of the serratus musculature, which one may expect to have been present — even if feebly developed — in plesiosaurs. Of the dorsal ribs, considerable material was preserved, but most had been disarticulated and badly broken. Those of vertebrae 22 and 23 alone are articulated and nearly complete. The heads are large, that of rib 23 having diameters of 102 by 88 mm. The total length of rib 23 was approximately

98 cm. The rib extends straight out from the transverse process for about 18 cm.; in the next 20 cm. there is a marked downward curvature to the extent of about 60°, followed by a further more gentle curvature to reach a total of 90° from the line of the transverse process and head. The shaft is somewhat flattened, with diameters, in section, of 58 and 47 mm. Distally the rib expands, terminating in an unfinished surface, for the ventral rib segment, which measures 80 by 65 mm.

Many of the fragments of more posterior ribs suggest similar proportions, except that the preserved heads of some of these ribs are more nearly circular in section. The sacral ribs are poorly preserved, and caudal ribs are absent in the material.

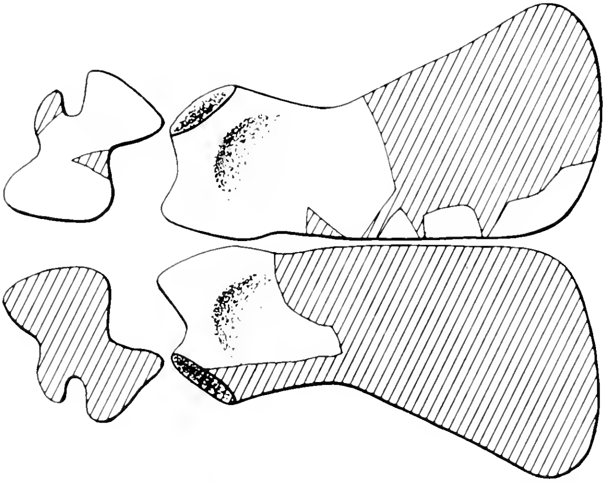

Fig. 1. Shoulder girdle of the mounted specimen in dorsal view. Hatched areas restored. X 1/30.

Girdles. White (1940, fig. 11a) has given a sketch of the shoulder girdle (Fig. 1). No remains of dermal elements were recovered. The right scapula, similar in shape to that of *Peloneustes*, is nearly complete, except for the dorsal blade; the left scapula was not found. Of the coracoids, much of the anterior half was present on both sides. Farther back, three portions of the medial margin of the right coracoid, shown in the figure, were in place. From them the outlines of the coracoid can be fairly accurately restored, except for the degree of development at the posteroexternal angle. As restored, the coracoid is extremely long (160 cm.). This figure is 270 per cent of the width of the bone, measured from the outer margin of the glenoid process to the midline (59 cm.). In *Peloneustes philarchus* and *Simolestes*, as figured by Andrews (1913, figs. 8, 21), the coracoid length is about twice the width. The *Kronosaurus* coracoid is thus even longer proportionately than in typical pliosaurs.

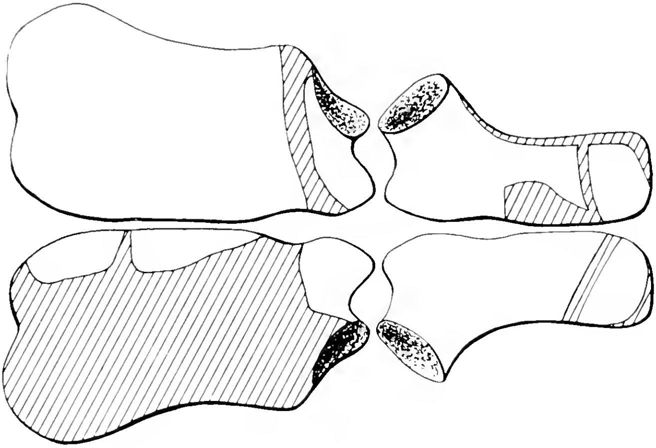

Fig. 2. Pubis and ischium of the mounted specimen in dorsal view. Hatched areas restored. X 1/30.

The pelvic girdle (Fig. 2) is exceptionally long. The left pubis is represented only by a small piece at the posterior end and two symphysial fragments, but the right pubis is nearly complete. The element measures 128 cm. in length, with a greatest width posteriorly of 74 cm. This is, again, an elongate bone, with the width 173 per cent of the length, contrasted with 122 per cent, 118 per cent and 122 per cent in Andrews' figures of *Peloneustes*, *Simolestes and Pliosaurus* (Andrews 1913, figs. 24, 10, 7). Except for part of the external and posterior margins, the ischia are nearly complete. The greatest length is 103 cm., the width to the outer margin of the acetabulum 52 cm. The proportions of the ischium (in contrast to the pubis) are not far from those of certain other pliosaurs, for the greatest length is 198 per cent of the width, as compared with figures of 189, 186, and 163 for the three pliosaurs mentioned above. In consequence, the bone is somewhat small in proportion to the pubis, for it is but 80 per cent of the length of the pubis in our skeleton whereas it is 118 per cent, 112 per cent, and 103 per cent in the three other pliosaurs described by Andrews. There is a well-defined but small puboischiadic vacuity. As in plesiosaurs generally, the pubes and ischia are considerably thickened medially below the acetabulum, indicating the presence of a very stout diamond-shaped symphysial cartilage. Of the ilium, the basal portion, with a breadth of 17.7 cm. and a greatest height of 38 cm., is preserved. The contours of this portion indicate that the iliac blade was considerably expanded.

Limbs. As noted, no remains of the pectoral paddles were preserved. Both pelvic limbs had been in position, but were in great measure eroded. The femora were present, but the middle of the shaft was missing on both. However, the gap in the left femur was short; as the bone lay, this was less than 10 cm., and the bone has been restored to this extent, with a total length of 106 cm. The contacts between left femur and tibia and fibula are lost, but most of the tibia and the anterior part of the fibula are present. Articulated with them are the two elements sometimes termed intermedium and fibulare and, beyond, two large distal tarsals and metatarsals III and IV. A fragment from the right limb includes the more posterior of the two distal tarsals seen on the left, and attached to it distally, metatarsals III and IV in addition to a fragment of metatarsal V.

Described plesiosaurs in general have the forelimb and mesopodial elements arranged (to borrow a phrase from mammalian osteology) in an "alternating" fashion, so that (as in the carpus of advanced ungulate mammals) the elements in each row alternate to some degree with those proximal and distal to them, and facets between successive elements may be tilted at an angle from a transverse line of the bone. Here, on the contrary, there is, in the elements preserved, a one-to-one relation of bones of the three proximal rows, and the lines of articulation between successive segments are directly transverse. A similar construction is present in a plesiosaur from the Kimmeridge Clay of Stretham now being described by Dr. Tarlo.

In both paddles a number of disarticulated and variably weathered phalanges, measuring on the order of 10 to 12 cm. in length, were present. The size of the limb elements present suggest a paddle, beyond the femur, of about twice the length of that of *Peloneustes philarchus*, i.e., about 120 cm. to 140 cm., and a total length of the limb of about 230 cm.

Hyoids. Beneath the cervical vertebrae was found a symmetrical pair of bones with expanded, diagonally-facing "heads"; neither is complete distally; the one with the longer shaft measures 262 mm. as preserved. These appear to be a pair of basihyoid elements; they differ markedly, however, from the slender elements generally reported in plesiosaurs.

Gastralia. A portion of the ventral armor was preserved, but the materials are too imperfect to warrant detailed description. There is evidence indicating that at least a part of the gastralia were of complex form, in contrast to the primitive rod-like shape.

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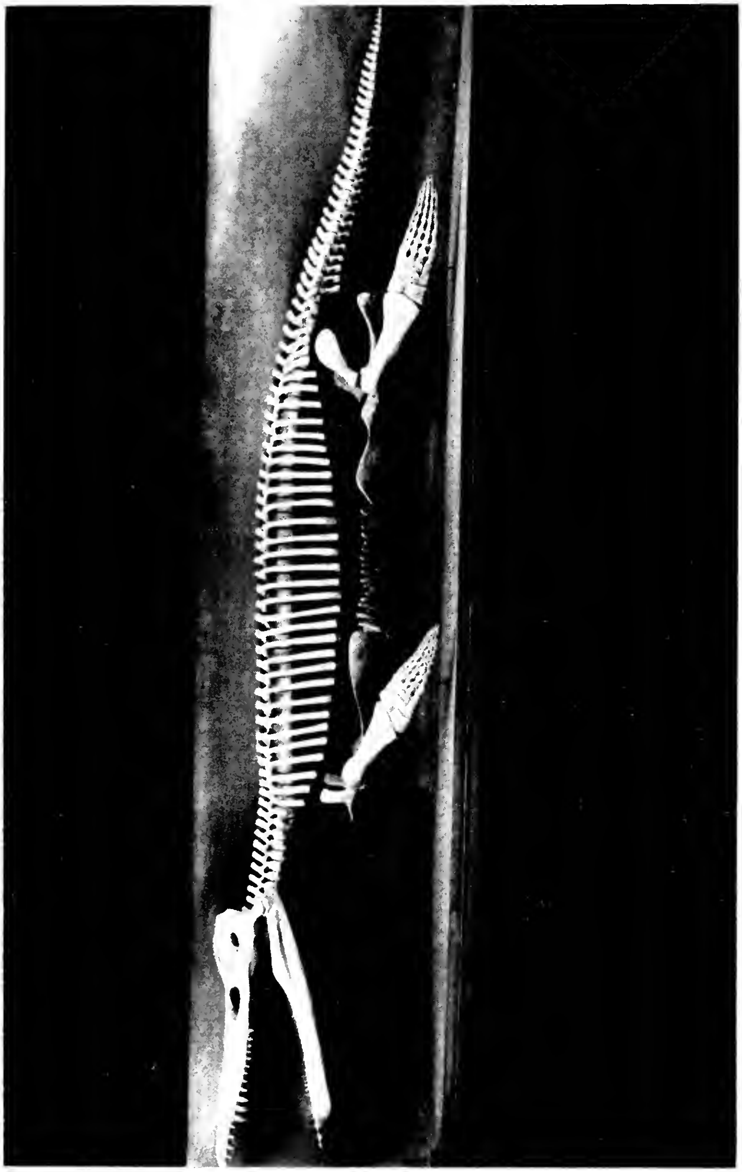

The skeleton of *Kronosaurus queenslandicus* as exhibited in the Museum of Comparative Zoology. Length as restored, 1280 cm.

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. November 2, 1959 Number 113

A NEW PHYLLOMEDUSA FROM BOLIVIA (SALIENTIA, HYLIDAE)

By Benjamin Shreve

In 1954 Carl Gans and Padre F. S. Pereira, C.M.F. collected amphibians and reptiles in the state of Mato Grosso in Brazil and the Department of Santa Cruz in Bolivia. W. C. A. Bokerman of the Departamento do Zoologia, São Paulo, Brasil, did some preliminary work on identifying the amphibia, while I was called upon to complete this task. While doing so, I discovered the novelty described here. Dr. Gans, who is planning to publish a complete report on his collection, has graciously presented about half of the amphibians to the Museum of Comparative Zoology, including the type of the new form, the remainder going to the Carnegie Museum of Pittsburgh, Pennsylvania.

Phyllomedusa pailona sp. nov.

Type. Museum of Comparative Zoology 29677, an adult male, from El Pailon, 5 kilometers from the eastern shore of the Rio Grande, altitude 350 meters, Department of Santa Cruz, Bolivia, collected by Carl Gans and F. S. Pereira March 5, 1954.

Paratypes. M.C.Z. 29678-79 and Carnegie Museum 36278-80, all adult males, with the same data as the type.

Diagnosis. Apparently most closely allied to *Phyllomedusa sauvagii* Boulenger but differing in apparently smaller size, longer hind limbs, immaculate venter and other aspects of coloration.

Description. Tongue slightly nicked behind; vomerine teeth in two slightly oblique groups between the choanae; snout longer than the diameter of the eye, obliquely truncated from behind forwards (male only?, shape of snout may be different in female); loreal region slightly oblique: interorbital space broader than the upper eyelid; tympanum (longest diameter) two-thirds the diameter of the eye (two-thirds or slightly less in paratypes); fingers free, first very slightly shorter than second, fourth somewhat shorter than third; toes free, first longer than second; disks of fingers and toes much smaller than tympanum; inner metatarsal tubercle fairly prominent; the tibio-tarsal articulation of the adpressed hind limb reaches to the tympanum; upper surfaces minutely granulate; parotoids large, short, a larger portion extending about as far as axilla, a rather obscure extension extending farther back (not evident in some paratypes); belly and lower surface of thigh granulate, other parts of lower surface less granulate; a subgular vocal sac and a brown nuptial pad on inner side of thumb.

Coloration in alcohol. Above, grey blue (quite light in some of the paratypes); inner two fingers and outer three toes yellowish suffused with brown, disks of other fingers and toes brownish; eye more or less narrowly bordered with white suffused with orange, decidedly more extensive and continuous on upper eyelid than lower (possibly bright orange in life). Below, yellowish; a white stripe on tarsus and forearm (that on the former curving around the tibio-tarsal articulation), separating dorsal and ventral pattern, continuing on to the adjoining digit; a similar stripe, but short, above anus; a wash of more or less purplish brown under limbs particularly in the vicinity of the stripe, the same color below anal stripe; also a white stripe on under side of upper arm curving around insertion anteriorly. Some of the paratypes show obscure white spotting under the thighs.

Head and body length. Type 67mm. Paratypes 60-69mm.

Remarks. A transforming individual (M.C.Z. 29680), apparently referable to this species, was taken from the stomach of a hatchling *Chironius pyrrhopogon* (Wied). This toad had the tail still present but the limbs appeared fully developed. Owing to some possible doubt about the identification, this individual is not included as a paratype. The data is the same as that of the type and paratypes.

The range of *sauvagii* is given by the most recent reviser of the genus, A. Funkhouser (1957, p. 54), as Argentina, southern Brasil, and southern Bolivia. While this roughly includes the type locality of the species described here, there appears to be no evidence that the two forms are sympatric. The nearest locality, El Carmen, at which Carl Gans collected *sauvagii* is about 488 kilometers to the east of El Pailon. L. Müller and W. Hellmich (1936, p. 107) record *sauvagii*, mentioning some variation in color, from "Curriche von San Ramon" north of San Jose de Chiquitos. "Curriche von San Ramon" is not specifically indicated on Müller and Hellmich's map (*loc. cit.*, p. 115), though a short spur from the main itinerary extending north and west from San Jose de Chiquitos may include or terminate at "Curriche." In any event, this locality is much closer to El Pailon than is El Carmen, San Jose de Chiquitos itself being about 218 km. to the east. In the absence of evidence of sympatry, the judgment that *sauvagii* and *pailona* are specifically distinct is based on the several differences cited in the diagnosis.

P. pailona seems also to be related to *P. boliviana* from which it appears to differ in having smaller discs on the fingers and toes, differently shaped parotoid glands, and in different coloration, consisting chiefly in the absence of white spotting or vermiculation on the sides, and a nearly immaculate ventral coloration.

According to Funkhouser (*loc. cit.*, p. 57), the range of *boliviana* is the eastern Andean foothills of Ecuador and Bolivia, thus apparently occurring at higher altitudes than that (350m.) at which *pailona* occurs. Again there appears to be no sympatry, and specific distinction is inferred from the extent of morphological and color differences.

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Phyllomedusa pailona, paratype, MCZ 29679, ventral view to show immaculate venter. Carl Gans, photographer.

BREVIORA

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ANOMALOPHIS BOLCENSIS (MASSALONGO), A NEW GENUS OF FOSSIL SNAKE FROM THE ITALIAN EOCENE

By Walter Auffenberg
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The genus *Archaeophis* as defined by Massalongo (1849) was based on two fossil specimens of presumed snakes originally in the collection of DI Canossa from the well known Middle Eocene teleost and plant beds of the Monte Bolca limestone near Verona, Italy.

One specimen was designated as the type of *Archaeophis proavus.* It was smaller than the second specimen and much more complete, including almost the entire skeleton as well as an impression of the skin. The larger specimen lacked a head, nor was there any indication of an impression of the skin. This specimen was made the type of his second new species, *Archaeophis bolcensis.* Both were considered to be primitive snakes. Massalongo thought that they were merely quite distantly related to the only fossil snakes known at that time (*Palaeophis* and *Palaeryx*). They were not compared with any Recent genera. On the basis of the round form of the vertebrae as well as the general shape of the tail, Massalongo believed that *Archaeophis* was a terrestrial genus.

In the following years the specimens became separated. The type of *A. proavus* was purchased by the Berlin Museum and the type of *A. bolcensis* was deposited in the Museum of Comparative Zoology, having been purchased by Louis Agassiz.

A recent study of the two species formerly attributed to *Archaeophis* shows that *A. bolcensis* differs radically from *A. proavus,* and necessitates erecting a new family and genus based on the characters exhibited by the type and only specimen of *bolcensis.*

In 1904, Janensch briefly described the skull, teeth, vertebrae and ribs of *Archaeophis proavus*, but in somewhat greater detail than had been previously done by Massalongo. It was also in this paper that Janensch first suggested that the genus may have been a highly specialized marine form. This idea was based on his interpretation of the shape of the tail and body which he thought were very compressed in life.

In 1906 he redescribed, in much more detail, the type of *Archaeophis proavus.* Various parts of the skeleton and particularly the skull had been further prepared, and all elements were examined with the aid of a binocular microscope. The description of the skull is far better than any previously given. Unfortunately, the skull capsule is badly crushed, so that the individual bones are very difficult, if not impossible to trace. The bones of the jaw apparatus are all fairly well preserved. Certain parts are missing, but in some cases the shape of the missing elements can be determined from stains or impressions appearing on the limestone slab on which the specimen is preserved. The head is unusually pointed for a snake, a fact of which Janensch was quite cognizant. The teeth are most non-snakelike in that in cross-sectional view they are definitely 5-sided. Janensch interpreted certain elements partially hidden by matrix as quadrates and squamosals. McDowell and Bogert (1954:67) suggest that the "quadrate" agrees fairly well with the branchial bones of an eel, but from what can be seen of them they are not considerably different from the same elements in Recent snakes. However. the major parts of the squamosals(?) are hidden by matrix, so that their exact shape, or method and place of articulation with the skull cannot be determined.

The vertebrae and ribs of *Archaeophis proavus* are very important, since only these elements can be compared with corresponding structures in *Archaeophis bolcensis.* Janensch points out that the exact form of each of these elements is very difficult to ascertain. This is due to several factors. The bone making up the neural arch of each element is very thin, and thus most of the elements are badly broken. When the limestone block in which the specimen was imbedded was split some of the bone making up the individual vertebrae was accidently removed. Furthermore, the outer layer of bone has been lost in most of the vertebrae along the column, so that only the deeper part remains. This means that only the more general structure of the vertebrae can be determined in most parts of the column. Reasonably complete elements occur in only a few areas. For the most part these are regions which were originally completely covered by matrix until prepared at the Berlin Museum. Unfortunately, full preparation was not possible due to the fragile nature of the elements. No single vertebra could be profitably removed intact, so that anterior and posterior views of separate elements are not available. In addition, because of the overlapping nature of these vertebrae, the exact shape of either the neural arch, cotyle or condyle is not determinable. Janensch prepared a reconstruction of the side view of one of the middle thoracic elements based on several vertebrae in this area. His ventral view of a vertebra from the same part of the column is taken from only one prepared element (Fig. 1C). One of the vertebrae was split when the block was separated into two slabs, providing a fair cross section (Fig. 1 I).

The exact number of vertebrae is difficult to ascertain with any degree of certainty due to broken or missing segments. Massalongo had estimated this number as 507. Janensch believes his estimate of 565 is much closer. One hundred and eleven of these are caudal members. The entire length of the specimen is about 95.5 cm., of which the tail makes up about 10.5 cm.

The individual vertebrae show considerable variation in size and proportion along the length of the column. The more anterior members are small, and higher than long. The middle vertebrae are largest. The posterior vertebrae are smaller, and longer than high. All of the segments appear to be procoelous. The condyle is strongly oval, with the main axis in the horizontal plane. From the side the condyle is flattened at its posterior end, not rounded as it is in all fossil and modern snakes. However, this difference may be due to breakage. The cross section of a thoracic element illustrates the unusual thinness of the neural

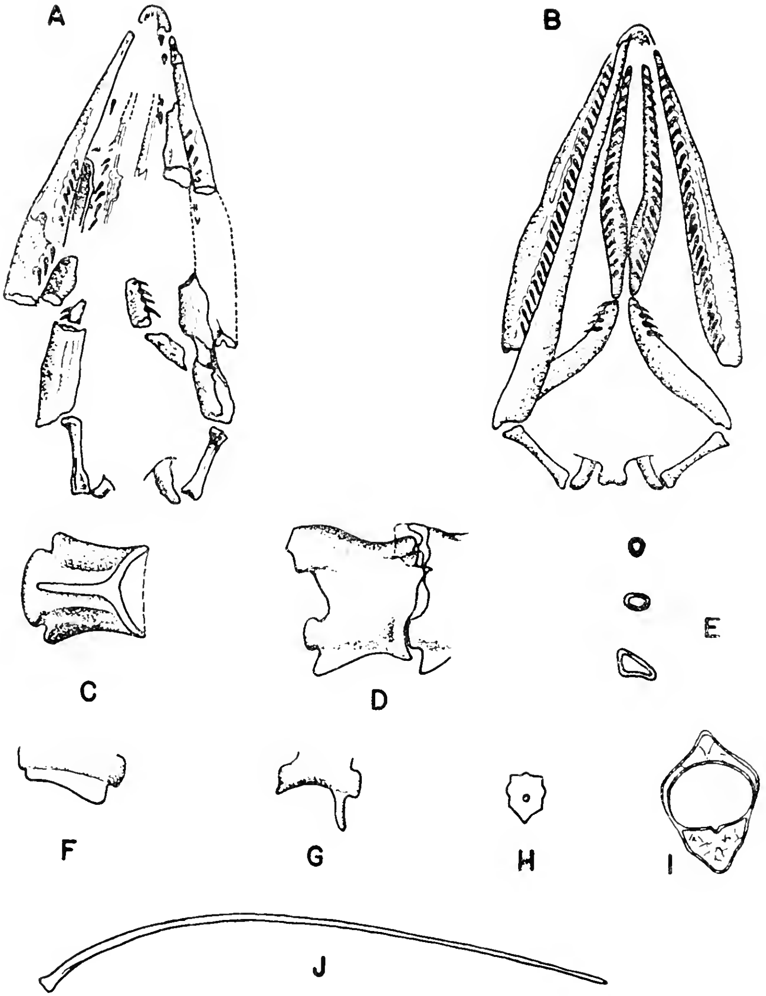

Fig. 1. Certain structural features of the type of *Archeophis proavus* Massalongo (*fide* Janensch, 1906). A, Skull, from below. B, Reconstruction of the jaw apparatus. C, Vertebra 78 seen from below. D, Vertebra 46, seen from the side. E, Cross sections of a single rib. F, Vertebral centrum and hypapophysis. G, Vertebral centrum and haemapophysis. H, Cross section of tooth. I, Cross section of vertebra. J, Rib from the middle of the body.

arch, even considering that the outer lamellae were accidently removed in splitting the rock. There is no well developed neural spine, but rather a small keel that begins near the anterior edge of the neural arch and continues posteriorly to near the posterior edge of the element. The neural canal is roughly pentagonal in shape when viewed in cross section. The centrum is seen to be subtriangular in cross-sectional view. This condition is not seen in any fossil or Recent snake, where the centra are always oval to round. The zygosphene is very small and its articular surfaces are little developed. The articular facets of the post- and prezygapophyses are horizontal, not vertical as McDowell and Bogert (1954) claim. This is obvious not only from Janensch's illustration, but is clearly stated in the text as well. The paradiapophysial articulations are single and rather small, located anterior to the middle of the vertebrae, and placed low on the centrum. Janensch states that several individual vertebral elements indicate that these small structures are not the result of erosion, but that they may have been topped by a cartilaginous surface of considerable extent in life. Whether or not they represent an entire, or partial, synapophysis or are even homologous to part of one is unknown. Accessory processes are apparently absent throughout the column, as they are in several families of fossil and Recent snakes. Well developed, laterally compressed hypapophyses are developed along the entire presacral portion of the vertebral column. From the side they vary from sigmoid-shaped structures in the anterior part of the column, to much lower, broad-based triangular structures posteriorly. A midventral keel runs anteriorly from the anterior edge of the base of the hypapophysis to near the anterior edge of the centrum. The posterior portion of the base of the hypapophysis does not come in contact with the base of the condyle. Paired haemapophyses are found on all of the caudal elements. They are long, spine-like structures, placed far back on the centrum and directed almost straight downwards. The ribs are quite long, bent posteriorly and considerably compressed laterally. There are no costal processes on any of the ribs.

These are the most important structural features of the vertebrae and the ribs, as described by Janensch. Many of the characters are not found in other snakes, such as the triangular centrum in cross section, the very small articular processes, the poorly developed zygantrum and zygosphene, and the strongly oval condyle. The ribs are considerably longer, less curved, and more compressed than in any other fossil or Recent snakes known. For a complete description of these structures as well as those of the skull and skin the reader is referred to Janensch (1906).

On the basis of his study of the type of *Archaeophis proavus*, Janensch concluded that: (1) the type of *A. proavus* is a highly specialized marine snake; (2) the type of *A. bolcensis* belongs to the same genus, perhaps even to the same species as the type of *A. proavus*; and (3) *Archaeophis* represents a new family of snakes, the Archaeophidae, distinguished mainly on the shape of the teeth.

McDowell and Bogert (1954: 66-67) point out several remarkable features of the vertebral structure of *Archaeophis*. These are: (1) the smooth and unsculptured vertebrae; (2) the fact that the prezygapophysis is reduced to a small spine; (3) the plane of the articular surface of the postzygapophysis is vertical, not horizontal; and (4) there is no neural spine. To these authors the combination of characters seemed to suggest that *Archaeophis* was not a snake. They point out that some of the features of the genus are found in certain eels, and other characters are similar to those found in some snakes. They state that, "Looking at Janensch's figures, we are led to suspect that *Archaeophis* might not even be reptilian, for there is much to suggest (though not enough to prove) affinities with the teleost fishes, particularly some eel of the *Ophichthus*-like group." They go on to suggest that *Archaeophis* might best be placed as a vertebrate of unknown affinities. Some of the characters they list as remarkable (if *Archaeophis* is a snake) are certainly not very important, or very remarkable, such as the degree of smoothness and sculpturing of the vertebrae. As pointed out above, some of the outer lamellae of bone have been lost. Only general shape of the structures is really determinable. Much detail has been lost, and absence cannot be used as any sort of criterion, except as regards degree of mineralization or breakage. Furthermore, details of configuration of Recent snake vertebrae vary greatly from genus to genus. The absence of a well developed neural spine is characteristic of several groups of Recent and fossil snakes. As pointed out previously, McDowell and Bogert misinterpreted Janensch's figure of the side view of the middle thoracic vertebra as well as his text discussion, since they stated that the articular surface of the postzygapophysis is vertical. Both the figure and the text clearly indicate that this surface is horizontal, as it is in all snakes. However, this in itself proves nothing, since a zygapophysial articular surface when present in fishes is sometimes horizontal.

McDowell and Bogert, as well as Janensch, assumed that the type of *Archaeophis bolcensis* was structurally very similar to the type of *A. proavus.* Massalongo stated that this was true, but his analysis of the characteristics of both species was rather superficial. Janensch examined *proavus* very closely, but failed to examine the type of *bolcensis.* McDowell and Bogert relied only on Janensch's description of *proavus* for the generic characters. The present study of the type of *A. bolcensis* has shown that this species is quite unlike *proavus* in many of its structural details. The two species are very different in a number of important features. I wish to thank Drs. E. E. Williams and A. S. Romer for permission to examine the type of *Archaeophis bolcensis,* and especially for allowing me to prepare it further.

The specimen in the Museum of Comparative Zoology is represented by sections of the anterior, middle and posterior parts of the vertebral column and their associated ribs. These were originally located on three limestone slabs (MCZ 1001, 1002 and 1003). One of the slabs was intentionally sawn in half and one became broken sometime in the past. The specimen is considerably larger than the type of *A. proavus.* There is no trace of the skull. A dark stain on the limestone matrix in several places may represent portions of the flesh, or skin, but no details of scalation, if it exists, can be made out. The middle and posterior parts of the specimen are resting on their dorsal sides, so that only the ventral surfaces of the vertebrae are visible. The anterior section rests on its ventral side. Unfortunately, throughout most of the column the vertebrae are crushed, or badly broken, on the exposed surface. However, most obvious at once is the fact that, broken as they may be, there are no hypapophyses on any of the middle or posterior vertebrae. On this basis alone it is obvious that two genera are involved. As in *A. proavus* the ribs are all long, curved backwards only slightly, and lack costal processes.

To aid in uncovering certain details of structure of both the vertebrae and ribs, acetic acid had been applied to several areas along the vertebral column, in the past. This was a most unsatisfactory undertaking, since the loss of the encasing matrix caused ends of ribs and the dorsal or ventral surfaces of some of the vertebrae to disintegrate. Fortunately, dry preparation was still possible in several areas. Two vertebrae were completely freed from the matrix so that anterior and posterior views could be drawn and studied. The surfaces otherwise hidden were examined and the structures compared with those in fossil and Recent snakes. The isolated vertebrae are considerably cracked. Some processes had been broken off in the past, and a few slightly damaged in extricating the delicate elements. It was thus necessary to reconstruct, very slightly, the missing parts of the isolated middle thoracic element. The reconstructed portions were drawn from other vertebrae, in the immediate area, in which these particular processes were still complete. The quite reasonable complete reconstruction of at least the middle dorsal member allows a thorough comparison with *A. proavus* and with all fossil and Recent snakes. Most important, it proves beyond doubt that *Archaeophis bolcensis* is a snake, regardless of the taxonomic position of *A. proavus*.

Unlike *A. proavus*, the vertebrae of *A. bolcensis* possess well developed zygantral and zygosphenal articular surfaces. There is a well developed neural spine. The pre- and postzygapophysial articular surfaces are also well developed. The vertebrae are much more robust than are those of *A. proavus*. The paradiapophysial articulating surface is better developed than in *A. proavus*. The elements are well ossified throughout the column, and the outer laminae of bone are still present.

To facilitate future comparisons of *Archaeophis bolcensis* with other fossil or Recent snakes, a description of the partly reconstructed middle thoracic vertebra is given below.

Description of vertebra: — Centrum long, the sides converging posteriorly, a truncated triangle from below, provided with a well developed, slightly oval cotyle anteriorly, and a well developed condyle posteriorly, which is only slightly separated from the basic portion of the centrum by a small constricted area. A haemal keel is present, gladiate to spatulate in shape, and slightly flattened ventrally. It extends from near the lip of the cotyle to just anterior to the condyle. The ventral surface of the centrum is slightly flattened on either side of the haemal keel. There is a faint subcentral ridge extending posteriorly from just behind the synapophysis, or the paradiapophysial articular facets on either side, to near the base of the condyle. The paradiapophysial articular facets are oval in shape, and located low on the centrum, well in front of the middle of the vertebra. From the side, the ventral surface of the centrum is reasonably straight, not concave, or convex, as it is in many snakes. The buttresses of the prezygapophyses are well developed. In anterior view they are seen to possess a sharp anterior edge. The buttress is closer to the median line ventrally than dorsally. Between the buttress and the projected lip of the cotyle there is a small scooped out area. Whether or not this small depression possessed a nutritive foramen is unknown. There is no extended accessory process below the prezygapophysial facet. The facet is slightly higher anteriorly and outwardly than posteriorly and medially. From above, the articulating surface is ovoid to sub-triangular. The articular surfaces of the postzygapophyses are developed on the laterally expanded posterior portion of the neural arch, as they are in all snakes. The facets are oval, the main axis being anteroposteriorly. The neural arch is fairly long and not greatly emarginate from above. The interzygapophysial ridges are fairly prominent, especially posteriorly. The neural spine is long at its base, extending from just above the base of the zygosphene to the anteriorly indented posterior edge of the neural arch. It is slightly thickened and truncated dorsally. The posterior edge is slightly lower than the anterior one. There are no overhanging edges at the top of the spine either anteriorly or posteriorly. From above, the dorsal edge of the spine is relatively thin, not overly thickened into a peg-like or oval-shaped structure, as in some primitive snakes. The zygosphene is well developed, robust, but small for the length of the centrum when compared to the Boidae. From above, the anterior edge of the zygosphene is

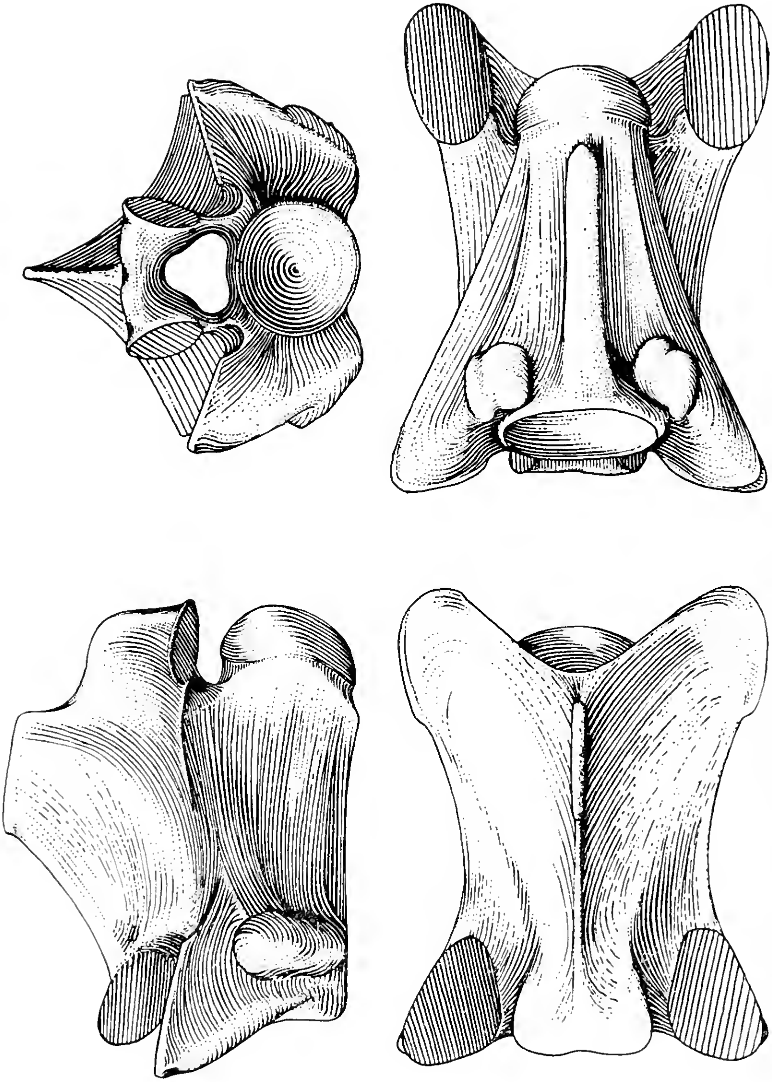

Fig. 2. Middle thoracic vertebra (slightly reconstructed), MCZ 1001, holotype, *Anomalophis bolcensis.*

almost straight, perhaps with a small median notch. From the front, the zygosphene is somewhat thickened dorsoventrally, the dorsal edge slightly convex, presumably with a small notch medially. The zygosphenal articular facets are oval, the anterior edge being at an angle of about 45 degrees when viewed from the front. The neural canal is fairly small, roughly triangular in shape. The medial edges of the prezygapophysial articular facets are even with the floor of the neural canal. It is impossible to determine the position and size of the zygantral foramina, if they are present at all. Whether or not a medial anapophysis occurs on the floor of the neural canal cannot be determined, since the canal is filled with matrix, which, if removed, would weaken the isolated fossil considerably.

The partially reconstructed middle thoracic vertebra is illustrated in Figure 2. Table 1 gives all of the pertinent measurements possible on the vertebra.

TABLE I

APPROXIMATE MEASUREMENTS (IN MM.) OF A SINGLE THORACIC VERTEBRA FROM THE TYPE OF *ARCHAEOPHIS BOLCENSIS*

Centrum length	11.0
Centrum width at its narrowest part	8.0
Pre-prezygapophysial width [1]	22.0
Post-prezygapophysial length [2]	16.0
Cotyle width	4.5
Cotyle height	4.0
Length of neural spine along dorsal edge	4.0
Height of neural spine along anterior edge	3.5
Zygantrum width at its widest part	5.5

A single vertebra was also removed from the anterior part of the column of the type of *A. bolcensis*. Unfortunately, the anterior elements are even more crushed than the middle and posterior ones. Unlike the middle thoracic region, the anterior

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[1] The pre-prezygapophysial width is measured from the outer edge of one prezygapophysial facet to the outer edge of the opposite prezygapophysial facet.

[2] The post-prezygapophysial length is measured from the posterior edge of the postzygapophysial facet to the anterior edge of the prezygapophysial facet.

portion of the specimen is resting in a natural position, so that the ventral surface of each vertebra is imbedded in the matrix and thus is somewhat protected. The dorsal and lateral surfaces are almost completely crushed. By careful preparation of one

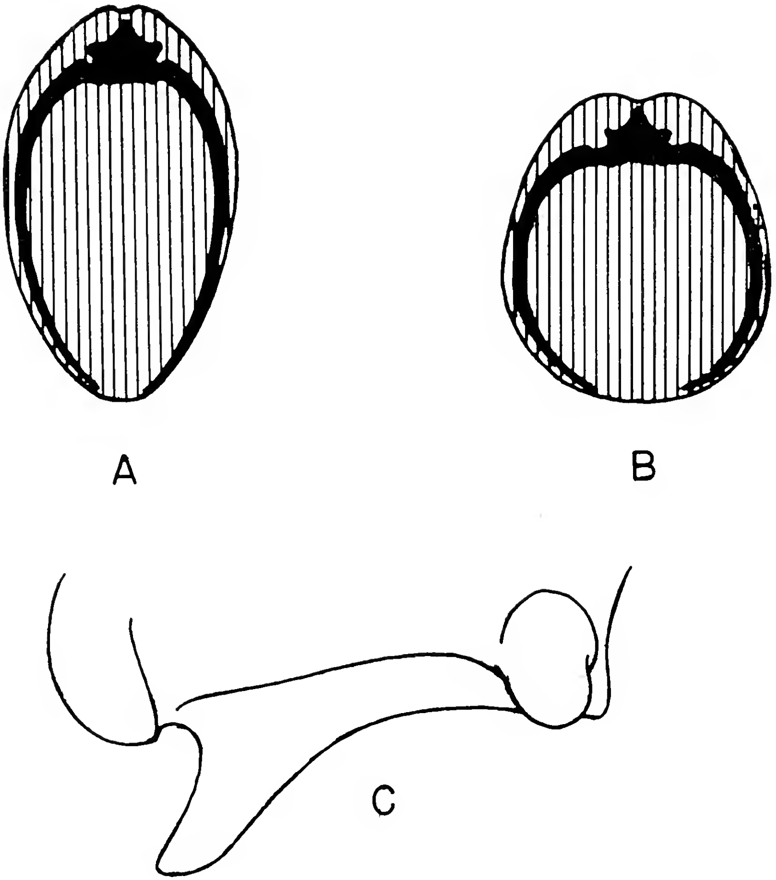

Fig. 3. Reconstruction of assumed cross section of the mid-body region in *Anomalophis bolcensis* (A), compared with that of a Recent *Constrictor constrictor* (B). The lower drawing (C) illustrates the general shape and position of the single hypapophysis present in the more anterior vertebrae of the type of *Anomalophis bolcensis*.

of these elements it was possible to remove it from the articulated position. The ventral surface of the centrum is provided with a well developed hypapophysis. It is only slightly compressed laterally. From the side it forms a very gentle sigmoid-shaped structure, directed more ventrally than posteriorly. Anteriorly, it is continued as a low midventral keel to the lip of the cotyle. The spine is located posteriorly on the centrum, the posterior edge beginning just anterior to the slight constriction near the base of the condyle (Fig. 3).

A well developed ridge extends from the posterior edge of each paradiapophysis to near the base of the condyle. These ridges converge only slightly posteriorly. The ventral surface of the centrum is quite flattened between the two ventrolateral subcentral ridges. The lateral borders of the centrum are almost parallel, but converge slightly posteriorly. No nutritive foramina are visible. Very little of the structure of the lateral or dorsal surfaces of the element are determinable. The prezygapophysial articular surfaces are quite evident. They are horizontal. From above, they are oval, with the long axis nearly parallel to the axis of the centrum, but diverging anteriorly.

The ribs vary considerably along the column in regards to their length, curvature, and degree of compression. Anteriorly, these elements are about 80 mm. long, only slightly curved, and very little compressed. They are quite attenuate. The middle thoracic members are somewhat more robust and more curved, particularly proximally. The entire length of a single rib in this area is about 90 mm. These members are proportionately more compressed proximally than are more anterior or more posterior ribs. Near the proximal end they are somewhat subtriangular in cross section. The more posterior ribs are about 110 mm. long, very filiform, little curved and hardly compressed at all along any part of their length. Views of the individual ribs and cross sections of them are given in Figure 4. The cross sections were obtained by taking out small broken sections of ribs in the various areas and then replacing them after examination. The proximal rib ends vary only slightly throughout the column from almost round to decidedly oval. The middle thoracic members are provided with a small indentation near the middle, presumably marking a very weakly developed costal process in these elements. More anterior and posterior ribs lack any evidence of such a structure.

The shape of the rib, i.e., its length and degree of curvature, indicates that *Archaeophis bolcensis* possessed a body which was much more laterally compressed than any of the living snakes (Fig. 3). Its body shape is probably approached most closely by the posterior portions of some of the living hydrophids. Janensch's conclusion that this compression indicates that *Archaeophis* represents a highly modified marine form seems quite reasonable.

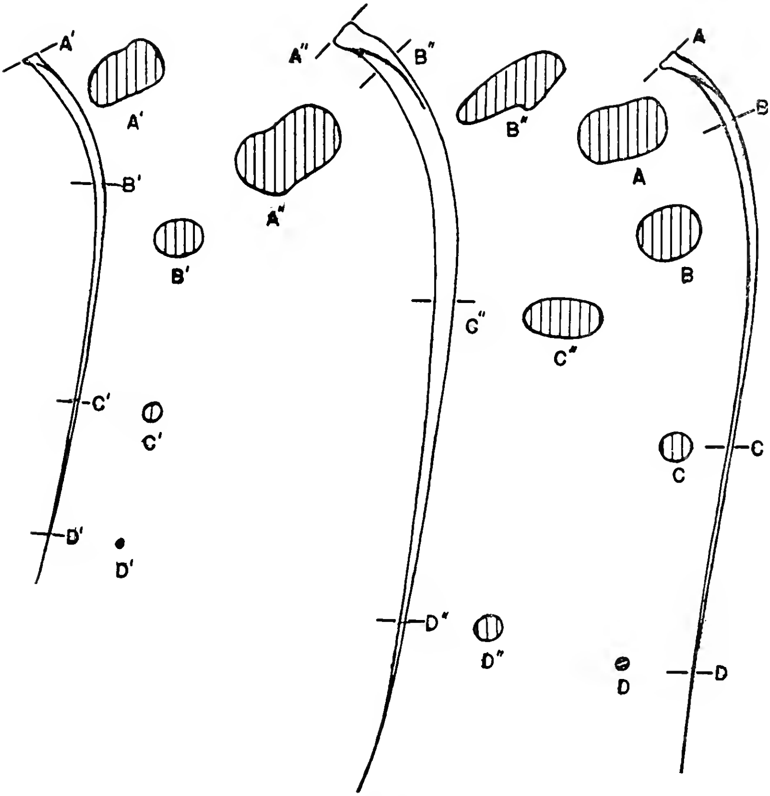

Fig. 4. Lateral and cross sectional views of the ribs from several regions along the body of the type of *Amomalophis bolcensis*. Left, anterior rib; middle, thoracic rib; right, posterior thoracic rib.

The type of *Archaeophis bolcensis* has been shown to differ in a number of structural features from that of *Archaeophis proavus*. The most important differences are: (1) the presence of a much better developed zygantrum, (2) the absence of hypapophyses throughout the middle and posterior portions of the vertebral column, (3) a condyle which is much more rounded, and (4) a well developed neural spine. *Archaeophis bolcensis* is unquestionably a snake. The type is to be referred to a genus other than that which includes the type of *A. proavus*. It has been suggested that the latter may be a fish (McDowell and Bogert, 1954). This idea was based on several characters already mentioned above. However, as these authors have pointed out, certain features of *A. proavus* are quite snakelike. The phyletic position of *A. proavus* is thus uncertain. Furthermore, this species is generically distinct from the type of *A. bolcensis*. The type of *Archaeophis* has been fixed as *proavus* (Kuhn, 1939). The species *bolcensis* is thus left without a generic name, for which I propose the following:

ANOMALOPHIS new genus

Diagnosis. A genus of Eocene snake, differing from all Recent and most fossil genera in lacking a costal process of the ribs. In the absence of this structure *Anomalophis* is approached by the Paleophidae.[1] It differs from members of this family in lacking well developed pterapophyses on the posterior part of the neural arch.

Genotype. Anomalophis bolcensis.

ANOMALOPHIS BOLCENSIS (Massalongo)

Diagnosis. Same as for the genus.

Holotype. MCZ 1001, 1002 and 1003.

Type Locality and Horizon. Near Verona, Italy; Monte Bolca limestone, Middle Eocene.

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[1] Romer has recently (1956:563) provisionally placed the Paleophidae in the Lacertilia. The family was formerly considered to include only *Paleophis* and *Pterosphenus*, though he added *Simoliophis* and *Pachyophis*. The two latter genera may indeed be lizards, since their vertebrae are quite varanoid in general appearance. These two genera are placed in the Simoliophinae (Pachyophinae). However, *Paleophis* and *Pterosphenus* (Palaeophinae) are most certainly snakes, though perhaps somewhat aberrant. I propose that *Paleophis* and *Pterosphenus* be returned to the Suborder Ophidia (Serpentes), and that they constitute a distinct family distinguished largely on the basis of well developed pterapophyses and double hypapophyses in some of the vertebrae.

The combination of the differences, pointed out above, in both the vertebrae and ribs suggests that *Anomalophis* should be placed in a separate family of snakes, the Anomalophidae, containing only one genus at the present time, *Anomalophis.* The single specimen of the type species of the genus lacks a skull, but certain vertebral and rib characters are quite distinctive. The new familial characteristics are as follows: A single hypapophysis occurs in each of the more anterior vertebrae; in the middle and posterior vertebrae the hypapophysis is reduced to a low keel; centrum long; neural spine with a long base and not overly thickened; neural arch normal, without aberrant processes; no well developed accessory processes; ribs long, filiform, no costal processes, slightly compressed, with little curvature.

Cranial and pelvic girdle material of all of the earlier fossil snakes is sorely needed. Until this becomes available it seems best to defer a complete comparison of all of the later Mesozoic and early Cenozoic boid-like snakes (of which *Anomalophis* seems to be a member) until a later date.

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BREVIORA

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THE LEMON-COLORED PLEXAURIDS FROM THE WEST INDIES AND BRAZIL

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In Kükenthal's monograph of 1924 are listed two yellow plexaurids, referred to different genera and each definitely falling outside the normal limits of the genus in which it is placed. These two forms are *Plexaura flavida* (Lamarck) — which, incidentally, also appears in a dark purple phase — and a species which, hitherto, most commonly has been listed as *Eunicea humilis* Milne Edwards and Haime. The latter, thanks to the junior author's delving into old, forgotten literature, has now been given the older name *sulphurea* Donovan. Lamarck's species appears to be common in the West Indies, from the northern shores of South America to the eastern coasts of Florida, but apparently it does not reach Bermuda (see Verrill, 1907, p. 261), while Donovan's species is one of the most characteristic elements of the Brazilian reef fauna, ranging from 7°S to 20°S latitude with a few, rather dubious, records from Curaçao, Aruba, and San Bartholomew Island, in the West Indies.

As the Museum of Comparative Zoology possesses a large amount of material of both forms, and since a number of confusing statements concerning them have crept into the literature, there seems good reason for revising these two species and allocating them to their proper place, and at the same time reviewing their history.

Verrill established in 1907, page 309, a new genus *Plexauropsis*, to accommodate what he considered a new species, *P. bicolor*, taken from shallow water in Bermuda. The species was not found again until 1951, when it was realized that this small form merely represented the immature stage of the tall *Pseudoplexaura crassa* (Ellis and Solander), with a few flat rods still retained in the tentacle bases, and with a greater number of clubs and spindles with spines on the external side than are usually present in the older colonies. Hence *Plexauropsis* is a straight synonym of Wright and Studer's *Pseudoplexaura* 1889.

Verrill's genus and species was, however, included in Kükenthal's monograph of 1924 (p. 118), with a somewhat distorted description: The presence of the few tentacle rods was omitted, and too great emphasis was placed on the one-sided spinulation of the external spindles — a feature which occurs more or less pronounced in a number of plexaurids, but often has not been specially noticed. Neither Kükenthal nor his students had, of course, access to Verrill's material.

As a result of Kükenthal's misleading account, Stiasny included a number of species in *Plexauropsis*, in his papers from 1935 to 1951.

His *tricolor*, from Bermuda (1935 a, p. 241; 1935 b, p. 69, pl. 3, fig. 13 and text fig. R), is identical with *Plexaura homomalla* (Esper), redescribed by Verrill in 1907.

His *bicolor*, based on some old material labelled *humilis* (from Curaçao and "No locality," 1935b, p. 73), was later transferred back to *humilis* (1935c, pp. 107-115, text figs. 1-3), with a detailed analysis of all earlier records appended.

His *humilis* (1935b, pp. 74-78, pl. 3, fig. 14, pl. 7, fig. 32, text fig. T), was later changed to *Eunicea hicksoni* (1935c, p. 115), but it represents merely the widespread form *Plexaura flexuosa* Lamouroux. Most of this material had been identified by Gordon (1925, p. 17) as *mutica* Duchassaing and Michelotti.

In addition, Stiasny had included the following feather-shaped forms in the genus *Plexauropsis:*

P. flavida n. sp. (1935a, p. 242: 1935b, p. 71, pl. 1, fig. 5, text fig. S) from Curaçao.

P. sp. (1935b, p. 72) from "Antillen."

P. puertorealis n. sp. (1942, p. 101, pl. 1, figs. 5-8) from Venezuela, taken with numerous colonies of his new "*flavida.*"

All these species are, however, identical with Lamarck's variable and widespread *Gorgonia flavida*. The latter is briefly mentioned by Stiasny (1935b, p. 57), but he merely states that the spicules agree with Kükenthal's description and, as the latter, he places it in the genus *Plexaura*.

The result of this survey is that of all the species referred by Stiasny to the now defunct genus *Plexauropsis*, only two remain, namely, Milne Edwards' *humilis*, now *sulphurea* of Donovan, and Lamarck's *flavida*, and for these two forms the proper generic name must be found.

In 1931, Aurivillius established a new genus, *Muriceopsis*, to which *humilis* (*sulphurea*) belongs — in fact it ends up by being the type species — and this genus has now had its diagnosis emended so it also accommodates Lamarck's *flavida*.

Whether any member of the genus occurs outside the tropical Western Atlantic remains to be seen. Possibly some little known West African species may have to be included in the genus. Furthermore, the Museum of Comparative Zoology possesses a branch which hardly can be distinguished from the typical *flavida* from the West Indies, but which bears the label Mauritius (N. Pike). While the possibility of mislabelling is not excluded, it must, nevertheless, be remembered that in the case of the crustaceans several West Indian forms have been taken in Mauritius and Madagascar, so this disjointed distribution is not unique. The branch from Mauritius bears some similarity to Lamouroux' figure of *olivacea* from the Indian Ocean and may possibly be referred to that species.

MURICEOPSIS Aurivillius 1931 (emended)

Muriceopsis Aurivillius, 1931, p. 115.

Diagnosis. Colonies either low, bushy, with crooked branchlets or tall, feather-shaped with crowded, straight pinnulae. Polyps small, either completely retractile so the pores are flush with the surface, or they form low mounds or crescent-shaped lower lips. Spicules arranged in an inner layer of slender, pointed spindles with distant warts, yellow or purple in color, a middle layer of slender or stout spindles and an external layer of clubs or spindles with large, mostly flattened, spines on the external side. Polyps with a delicate operculum of flattened, warted rods, bent or straight. Color lemon yellow, buff or purple.

Type species. Gorgonia sulphurea Donovan 1825.

Remarks. Milne Edwards and Haime's name, *Eunicea humilis* 1857, has been most commonly used and that name takes in *Muriceopsis tuberculata* Aurivillius 1931, *nec Gorgonia tuberculata* Esper 1791.

Aurivillius selected, quite properly, what he considered to be Esper's *tuberculata* as the type, on the basis of some material from the West Indies which had been identified by Kölliker. However, Esper's species came from the Mediterranean and his figure (1791, pl. 37) agrees completely with a number of fans received from the Mediterranean in 1957 (in U.S.N.M.). These have been referred to *Eunicella lata* Kükenthal, but the clubs, 0.07 mm. long, are rather similar to those found in *Eunicella verrucosa* (Pallas) — from the same lot — hence *lata* possibly should be withdrawn as a synonym of Pallas' species. On the other hand, some of Esper's material — possibly that which was examined by Kölliker — may well have been a West African species, which is known to range from Congo to Cape Blanco, and possibly farther north. This species appears in several of Stiasny's papers, first as *Plexauropsis mauritaniensis*, but finally withdrawn by himself as a synonym of *Muriceides chuni* Kükenthal (see Stiasny 1951, p. 17). From the excellent figures which Stiasny has given, one has the impression that he is dealing with a form which externally is quite similar to Esper's *tuberculata*. As for the spicules, Stiasny indicates that some are deep yellow, often with purple center, and that purple spicules, including some red ones, occur scattered but do not form a continuous inner layer. We do not know whether Kölliker had any material of such a species, but he referred two colonies from St. Bartholomew Island, West Indies, to Esper's *tuberculata* and *gracilis* n. sp. Both colonies, in the Zoological Museum in Stockholm, were re-examined by Aurivillius, who considered *gracilis* a variety of *tuberculata*.

In this connection the question is of little importance since Aurivillius' "*tuberculata*" is based on specimens of what commonly has been called *Eunicea humilis* Milne Edwards and Haime, now *sulphurea* Donovan.

The three other species which Aurivillius lists as valid (in his key) are all synonyms of the type species (*Muricea bicolor* Wright and Studer 1889, *Muricea acropora* Verrill 1912, and *Eunicea humilis* Milne Edwards and Haime 1857).

As dubious species, he lists three. Of these *Muricea granulosa* Verrill (1870, p. 373, text fig. 4) came from Sherbro Island, West Africa; it has clumsy spindles and clubs, which are stated to be all yellow or white, with tendency to form flat spines with bi-lobed or tri-lobed ends; the largest spindles measure 0.69 mm., while the clubs measure 0.49 mm. From Verrill's description it looks as if the colony is fan-shaped and it may possibly represent a colony of *Muriceides chuni* Kükenthal in which no purple or red spicules were observed.

The second, *Muricea vatricosa* (Valenciennes) — not Esper, as Aurivillius writes — from Bissago Archipelago, West Africa, has coarser spicules; the spindles are up to 0.84 mm. long, the clubs 0.66 mm., and the slender spindles 0.72 mm. long. (Verrill's measurements [1870, p. 374] are based on material received from Kölliker, who lists the species [1865, p. 136]). Nothing is said about its outer form and its position is quite uncertain; it is not even mentioned by Kükenthal in 1924.

The third, *Muricea humosa* (Esper) (1794, p. 36, pl. 6, figure erroneously labelled "*placomus*"!) is stated to have come "most likely" from Curaçao. Its crumbling, earth-like tissue and its general shape suggest *Plexaura homomalla* (Pallas), a form not uncommon along the northern shores of South America. The spicules of *humosa* are — according to Kölliker — small, 0.44-0.67 mm. long, which fact agrees reasonably well with what one finds in *homomalla*, where the clubs and spindles have a tendency to form long, flat, narrow spines on the external side.

Key to the species accepted in the genus *Muriceopsis* Aurivillius 1931

Low, 10-20 cm. high, scrubby bushes, with crooked branchlets, strongly warted; polyps completely retractile, with minute pores, scattered over the surface. Inner layer slender, pointed rods with distant warts, about 0.35 mm. long; middle layer with heavy warted spindles, mostly 0.60 mm. long; outer layer clubs and spindles 0.25-0.35 mm. long with laciniated leaves on the external side. All spicules yellow or those in the inner layer purple.

Shallow water, coasts of Brazil, possibly in some localities farther north. (St. Bartholomew, Venezuela.) . . . . *Muriceopsis sulphurea* (Donovan)

Tall, up to 40 cm. high, feather-shaped colonies, often secondary feathers arising in the same plane; pinnulae 3-6 cm. long, crowded, not all in one plane; polyps with minute pores, rarely forming low warts or halfmoons. Inner layer slender, pointed rods averaging 0.27 mm. in length; middle layer mostly slender rods with distant warts, often slightly bent, mostly 0.3 mm. long, rarely up to 0.5 mm. long; outer layer clubs and spindles with tall spines on the external side, up to 0.40 mm. long. Spicules in inner layer purple; in middle and outer layer yellow, or partly or all purple. Shallow water, West Indies, possibly also Mauritius. . . . . *Muriceopsis flavida* (Lamarck)

MURICEOPSIS SULPHUREA (Donovan)
Plates 1, 3

Gorgonia sulphurea Donovan, 1825, p. 126, and a colored plate.

Eunicea humilis Milne Edwards and Haime, 1857, pp. 149-150, pl. B 2, fig. 1; Verrill, 1866-1871, p. 360, pl. 4, figs. 4, 4a-b; Kunze, 1916, p. 550 (not examined).

Muricea humilis and var. *humilis*, var. *mutans* and var. *macra* Verrill, 1912, pp. 377-379, pl. 29, figs. 1-1a, pl. 32, figs. 4-5, pl. 35, fig. 2, text fig. I.

Muriceopsis humilis Aurivillius, 1931, p. 115 (not examined).

Muricea acropora Verrill, 1912, p. 379, pl. 32, fig. 3, pl. 35, figs. 1, 1a.

Muriceopsis acropora Aurivillius, 1931, p. 115 (not examined).

Nec Eunicea mutica Duchassaing and Michelotti, 1860, p. 28, pl. 3, fig. 10; Gordon (*partim*) 1925, p. 17 (=*Plexaura flexuosa* Lamouroux 1816).

Nec E. humilis Stiasny, 1935b, p. 74, pl. 3, fig. 14, pl. 7, fig. 32, text fig. T (=*Plexaura flexuosa* Lamouroux 1816).

Eunicea citrina Valenciennes, 1855, p. 13.

Nec Gorgonia citrina Esper, 1794, p. 129, pl. 38 [=*Pterogorgia citrina* (Esper)].

Muricea bicolor Wright and Studer, 1889, p. 134, pl. 23, fig. 11, pl. 25, fig. 8; Verrill, 1912, p. 380 (not examined).

Muriceopsis bicolor Aurivillius, 1931, p. 115 (in key).

Plexauropsis bicolor, Stiasny, 1935b, p. 73.

Nec Plexauropsis bicolor Verrill, 1907, p. 265, pl. 33B, figs. 2b-c, pl. 35A, figs. 1-2; text fig. 149 [=*Pseudoplexaura crassa* (Ellis and Solander 1786].

Muricea tuberculata Kölliker, 1865, p. 136.

Nec Gorgonia tuberculata Esper, 1794, p. 137, pl. 37. [=*Eunicella* sp. (*partim*) and ? *Muriceides chuni* Kükenthal, 1919].

Muriceopsis tuberculata Aurivillius, 1931, p. 115.

Diagnosis. Low, scrubby colonies, 10-20 cm. high, with crooked branchlets, 3-5 mm. in diameter; surface knobby and the small pores mostly upwardly directed, toward the tip of the branchlets; sometimes a short, hook-like lower lip is formed. Branching dichotomously or loosely pinnately, with branchlets alternate or opposite, occasionally all developed from one side. Color bright yellow, whitish or pale buff.

Spicules in inner layer slender, pointed rods with distant warts, usually about 0.35 mm. long; in middle layer a varying number of moderately thick spindles, about 0.6 mm. long with composite warts of fairly uniform distribution and size; a few may be 0.7 mm. long. In some colonies this middle layer is weakly developed. Outer layer with large asymmetrical clubs and spindles with large irregular spines or laciniated leaves on the external side while the inner side has low, composite warts. The polyps have a weakly developed operculum of flat rods of which the largest are curved, with warts along the edge; length varying from 0.10-0.12 mm.

The spicules are either all yellow or those in the inner layer — and occasionally a few in the middle and outer layer — are purple.

Type. Possibly in some collection in England.

Type locality. "Brazilian Sea." Collected in numbers by Señor Ribello.

Distribution. Taken under various names in Bahia: *humilis, bicolor, acropora.* According to Verrill, common in Porto Seguro and ranging at least from Parahiba, N. of Pernambuco, to Guarapary in the South, that is, from about 7°S to 21°S latitude.

In addition, the species has been listed from San Bartholomew, W.I., by Kölliker and Aurivillius (same material), and from Curaçao (old material in Holland) by Stiasny. Both these non-Brazilian localities may possibly be wrong. At least the species has not been reported from north of Pernambuco in any recent collection.

Specimens examined. One fragment with purple inner spicules and no locality, probably from Kölliker (labelled no. 51 — not a M.C.Z. number). Twelve lots from Brazil: Murraio, Armaçao, Victoria, Guarapary, Porto Seguro, Bahia and "Brazil."

Remarks. Donovan's material is brilliantly sulphur-colored and, as the plate indicates, falls into two varieties: an elongate and a more scrubby one. It is not known whether the type of *humilis* lacked the purple inner spicules, but this was apparently assumed by Wright and Studer, who realized that their *bicolor* otherwise was almost identical with *humilis* (*sulphurea*). Verrill described, in 1912, the three varieties of *Muricea humilis* as having purple spicules in the inner layer, while his own species, *M. acropora,* has only yellow or white spicules.

The material in the Museum of Comparative Zoology lacks in all cases the purple spicules, except the old fragment, without locality, "no. 51" — in all likelihood received from either Kölliker or the Paris Museum. The material shows great variation in the size of the colonies as well as in the number of branchlets and their thickness. Here and there are found colonies with very slender branchlets, and in these the middle layer of thick spindles is poorly developed, as in *Muricea gracilis* of Kölliker (forma *gracilis* of Aurivillius) — perhaps the result of unfavorable ecological conditions.

MURICEOPSIS FLAVIDA (Lamarck)
Plate 4

Keratophyton Seba, 1734-1765, III, p. 198, pl. 107, fig. 8.

Gorgonia flavida Lamarck, 1815, p. 158; 1816, p. 318; 1836, p. 496; Lamouroux, 1816, p. 402; Dana, 1848, p. 664.

Plexaura flavida Valenciennes, 1855, p. 12; Milne Edwards and Haime, 1857, p. 153; Kölliker, 1865, p. 138, pl. 13, fig. 6 (cross-section of axis); Verrill, 1907, p. 138, pl. 36A, fig. 4 (table explanation to 35A), text fig. 148; Kükenthal, 1917, p. 335; 1924, p. 117; Moser, 1921, p. 114; Stiasny, 1935b, p. 57; 1951, p. 54.

Gorgonia spicifera Dana, 1848, p. 117.

Nec *Gorgonia spicifera* Lamouroux, 1821, p. 36, pl. 70, figs. 1-2. (=*Muricea spicifera*).

Plexauropsis flavida Stiasny, 1935a, p. 242; 1935b, p. 71, pl. 1, fig. 5, text fig. 8; 1942, p. 106, pl. 1, figs. 6-7; 1951, pp. 51, 56.

Plexauropsis puertorealis Stiasny, 1942, p. 107, pl. 1, figs. 7-8, text fig. B.

Plexauropsis sp. Stiasny, 1935b, p. 72.

? *Plexaura olivacea* Lamouroux, 1816, p. 431, pl. 16.

Diagnosis. Colonies tall, up to 40 cm., feather-shaped, often with secondary branches developing into new feathers, placed in the same plane as the original one. Pinnulae crowded, round, straight, 3-6 mm. long and about 3 mm. in diameter. Polyps numerous on all sides of the pinnulae usually completely retracted so only a fine pore is visible, as a pin-prick, rarely forming low warts; openings usually at right angles to the branchlet. Color of colonies varying from bright lemon-colored to buff or light to dark purple.

Spicules in inner layer slender, purple, spindles with distant warts, length about 0.27 mm. Middle layer with numerous, slender, spindles with similar armature of warts and often slightly curved or bent, length about 0.35 mm., rarely up to 0.50 mm. in length, and extremely rarely becoming stout. External layer clubs and spindles, with long spines on the external side and low, composite warts on the inner side; length up to 0.40 mm. Tentacles with delicate operculum of flattened rods, often curved and with marginal warts, length up to 0.20 mm., mostly around 0.13 mm. Spicules in middle and external layer yellow or purple or mixed; those in the operculum always colorless.

Type. Possibly in the Natural History Museum in Paris.

Type locality. "Antilles"; Seba's *Keratophyton* came from Nova Hispania (=Mexico).

Distribution. Seems to be not uncommon in the West Indian region, ranging from the coast of Venezuela, Mexico, Dominica, Tobago, Puerto Rico, Florida to the Bahamas. Some old records from Bermuda mentioned by Verrill are rejected, as the species has not been taken in that well-explored region during the last 50 years. Verrill's figures are based on spicules from a specimen from Dominica.

From Mauritius, the Museum of Comparative Zoology possesses a fragment, buff in color, with slightly more delicate spicules (Plate 5, figs. 25-34). It may possibly represent Lamouroux' *olivacea* from "Indes orientalis" (Plate 2). Wright and Studer have with some doubt placed the latter as a synonym of their *Euplexaura pinnata*, 1889 (p. 144, pl. 33, fig. 5), from Japan, 8 and 50 fathoms depth. From the figures given of the spicules, I doubt that their species is identical with the one from Mauritius. There is of course the possibility that the M.C.Z. specimen has had a locality label misplaced and merely represents the West Indies form. The spicules are figured here and it is hoped that future workers may be able to procure more material — from Mauritius or localities in the vicinity — and thereby settle the question.

Specimens examined. A total of 20 colonies or fragments from 11 different lots: Gulf of Mexico, Guadeloupe, Cuba, "Antilles" Tobago, Puerto Rico, Bahamas, Key West, Florida, Indian River, Florida, "Florida" and "W.I.", besides the branch from Mauritius.

Remarks. The species varies in color as well as in spicules, but it does not seem possible to separate the material into different groups. As far as color is concerned, those from the Caribbean region have all been dull brown or buff in color, as are the colonies of *Plexaura flexuosa* Lamouroux and *Antillogorgia acerosa* (Pallas), while in other parts of the West Indies both purple and yellow or buff colonies are found.

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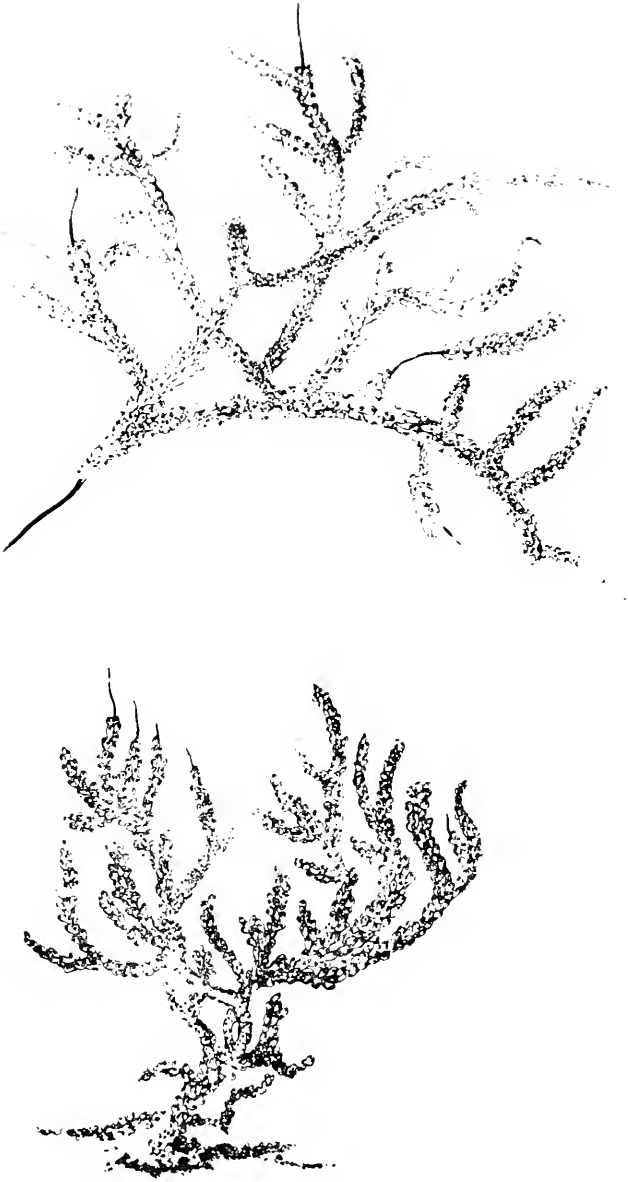

Plate 1

Muriceopsis sulphurea (Donovan), two colonies from Brazilian waters. Reproduction of Donovan's original plate.

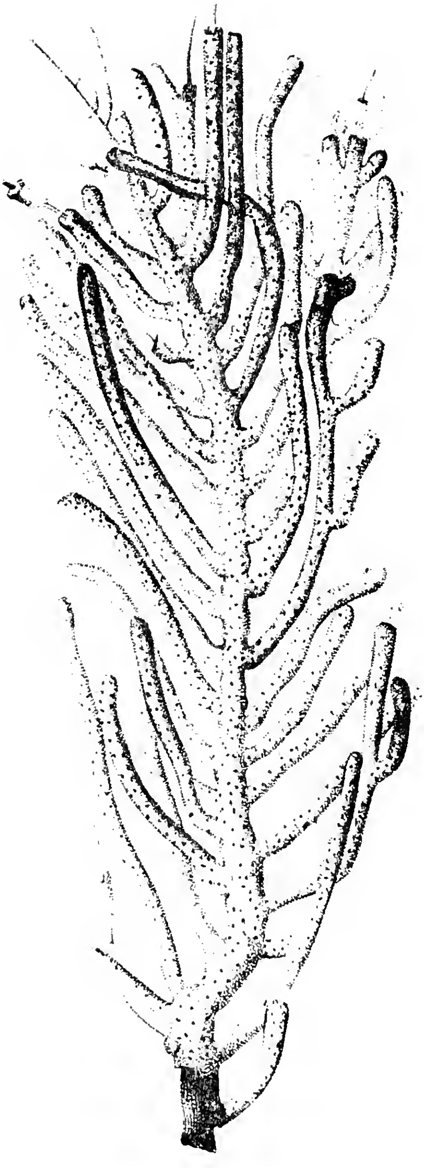

Plate 2

Muriceopsis olivacea (Lamouroux), a branch from "Ocean Indien." Reproduction of Lamouroux' original figure.

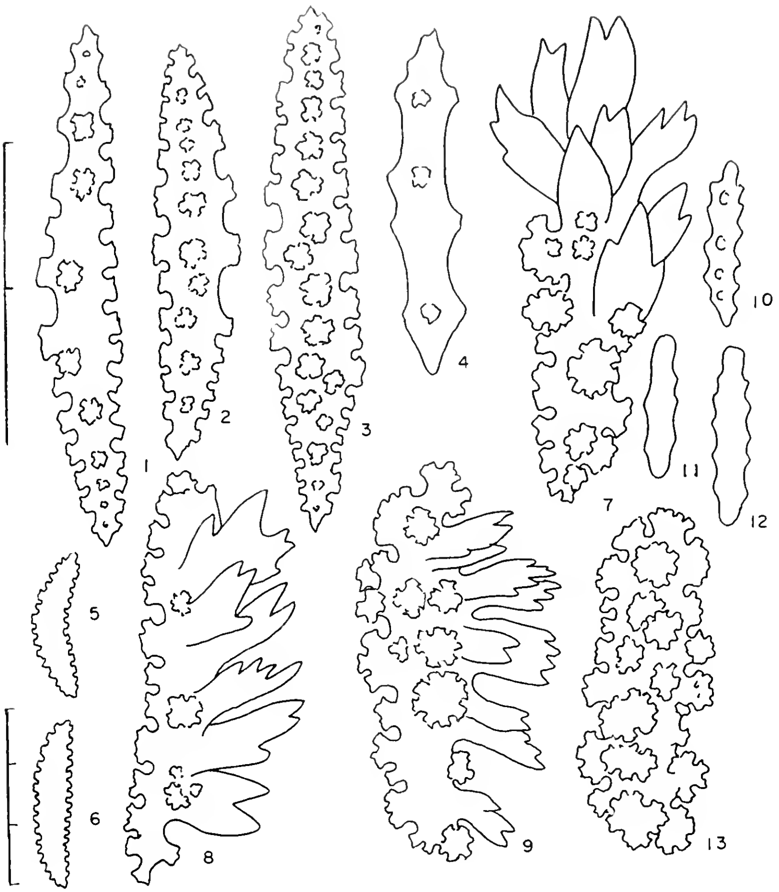

Plate 3

Muriceopsis sulphurea (Donovan), from Brazil; M.C.Z. material.

1-4. Spindles from the inner layer.
5-6. Spindles from the middle layer (low magnification).
7-9. Spicules from the external layer.
10-12. Rods from the tentacles.
13. Short warted rod from the middle layer.

All except 5-6 drawn with high magnification.
Division of scales 1/10 mm.

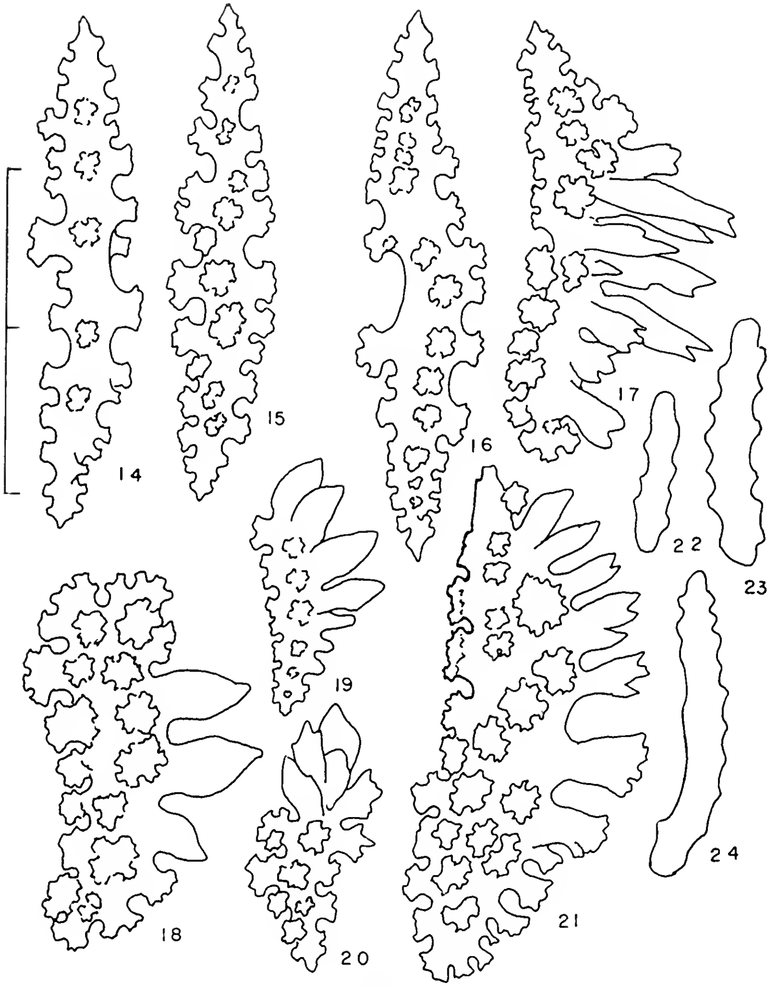

Plate 4

Muriceopsis flavida (Lamarck), from West Indies; M.C.Z. material.

14-16. Spindles from the inner layer.

17-21. Spicules from the external layer.

22-24. Rods from the tentacles.

All drawn with high magnification.

Division of scale 1/10 mm.

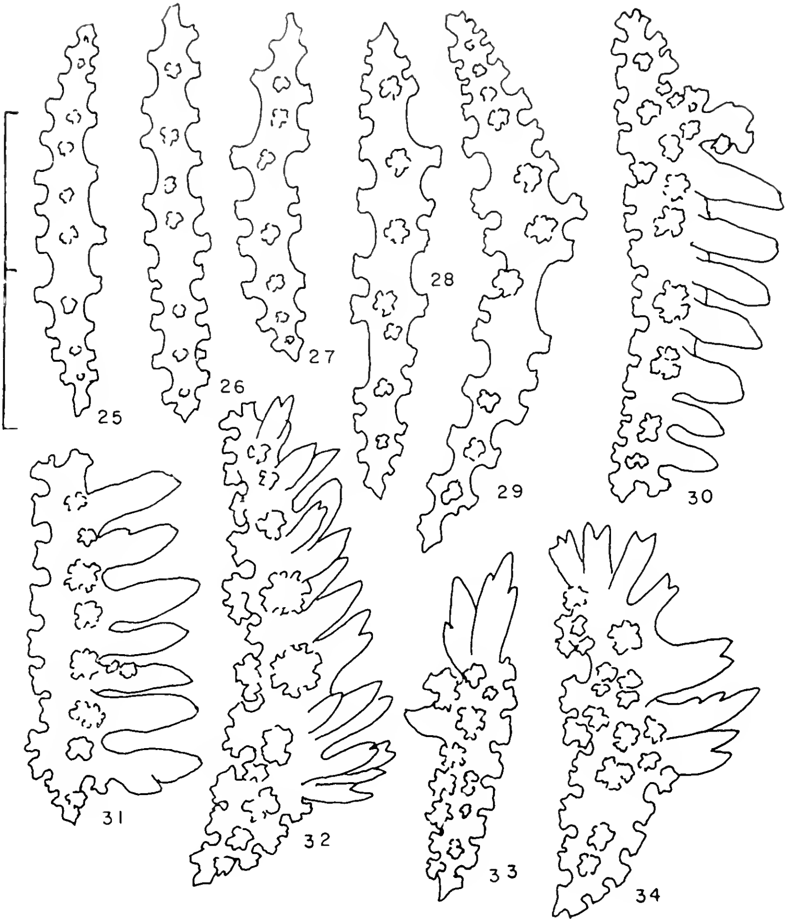

Plate 5

Muriceopsis flavida (Lamarck), from Mauritius (?); M.C.Z. material.

25-29. Spicules from the inner layer.

30-34. Spicules from the external layer.

All spicules drawn with high magnification.

Division of scale 1/10 mm.

BREVIORA

Museum of Comparative Zoology

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INSECTIVORES OF THE MIDDLE MIOCENE SPLIT ROCK LOCAL FAUNA, WYOMING

By Katherine Milmine Reed

During the years 1947, 1948 and 1951, field parties from the University of Wyoming, Amherst College, the Royal Ontario Museum, and the Chicago Natural History Museum made collections of a microfauna from the Middle Miocene Split Rock locality near Muddy Gap, Fremont County, Wyoming. The present paper is the third in a series dealing with this material. Black (1958), and Black and Wood (1956) have published on sicistine and mylagaulid rodents. Studies are in progress on the lagomorphs by Dr. Mary R. Dawson and on the reptiles by Dr. Walter Auffenberg. Mr. Craig C. Black is currently working on the rodents and carnivores. The collection includes both teeth and postcranial elements; I have not recognized any remains definitely referable to insectivores among the latter. A mole, a hedgehog and a shrew are present in the fauna, the former two represented by numerous isolated teeth, the latter by one incomplete ramus. The scarcity of shrews in so large a collection is surprising.

Material for this study was made available by Amherst College, the University of Wyoming, the Royal Ontario Museum and the Chicago Natural History Museum, to all of which I am grateful. I wish to express my thanks to Professor Bryan Patterson for his suggestion that this work be undertaken and to him and to Mr. Black and Mr. Clayton E. Ray for help and advice during the study. I am indebted to Dr. R. A. Stirton for the loan of the type of *Metechinus nevadensis*, to the American Museum of Natural History for specimens of *Proscalops*, and to the Chicago Natural History Museum for the type of *Metechinus*

marslandensis. My thanks are also due to the Mammal Department of the Museum of Comparative Zoology for access to Recent talpid and erinaceid material. I am very grateful to Dr. H. B. Whittington for his generous assistance with the photography of the specimens.

The following abbreviations are used:

A.C.M. — Amherst College Museum
C.N.H.M. — Chicago Natural History Museum
R.O.M. — Royal Ontario Museum
U.C.M.P. — University of California Museum of Paleontology
U.W. — University of Wyoming

Family TALPIDAE
Subfamily SCALOPINAE
MESOSCALOPS[1] new genus

Type species. Mesoscalops scopelotemos, new species.

Diagnosis. In general, similar to *Proscalops* but differing as follows: protocone of upper molars more rounded and somewhat larger than hypocone, situated nearly directly internal to paracone, imparting a square appearance to outline of teeth; P^4 with lingual face faintly grooved and with wide lingual shelf; lower molars with small median cingulum just above gum line between hypo- and protoconids; talonid of M_1 wider than trigonid.

MESOSCALOPS SCOPELOTEMOS new species

Type. A.C.M. No. 10461, isolated left M^1.

Hypodigm. Type and A.C.M. Nos. 10483-10499, 10503-10522, 10456-10459, 11322-11324, 11304-11414, 11326-11328, 11420-11426, 11431-11433; U. W. No. 1074; R.O.M. No. 2077, C.N.H.M. Nos. PM 2125-2129, 2136-2159. These numbers include numerous isolated specimens of right and left P^4-M^3 and M_{1-3}.

Horizon and locality. Middle Miocene; NW$\frac{1}{4}$, Sec. 36, T29N, R90W, Fremont County, Wyoming, from the vicinity of the *Brachyerus* quarry (Schultz and Falkenbach, 1940, p. 251), seven miles west of Muddy Gap filling station, in a draw about $\frac{1}{4}$ mile south of U.S. highway 287.

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[1] The generic name is given in reference to the Middle Tertiary age of the genus.

Diagnosis. As for the genus. For measurements see Table 1.

Description. P^4 consists of a blade-like paracone with a metastylar area and a lingual cusp in the form of a wide shelf. Some specimens show a partial division of the lingual cusp into two cuspules, and several also show some irregularities on the inner margin. One tooth has a very small accessory cuspule on the posterior side of the labial cusp. There is usually a faint groove running down the lingual face of the tooth, and when the lingual cusp is divided, this groove runs between the cuspules (Pl. 1, fig. 1). M^1 is as described in the generic diagnosis above. Two unworn specimens show a small metastyle. An accessory cuspule is often found at the base of the anterior face of the tooth, which, when the tooth is worn, forms an irregularity in the outline. The size of this cuspule varies, and it is not present in some specimens (Pl. 1, figs. 2, 3, 4). M^2 exhibits the same general size relationships of hypocone and metacone as does M^1, and both this tooth and M^1 show no pinching, such as is seen in *Proscalops miocaenus*, in the unworn protocone; with wear, however, the pinched shape becomes noticeable. M^2 is more nearly quadrate than M^1, the antero-posterior and transverse dimension being nearly equal. Both metacone and paracone are distinctly V-shaped in M^2, whereas in M^1 only the former has this shape. The paracone of M^2 is slightly the larger of the two. There is a small notch between the cusps on the labial side of the tooth. The valley between the arms of the metacone opens externally nearer the mid-line of the tooth than in M^1, due to the presence of an anteriorly-curving projection from the posterior arm of the metacone; this projection is, however, variable and not always present (Pl. 1, fig. 5). In M^3, the protocone is much larger than the hypocone, the latter being rudimentary and assuming a variety of shapes. The paracone is larger than the metacone, which is simply an oblique blade across the posterior border of the tooth. The two cusps are separated by a labial notch. The protocone is situated almost directly lingual to the paracone. M^3 is less quadrate than M^1 or M^2, but is, nevertheless, not triangular in contour. Between the arms of the paracone on the labial side there may be irregularities in the enamel in the form of swellings that are variable in size and number. M^3 is the smallest of the upper molars (Pl. 1, fig. 6). All the upper molars have two short, slender, labial roots and one stout lingual root.

In M_1 the talonid is wider than the trigonid. The protoconid is the highest cusp and the hypoconid next in prominence. The paraconid is widely divergent from the metaconid. The hypoconulid is small and posterior to the entoconid and at the inner end of the low posterior cingulum as is usual in dilambdodont teeth. The crest between the hypo- and entoconid shows some variation; it may not be continuous and may bear a swelling in the enamel midway between the cusps. There is also variable development of a small anterior cingulum, which appears in the majority of specimens; at most this is a very narrow median shelf that slopes downward labially. All lower molars have a small basal cingulum between the hypoconid and the protoconid (Pl. 2, fig. 1). The trigonid and the talonid are nearly equal in width. The protoconid is generally but not invariably higher than the hypoconid. Metaconid and paraconid are much less divergent than in M_1. There is an accessory cuspule, formed by the anterior cingulum and the base of the paraconid. The metaconid in unworn specimens shows a rudimentary metastylid which is not continuous with the crest from metaconid to hypoconid. M_2 is similar to M_1 in length (Pl. 2, fig. 2). In M_3, the trigonid is wider than the talonid; the basin of the latter opens anteriorly. The protoconid is the highest cusp. There is an anterior cingulum and accessory cuspule as in M_2. M_3 is the smallest of the lower molars (Pl. 2, fig. 3).

Discussion. Mesoscalops appears to be related to and is probably derived from *Proscalops.* A study of the *Proscalops* group of talpids, based partly on new material accumulated since Matthew's work (1901, 1909), will be presented in a forthcoming paper.

Family ERINACEIDAE

Subfamily ECHINOSORICINAE

METECHINUS Matthew 1929

METECHINUS MARSLANDENSIS Meade 1941

In addition to isolated teeth that are similar in every respect to those preserved in the type, there are numerous, certainly conspecific, teeth that considerably enlarge our knowledge of the dentition of this species.

Type. C.N.H.M. No. P 26399, incomplete left mandible with M_1 and M_2.

Hypodigm. Type and A.C.M. Nos. 10459-10460, 10462 10482, 11325, 11315-11321, 11427-11430; R.O.M. Nos. 2078, 2079; U.W. Nos. 1072, 1073, 1075; C.N.H.M. Nos. PM 2130-2135, 2108-2124. These numbers include numerous isolated specimens of P^4-M^2 and M_{1-2}.

Horizon and locality. As for *Mesoscalops scopelotemos*, above.

Emended diagnosis. P^4 and molars as in *M. nevadensis*, differing as follows: slight re-entrant between hyocone and metacone in M^1; hypocone rather well separated from U-shaped crest joining metacone and paracone; labial cusps of P^4 subequal in size. Lower molars as determined by Meade (1941, p. 43): "Talonid and trigonid on M_{1-2} of equal width . . . Hypoconid of M_1 less elongated antero-posteriorly and higher than in *M. nevadensis.* M_2 proportionately smaller and with trigonid slightly longer antero-posteriorly than in *M. nevadensis.*"

For measurements, see Table II.

Description. The specimens of M_1 agree closely with the type. Meade has stated that the hypoconulid of M_1 is an "inconspicuous eminence": in at least four of the less worn specimens there is a distinct protuberance in the position of the hypoconulid. It is best developed on the larger specimens but is easily seen on others as well. I was unable to find a specimen in which the antero-posterior dimension was as large as that given by Meade, namely, 4.6 mm. Indeed, I was unable to duplicate his measurements on the type. From the anterior edge of the paraconid to a point between the hypoconid and the entoconid, I get a measurement of 3.8 mm. Measuring from the paraconid to the postero-external edge of the entoconid, the dimension is still only 3.9 mm. Among 25 specimens, the greatest length obtained was 4.0 mm. There is nothing to add to Meade's description of M_2. In this material, as in the type specimen and in *M. nevadensis*, there is no trace of M^3_3.

In the upper dentition, P^4 is three-rooted, with one lingual and two labial roots. The posterior labial root is the stoutest. The paracone and metacone are laterally compressed, equal in height and form a very broad V. The lingual part of the tooth is in the form of a shelf that may extend slightly antero-internal to the paracone. This shelf bears two cuspules, one situated on the anterior edge, the other and larger at about the mid-line of the tooth. This cuspule development shows variation and does not seem to be of taxonomic importance. The shelf widens posteriorly and there are slight re-entrants where it joins the paracone and metacone (Pl. 2, fig. 4). In M^1 the metacone is more internally situated than the paracone, with a crest running from it postero-externally. There is a small parastyle. The protocone is situated on the lingual side of a U-shaped crest running from a point below the center of the metacone to the antero-internal side of the paracone. There is a small protoconule that varies in the degree of development. The hypocone is more externally situated than the protocone and is connected to the metastyle by a short, antero-externally directed spur (Pl. 2, fig. 5). M^2 is triangular in shape and consists of three main cusps, probably the para-, proto- and hypocones. There is a small parastyle situated directly external to the paracone and a very small cingulum running along the posterior edge of the tooth for about half its length.

There are numerous antemolar teeth, largely premolars, but I am uncertain as to their position and accordingly omit description.

Discussion. This new material, although from a higher horizon, supports Meade's reference of the species to the genus *Metechinus.* The upper teeth show only minor differences as compared with *M. nevadensis;* the major difference is the size, *M. nevadensis* being half again as large as the earlier form. Other differences are the slightly wider, relatively speaking, lingual cusp of P^4, the smaller metastyle and the degree of separation from the U-shaped crest in M^1 mentioned above. M^2 differs in the shift to the posterior of the exterior (stylar) cusp in *M. marslandensis.*

Family SORICIDAE
LIMNOECUS Stirton 1930
LIMNOECUS ? sp.

Referred specimen. C.N.H.M. PM 2167, incomplete left ramus with M_1 and partial M_2, both badly worn.

Horizon and locality. As for *Mesoscalops scopelotemos*, above.

Description. The trigonid of M_1 is narrower than the talonid. There is a very small anterior cingulum which widens slightly to the exterior. A minute posterior cingulum is also present. There is a small swelling in the talonid at the position of the entoconid.[2] The remnant of M_2 shows a larger anterior cingulum and suggests that the trigonid of the tooth is wider than the trigonid of M_1. The trigonid and talonid valleys open antero-internally. A foramen is present below the anterior root of M_1. Examination of the specimen in ultra-violet light showed no traces of pigmentation which is in agreement with the findings of MacDonald (1947).

Measurements: in millimeters	a-p	trig.	tal.	
Limnoecus ? sp.	1.3	0.8	0.9	
L. niobrarensis	1.1	0.50	0.78	U.C.M.P. 36172
	1.1	0.75	0.82	U.C.M.P. 36171
L. tricuspis	1.0	0.62	0.69	U.C.M.P. 31047

The last three measurements are from figures given by MacDonald (1947) and Stirton (1930).

Discussion. The specimen is tentatively referred to this genus because of the agreement in size and what can be seen of the structure, in particular the cingula. It is closer to *L. niobrarensis* than to *L. tricuspis*. It is unlikely on a size basis that the specimen should be referred to *Mystipterus*. Because of its poor condition, the specimen has not been figured.

TABLE I

Measurements of cheek teeth of *Mesoscalops scopelotemos*, in millimeters

Tooth		N.	Range	Mean	S.D.	V.
P^4 left,	a-p	7	2.65-2.1	2.23	.221	
	trans.		1.9-1.55	1.8	.119	
P^4 right,	a-p	17	2.7-2.05	2.24±.03	.199±.03	8.8±1.5
	trans.		2.1-1.75	1.92±.02	.079±.01	4.1±.7

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[2] Following the terminology of Patterson and McGrew (1937).

TABLE 1 (Continued)

Tooth		N.	Range	Mean	S.D.	V.
M^1 left,	a-p	21	3.35-2.45	2.80±.04	.191±.02	6.8±1.0
	trans.		2.9-2.25	2.42±.03	.144±.02	5.9±.9
M^1 right,	a-p	6	3.2-2.7	2.96	.197	
	trans.		2.8-2.25	2.49	.171	
M^2 left,	a-p	8	2.62-2.2	2.41	.111	
	trans.		2.45-2.25	2.33	.062	
M^2 right,	a-p	10	2.65-2.2	2.47±.03	.116±.02	4.7±.1
	trans.		2.6-2.0	2.49±.05	.180±.03	7.2±1.8
M^3 left,	a-p	9	2.5-2.15	2.30	.125	
	trans.		2.0-1.6	1.85	.148	
M^3 right,	a-p	8	2.6-2.0	2.21	.186	
	trans.		1.95-1.8	1.81	.083	
M_1 left,	a-p	27	3.1-2.55	2.81±.02	.115±.01	4.0±.5
	trig.		2.0-1.5	1.73±.02	.136±.01	7.3±.9
	tal.		2.2-1.6	2.03±.03	.130±0.1	6.4±.8
M_1 right,	a-p	27	2.95-2.5	2.71±.02	.133±.01	4.9±.6
	trig.		2.05-1.55	1.70±.01	.095±.01	5.5±.7
	tal.		2.25-1.65	2.07±.02	.150±.02	7.2±.9
M_2 left,	a-p	12	3.05-2.5	2.75±.04	.140±.02	5.0±1.0
	trig.		2.1-1.55	2.01±.05	.186±.03	9.2±1.8
	tal.		2.2-1.7	1.93±.04	.145±.02	7.5±1.5
M_2 right,	a-p	13	2.9-2.45	2.65±.03	.126±.02	4.7±.9
	trig.		2.2-1.7	1.95±.03	.122±.02	6.2±1.2
	tal.		2.2-1.8	1.95±.04	.152±.02	7.7±1.5
M_3 left,	a-p	9	2.4-2.0	2.15	.122	
	trig.		1.6-1.3	1.45	.091	
	tal.		1.4-1.0	1.17	.155	
M_3 right,	a-p	9	2.25-1.9	2.07	.133	
	trig.		1.5-1.35	1.42	.056	
	tal.		1.25-.85	1.01	.140	

a-p = antero-posterior dimension
trans. = transverse dimension
trig. = transverse dimension of trigonid
tal. = transverse dimension of talonid

TABLE II

Measurements of cheek teeth of *Metechinus marslandensis*, in millimeters

Tooth		N.	Range	Mean	S.D.	V.
P^4 left,	a-p	9	3.2-2.8	3.02	.133	
	trans.		2.5-2.05	2.30	.089	
P^4 right,	a-p	8	3.5-2.6	3.04	.21	
	trans.		2.5-2.15	2.31	.098	
M^1 left,	a-p	12	3.05-2.8	2.9±.05	.179±.03	6.1±.12
	trans.		3.55-3.1	3.31±.04	.143±.03	4.3±.8
M^1 right,	a-p	10	3.05-2.7	2.92±.1	.319±.07	10.2±2.2
	trans.		3.7-2.5	3.29±.08	.264±.05	8.0±1.7
M^2 left,	a-p	9	2.05-1.55	1.86	.160	
	trans.		2.4-2.15	2.19	.125	
	pa-hyc		2.4-2.1	2.29	.131	
M^2 right,	a-p	7	2.5-1.6	1.86	.171	
	trans.		2.5-2.15	2.29	.156	
	pa-hyc		2.55-2.05	2.29	.208	
M_1 left,	a-p	19	4.0-3.2	3.70±.06	.27±.04	7.3±1.2
	trig.		1.95-1.6	1.80±.00	.016±.00	8.8±1.4
	tal.		2.0-1.6	1.85±.04	.13±.02	7.0±1.1
M_1 right,	a-p	4	3.85-3.4	3.64	.217	
	trig.		1.9-1.8	1.85	.057	
	tal.		2.0-1.8	1.88	.24	
M_2 left,	a-p	11	2.7-2.25	2.53±.04	.134±.02	5.2±1.1
	trig.		1.55-1.3	1.46±.02	.076±.01	5.2±1.1
	tal.		1.5-1.05	1.28±.04	.164±.03	12.8±2.7
M_2 right,	a-p	11	2.7-2.1	2.45±.06	.177±.03	7.2±1.8
	trig.		1.6-1.1	1.42±.03	.26±.02	8.8±1.9
	tal.		1.4-0.9	1.19±.04	.141±.03	11.8±2.5

Measurements of cheek teeth of *M. nevadensis* (Matthew, 1929), in millimeters

Tooth	Dimension
P^4, a-p	4.5
trans.	4.2
M^1, a-p	3.9
trans.	5.05
M^2, a-p	2.7

TABLE II (Continued)

Tooth	Dimension
trans.	3.7
M_1, a-p	5.3
trans.	2.7
M_2, a-p	3.6
trans.	2.2

a-p = antero-posterior dimension
trans. = transverse dimension
trig. = transverse dimension of trigonid
tal. = transverse dimension of talonid
pa-hyc = paracone-hypocone dimension

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Plate 1

Stereoscopic photographs

Fig. 1. *Mesoscalops scopelotemos*, P^4 left, A.C.M. No. 10456, crown view.

Fig. 2. *Mesoscalops scopelotemos*, M^1 left, A.C.M. No. 10461, crown view.

Fig. 3. *Mesoscalops scopelotemos*, M^1 left, A.C.M. No. 11323, crown view.

Fig. 4. *Mesoscalops scopelotemos*, M^1 right, C.N.H.M. No. PM 2127, crown view.

Fig. 5. *Mesoscalops scopelotemos*, M^2 left, A.C.M. No. 10458, crown view.

Fig. 6. *Mesoscalops scopelotemos*, M^3 left, C.N.H.M. No. PM 2126, crown view.

In all figures, the exterior is to the top of the figure. All x10.

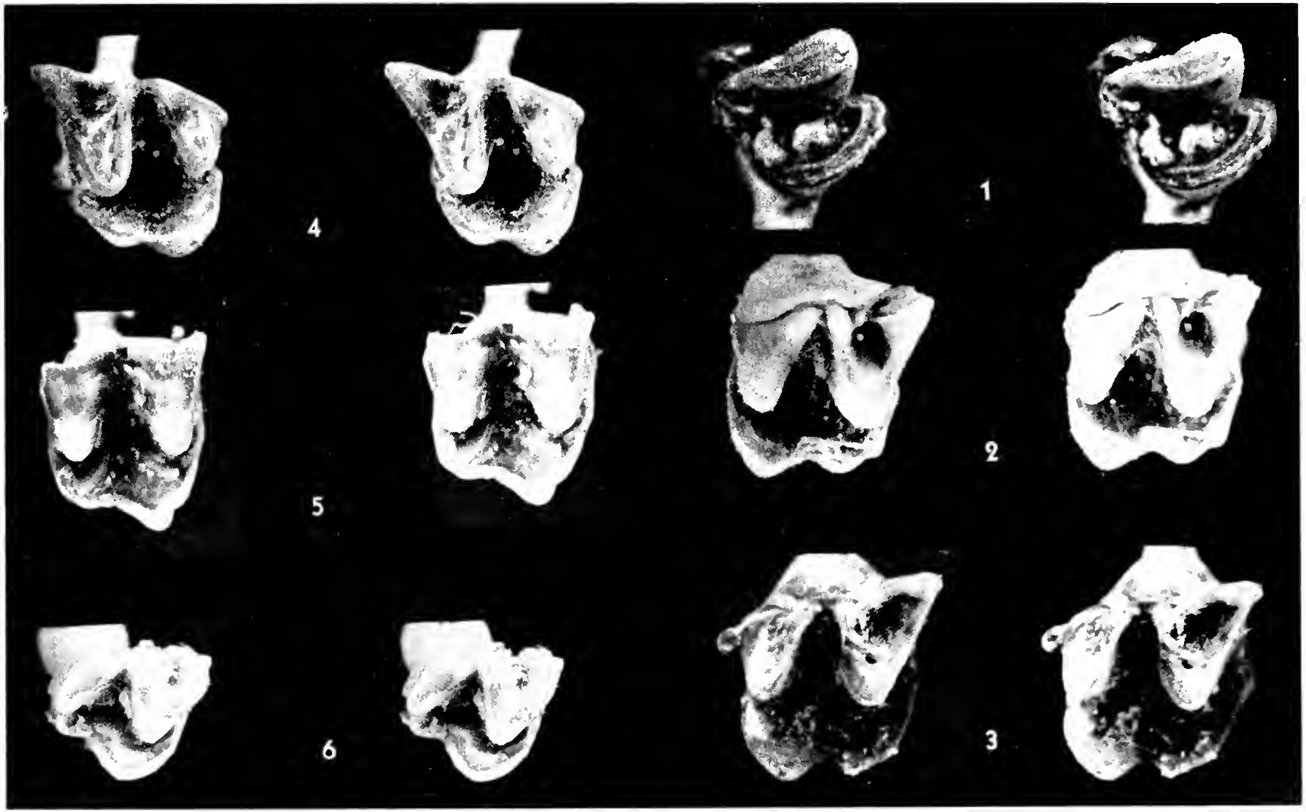

Plate 1

Plate 2

Stereoscopic photographs

Fig. 1. *Mesoscalops scopelotemos*, M_1 left, A.C.M. No. 11431, lingual view.

Fig. 2. *Mesoscalops scopelotemos*, M_2 right, A.C.M. No. 11322, lingual view.

Fig. 3. *Mesoscalops scopelotemos*, M_3 left, C.N.H.M. No. PM 2128, lingual view.

Fig. 4. *Metechinus marslandensis*, P^4 left, C.N.H.M. No. PM 2130, crown view.

Fig. 5. *Metechinus marslandensis*, M^1 left, C.N.H.M. No. PM 2133, crown view.

Fig. 6. *Metechinus marslandensis*, M^2 right, U.W. No. 1074, crown view.

In Figures 4, 5, 6, the exterior is to the top of the figure. All x10.

Plate 2

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. January 20, 1960 Number 117

NOTES ON HISPANIOLAN HERPETOLOGY
1. *ANOLIS CHRISTOPHEI*, NEW SPECIES, FROM THE CITADEL OF KING CHRISTOPHE, HAITI

By Ernest E. Williams

Re-examination of the three specimens on the basis of which Cochran (1928 and 1941) postulated the existence of *Anolis coelestinus* in the north of Haiti near Cap Haitien has revealed that one of them (MCZ 25485) represents an undescribed species. (The other two are also not *A. coelestinus* and will be discussed at another time.)

The specimen in question is poorly preserved and was, when first examined, soft-bodied and much contorted. It has now been straightened and hardened in 90 per cent alcohol.

A majority of the scale characters usually employed in the identification of anoles do indeed appear to ally MCZ 25485, a juvenile ♀, with *A. coelestinus*.

It has smooth ventrals, somewhat squarish, juxtaposed, arranged in transverse rows, larger than the dorsal and flank scales which are relatively coarse and nearly homogeneous. The scales of two middorsal rows are very slightly larger than the adjacent scales. There are multiple keels on the scales of limbs and digits. The number of loreal rows and of rows between the supraorbital semicircles, as well as the number of rows between interparietal (pineal) scale and the supraorbital semicircles fall within the known range of *A. coelestinus*. As in the latter, the scales on the snout are small and numerous.

However, there are several features of the specimen that are difficult to reconcile with its identification as *coelestinus*.

1. *Its locality:* The Citadel of King Christophe near Cap Haitien is very remote from any other mainland record of

coelestinus, a species characteristic of the Cul-de-sac plain and Tiburon and Barahona peninsulas.

2. *Its color:* MCZ 25485 has an elaborate pattern well described by Miss Cochran (1941, p. 179). A number of specimens of undoubted *coelestinus* of similar or smaller size are available which show no trace of such a complex pattern.

3. *The digital dilations:* In the specimen these are conspicuously narrower than in typical specimens of *A. coelestinus*. The lamellae under the fourth toe are also fewer: about 19 under the second and third phalanges, (as compared with 27 in *coelestinus*), about 32 under the whole toe (as compared with 47 in *coelestinus*).

The last feature is crucial. The locality might be valid, and only appear anomalous because of insufficient collecting in the intervening area. The color also might be explained by the chance preservation of one phase in the repertoire of color changes possible in the species. However, the narrowness of the digital dilations suggested that it might not even be a member of the arboreal *chlorocyanus* group, that it might instead be a ground anole or spend a large part of its time on the ground.

The specimen was therefore subjected to very careful examination and direct comparison with *chlorocyanus* and *coelestinus* and other Hispaniolan forms. It proved to differ from all of them in a combination of significant features and seems not to be identical with any known species of anole. A specimen from the unidentified Hispaniolan collection of the American Museum of Natural History from the same locality proves to belong to the same species, which because of its occurrence in the vicinity of the famous Citadel built at the command of Henri Christophe is named:

ANOLIS CHRISTOPHEI new species

Type. MCZ 25485, ♀

Type locality. "At or near the Citadel of King Christophe, Cap Haitien, Haiti."

Collector. W. S. Eyerdam, 4. x. 1927.

Paratype. AMNH 49736, same locality, collected by W. G. Hassler 16. vi. 1935, ♀

DIAGNOSIS. An *Anolis* resembling *Anolis coelestinus* in many of its scale characters, but differing in the following: narrower digital dilations and fewer lamellae under fourth toe; the longer legs; the presence of a distinct frontal depression; a pattern of canthal scales with the anterior four or five abruptly smaller than the posterior two or three; a long rather than a wide mental; larger sublabials; in the continuation of strongly enlarged scales of the subocular series behind the eye and in a complex color pattern of bands and lines.

DESCRIPTION. *Head:* Head scales mostly smooth, a few feebly or bluntly unicarinate; about 10 scales across snout at level of second and third canthals. A moderate frontal depression, the scales in the depression relatively small and numerous.

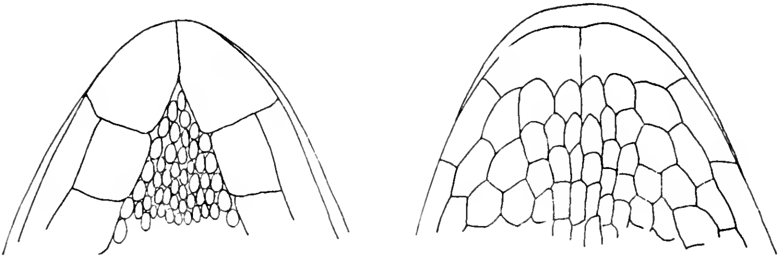

Fig. 1. Mental and neighboring scales. Left, ***Anolis christophei*** **n. sp.**; right, *Anolis coelestinus*.

Supraorbital semicircles separated from one another by one scale and from the supraocular disks by 1-2 rows of granules. Supraocular disks consisting of about 9 to 11 keeled scales which are separated from the elongate supraciliaries by at least three rows of granules. Canthus low, canthal scales seven, the anterior four or five abruptly smaller than the posterior two or three. Loreal rows 6-7. Temporal scales granular, as small as the scales of the lower flanks, not bounded dorsally by any well-marked supratemporal line of larger scales. Supratemporal scales granular, grading into larger scales surrounding the interparietal. Interparietal scale smaller than ear opening, separated from supraorbital semicircles by 5-6 slightly enlarged scales, in contact posteriorly with granules like those of the dorsum.

Posterior frontal small, about one-third the size of the anterior supraorbital. Two scales as large or larger than the posterior frontal between the latter and the canthals.

Suboculars separated from supralabials by a single row of scales. One scale intervening between subocular series and canthal row. Six to seven supralabials to the center of the eye.

Mentals longer than wide, 2-4 scales inserted between the tips posteriorly. One sublabial on each side in contact with infralabials. Central throat scales granular, rounded.

Trunk: Middorsal scales granular, not keeled, hardly larger than the flank scales into which they grade very gradually. Ventrals in transverse rows, larger than dorsals, squarish, smooth, juxtaposed.

Limbs and digits: Hand and foot scales multicarinate, about 19 lamellae under phalanges 2 and 3 of fourth toe, about 32 under whole toe. Scales of anterior upper arm smaller than ventrals, unicarinate. Lower arm scales about as large as ventrals, tricarinate. Anterior thigh scales and lower leg scales about as large as ventrals, unicarinate.

Tail: Tail subcircular in section; verticils distinct, surmounted by 6 keeled scales, very slightly larger than the lateral caudal scales; ventrally four keeled still larger scales per verticil.

Size: Type ♀ 44 mm. Paratype ♀ 39 mm.

Color: The paratype was preserved too long in formaldehyde and is a uniform dingy brown. The pattern of the type was well described by Doris Cochran (1941), whose observations may be quoted in full: "Above mottled with dark gray and sepia; a light dorsal line with diamond-shaped dark brown patches approaching it from the side at intervals and set off by light posterior margins; a dark scalloped band on the nape of the neck with a very definite dark posterior margin which is further accented by a pale tan area directly following it; a butterfly-shaped dark spot across the occipital region; two dark bands across the supraorbital region; top and sides of snout marbled with dark and light; a wide light gray stripe leaving posterior border of ear and continuing about halfway to shoulder, at which point it abruptly ends; a light stripe issuing from beneath this ending continues above the shoulders and fades out gradually behind the axilla; limbs marbled with tan and brown; tail dark gray above, rather uniform; under surfaces of arms, legs and tail pale yellowish white, throat with pale brown reticulations over it; belly light blue green, highly iridescent; heavy brown marblings all over lower labials and sides of chin; center of throat with two pale brown stripes marking off each side of where the gular fan will develop."

Relationships: I have provided tables of the condition in Hispaniolan species of the most commonly used scale characters of anolines in order to provide a conspectus of the genus and its close relatives in this island. I have added in the final column of the table one or two special or unique diagnostic characters for each species or species group. It should be evident from this table that the resemblances of *A. christophei* to *coelestinus* are not greater than its resemblances in some respects to other forms. The complex pattern of the type is somewhat like that of juvenile *cybotes* but there is again no sufficient warrant for inferring special relationship, since *christophei* differs sharply from *cybotes* in its squarish rather than cycloid ventrals, slenderer head, and in having the middorsals not enlarged. The elongate mentals of *christophei* are quite distinctive as compared with *coelestinus* but similar to those of *distichus,* which also has the ventrals squarish and arranged in transverse rows, but the new species clearly differs from *distichus* in the longer head and in the absence of the two parallel rows of scales on the front, in the number of scales between parietal and semicircles, etc.

From the other Hispanolian species with ventrals arranged in transverse rows the new species differs in much the way it differs from *coelestinus,* or in other features as well. Further speculation on its relationships seems unwarranted with only two female specimens at hand and no knowledge of the species in life.

Acknowledgments: I am grateful to Mr. Charles M. Bogert for the privilege of studying the unidentified Hispaniolan collections in the American Museum of Natural History. Miss Margaret Estey made the sketches for Figure 1. Mr. A. Stanley Rand made a number of measurements and counts that have only partly been used here.

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	S V length adult ♂	lamellae 4th toe	canthals	loreals	labials to center of eye
Anolis					
ricordii	137	33	3+	4-8	9
semilineatus	38	20	4	4-5	5-6
olssoni	40	20	4	3-5	6
distichus	51	20	4	4	5-6
cybotes	67	20	3	4-10	7
armouri	46	18	3-4	4-6	6-7
shrevi	58	17	3	6	6-7
monticola	40	17	5	7-9	7
darlingtoni	42	14	5	6	6
chloracyanus	71	29	4	3	7-8
coelestinus	64	28	6	5	8-9
christophei	(44)*	19	7=4(+3)	6-7	6-7
hendersoni	46	21	6	6-7	6
bahaorucoensis	46	19	7	7	6-7
Xiphocercus					
darlingtoni	75	23	4-5	2-3	7
Chamaelinorops					
wetmorei	26	ca. 11	2	4	9

No adult ♂ available.

Table 1: Comparison of certain characters in Hispaniolan anolines. Data mostly from Cochran (1941). Where a single number is given, this is to be considered the mode around which variation is to be expected. Extreme variants are usually not listed. Lamellae under fourth toe are counted under phalanges II and III only.

	scales between semi-circles	inter-parietal from semi-circles	middorsal rows enlarged	ventrals	
Anolis					
ricordii	2-4	3-6	1	s(i)t	plates + granules on flanks
semilineatus	1-2	1-3	10	ki	(a dorsal zone of enlarged keeled scales
olssoni	1	2-3	10	ki	*ca* = ventrals)
distichus	0	0-1	0	si(sq)t	(snout with 2 parallel rows of squarish scales)
cybotes	0	2-3	2	si(cy)	head large, body stocky
armouri	0-1	2	(2)	si(cy)	(a strong transverse neck- fold in addition to a
shrevei	1	2	5-6	ki	longitudinal fold)
monticola	3	4	2-4	ki t	(middorsals swollen, tubercular, keeled)
darlingtoni	3	3-4	0	si(sq)t	digital lamellae very reduced
chlorocyanus	1	2	0	si(sq)t	(green tree anoles with short legs)
coelestinus	2	4	0	si(sq)t	
christophei	1	5-6	0	s (sq)t	(mental elongate (fig. 1) + narrow digital dilations)
hendersoni	1	4	4-5	s (sq)t	dewlap small } head elongate
baharucoensis	1	4-6	2-4	si t	dewlap absent }
Xiphocercus					
darlingtoni	1	1	0	si(sq)t	(head scales large, regular, smooth, few in number)
Chamaelinorops					
wetmorei	3	6	6	ki	(2 lateral rows of enlarged keeled scales)

s = smooth k = keeled i = imbricate (i) = subimbricate
cy = cycloid sq = square t = in transverse rows

Table II. Comparisons of certain characters in Hispaniolan anolines. Data mostly from Cochran (1941).

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A SURVEY OF THE LEPTODACTYLID FROGS, GENUS *EUPSOPHUS*, IN CHILE

By José M. Cei*

INTRODUCTION

The interesting leptodactylid genus *Eupsophus* Fitzinger, 1848, consists of three allopatric Neotropical species groups widely disjunct in distribution. One, the *peruanus-wettsteini* group, is found in the plateau of central Peru. The second is composed of several species from southeastern Brazil (*Thoropa* of some authors). A third stock, the subject of the present report, now occurs only in Chile, although fossil evidence (Schaeffer, 1949) suggests that during late and middle Tertiary species of the group ranged much farther to the east. The Chilean forms have been variously referred to the genera *Borborocoetes, Cacotus* or *Cystignathus* previous to their current allocation to *Eupsophus* (Parker, 1932).

The following nominal forms of *Eupsophus* have been recognized from Chile: *bibroni* (Bell); *calcaratus* (Günther); *coppingeri* (Günther); *grayi* (Bell); *hidalgi* (Espada); *kriegi* (Müller); *maculatus* (Günther); *masarcyi* (Roux); *nodosus* (Duméril and Bibron); *roseus* (Duméril and Bibron); *taeniatus* (Girard); *verrucosus* (Philippi). In addition, a number of names were proposed by Philippi (1902) but his descriptions are inadequate for identification and, since his types are no longer in existence, I follow Vellard (1947) and Schmidt (1954) in disregarding these names. The majority of the species in the genus are known only from their original descriptions, life history information is scanty or wanting, all are of doubtful status, and their affinities are

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unknown (Vellard, 1947; Schmidt, 1954). A detailed revision of *Eupsophus* is thus badly needed.

MATERIAL AND ACKNOWLEDGMENTS

During my extensive stay in Chile during 1956-1957 I concentrated on a preliminary review of the systematics of the Chilean amphibian fauna and particularly emphasized field observation and life history data in my work. On the basis of experience with living *Eupsophus*, together with a study of preserved materials from world collections, it is now possible to critically survey the Chilean portion of the genus. Accordingly, the Chilean forms may be placed into three species groups and only five forms may be accepted as valid. These conclusions are based upon a comparison of all type specimens with material collected at the type localities and throughout the range of the genus in Chile. Measurements are based upon a total of 115 sexually mature examples: 3 *E. coppingeri* (west Patagonian coast); 53 *E. grayi* (Valdivia, Chiloe, Concepcion); 11 *E. nodosus* (Valdivia, Chiloe, Zapallar): 10 *E. roseus* (Valdivia, Chiloe); 38 *E. taeniatus* (Valdivia, Chiloe, Malleco, Puerto Blest, east slope of the Cordilleras). Additional material, especially of *taeniatus, nodosus*, and *grayi*, was examined but not measured. All measurements were taken with calipers with an accuracy of 0.5 mm. Characteristics of the pectoral girdle, prevomerine teeth and external morphology were also examined.

Eupsophus is poorly represented in herpetological collections but through the courtesy of Mr. C. M. Bogert, Dr. R. F. Inger, and Dr. E. E. Williams, I have been able to examine and study the samples of this genus in the American Museum of Natural History, the Chicago Natural History Museum, and the Museum of Comparative Zoology at Harvard University, respectively. Specimens in the Instituto de Biologia, Universidad Nacional de Cuyo, Mendoza, Argentina, and Instituto Miguel. Lillo, Universidad Nacional de Tucuman, Argentina, as well as in Centro Investigaciones Zoologicas Universidad de Chile were also studied. Comparative descriptions and photographs of all existing primary types were provided through the efforts of Miss A. C. C. Grandison (British Museum, London), Dr. J. Guibé (Museum National d'Histoire Naturelle, Paris), and Dr. E. Forcart (Naturhistorische Museum, Basel). I wish to acknowledge this valuable assistance.

Other important information relative to the current problem was obtained from the following museums and institutions: Academy of Natural Sciences, Philadelphia; Carnegie Museum, Pittsburgh; Museo Bullock, Angol, Chile; Museo de Concepcion, Chile; Museo Nacional B. Rivadavia, Buenos Aires, Museo Nacional Historia Natural, Santiago de Chile; Museu Nacional, Rio de Janeiro; Museum d'Histoire Naturelle, Geneve; Museum of Zoology, University of Michigan; Naturhistoriska Museum, Stockholm; Peabody Museum, Yale University; Senckenberg Museum, Frankfort a.M.; United States National Museum; Zoölogische Museum, Berlin; Zoölogische Museum, Hamburg; Zoologische Sammlung des Bayerischen Staates, Munich. Finally, Dr. Jay Savage, Department of Biology, University of Southern California has read over the completed manuscript and offered numerous helpful suggestions.

SYSTEMATIC NOTES

Species groups. Morphological and biological data support the concept of three phyletic lines in Chilean *Eupsophus:* (1) *coppingeri-nodosus*, (2) *grayi-roseus*, (3) *taeniatus*.

Figure 1 illustrates the anatomical features of the pectoral girdle and prevomerine teeth in the five valid species. Similarities in the structure of omosternum, xiphisternum, and in the prevomerine teeth are evident between *E. coppingeri* (Günther, 1881) and *E. nodosus* (Duméril and Bibron, 1841). *E. taeniatus* (Girard, 1854) differs markedly from these forms in the unnotched xiphisternum. *E. grayi* (Bell, 1843) and *E. roseus* (Duméril and Bibron, 1841) belong to a quite different stock on the basis of their greatly developed omosternum, the peculiar rounded form of the carinate and calcified xiphisternum (most accentuated in *grayi*), and more posterior placement of the vomerine teeth. Affinities between *coppingeri* and *nodosus* are also indicated by other morphologic features (see key).

Synonymous species. Eupsophus kriegi, E. maculatus and *E. verrucosus* are synonyms of *E. nodosus. E. bibroni, E. calcaratus* and *E. masareyi* are synonyms of *E. grayi*. The type of *E. hidalgi* (Jiménez de la Espada, 1875) is probably lost and the position of this very poorly described species (only the type is known) appears uncertain. It may be synonymous with *E. taeniatus* on the basis of morphological characters, but no final decision is possible.

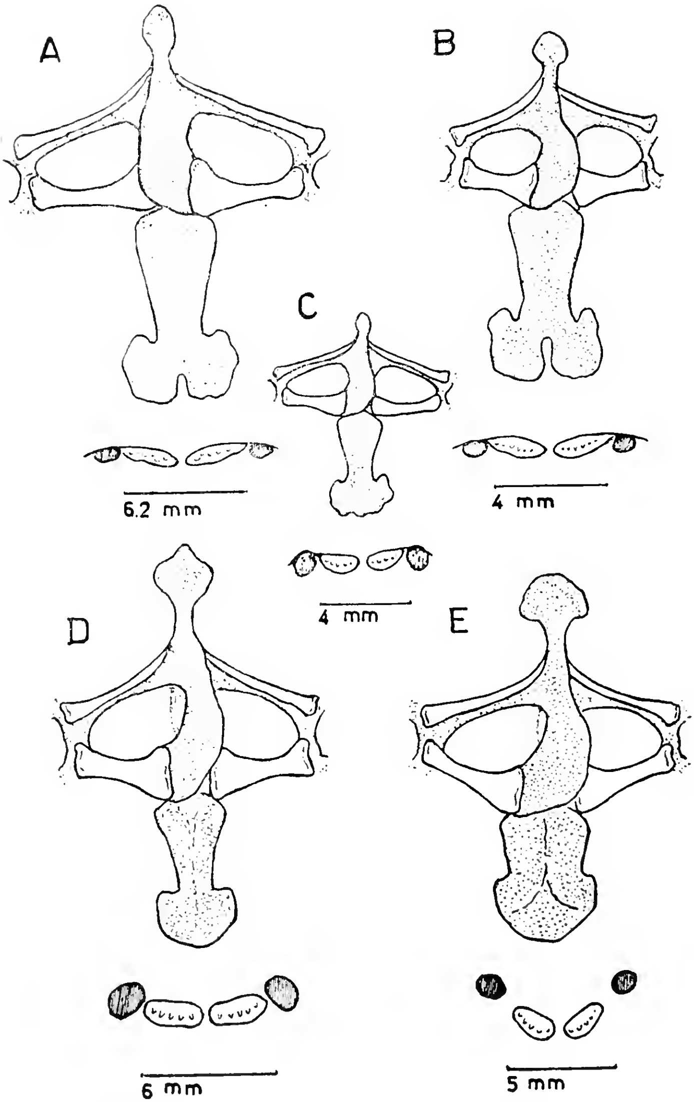

Fig. 1. Pectoral girdles and prevomerine teeth in Chilean *Eupsophus*. A, *E. coppingeri*, Puerto Eden, Patagonia; B, *E. nodosus*, Valdivia; C, *E. taeniatus*, Angol; D, *E. roseus*, Valdivia; E, *E. grayi*, Concepción.

Identity of the pectoral girdle and prevomerine teeth and an analysis of many characters, both in the holotypes of *E. maculatus* (British Museum 60-9-23-4-1947-2-19-99) and *E. nodosus* (Paris Museum, 763) and in my samples, fully support the proposed synonymy of *E. maculatus* (Günther, 1868) with *E. nodosus*. Some local differences due to geographic variation may have influenced Günther in describing *maculatus*. *Eupsophus kriegi* (Müller, 1926) was described from male specimens, and *maculatus* and *nodosus* were at that time known only from females, as pointed out by Philippi (1902). A remarkable sex-dimorphism in *nodosus* apparently has resulted in the continued recognition of *kriegi*. Only the two type specimens of Müller's species were known (Valdivia, Munich 141/1925; Quebrada de Penalolen, Santiago de Chile, Munich 35/1931); both were destroyed during World War II. The excellent description by Müller and my observations on living specimens from the central zone of Chile, are sufficient to identify *E. kriegi* as the adult male of *E. nodosus*, characterized by tremendous development of secondary sex characters (Fig. 2).

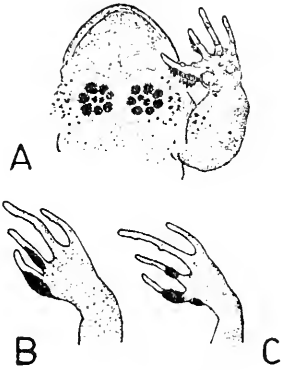

Fig. 2. Secondary sexual features of male *Eupsophus*. A, *E. nodosus*; B, *E. grayi*; C, *E. taeniatus*.

A direct examination of the neotype (Instituto Miguel Lillo 00162) of Vellard, and a preliminary analysis of geographic variation in *nodosus* make it possible to recognize the redescribed

E. verrucosus (Philippi, 1902) as a juvenile specimen of *nodosus* from the Valdivian forest population.

Synonymy of *Eupsophus bibroni* (Bell, 1843) with *E. grayi* is easily verified by study of the original descriptions of Bell and a re-examination of the holotypes (British Museum 45-5-25-43-1947-2-19-26, and 45-5-25-25-1947-2-17-83, respectively). In my opinion *E. calcaratus* (Günther, 1881) is based upon a juvenile *grayi* from the Chiloe Islands. All external characters correspond in both forms, and the peculiar characters of *calcaratus* (V-shaped glandular dorsal line, tibio-tarsal inner tubercle) occur frequently as individual variants, in insular (Chiloe) and continental populations (Malleco) of *E. grayi*. Besides the holotype, a specimen collected by Cunningham (British Museum 68-9-22-8-1947-2-20-1), only two young individuals from Ancud (Chiloe) are listed in the British Museum as *calcaratus* (personal communication by A. C. C. Grandison). The holotype of *E. masarcyi* (Roux, 1910) (Basel 2786) matches extreme individual variants in my Valdivian sample of *grayi*. Specimens such as Museum of Comparative Zoology 13742, from Valdivia, agree quite well with the description by Roux (1910) and also with the type re-examined through the courtesy of Dr. Forcart.

Geographic variation. Geographic variation is an important feature needing further study in populations of these Chilean batrachians. Statistically significant differences are indicated in cephalic shape between the samples from the continent and Chiloe Island (males and females), both in *E. grayi* and *E. taeniatus*. The head of insular specimens is noticeably more elongated. A statistical analysis of Chilean *Eupsophus* will be presented later in a more detailed paper.

Color. Color patterns exhibit some interesting trends in all Chilean *Eupsophus* (Fig. 3). *Eupsophus nodosus* (Fig. 3A) presents characteristic enlarged dorsal spots, dark bands on the legs, and a triangular brownish or greenish spot. *Eupsophus coppingeri* (Fig. 3B) shows a reduced dorsal pigmentation; the enlarged spots and bands are not indicated, but the interocular greenish spot is present and brilliant in life. The manner of the evolution of typical color pattern of *nodosus* is suggested in *E. grayi* (Fig. 3 D and E). In some specimens a whitish dorsal line is evident (Fig. 3E). A line also appears in 40 per cent of the observed

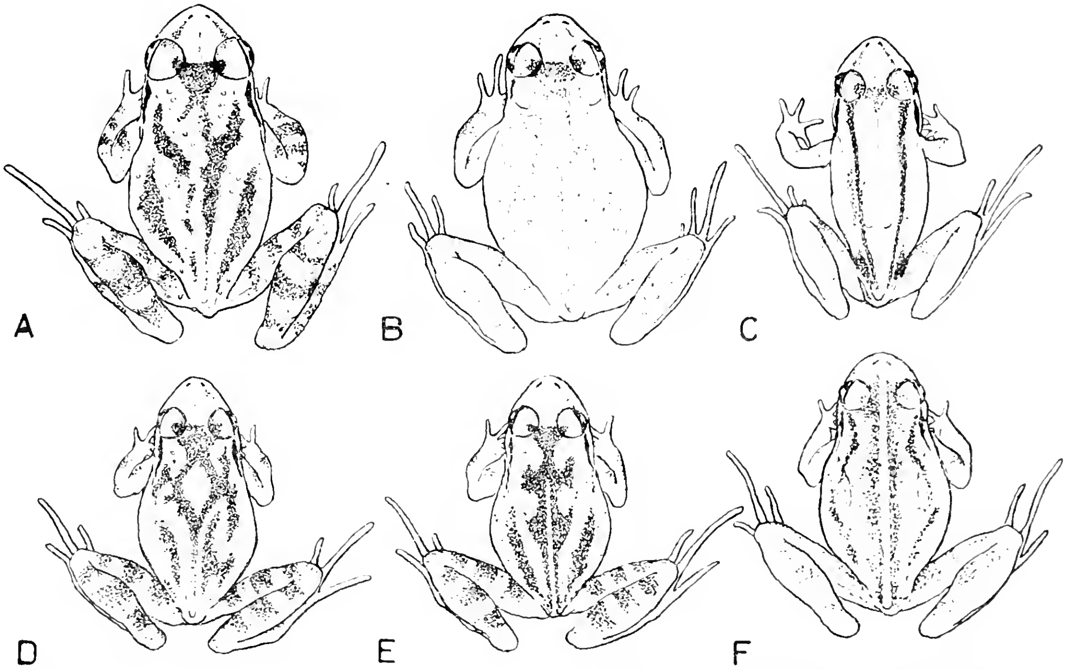

Fig. 3. Color patterns in Chilean *Eupsophus*. A, *E. nodosus*; B, *E. coppingeri*; C, *E. taeniatus*; D, *E. grayi*; E, *E. grayi*; F, *E. roseus*.

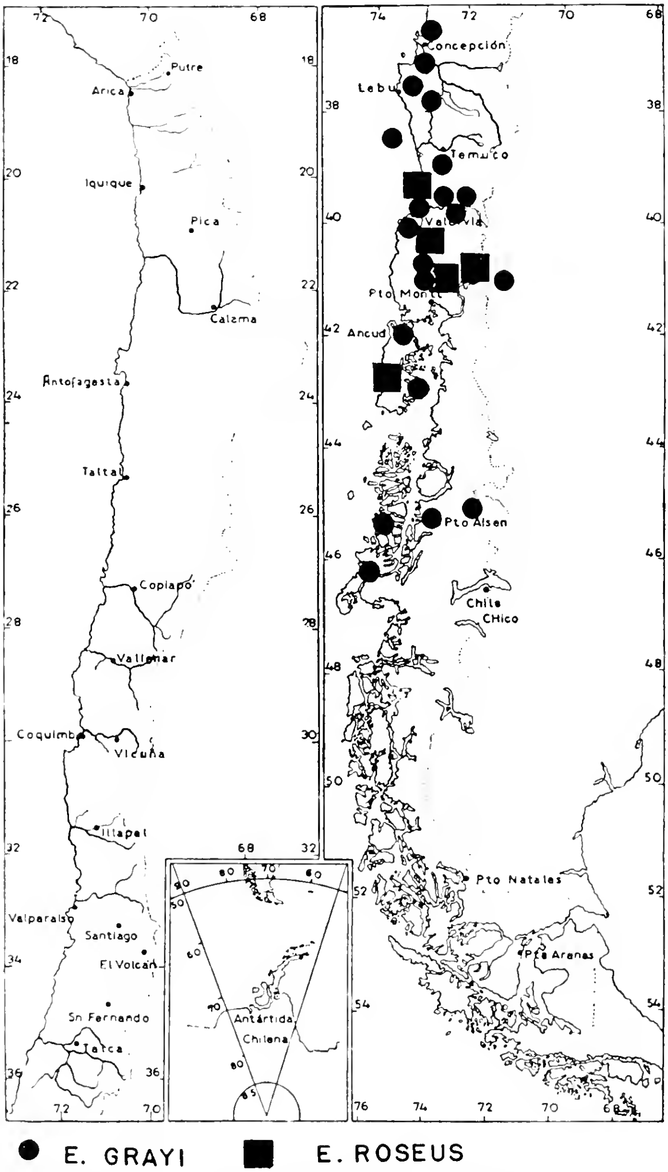

Fig. 4. Distribution of Chilean *Eupsophus. Grayi* group.

specimens of *E. roseus* (Fig. 3F), a species which agrees in coloration with some examples of *grayi* but with the spotting reduced or indistinct. The dorsal surface is generally ochraceous, greenish or gray in *Eupsophus*, but in some specimens (the *masareyi* form of *grayi*) a brilliant reddish color has been reported. Individual variation probably is involved. *Eupsophus taeniatus* (Fig. 3C) is the most distinctive Chilean form in color pattern. The interocular spot and brownish dark bands on the legs are occasionally indicated and two peculiar lateral dorsal brownish stripes are also present. Inguinal dark spots are typical of *taeniatus* and sometimes occur in *grayi* on Chiloe Island.

Distribution. Apparently *Eupsophus nodosus* and *E. taeniatus* are primitive, well adapted and formerly widespread species. Similarities in shoulder girdle and prevomerine teeth indicate the relationship between the two forms. *Eupsophus coppingeri* appears to be a specialized form derived from *nodosus* and is sympatric with the southern populations of *Eupsophus nodosus* over a wide area. The distribution of *Eupsophus nodosus* and *E. taeniatus* is significant. Present relict populations of both species are found in the Valparaiso coastal forest and in the valleys of Santiago and probably reveal a late Tertiary invasion, under other climatic and ecological conditions (Capurro, 1952). *Eupsophus nodosus* and *E. taeniatus* also are found, with *E. grayi*, on the eastern slopes of the Cordilleras (Bariloche, Argentina), and Schaeffer (1949) suggests a late Tertiary occurrence of *Eupsophus* in Patagonia.

Eupsophus grayi and *E. roseus* are sympatric in the Valdivian rain forest, but the interspecific and physiological limits of both forms are not yet known. Similarities in the pectoral girdle, prevomerine teeth and color patterns of *grayi* and *roseus* have been pointed out above (Figs. 1 and 3). Evolution of their color patterns from a primitive *nodosus*-like pattern is probable (see Fig. 3). Other significant biological features of Chilean *Eupsophus* are the male secondary sex characters. In the *grayi* and *taeniatus* groups the dark queratinous pads (first and second fingers) are similar, but quite different from the spiny complicated pads of *nodosus*, in which circular spiny areas are also present.

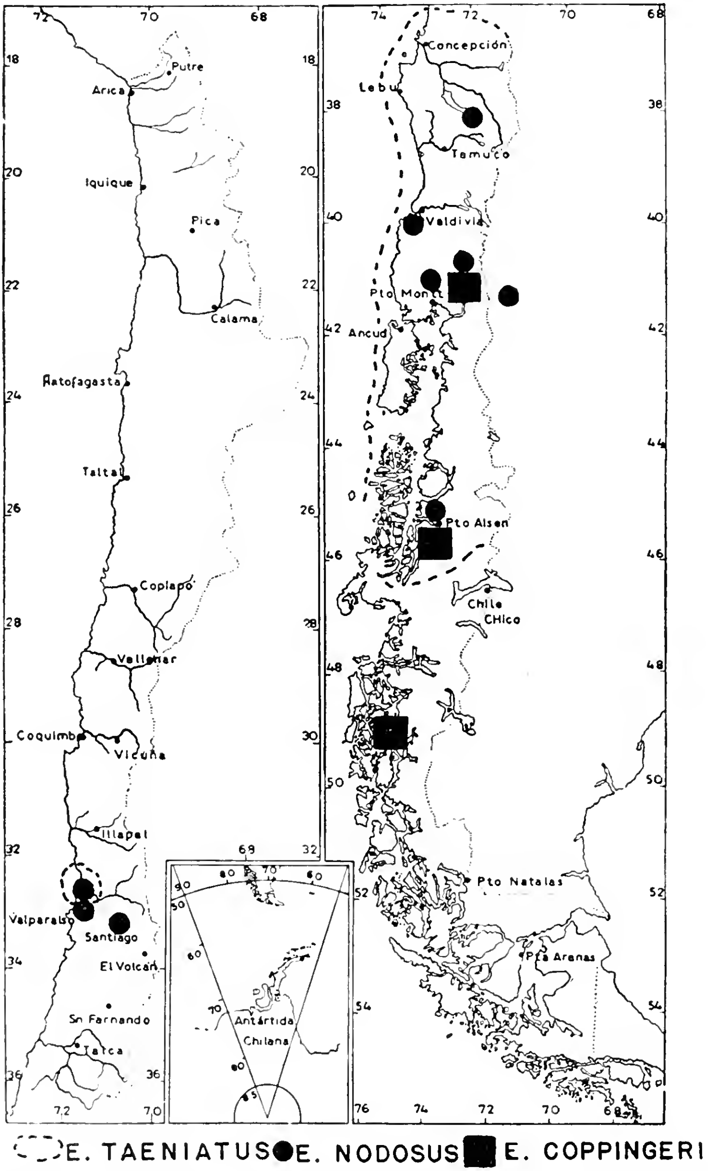

Fig. 5. Distribution of Chilean *Eupsophus*. *Nodosus* and *taeniatus* groups.

Life history. The life history and development of Chilean *Eupsophus* are poorly known, but *Eupsophus taeniatus* shows similarity (see Cei and Capurro, 1958) to the Brazilian species of *Thoropa* which was called *Borborocoetes* by Boulenger (1891) and Noble (1931) but is referred to *Eupsophus* in the recent paper by Cochran (1955). Eggs of *Eupsophus taeniatus* are pigmented but they are without pigment in the *grayi* and *nodosus* groups.

SUMMARY

Chilean species of *Eupsophus* are reviewed. Only three fundamental groups are recognized: *grayi-roseus, nodosus-coppingeri, taeniatus.* Synonymy of *E. kriegi, E. maculatus* and *E. verrucosus* with *E. nodosus*, and of *E. bibroni, E. calcaratus* and *E. masareyi* with *E. grayi* is demonstrated.

Morphological affinities in pectoral girdle, prevomerine teeth and color patterns in Chilean species are analyzed. Secondary sex characters of *grayi, nodosus* and *taeniatus* are compared and illustrated. The present distributions of *nodosus* and *taeniatus* express their probable position as ancient and formerly widespread forms. Biological affinities between *E. taeniatus* and Brazilian *Thoropa* are mentioned.

Eupsophus coppingeri and *E. roseus* are specialized and rare forms, sympatric with *grayi* and *nodosus* in the southern Chilean rain forest belt.

A Key to the Chilean Species of Eupsophus

1a. Prevomerine teeth between anterior edges of choanae; cartilaginous omosternum very reduced, much shorter than epicoracoid cartilages; xiphisternum not calcified, notched or irregular at posterior margin, longer than epicoracoid cartilages 2

1b. Prevomerine teeth between or behind posterior edges of choanae; cartilaginous omosternum dilated, only slightly shorter than epicoracoid cartilages; xiphisternum partially calcified, rounded at posterior margin, shorter than epicoracoid cartilages 4

2a. Xiphisternum irregularly rounded posteriorly; tympanum evident; adults not exceeding 46 mm. in standard length; slender habitus; skin smooth; snout prolonged; gray or greenish, with two lateral dark stripes; belly yellowish . . . *taeniatus*

2b. Xiphisternum deeply notched posteriorly; tympanum not evident, covered by granular skin; adults more than 46 mm. in standard length; stout habitus 3

3a. Skin tubercular; snout obtuse; a glandular tympanic ridge; head not markedly depressed; gray or greenish with dark irregular dorsal spots; belly whitish . . . . . . *nodosus*

3b. Skin smooth; snout truncate; no glandular tympanic ridge; head markedly depressed; olive-brown, with obscure brownish markings; belly salmon-pink . . . . *coppingeri*

4a. Prevomerine teeth far behind choanae; snout prolonged; skin smooth, no glandular ridges; brownish or greenish with dark dorsal blotches; belly grayish-white; adults no more than 50 mm. in standard length . . . . *grayi*

4b. Prevomerine teeth between posterior margins of choanae; snout rounded; skin smooth but with a few glandular ridges; brownish with obscure dark markings; belly whitish; adults more than 50 mm. in standard length . . . . . . *roseus*

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ARCTIC ARCHIBENTHAL AND ABYSSAL MOLLUSKS FROM DRIFTING STATION ALPHA

By Arthur H. Clarke, Jr.
National Museum of Canada
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INTRODUCTION

During the summer of 1958 a floating Arctic ice station (Station Alpha) was manned by personnel from the Cambridge Air Force Research Center and the Lamont Geological Observatory. While the station drifted slowly northeasterly in the high Arctic region about 800 miles north of Point Barrow, Alaska and 300 miles from the North Pole, eight representative bottom samples were taken from deep archibenthal and abyssal depths.

All of these samples contained mollusks (see Tables 1 and 2), a total of seventeen species. Unfortunately, the samples were not placed in preservative and it is now impossible to ascertain which, if any, were taken alive. Notwithstanding this limitation, the collections are significant in that, (1) they come from a region that is very poorly known biologically; (2) they represent major extensions in the known geographic and bathymetric ranges of many of the species; (3) they contain three new species; and (4) they indicate the presence of large scale sediment transfer processes within the area studied.

There is only one other report on archibenthal and abyssal mollusks from this part of the Arctic Ocean. This is by O. A. Scarlato in a report by K. A. Brodskii and M. M. Nikitin of the hydrobiological work done at the Russian Scientific-Research Drifting Station of 1950-1951. Fourteen species of mollusks are listed from six stations scattered between points lying approximately 350 miles N.W. and 550 miles north of Point Barrow, Alaska. For completeness, the station data and the mollusks obtained are listed below (see Tables 3 and 4).

Table 1. U. S. Station Alpha Bottom Samples Which Yielded Mollusks [1]

Sample No.	Depth (fms.)	Latitude ° N	Longitude ° W	Bottom	Instrument used	Quantity of material taken
2	1370	83° 59′	151° 44′	brown ooze	10 gal. can	3 gal.
3	1364	84° 09′	150° 23′	mud, and pebbles	1 M. trawl	1 gal.
4	907	84° 16′	149° 11′	pebbles	1 M. trawl	10 cc.
5	971	84° 23′	148° 51′	lt. brown sediment	Ekman grab	1½ qts.
6	924-934	84° 28′	148° 28′	mud & rocks	1 M. trawl	1 gal.
7	1208	84° 34′	146° 24′	brown mud	1 M. trawl	1 qt.
8	1257	84° 30′	145° 00′	brown clayey mud	1 M. trawl	1 gal.
10	1000	85° 01′	138° 00′	rocks & silt	1 M. trawl	1 pt.,& rocks

Table 2. Mollusks in Bottom Samples Taken from U. S. Drifting Station Alpha [2]

Sample No.	4	6	5	10	7	8	3	2
Depth (fathoms)	907	924-934	971	1000	1208	1257	1364	1370
Colus hunkinsi, n. sp.	—	1	—	1	4	—	—	—
Siphonodentalium lobatum Sby.	—	7	—	—	—	—	—	—
Nucula zophos, n. sp.	1	73	—	11	—	—	—	—
Portlandia intermedia Sars	—	3	—	—	14	—	11	—
P. lenticula Moller	—	1	—	—	—	—	—	—
Malletia abyssopolaris, n. sp.	—	30	—	12	31	4	5	6
Bathyarca frielei Friele	2	50	4	34	34	6	8	—
Hyalopecten frigidus Jensen	—	25	—	3	36	2	—	—
Cyclopecten (Delectopecten) greenlandicus Sowerby	—	5	—	3	13	6	10	4
Astarte borealis Schumacher	—	1	—	—	—	—	—	—
A. montagui Dillwyn	—	2	—	—	—	—	1	—
Serripes groenlandicus Bruguière	—	—	—	—	3	—	—	—
Macoma sp.	—	1	—	—	—	—	—	—
Hiatella arctica Linné	—	1	—	1	—	—	3	—
Lyonsiella alaskana Dall	—	—	—	—	1	—	—	—
Poromya sp. (fragment)	—	—	—	1	—	—	—	—
Cuspidaria sp. (fragments)	—	1	—	—	1	—	—	—
TOTALS	3	201	4	66	137	18	38	10

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[1] One live brittle star and 4 live holothurians occurred in samples 7 and 10 respectively. No other living animals were specifically noted by the collector.

[2] Samples are arranged in order of increasing depth. Quantities refer to the number of specimens (gastropods and scaphopods) or valves (bivalves) obtained.

Table 3. Russian Bottom Samples Which Yielded Mollusks [3]

SAMPLE No.	DEPTH (fms.)	LATITUDE °N	LONGITUDE °W
R 1	400	76° 25′	167° 14′
R 2	1400	76° 44′	170° 15′
R 4	550	78° 22′	167° 10′
R 6	1000	78° 52′	165° 00′
R 7	650	78° 54′	162° 00′
R 11	1800	80° 45′	161° 00′

Table 4. Mollusks Reported From Russian Bottom Samples [4]

Sample No. Depth (fathoms)	R 1 400	R 4 550	R 7 650	R 6 1000	R 2 1400	R 11 1800
Lora violacea Mighels	—	—	2	—	—	—
Lora sp.	—	2	—	—	—	—
Sipho sp.	—	—	sev.	—	—	—
Cylichna alba (Brown)	—	—	2	—	—	—
Siphonodentalium lobatum Sby.	sev.	sev.	many	sev.	1	—
Nucula tumidula Malm	—	—	1	—	—	—
Nucula sp.	—	sev.	sev.	1	—	—
Portlandia sp.	—	1	1	—	—	sev.
Arca pectunculoides Scacchi	—	—	—	1	1[5]	—
Arca frielei Jeffries	—	—	sev.	—	—	—
Dacrydium vitreum (Möller)	—	—	—	sev.	—	—
Propeamussium frigidus (Jensen)	1	—	—	—	2	—
Cuspidaria glacialis (G. Sars)	frag.	—	2	—	—	—
Cuspidaria sp.	—	—	—	—	1	—

SYSTEMATICS

Family NEPTUNEIDAE

COLUS HUNKINSI, new species

Plate I, figure 9

Shell fusiform, approximately one inch long, white, rather thin, and with revolving carinae. Whorls 6½, convex, rather strongly shouldered, and with sutures deeply impressed. Sculpture consisting of about 18 well defined carinae on the body whorl (only the upper 5 or 6 of which are prominent), about 6 on the

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[3] Locations and depths are from a map showing the stations. The values are therefore only approximate.

[4] The abbreviations "sev." and "frag." are for "several" and "fragments," respectively.

[5] Taken alive. All other mollusks represented by empty shells only.

penultimate whorl, and 3 on the upper whorls. Fine, incremental lines are also present below the protoconch. Spire produced at an angle of about 42°. Parietal lip with a thin callus. Palatal lip thin or slightly thickened and convex. Columella broadly sigmoid. Aperture ovate, medium sized. Siphonal canal short and open. Umbilicus absent. Periostracum very thin, light brown. Nuclear whorls about 3½, with no distinct demarcation between the nuclear whorls and the postnuclear whorls. First whorl small (0.8 mm. in diameter), planospiral, and unsculptured; second and later whorls turreted and rapidly increasing in size. On the second whorl the upper carina and numerous fine longitudinal riblets appear. On the third whorl the second and third carinae appear and the longitudinal riblets become stronger and evenly spaced, equaling the carinae in height and thickness. On the fourth whorl the carinae become stronger, the riblets gradually give way to fine, incremental lines, and the whorl assumes adult sculpture. Operculum not seen.

	Height	Width	Length of Aperture	Number of Whorls
Holotype (sample 6)	24.4 mm.	12.0 mm.	12.0 mm.	6½
Paratype (sample 10)	20.0[6]	12.2	11.2	—
Paratype (sample 7)	10.0	6.0	5.8	4½
Paratype (sample 7)	7.3	5.0	4.6	4

Types. The holotype, a dead specimen from Station Alpha sample 6 (924-934 fathoms, 84° 28′ N, 148° 28′ W), is No. 222066 in the Museum of Comparative Zoology. Paratypes from samples 7 and 10 are at the National Museum of Canada, the Museum of Comparative Zoology, and Lamont Geological Observatory.

Remarks. *C. hunkinsi* has the aspect of a typical archibenthal or abyssal neptuneid. It is similar to *C. parvus* (Verrill and Smith 1882) from off Martha's Vineyard in 312 to 506 fathoms, but that species is smaller (14 mm. in length, 7 whorls), much less strongly shouldered, and longitudinal riblets are not present on the nuclear whorls or at least they are not mentioned in the description. Another similar species is *C. krampi* (Thorson 1951) from 1028 fathoms between Disko Island, Greenland, and Baf-

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[6] Top of spire broken, only 2½ whorls remaining.

finland, but that is significantly larger (36 to 39 mm., 5 to 6 whorls), the constriction between the aperture and siphonal canal is much less prominent, and the whorls are much less strongly shouldered.

The species is named for Mr. Kenneth Hunkins of the Lamont Geological Observatory who collected the Station Alpha material treated in this report.

Specimens examined. This species is known only from six dead specimens collected from Station Alpha in samples 6, 7, and 10, taken in 924 to 1208 fathoms about 800 miles north of Point Barrow, Alaska. The "*Sipho* sp." reported from Russian sample R 7 (650 fathoms, 470 miles N.N.W. of Point Barrow) may be *C. hunkinsi*, but this is uncertain.

Family SIPHONODENTALIIDAE

Siphonodentalium lobatum Sowerby 1860

The seven dead specimens from Station Alpha sample 6 (924-934 fms.) are all typical, measuring up to 13 mm. in length. *S. lobatum* occurs throughout the Arctic Ocean from shallow water to 2000 meters (approximately 1100 fathoms) on soft silty and silty-sandy bottoms with a bottom temperature of −1.8 to +4° C (Brodskii and Nikitin 1955). It is also recorded from the North Atlantic in 60 to 1813 fathoms (La Rocque 1953).

Family NUCULIDAE

Nucula zophos, new species

Plate I, figures 15-18

Shell subtriangular, compressed, rather large for the genus (over ½ inch long), finely sculptured, with medium sized, well developed taxodont hinge teeth and a brownish or blackish periostracum. Outline triangular, with prominent, elevated beaks located near the posterior third of the shell and with a flattened base which is usually nearly straight centrally. Surface sculptured with numerous, rather fine, closely spaced concentric ridges and grooves, and fine, closely spaced radial lines which cause the surface to appear cancellate when viewed under the microscope. Exterior stained with brown and black, but portions of what appears to be a thin brown periostracum remain. Inner surface nacreous and exhibiting the radial lines which end at the strongly crenulated shell margin. Anterior and posterior muscle scars and simple pallial line present but not prominent. Hinge plate V-shaped, with an anterior and a posterior row of somewhat compressed, columnar, taxodont teeth. The two rows are separated by a prominent, narrow, anteriorly directed chrondrophore. Taxodont teeth somewhat heavier anteriorly, and numbering about 15 to 17 in the anterior row and 7 to 10 in the posterior. Umbones deeply excavated.

	Length	Height	Width (1 valve)
Holotype (sample 6)	10.0 mm.	7.6 mm.	2.5 mm.
Paratype (sample 6)	14.6	9.9	2.8
Paratype (sample 6)	14.5	10.0	3.0
Paratype (sample 10)	9.7	7.3	2.2

Types. The holotype, a left valve from Station Alpha sample 6 (924-934 fathoms, 84° 28′ N, 148° 28′ W), is number 222067 in the Museum of Comparative Zoology. Paratypes from samples 4, 6, and 10 are at the National Museum of Canada, the Museum of Comparative Zoology, and Lamont Geological Observatory.

Remarks. Because of its peculiar elongate shape, flattened base, sub-central umbones, and reticular sculpturing, *N. zophos* does not closely resemble any other species. In sculpturing it is somewhat similar to *N. nucleus* Linné, but *nucleus* is smaller, more rounded, with the beaks far forward, and much different in general appearance. *N. iphigenia* Dall 1908 from 259 fathoms in the Bay of Panama is probably morphologically closer to *zophos* than is any other *Nucula,* but that is much larger and more ponderous, the base is more rounded, and the radial sculpturing is different and much more conspicuous.

Specimens examined. The only known specimens are the 85 single valves dredged from Station Alpha, about 800 miles north of Point Barrow, Alaska, in 907 to 1000 fathoms. It is possible that the "*Nucula* sp." collected from the Russian Drifting Station at localities R4, R6, and R7 (550 to 1000 fms.) also represent this species, but those specimens have not been examined by the writer.

Family MALLETIIDAE

MALLETIA ABYSSOPOLARIS, new species

Plate I, figures 19-22

Shell subovate, inflated, of medium size (length about ½ inch) and thickness, weakly sculptured and with small, well developed taxodont hinge teeth and a brown (?) periostracum. Outline varying from nearly circular to ovate-rhomboid and with or without a postbasal swelling. Beaks rather prominent and inflated. Surface sculptured with narrow lines and rays. Ligament groove narrow and elongate, running from below the umbo to near the middle of the posterior row of teeth. Exterior stained brown or blackish, but portions of what appears to be a thin brown periostracum remain. Inner surface iridescent and showing the external sculpturing. Anterior muscle scar impressed, posterior scar and pallial line less prominent but usually clearly visible. Pallial sinus absent. Hinge plate concave anteriorly and convex posteriorly. Hinge teeth taxodont, V-shaped when viewed apically, continuous under the umbones, larger and higher anteriorly, smaller posteriorly, and numbering about 32 to 40 in adult specimens, of which 10 to 12 are anterior and 22 to 28 are posterior. Umbones excavated.

	Length	Height	Width (1 valve)
Holotype (sample 6)	12.6 mm.	11.0 mm.	3.6 mm.
Paratype (sample 6)	14.0	10.0	4.3
Paratype (sample 6)	12.9	9.6	3.7
Paratype (sample 7)	11.0	8.0	3.5

Types. The holotype, a left valve from Station Alpha bottom sample 6 (924-934 fathoms, 84° 28′ N, 148° 28′ W), is No. 222068 in the Museum of Comparative Zoology. Paratypes from samples 2, 3, 6, 7, 8, and 10 are at the National Museum of Canada, the Museum of Comparative Zoology and Lamont Geological Observatory.

Remarks. M. abyssopolaris resembles *M. abyssorum* Verrill and Bush 1898 taken off Chesapeake Bay in 2620 fathoms, but that species is only 5 mm. long, the teeth are not continuous under the beaks, and it is without radial lines. *M. dunkeri* Smith

1885 from off Japan in 1875 fathoms is also somewhat similar, but it too is only 5 mm. long, it is without radial lines, and the beaks are proportionately much smaller.

This species is apparently more closely related to *Malletia* than to other existing genera, notwithstanding the absence of the pallial sinus, which according to most authors is present in all species of *Malletia*. This is a case similar to that of *Tindaria erebus* Clarke, 1959, in which the pallial sinus is present, although it is supposedly absent in species of *Tindaria*. For reasons given there, this single character is not considered sufficient to disrupt an otherwise acceptable generic placement, and rather than place *M. abyssopolaris* in a new genus or subgenus, it is left in *Malletia*.

Specimens examined. Known only from 88 single valves collected from Station Alpha between 924 and 1370 fathoms about 800 miles north of Point Barrow, Alaska.

Family NUCULANIDAE

PORTLANDIA INTERMEDIA Sars 1865

Plate I, figures 6-8

Single valves of this species occurred in samples 3, 6, and 7 in depths ranging from 924 to 1364 fathoms. It is panarctic in distribution and has been recorded alive from depths ranging from 4 to 5 fathoms in the Siberian Ice Sea to 630 fathoms near the Shetland Islands. Dead shells have been recorded in the North Atlantic from depths as great as 1273 fathoms (Ockelmann, 1958). It usually occurs on clay or mud bottoms, sometimes with admixtures of sand and gravel.

PORTLANDIA LENTICULA Møller 1842

Plate I, figure 4

A single valve in sample 6 (924-934 fathoms) seems to belong to this species. It is another panarctic species and has been recorded from zero fathoms in eastern Greenland to about 765 fathoms north of the Shetland Islands. It is reported as usually occurring on clay or mud which may or may not contain additional sand or gravel, as in *Portlandia intermedia*.

Family ARCIDAE

BATHYARCA FRIELEI "Jeffreys" Friele

Plate I, figures 10-14

Arca frielei (Jeffreys m.s.) Friele 1877, Nyt Magazin for Naturvidenskaberne, **23**:2. Type locality: Norwegian Sea, Norwegian 1876 Expedition stations 40 (1180 fms.), 51 (1130 fms.), and 53 (1500 fms.); also Porcupine Expedition.

? *Arca imitata* Smith 1885, Challenger Reports, Lamellibranchiata, p. 321 + text figs. Type locality: Challenger station 244, Mid-North Pacific in 2900 fathoms.

The specimens collected from Station Alpha are variable in shape, and since the extremes are all connected by intergrades it is impossible to separate them objectively. It is probable that the Russian report of both *Arca pectunculoides* Scacchi and *Arca frielei* is the result of such an attempt. The type figures of *pectunculoides* in Scacchi 1835 (pl. 1, figs. 12 a, 12 b) are poor but certainly do not represent this species. We are left with the choice of using *frielei* "Jeffreys" Friele 1877 or *imitata* Smith 1885, both of which represent forms which are very similar to each other and to the present species, but not identical to it. Smith's figures of the two forms of *imitata* resemble the most frequent variations seen in the present species, but since *frielei* is more frequently used and is the earlier name, it is used here. The problem should be studied further.

Dead specimens of this species were found in seven of the eight samples collected from Station Alpha, in depths ranging from 907 to 1364 fathoms. The Russian report of a living specimen of *A. pectunculoides* at 1400 fathoms probably represents this species. It is recorded from the North Atlantic and adjacent Arctic Ocean in depths ranging from 10 to 12 fathoms (northeast Greenland) down to 1540 fathoms (off western Norway), and as living only in regions having a temperature of −1° to +1° C. It is also reported from the Barents and Kara seas on brown, soft silt at depths of approximately 80 to 110 fathoms and deeper (Brodskii and Nikitin). According to Ockelmann (1958), on the coast of eastern Greenland it is much more common below 130 fathoms than in shallower depths.

Family PECTINIDAE

HYALOPECTEN FRIGIDUS Jensen

Plate I, figures 1-3

Pecten fragilis Jeffreys 1876, Annals and Magazine of Natural History, (4) 18, 424. Type locality: Valorous Expedition stations 9, 12, and 16, between Ireland and Greenland, 1450 to 1785 fathoms and Norwegian Expedition of 1876, 1000 to 1500 fathoms, Greenland and Norwegian Seas. Includes three species: *P. undatus* Verrill 1884, *P. greenlandicus* Sowerby 1845, and *P. frigidus* Jensen 1912. Figured by Jeffreys (Proceedings of the Zoological Society of London for 1879, pl. 45, figs. 1, 1). Not *Pecten fragilis* Montagu 1808.

Pecten frigidus Jensen 1912, The Danish Ingolf Expedition, **2**, part 5 (Lamellibranchiata, part 1), p. 33, pl. 1, figs. 7 a-f. New name for *P. fragilis* Jeffreys, in part.

Jensen 1912 has clarified the previously confused taxonomic status of this species by pointing out the following facts: (1) Jeffreys' original description of *fragilis* was based on three species: *P. undatus* Verrill (= *P. biscayensis* Locard 1898), fragments of which were collected by the Valorous Expedition between Ireland and Greenland; *P. greenlandicus* Sowerby, from the same source, believed by Jeffreys to be the lower valve of *fragilis;* and a third species from the Norwegian Sea went to Jeffreys by Friele, and later named *frigidus* by Jensen. (2) Jeffreys' two figures of *fragilis* are of this third species but show a right valve in the right-hand figure and the mirror image of the right valve in the left-hand figure.

The right-hand figure (Jeffreys 1879, *loc. cit.*) is hereby selected as the type figure of *fragilis* Jeffreys 1876. It therefore becomes automatically also the type figure of *frigidus* Jensen 1912. Pending possible location of the specimen, with locality data, from which the figure was drawn, the type locality cannot be restricted within the region explored by the Norwegian North Atlantic Expedition of 1876 to 1878, viz., the Norwegian and Greenland seas.

Seventy-six specimens and fragments from Station Alpha samples 6, 7, 8, and 10 (924-1257 fathoms) appear to belong to this species. It has been reported alive from the Norwegian and Greenland seas in 579 to 1539 fathoms in localities where bottom temperature is between 0 and −1.1° C.

CYCLOPECTEN (DELECTOPECTEN) GREENLANDICUS Sowerby 1845

Forty-one single valves and fragments of this fragile species occurred in Alpha Station samples 2, 3, 6, 7, 8, and 10 (924 to 1370 fathoms). The species is recorded from the subarctic North Atlantic Ocean and from localities generally distributed over the entire Arctic coasts of North America, Europe, and Asia. It occurs alive from 2 fathoms in east Greenland (Ockelmann, 1958) to 1100 fathoms between Greenland and Jan Mayen (Hägg 1905), usually on clay containing stones, gravel, or shells.

Family ASTARTIDAE

ASTARTE BOREALIS Schumacher 1817

Only one small, damaged valve was collected from Station Alpha of what is assumed to be this species. This occurred in sample 6 (924-934 fathoms). It is a panarctic, circumpolar species, recorded also from the North Atlantic. Living specimens are known from 0 fathoms in east Finmark to 254 fathoms north of Spitzbergen. Dead shells have been recorded from 1482 fathoms in the North Atlantic.

ASTARTE MONTAGUI Dillwyn 1817

Plate I, figure 5

Jensen (1912) and Ockelmann (1958) have done much to clarify the status of this variable species. Three valves from Station Alpha samples 3 and 6 (924 to 1364 fathoms) appear to belong to it. *A. montagui* occurs in the North Atlantic and throughout the Arctic in depths ranging from the low tide line (western Baltic Sea) to 244 fathoms (western Greenland). Usually found on sand or clay, the species also occurs on rocky or muddy bottoms (Ockelmann, 1958).

Family CARDIIDAE

SERRIPES GROENLANDICUS Bruguière 1789

Three fragments from station 7 (1208 fathoms) belong to this species. *S. groenlandicus* is panarctic, extending south in the Pacific to Hokkaido, Japan, and Puget Sound, Washington, and south in the Atlantic to Cape Cod, Massachusetts, and northern Norway.

In depth it ranges alive from just below the low tide line (Iceland) to 166 fathoms (western Greenland), and single valves have been found as deep as 1340 fathoms in the North Atlantic. Although it is most abundant on sand or mud bottoms, it occurs on other substrates also.

Family TELLINIDAE

MACOMA sp.

This genus is represented by a fragment collected in Station Alpha sample 6 (924 to 934 fathoms). It is a panarctic and circumboreal group and occurs alive from low tide to depths of only a few fathoms.

Family SAXICAVIDAE

HIATELLA ARCTICA Linné 1767

Five valves from Station Alpha samples 3, 6, and 10 (924 to 1364 fathoms) show the double row of spines on the posterior slope which is characteristic of *H. arctica* (see Abbott 1954, fig. 92, after Lebour, 1938). The species has an apparently enormous geographic range, being recorded as panarctic and south to western Panama, the West Indies, the Mediterranean, and even from the Cape of Good Hope. Probably several sibling species are involved however. In the Arctic it occurs principally at the low tide line or in shallow water, although a doubtful record for live specimens in 1200 fathoms off Ireland has been reported (Ockelmann, 1958). Single valves are reported from the North Atlantic in about 1300 fathoms. A common habitat is among the holdfasts of kelp although the species is also known to bore into soft rock.

Family VERTICORDIIDAE

LYONSIELLA (LAEVICORDIA) ALASKANA Dall 1895

One valve from sample 7 (1208 fathoms) apparently belongs to this species. It was described from a living specimen found in 1569 fathoms in the Gulf of Alaska south of Sitka, Alaska, in green ooze and later recorded also from off Catalina Island, California, in 600 fathoms.

Family POROMYIDAE

Poromya sp.

A single unidentifiable fragment of *Poromya* occurred in sample 10 (1000 fathoms). *Poromya* is a cosmopolitan genus of archibenthal and abyssal bivalves.

Family CUSPIDARIIDAE

Cuspidaria sp.

An unidentifiable fragment of *Cuspidaria* occurred in samples 6 (924 to 934 fathoms) and 7 (1208 fathoms). Like *Poromya*, *Cuspidaria* is also a cosmopolitan archibenthal and abyssal genus.

CONCLUSIONS

Samples 3, 6, 7, and 10 (see Tables 2 and 5) contain shells which clearly were derived from shallow water. All of the samples contain species that might have come from shallow water and it is therefore probable that transport from shallow water has occurred at most, or possibly all, of the stations on which this study was based.

Table 5.

Species probably living where collected	Species probably transported from shallow water	Species which could be living where collected or could have been transported from shallow water
Colus hunkinsi	Portlandia intermedia	Siphonodentalium lobatum
Nucula zophos	Portlandia lenticula	Bathyarca frielei
Malletia abyssopolaris	Astarte borealis	Cyclopecten greenlandicus
Hyalopecten frigidus	Astarte montagui	Poromya sp.
Lyonsiella alaskana	Serripes groenlandicus	Cuspidaria sp.
	Macoma sp.	
	Hiatella arctica	

Supporting evidence for the transport theory lies in the following observations. (1) Many of the specimens, especially those which are considered to have been transported and those in the questionable category, are predominantly fragmentary and give evidence of having been subjected to much more friction and mechanical wear than is observed in specimens from stable environments. (2) Most of the species which are thought not to have been transported, because of agreement between observed depth and recorded depth range, including some which are very fragile (e.g. *Hyalopecten frigidus*), are noticeably less worn and fragmentary. (3) The character of the sediments in the samples from which the mollusks were removed shows them to be unsorted (see Table I) and composed of several kinds of rock.

Friele and Grieg (1901) and others report similar mixtures of shallow and deep water species from archibenthal and abyssal depths off northern Norway, south of Spitzbergen, and between Jan Mayen and Iceland. Large stones were also observed scattered over the bottom in the Greenland Sea and elsewhere. They also point out that ice masses are frequently seen to carry large quantities of mud and other sediment derived from shallow water areas, and postulate that it is the melting of such sediment-laden ice masses far from land that causes shallow water mollusks, stones, etc. to be deposited in these regions.

Similar mechanisms must have operated in the high Arctic and probably account for the presence of shallow water species in the archibenthal and abyssal samples dredged from Station Alpha. Most of the specimens were covered with a thin coating of magnesium oxide when collected, indicating that they had been exposed at the surface of the sediment for a protracted period. This observation, together with (1) data derived from gravity cores indicating a slow rate of sedimentation and (2) observations made at Station Alpha that the present Arctic Ocean ice cover contains little or no rock fragments or sand, has led Donn *et al.* (1959) to the conclusion that the rafting must have occurred during an interval of open water which predated the Recent Epoch.

In 1954 the author examined mollusk shells and other invertebrates taken along with stones and dirt from one of the floating ice islands (Arctic Ice Island T-3, see Crary, 1958 and Fletcher, 1953). Fifty-seven valves of *Astarte crenata* Gray and three of *Bathyarca frielei* Friele were present in the sediment as well as approximately 150 serpulid worm tubes and four colonies of an unidentified ectoproct bryozoan. The mollusks are common, panarctic, sub-tidal to archibenthal species. Clearly, some ice transport of sediment, shells, etc. from shallow water is still going on and the process has not been confined to pre-Recent epochs.

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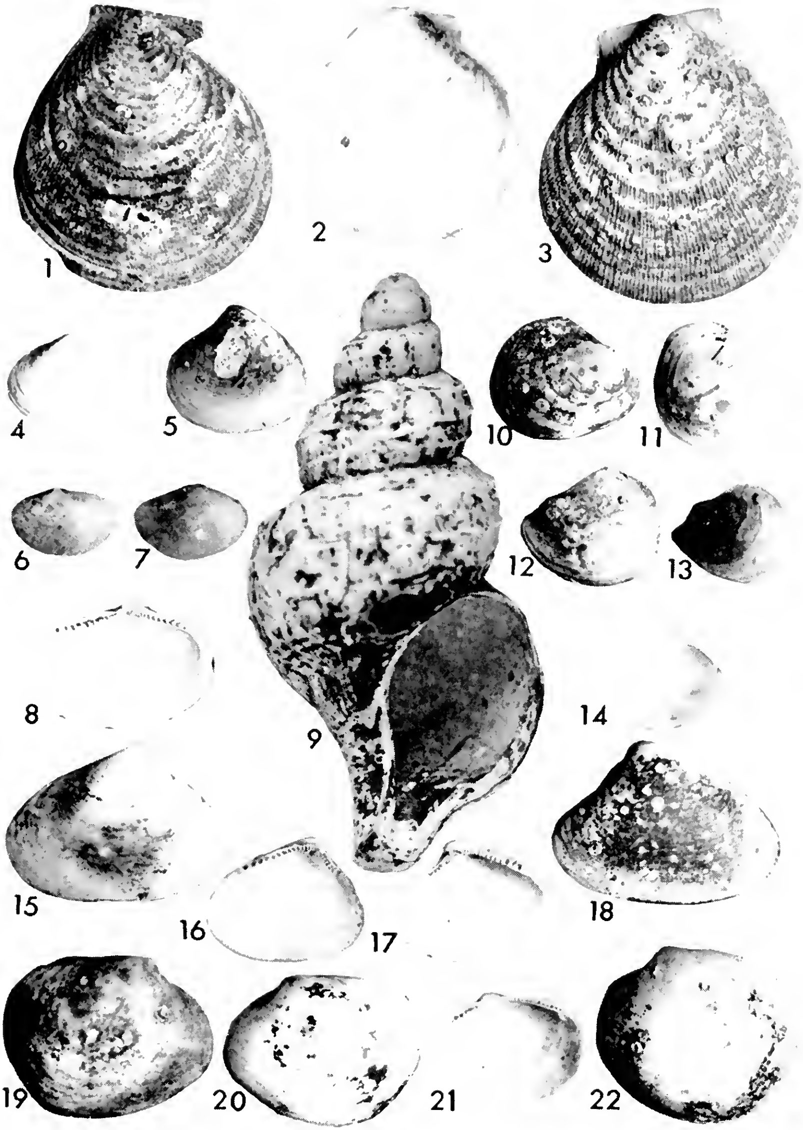
Plate

Arctic Archibenthal and Abyssal Mollusks collected from Station Alpha

1 - 3 *Hyalopecten frigidus* Jensen, sample 6;
4 *Portlandia lenticula* Møller, sample 6;
5 *Astarte montagui* Dillwyn, sample 6;
6 - 8 *Portlandia intermedia* Sars, sample 3;
9 *Colus hunkinsi* Clarke, holotype, sample 6;
10 - 14 *Bathyarca frielei* ''Jeffreys'' Friele, station 6;
15 - 18 *Nucula zophos* Clarke, holotype (16) and paratypes, all sample 6;
19 - 22 *Malletia abyssopolaris* Clarke, holotype (22) and paratypes from sample 6 (19, 20, 22) and sample 7 (21).

Figures 1 - 8 and 10 - 14 are 2.4 X, figure 9 is 3.2 X, and figures 15 - 22 are 2.1 X.



Plate

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. March 9, 1960 Number 120

TWO SPECIES OF TORTOISES IN NORTHERN SOUTH AMERICA

By Ernest E. Williams

In 1825 Thomas Bell beautifully figured and clearly distinguished two species of land tortoise from northern South America. His plates (later reproduced in Sowerby and Lear) give an excellent idea of most of the characters by which they are even now to be distinguished. Yet 130 odd years later the two forms are still customarily synonymized, though occasional (not fully documented) suggestions that they may be distinct have been made (e.g., Luederwalt, 1926).

I was first led into the study of this problem when, during my work on a fossil Cuban tortoise, I was struck by the variability of the position of the gular-humeral sulcus in relation to the entoplastron in American Museum specimens of "*Testudo denticulata.*" At that time (1950, p. 14) I published a mention of this remarkable (as I then thought) intraspecific variability. However, during my visits to European museums during tenure of a Guggenheim Fellowship in 1952-53, I became aware that two forms, each defined by several correlated characters, were being confused under the names "*denticulata*" or "*tabulata,*" used synonymously, but I was not then sure whether subspecies or species were involved. I have since examined all northern South American tortoises in the Museum of Comparative Zoology (MCZ), the American Museum of Natural History (AMNH), the Chicago Natural History Museum (CNHM), the Philadelphia Academy of Natural Sciences (PANS), and the United States National Museum (USNM), as well as those of the Departamento de Zoologia (DZ), São Paulo, Brasil. It has become evident that the two forms are in several places sympatric or nearly so and that they are best interpreted as two species — the same two species distinguished by Bell in 1825.

The species are not difficult to separate and are not in any genuine sense siblings, despite some tendency to overlapping variability. Variability tending to produce overlaps in individual characters is characteristic of all closely related species of turtles — that is, of all forms which have not at some time been separated generically. In this case as in others of this sort, recognition of species is never to be made on any single supposed key character but on the balance of characters in the character complex. If determination of species is made on total characters, no individual should be at all doubtful or difficult to place.

I present below in parallel columns the differences which seem to me useful in diagnosing the two species.

denticulata	*carbonaria*
Adult dorsal shell brown, nearly uniform or with vaguely bounded lighter areolae—juveniles nearly uniform yellow brown	Adult dorsal shell black, usually with small sharply bounded yellow areolae—juveniles like adults black and yellow
Prefrontal scales elongate	Prefrontal scales short
Frontal scale usually broken up	Frontal scale usually entire
Juveniles with a finely denticulate margin	Juveniles with a nearly smooth margin
Concentric grooving on carapace shields weak or absent	Concentric grooving on carapace shields usually strong
Posterior angle of gular scutes well forward of the entoplastron	Posterior angle of gular scutes encroaching on the entoplastron
Dorsal surface of each gular scute usually divided (=4 dorsal gulars)	Dorsal surface of each gular scute usually undivided (=2 dorsal gulars)
Humeral median suture usually longer than femoral median suture	Femoral median suture usually longer than humeral median suture
Inguinal narrowly in contact with femoral on ventral plane of plastron, i.e. inconspicuous in ventral view	Inguinal broadly in contact with femoral on ventral plane of plastron, i.e., conspicuous in ventral view

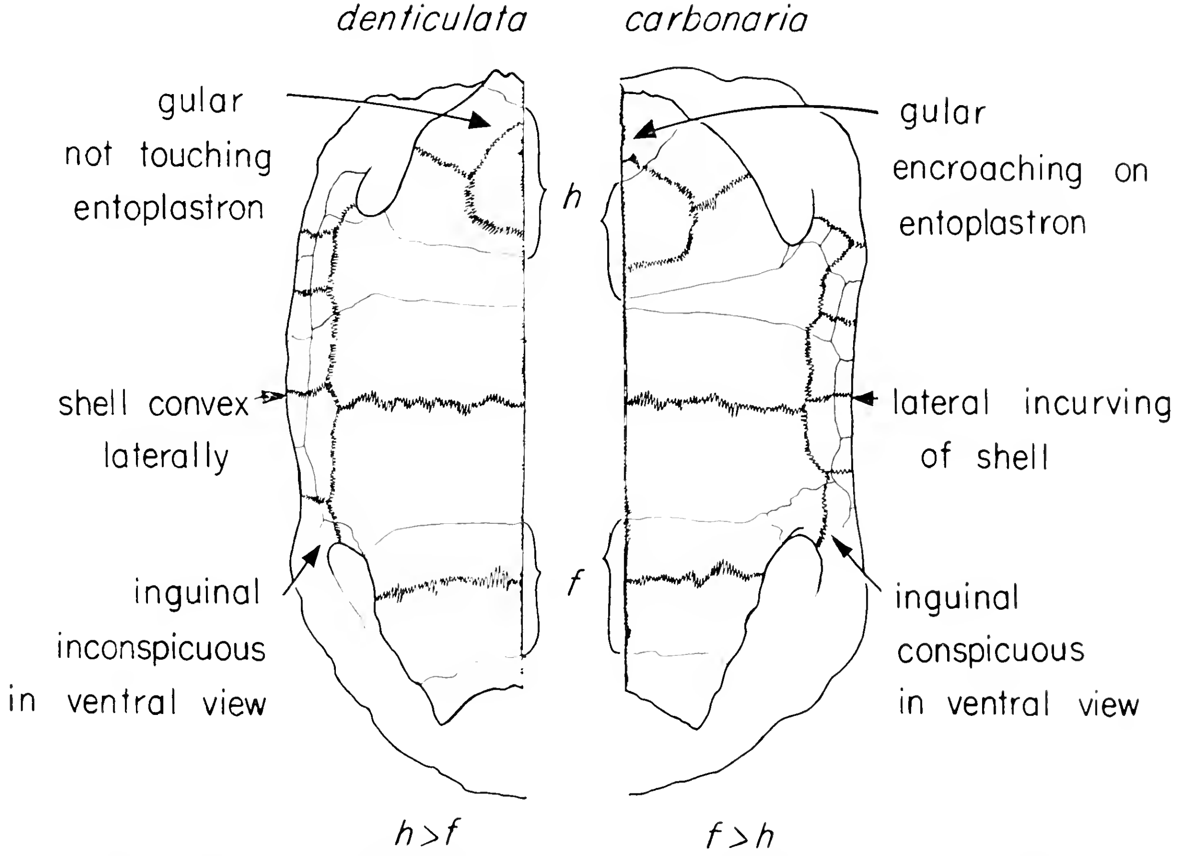


Fig. 1. Plastra of *G. denticulata* and *G. carbonaria* compared. *h*, humeral; *f*, femoral.

Each of these characters shows variation and therefore requires comment:

Color. The color of the carapace is very strikingly distinct in most specimens of the two species, and, so far as I know, is invariably diagnostic in juveniles. However, a few of the older *denticulata* may show a strongly contrasting pattern of orange and dark brown not unlike the black and yellow of *carbonaria;* the colors, however, are duller and the light areolae wider and less sharply bounded.

Prefrontal and frontal scales. These differences will hold in most specimens but not in all. Some tendency to a break-up of the frontal occurs in a few *carbonaria;* while the converse tendency to a nearly entire frontal is present in some *denticulata.*

Denticulate margin in juveniles. This is a very consistent character in spite of the fact that, examined under magnification, hatchlings of *carbonaria* show faint traces of the denticulations so characteristic of its sibling.

Concentric grooving of carapace shields. A character often but not invariably useful.

Gular scutes encroaching on entoplastron or not. So far as it has been possible to check, a consistent character.

Dorsal surfaces of gular scutes subdivided or not. Only statistically useful.

Humeral/femoral ratio. Usually a very good character, but a few *carbonaria* have the femoral and humeral subequal.

Inguinal-femoral relationship. An excellent diagnostic character if attention is paid to the precise relationship. In both *carbonaria* and *denticulata* the inguinal scute is rather triangular, not narrowed anteroposteriorly as in the two other species of neotropical tortoises, *chilensis* and *elephantopus.* In *denticulata,* however, the scute is smaller than in *carbonaria* and not at all conspicuous in direct ventral view. There may be in *denticulata* a relatively broad contact with the femoral but this is on the edge of the plastron at the inguinal, not as in *carbonaria* on the main ventral plane of the plastron. To see the inguinal-femoral contact clearly in *denticulata* it is necessary to turn the animal to the side to examine the plastral edge. In *carbonaria* the broad contact of inguinal and femoral is best seen in straight ventral view.

Two characters not tabulated may be significant:

1. *Size.* Specimens of *denticulata* from eastern Peru (Bassler collection, American Museum) are the largest South American tortoises I have seen. AMNH 58084 has a carapace length of 673 mm. and AMNH 58085 is but little smaller (637 mm.). No *carbonaria* approach this size, though both species of northern South America are larger than *chilensis*, the third species in southern South America.

2. *Carapace shape.* Both species tend to have parallel-sided shells. However, *carbonaria* appear on the average to have narrower shells, often in fact indented midlaterally to give a dumbbell shape in dorsal view. *Denticulata* may have more rounded contours. There is, however, much variability.

Many of the South American tortoises in collections have no or very poor data. It is therefore difficult to get a precise idea of the geographic relationships of the two species. I list below in parallel columns the most precise localities that I have been able to obtain for specimens examined by me.

denticulata	*carbonaria*
Colombia	**Colombia**
....	*Dept. Atlantico:* Cienega de Guajaro Puerto Bello
....	*Dept. Antioquia:* Golfo de Urabá
Dept. Caquetá: S. of Florencia Morelia	....
....	*Dept. Cundinamarca:* W. of Honda
....	*Dept. Magdalena:* Rio Frio Totumal
Dept. Meta: Villavicencio	....
Venezuela	**Venezuela**
....	*Barinas State:* Barinas

denticulata (cont.)

Monagas State:
- Juanipa River near Caripito

Territorio do Amazonas:
- foothills Mt. Dueda

Trinidad

British Guiana

- Demerara
- Essequibo River
- Kamakusa
- Kartabo
- Oho Mtn.

Surinam

- "Paramaribo"

French Guiana

- "Cayenne"

Peru

Dept. Junin:
- Atalaya

Dept. Loreto:
- Alto Rio Pisqui
- Iquitos
- Pucallpa
- Rio Ucayali
- Rio Napo
- Yarinacocha

Brasil

Amazonas State:
- Lago Aleixo (Thayer Exped.)
- Lago Januarí (Thayer Exped.)
- Manaus
- Rio Negro

carbonaria (cont.)

Carabobo State:
- Maracay

no state:
- Orinoco Region
- Rio Apure
- Los Testigos

British Guiana

- Essequibo River nr. Onara (70 miles from Georgetown)
- Kamakusa
- head of Rupononi River

Surinam

- Cottica

Brasil

Amazonas State:
- Manaus
- Villa Bella (Thayer Exped.)

denticulata (cont.)	*carbonaria* (cont.)
Rio Jurua Tefé	
Para State: Belem (= "Pará") Fordlandia	*Para State:* Belem (= "Pará") Fordlandia São Mateus
Maranhão State: Chatão, Rio Gurupi	*Maranhão State:* Barra do Corda, Rio Mearim
Goiás State: Anapolis	*Goiás State:* Barra do Rio São Domingo Cana Brava
....	*Mato Grosso State:* Maracuju Miranda Nioac
Espirito Santo State: Rio Doce	....
....	*Rio Branca Prov.:* between Frechal and Limao on Rio Surumú
.....	*Distrito Federal:* Recreio de Bandeirantes, S. of Rio de Janeiro
state unknown Fia (W. James—Thayer Exped.) Xeberos (Brit. Mus.—purch. Higgins)	
Bolivia	**Bolivia**
..	*Dept. Chaco:*
Dept. Pando: Baracca, Rio Madidi	...
Dept. Santa Cruz: Fortin Cañada Larga	*Dept. Santa Cruz:* San Jose de Chiquitos
....	**Paraguay** Asuncion Rio Paraguay Ybabopo

It is easily seen that the localities, more restricted than state or department, from which both species are currently recorded, are few. Even in these cases it is doubtful whether the two species have been taken together in any literal sense: it may well be that these place names are merely central points for large collecting areas.

However, the localities for the two forms are so interwoven and the forms themselves so distinct that any interpretation except that of species distinction appears difficult. In any event, the biological situation is an extremely interesting one, and it would be worthwhile to have precise information on their habitats and habits. No detailed information of this sort is at present available. Dr. P. E. Vanzolini comments on the Brasilian localities as follows:

"Some are in deep forest, some in the cerrado. I have collected the beast in the cerrado area (Barra do Corda), but it was in small wooded spots or gallery forests. Our eastern Goiás specimens are in the same case — in the Blaser collection are several typical forest forms. I flew over the area on purpose and found out that there are quite extensive wooded areas.

Localities in undoubtedly forested areas: All in Amazonas and Pará, Chatão, Rio Doce, Recreio dos Bandeirantes.

Localities where I know there is for sure at least gallery forest: Every single other!

Incidentally, in Maranhão (Barra do Corda) several of my specimens were caught in dens (terribly damp and muddy) but not by myself. The habit is known by all *there*."

It is interesting that in eastern Peru only *denticulata* is known. This was reported already by Sclater in 1871 (p. 744) from observations by E. Bartlett. The situation in Amazonian Colombia appears similar. By contrast, only *carbonaria* is known from northern Colombia, Paraguay and southern Brasil (Rio de Janeiro).

I have thus far used the names *denticulata* and *carbonaria* without justifying this procedure. A few comments on the nomenclature are required.

Testudo denticulata was described by Linnaeus in the 12th edition of the *Systema Natura* (1766) on the basis of a specimen in the Museum de Geer. The brief description would not suffice for identification if Schoepff had not published in 1792 a figure of a specimen which may well be the one cited by Linnaeus. According to Schoepff (p. 140), the Museum de Geer had had not one but two specimens, one of which, at the time of Schoepff's writing, was located in Stockholm and the other in Upsala. The latter specimen is that figured by Schoepff (in color, in some editions). Schoepff compares this specimen carefully with Linnaeus' description and considers it to be Linnaeus' type; Andersson (1900), re-examining the specimen, has agreed with Schoepff.

Schoepff's figure (plate 28), in spite of a certain crudity, is unquestionably the species here called *denticulata*. The denticulations that gave the species its name are clearly shown and the colored editions show the characteristic yellow brown of juveniles of this species. Thus there can be no doubt about the name of this form.

The next name proposed was *Testudo tabulata* Walbaum 1782. No figure exists, but the description of the color of the shell as "castaneo et sulphureo" in the Latin text (p. 122), or "castanien brauner und hellgelber Farbe" in the German text (p. 75), sufficiently identifies this as the brown form and thus a synonym of *denticulata* Linnaeus.

Testudo tessellata Schneider 1792 is the next name available. It is, however, a composite, based partly on an older description which has always been cited in the synonymy of *carbonaria* and partly on a description and figure which as clearly apply to *denticulata*. Schneider's detailed description is taken from the figure and it is best to assign his proposed name to this concept and thus to the synonymy of *denticulata*.

Four names were proposed by Spix (1824), all illustrated by adequate figures. Three — *hercules*, *sculpta*, and *cagado* — are clearly differing sizes and minor color varieties of the brown tortoise of northern South America. The fourth — *carbonaria* — is clearly the black and yellow species of this paper.

The adjoining plates of *sculpta* and *carbonaria* show, in addition to the difference in coloration (here at its most extreme because an essentially unicolor young *denticulata* is pictured), the characteristic differences in humeral-femoral ratio and in the relation of inguinal to femoral. *Carbonaria* Spix is unmistakably the name to be applied to the second species in northern South America.

T. boiei Wagler 1833 is a later name and cannot disturb the nomenclature here adopted. Wagler's plate clearly identifies his species as *carbonaria*. Once again the black and yellow of the dorsal shell is well shown and on the plastron the diagnostic humeral-femoral ratio and inguinal pattern.

Other Neotropical Species

The tortoises of South America and the Galapagos form a natural group for which the subgenus *Chelonoidis* of the genus *Geochelone*[1] may be employed. There are four living species: *Geochelone denticulata* Linnaeus, *G. carbonaria* Spix, *G. chilensis* Gray, *G. elephantopus* Harlan.

The following key will aid in the separation of these species:

1\. Dorsal color uniform brown or black, or brown with vaguely bounded orange areolae. Humeral median suture longer than femoral . . . 2

Dorsal color black and yellow, the areolae bright yellow sharply delineated. Femoral median suture longer than humeral.

G. carbonaria Spix.

Northern South America south to Paraguay and
Rio de Janeiro but not Amazonian Peru.

2\. Inguinal *narrow* anteroposteriorly with a conspicuous contact with the femoral. Shell rounded elliptical in adults, not denticulate in hatchlings 3

Inguinal smaller, more triangular, not conspicuously in contact with femoral in straight ventral view. Shell elongate elliptical in adults, denticulate in hatchlings. *G. denticulata* Linnaeus.

Northern South America except northern Colombia,
south to Bolivia but not Paraguay, and to Espiritu
Santo but not Rio de Janeiro.

3\. Size small (to 220 mm.). Gular region bifid, shell margin subserrate.

G. chilensis Gray.

Paraguay, S. Brasil and N. Argentina.

Size giant (to more than 1 m.). Gular region truncate, shell margin entire. *G. elephantopus* Harlan.

Galapagos Islands.

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[1] For the use of *Geochelone* rather than *Testudo* see Loveridge and Williams, 1957, pp. 211-219.

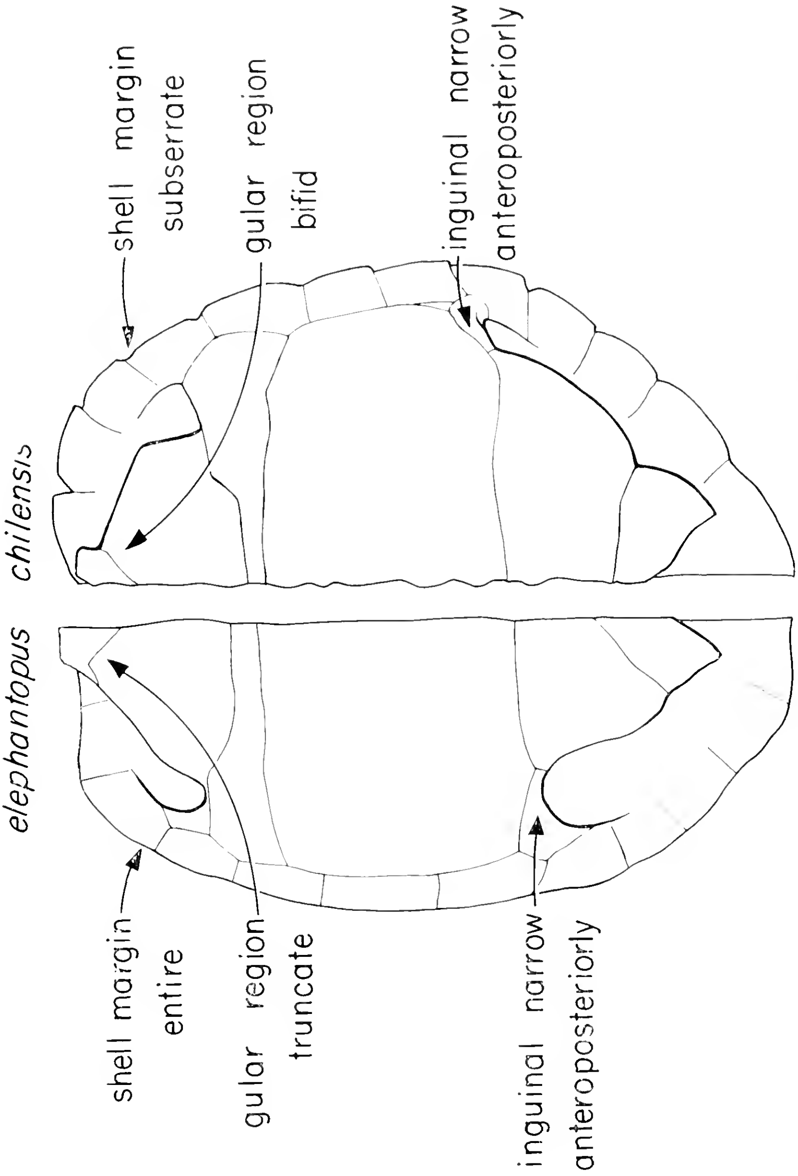

Fig. 2. Plastra of *G. elephantopus* and *G. chilensis* compared.

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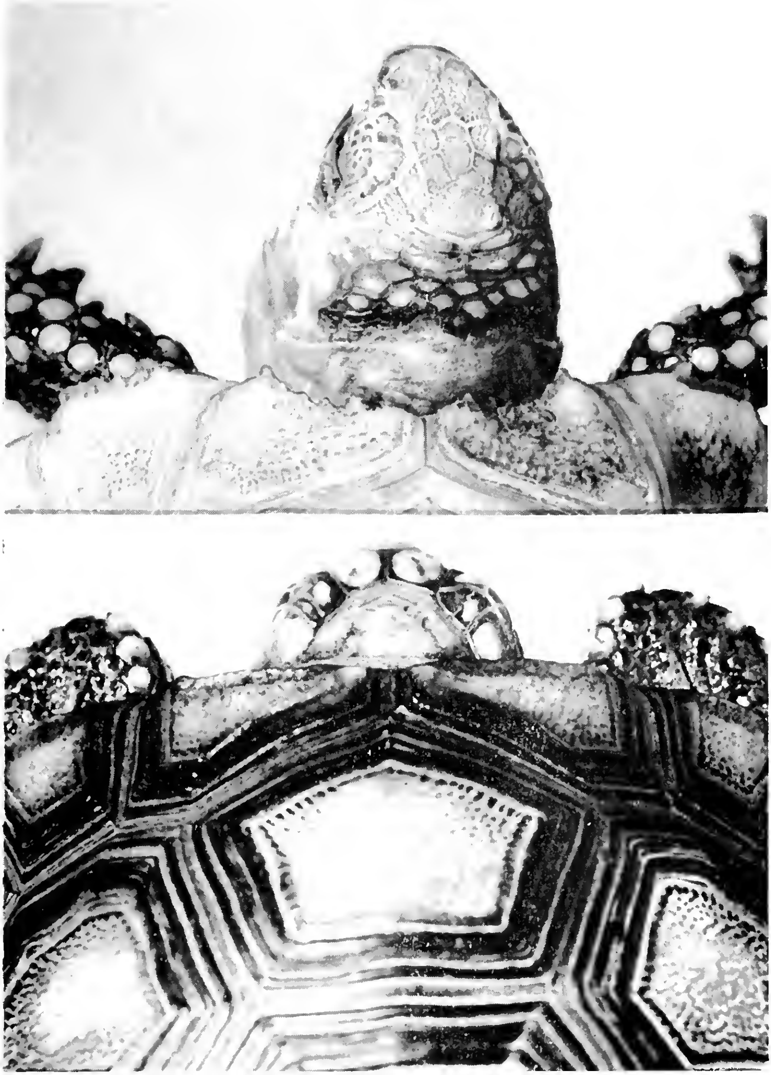

Plate 1. Top: Head and anterior carapace of *Geochelone denticulata* juv. Note denticulation of edges of first marginals, elongate prefrontal shields and frontal shield broken up into smaller scales. Bottom: Head and anterior carapace of *Geochelone carbonaria* juv. Note absence of denticulation of edges of first marginals, the short prefrontals and the large frontal. F. White phot.

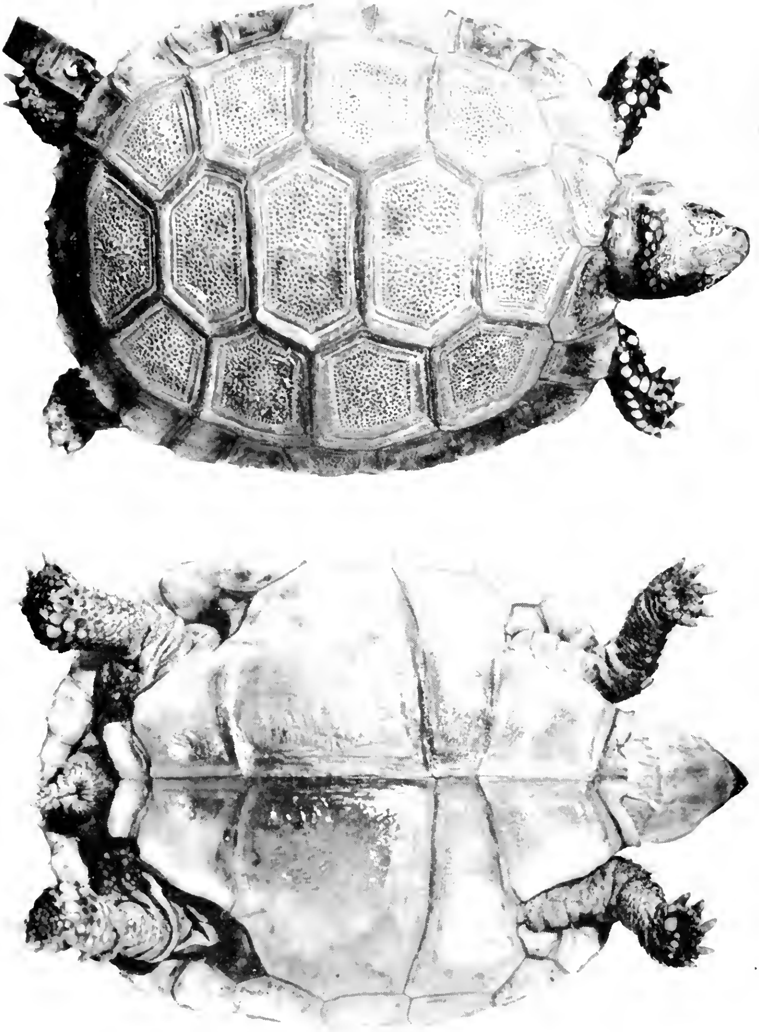

Plate 2. Dorsal and ventral views of *Geochelone denticulata* juv. F. White phot.

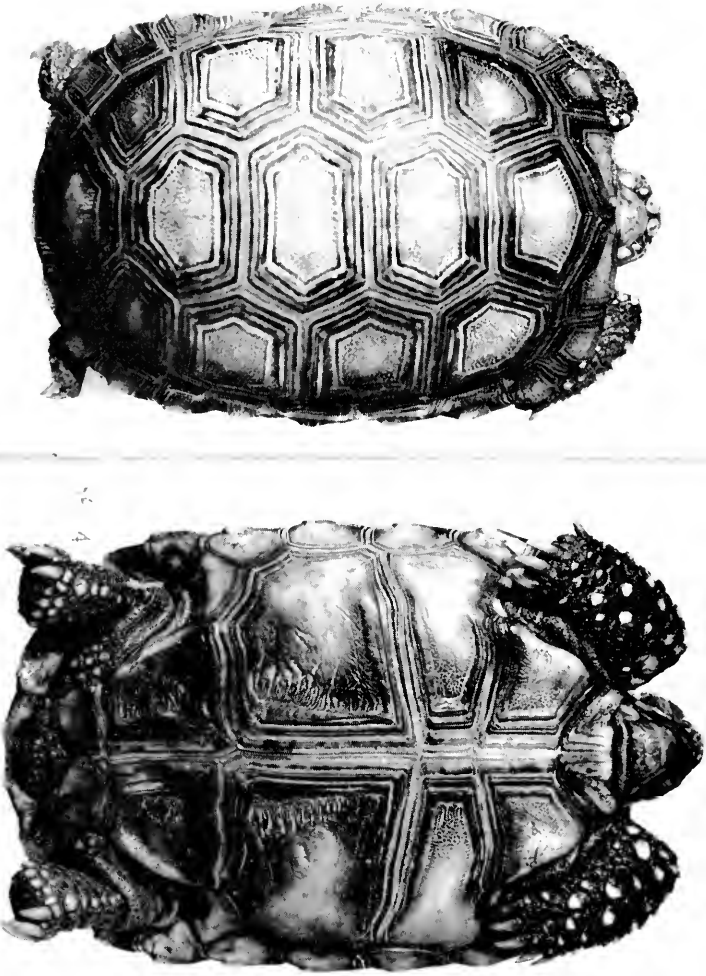

Plate 3. Dorsal and ventral views of *Geochelone carbonaria* juv. F. White phot.